Humboldt County Iowa

Countywide G.P.S. Survey Control Network

2006

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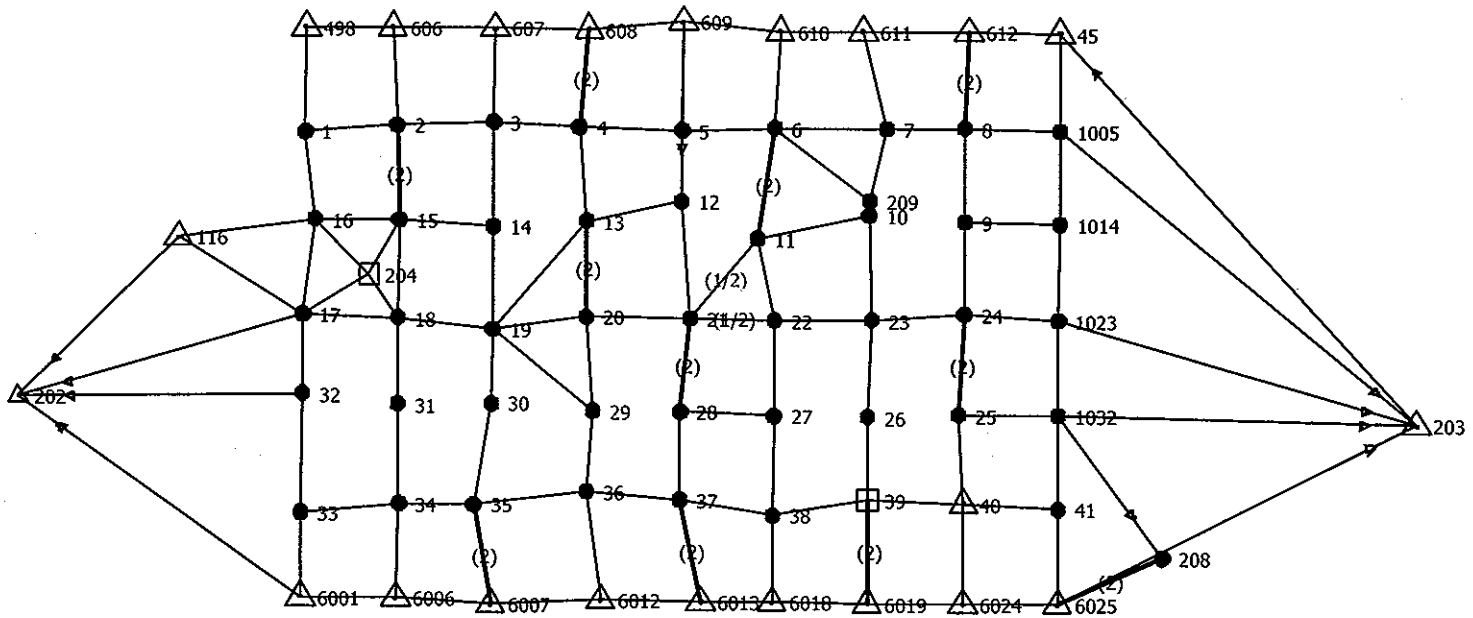
Field surveyor:
GGB & DC
Computer operator:
GGB
Reference:
Humboldt Co. GPS Project



Scale 1" to 30500 ft
0 50000 sft
US survey feet

0°00'00"

Plot Scale: 1" to 30500 ft
Printed on 1/7/2007, at 12:48:06 PM

Printed from Trimble Geomatics Office

Site: Not selected, System: US State Plane 1983
Zone: Iowa North 1401, Datum: NAD 1983 (Conus)

Project: Humboldt1
USFeet Template

INTRODUCTION

In 2006, The Sidwell Company contracted with the team of DC Inc. and GB Consulting to complete a high accuracy GPS control survey in Humboldt County, Iowa for the purpose of establishing a county-wide survey control system and for future use in a county-wide GIS system.

Thirty nine (39) new control stations were added within Humboldt County along with, one (1) existing Palo Alto County GPS control point, seven (7) existing Kossuth County GPS control points, four (4) Wright County, nine (9) Webster and one (1) Hancock County GPS control points were recovered and tied into the GPS network. An additional eight (8) control stations consisting of two (2) USGS third order benchmarks, two (2) USGS second order benchmarks, one (1) second order vertical benchmark with a HARN coordinate from the Kossuth and Palo Alto project survey and three (3) existing HARN positions two with first order vertical control. A total of sixty nine (69) points were measured and included in the network.

PROJECT REQUIREMENTS

The purpose of this survey was to establish new state plane control throughout the project area, using a new horizontal and vertical control network with GPS survey equipment and techniques. This network was horizontally referenced to the Iowa High Accuracy Reference Network (HARN) of 1996. Vertically the network was referenced to the North American Vertical Datum of 1988 (NAVD88). Because this control would be utilized for many different purposes, it was important that the network geometry be ideal for a strong GPS survey. All new point locations for control were selected with the needs of future multiple uses and GPS survey requirements in mind. In some instances, it was necessary to adjust locations because of physical obstructions or existing land features. In these instances, the network was constructed with the coverage of the county held as primary and the GPS survey needs satisfied secondly. Because both of these philosophies support good geometry the network structure was not compromised.

MONUMENTATION

To perpetuate the GPS control measurements, 39 new permanent monuments were set in Humboldt County for this survey by DC Inc. BERNTSEN driven aluminum rod monuments were selected for the permanent monuments. Each BERNTSEN station monument consists of one three-foot smooth rod section and one three-foot top security fluted rod section with a stamped cap fastened to the top, all constructed of aluminum material. There is a permanent magnet mounted on the underside of the monument cap for future recovery with a magnetic locator. These monuments were driven to approximately 6" below the existing ground surface. For easy access and protection, a 24" long 5" diameter PVC pipe was placed over each rod monument along with a pre-cast aluminum access cover and backfilled with sand to facilitate drainage and to minimize frost movement. A steel fence post with a plastic sleeve was placed as a witness point at each new permanent monument position.

DC Inc. handled the creation of the One Call data and the handling of the One Call coordination for marking the various underground utility locations for each new permanent monument site.

RECONNAISSANCE

The most important criterion for GPS observations at any given location is a clear view to the sky. In terms of network design, it is desirable that the horizontal control be located near the perimeter and also throughout the project site if possible. With this in mind, existing HARN horizontal stations were recovered in and/or near Humboldt County along with other control that has been adjusted to the HARN. All positions in and near the county were chosen to be included in the network.

Vertical control was selected to provide as much coverage as possible, both at the periphery and in the interior of the project area.

FIELD SURVEY

Five Trimble dual frequency Geodetic GPS receivers with Everest multi-path mitigation and high performance low elevation satellite tracking were used in this survey. GPS observations were made during daylight and evening hours from Sunday, December 10, 2006, through Friday, December 15, 2006

Rapid static GPS techniques were utilized to minimize the time and cost of the survey. The satellite "window", where at least six satellites were observable, was open for much of the day with only a short period of unacceptable coverage because of the number of satellites or bad geometry. Each measurement period during which all receivers observe satellites simultaneously lasted from 15 minutes to 130 minutes, depending on the distance being measured and the geometry of the satellite constellation.

DATA ADJUSTMENT

A total of 258 vectors were observed and processed. Based on statistical indicators from the Trimble Geomatics Office processing software, there were no vectors flagged as outliers. After the removal of trivial vectors the final network is comprised of 69 stations and 135 baselines. All data adjustment was performed using the Trimble Geomatics Office least squares adjustment software. An initial free adjustment was performed in NAD83 to check the overall quality of the GPS data and the nature of the control. The initial unconstrained (free) adjustment yielded baseline precisions which ranged from 1:153,896 to 1:5,708,316 with the 3 mile baselines falling in the 1:600,000 to 1:1,400,000 range. Once the horizontal and vertical control was verified, subsequent adjustments were performed to arrive at the optimal solutions for each datum.

NAD83 (1996)

The initial free adjustment was performed holding HARN point Webster County Pt 6001 fixed horizontally with the vertical adjustment disabled. Coordinate values on the other HARN control stations were then checked against the published values. The network fit the published HARN values within a few hundredths of a foot. Because all of the horizontal data fit so well, the HARN-referenced stations from other counties were added to the network and a new adjustment performed. After each adjustment a comparison of adjusted coordinates vs published values was made. By

holding all of the existing HARN stations fixed, and the control that was adjusted to the HARN, the precision of the adjustment degraded very little as compared to the unconstrained adjustment. Wright County stations 5, 14, 23 and 32 were not held in the horiizontal because of poor correlation to existing HARN control in the area. New positions will be established for these points. The original 2004 Wright County GPS control monument #41 set in the south R.O.W. of 250th St. has been completely destroyed. A new Humboldt County GPS control monument #2006-041 was established in the north R.O.W. of 250th St and included in the Humboldt County network adjustment. New horizontal and vertical coordinates were published for this point.

Once we were satisfied with the horizontal adjustment, we locked the horizontal positions and concentrated on the vertical adjustment. The Geoid 03 Conus was utilized to provide a model of the height of the Geoid. Adjustments were then performed locking on to the orthometric vertical control stations one at a time beginning with Webster County Pt. 6001. Vertical control was added station by station with the elevations on the benchmarks being then checked against the published values. All vertical control fit extremely well. Wright County stations 5, 14, 23 and 32 were not held in the vertical because of poor correlation to existing vertical control in the area.

A final adjustment of both horizontal and vertical was then performed. All of the horizontal control points were held fixed in x and y and all vertical control were held fixed in z. This fully constrained adjustment solved for scale and rotation. In the final adjusted network, 100% of the adjusted vectors have an estimated error of x, y and z baseline precision between 1:78,306 to 1:3,197,550, with short baselines, less the one mile, falling in the 1:100,000 range, with the 3 mile baselines in falling in the 1:400,000 to 1:800,000 range or better, with 5 mile or longer baselines falling in the 1:1,300,000 or better. All of the processed data and error factors were computed using a 95% confidence level factor.

On line user positioning (OPUS) service was utilized to calculate solutions at 4 sites within the network. The final adjusted 1996 HARN positions fit within a few hundredths of a foot horizontally and 0.08' to 0.21' vertically to these solutions.

CONCLUSION

The results are well in excess of Order C class 1 (first-order precision) on short baselines (less than 3 miles) and between Order C class 1 and Order B on longer baselines (3 to 4 miles in length). On long baselines (over 6 miles) the precision is near Order B. The control point locations are within $\pm$ 0.03 ft horizontal position and within $\pm$ 0.08 ft. vertically for benchmark use.

Network Adjustment Report

Project : HumboldtAdj

User name	Gary Brown	**Date & Time**	12:35:38 PM 1/7/2007
Coordinate System	US State Plane 1983/1996 HARN	**Zone**	Iowa North 1401
Project Datum	NAD 1983 (Conus)		
Vertical Datum	NAVD88	**Geoid Model**	Geoid 03 (Conus)
Coordinate Units	US survey feet		
Distance Units	US survey feet		
Height Units	US survey feet		

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 : True

Horizontal and Vertical adjustment performed

Set-up Errors

GPS
Error in Height of Antenna : 0.015sft
Centering Error : 0 015sft

Statistical Summary

Successful Adjustment in 1 iteration(s)

Network Reference Factor : 1.00
Chi Square Test (α=95%) : PASS
Degrees of Freedom : 261.00

GPS Observation Statistics

Reference Factor : 1.00
Redundancy Number (r) : 243.45

Geoid Model Statistics

Reference Factor : 1.02
Redundancy Number (r) : 17.55

Weighting Strategies

GPS Observations
User-defined Scalar Applied to All Observations

Scalar : 1.07

Geoid Observations
User-defined Scalar Applied to All Observations

Scalar : 0.12

Adjusted Coordinates

Adjustment performed in NAD 1983/1996 HARN (Conus)

Number of Points : 69
Number of Constrained Points : 24
Horizontal Only : 1
Elevation Only : 2
Horizontal and Elevation Only : 21

Adjusted Grid Coordinates

Errors are reported using 1.96σ.

Point Name	Northing	N error	Easting	E error	Elevation	e error	Fix
32	3733663.431sft	0.028sft	4667936.224sft	0.028sft	1230.669sft	0.089sft	
33	3713700.119sft	0.028sft	4667680.552sft	0.028sft	1211.123sft	0.080sft	
202	3733082.875sft	0.000sft	4620492.550sft	0.000sft	1227.996sft	0.138sft	N E
116	3759954.810sft	0.000sft	4647238.160sft	0.000sft	1180.390sft	0.000sft	N E e
6001	3699534.500sft	0.000sft	4667577.620sft	0.000sft	1212.200sft	0.000sft	N E e
16	3763080.002sft	0.024sft	4670016.035sft	0.024sft	1128.176sft	0.071sft	
17	3747013.126sft	0.021sft	4668116.844sft	0.021sft	1197.773sft	0.072sft	
6006	3699381.690sft	0.000sft	4683525.790sft	0.000sft	1166.460sft	0.000sft	N E e
606	3795253.840sft	0.000sft	4683086.750sft	0.000sft	1147.680sft	0.000sft	N E e
498	3795341.030sft	0.000sft	4668578.060sft	0.000sft	1167.380sft	0.000sft	N E e
15	3762945.080sft	0.025sft	4684151.440sft	0.025sft	1168.907sft	0.070sft	
18	3746427.770sft	0.026sft	4683982.641sft	0.026sft	1143.542sft	0.068sft	
20	3746499.403sft	0.028sft	4715515.791sft	0.027sft	1155.167sft	0.103sft	
19	3744480.517sft	0.025sft	4699718.226sft	0.025sft	1138.423sft	0.093sft	
6007	3698341.790sft	0.000sft	4699382.750sft	0.000sft	1172.200sft	0.000sft	N E e
35	3714950.769sft	0.022sft	4696554.613sft	0.022sft	1158.352sft	0.080sft	
37	3715822.735sft	0.022sft	4731078.982sft	0.022sft	1112.329sft	0.082sft	
6013	3698751.530sft	0.000sft	4734634.260sft	0.000sft	1043.830sft	0.000sft	N E e
609	3796121.410sft	0.000sft	4731708.590sft	0.000sft	1095.250sft	0.000sft	N E e