

MAP ACCURACY REPORT
Countywide Imagery & DEM
Chisago County

| | | | |
|-----------------------------|---------------------|--------------------------------|-------------------------|
| Data Contact Person: | Terry Johnson, LS | Department: | Public Works |
| Type of Mapping: | DEM (LiDAR) & Ortho | Contractor: | Optimal Geomatics, Inc. |
| Independent Testing: | Mn/DOT Photo Unit | Contract Delivery date: | 2 April 2008 |

The purpose of this report is to independently test orthophotos and LiDAR derived digital elevation model data that was contracted for by Chisago County for horizontal and vertical accuracy. This project consisted of flights flown on 18, 19, 27 & 28 April 2007 for aerial imagery acquisition and on 19, 24, 25, 28, & 29 April, 18 & 19 May 2007 using Light Detection and Ranging (LiDAR) and GPS/IMU technologies. A supplemental acquisition flight was necessary and took place on 23 & 25 October 2007. The photographic flights were controlled using ground targets and by the GPS/IMU equipment onboard the aircraft. The specific equipment used for the aerial imagery collection was a Cessna 208B Grand Caravan plane, a Leica RC30 camera, serial number 5296, calibration date 17 March 2005. A copy of the calibration report is included in this report. For the aerial-triangulation, ISAT software was used and for the measurement and production a Z/I ImageStation softcopy stereoplotter. The specific equipment used for the DEM acquisition was the same plane with an Optech 3100 ALTM 70 kHz. laser system, serial number 04SEN155 and Realm Terrascan (Terrasolid), Geocue (NIIRS10) Survey processing software. The preflight mission was scheduled so that photography was flown at 5000 feet AGL and LiDAR were collected and flown at 2788 feet AGL. The flights were controlled using Leica System 500 GPS receivers on the ground and by LN200 GPS/IMU equipment in the aircraft. Optimal Geomatics, Inc. eliminated that portion of the data set that did not come in contact with the ground surface. There was no additional file manipulation or filtering done by Chisago County or Mn/Dot.

The vertical Datum used was the North American Vertical Datum of 1988 (NAVD 88) and the Horizontal Datum used was the North American Datum of 1983 (NAD 83). The products were delivered in the Chisago County Coordinate System, NAD 83 (1996 adj.) The Geoid model used was the GEOID 03. The Ortho and LiDAR portions of this project contain approximately 289,690 acres in area each.

ORTHOPHOTO

EAST BOUNDING COORDINATE: 92° 38' 38.94509" W. Long.
WEST BOUNDING COORDINATE: 93° 08' 37.83667" W. Long.
NORTH BOUNDING COORDINATE: 45° 43' 55.12129" N. Lat.
SOUTH BOUNDING COORDINATE: 45° 17' 42.39195" N. Lat.

DEM

EAST BOUNDING COORDINATE: 92° 38' 40.94383" W. Long.
WEST BOUNDING COORDINATE: 93° 08' 37.71644" W. Long.
NORTH BOUNDING COORDINATE: 45° 43' 55.20498" N. Lat.
SOUTH BOUNDING COORDINATE: 45° 17' 42.18316" N. Lat.

Geodetic monumentation used to control this project was published by Mn/DOT and can be found in the geodetic database online at www.olmweb.dot.state.mn.us. Data sheets, as reported by Optimal Geomatics, Inc. are attached to this report. Mn/DOT's Metro District Surveys report using the VRS system.

Optimal Geomatics, Inc. delivered the LiDAR and ortho-photos on a portable hard drive in MicroStation V8 format and a transmittal. The tiling scheme maps for both products are included as part of electronic file package.

The overall project area encompasses the entire county with flight strips extended to include portions of the Buffalo Creek Watershed.

The vertical accuracy test done for the DEM portion of this project were a direct comparison of the field surveyed elevations and the elevations derived from Geopak TIN model created from the LiDAR data at the surveyed X,Y coordinates. The contract called for 3.6' or 1.10m pre-process spacing as a deliverable product.

The horizontal accuracy test done on the orthophotos were a direct comparison of field surveyed features on the ground, such as sidewalk intersections, to the closest pixel location that an experienced technician could find. There is a certain amount of personal bias involved in this type of testing, knowing this, when the operator selected a pixel that was outside of the norm, a second technician was asked to see if they could replicate the results. The contract called for a 1" = 200 feet, 6" pixel size orthophoto to National Map Accuracy Standard (NMAS). The NMAS was and often is still used as the standard for testing hard copy or paper maps, where as digital data is tested against the current National Standard for Spatial Data Accuracy (NSSDA). The NSSDA for the horizontal (R) component or the combined X and Y coordinate for this project are:

| <u>Photo Identifiable Points</u> | <u>RMSE_r</u> | <u>NSSDA (Horizontal)</u> |
|----------------------------------|-------------------------|---------------------------|
| Urban Areas Only | 1.00' | 1.74' with 69 points |

The test data was obtained by Metro District Survey personnel throughout the project area encompassing different ground cover types per the American Society for Photogrammetry and Remote Sensing (ASPRS) Guidelines for Vertical Accuracy Reporting for LiDAR Data, May 2004. The test data itself was collected by VRS – RTK methods for each cover type except the forested area where a total station was used. Each test point was collected twice to ensure that the independent test source was at least 3 times as accurate. The MultShot program was utilized for comparing the two independent test points and is a part of this report. When applying the test data to the elevation model produced the accuracy test results indicated below. Metro District Surveys selected test points that geographically represent the various cover types as well as the general layout of the county.

The National Standard for Spatial Data Accuracy (NSSDA) for the vertical (Z) component of the DEM by ground cover/type for this project is:

| <u>Ground Cover/Type</u> | <u>RMSE_r</u> | <u>NSSDA (Vertical)</u> |
|-----------------------------------|-------------------------|-------------------------|
| Open Terrain – L1O | 0.24' | 0.47' with 35 points. |
| Tall Weeds & Crops – L2T | 0.41' | 0.80' with 32 points. * |
| Brush Lands & Low Trees – L3B | 0.47' | 0.93' with 27 points. * |
| Forested Areas with Canopy – L4F | 0.36' | 0.70' with 23 points. * |
| Urban Areas with Structures – L5U | 0.23' | 0.45' with 97 points. |
| All Ground Cover | 0.32' | 0.62' with 214 points. |

* Certain test points in these categories fell outside of the norm and were reported to the contractor for further inspection and review of data and procedures. The contractor provided me a response and is included in this report.

The horizontal accuracy of the DEM was not tested as part of this project due to the fact that the model does not contain distinct or well-defined topographical features but the expected horizontal accuracy as stated by the laser manufacturer is 1/2000th of the flying height which calculates to 1.4 feet. The outcome of the vertical testing results suggests that the horizontal accuracy is of sufficient accuracy otherwise it could not support this type of vertical accuracies.

The tabulated test results, correspondence, related notes and hard copies are attached to this report.

Peter Jenkins, LS
 Minnesota Department of Transportation
 395 John Ireland Boulevard, MS 640
 St. Paul, MN 55155

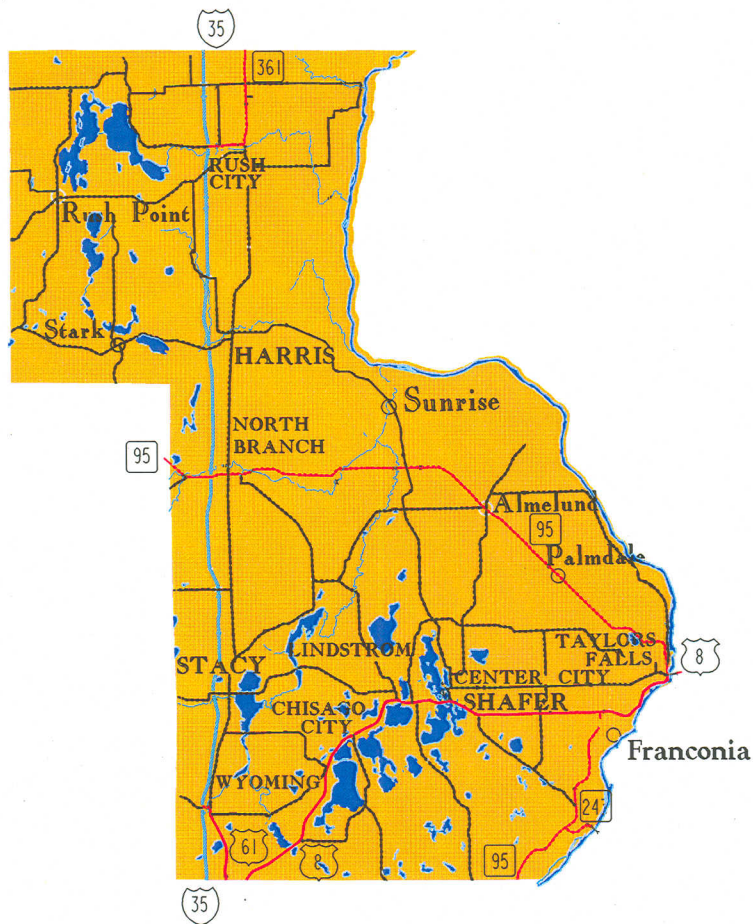
Phone: (651) 366-3457
 e-mail: peter.jenkins@dot.state.mn.us

I HEREBY CERTIFY THAT THIS SURVEY, PLAN OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A LICENSED LAND SURVEYOR UNDER THE LAWS OF THE STATE OF MINNESOTA.

Peter W. Jenkins

PETER W. JENKINS

DATE 8 July 08 REG. NO. 22683



S. P. : CHISAGO COUNTY LIDAR
 T.H. : TH 35
 COLLECTION DATE : 07
 LOCATION : CHISAGO COUNTY
 MAPPING : LIDAR
 CONSULTANT MAPPING : YES
 MAPPING COMPLETED : 07-08-2008
 ARCHIVE INFO : 651.366.3457
 ARCHIVE TAPE : J:\ARC\LIDAR\ 2007-S\ CHISAGO COUNTY

MAP DATUM

The vertical datum of the TIN file associated with this map is based on the North American Vertical Datum of 1988 (NAVD 88).

The horizontal datum of this map is based on Chisago county coordinate system which is related to the Minnesota state plane coordinate system NAD 1983 (HARN 1996) adjustment center zone.

MAP ACCURACY

The vertical accuracy of the TIN file associated with this map has been tested using NSSDA (June 1998) methods and computes to 0.62 FT. based on 214 test elevations.

The horizontal accuracy of the orthophoto has been tested using NSSDA (June 1998) methods and computes to 1.74 FT. based on 67 test points.

Chisago County
Pilot Area
Horizontal Accuracy Test

| Point Number | Point Description | X From Survey | Y From Survey | X From Map | Difference in X | X-Difference Squared | Y From Map | Difference in Y | Y-Difference Squared | X-Diff. Sq. + Y-Diff. Sq. |
|--------------|-------------------|---------------|---------------|------------|-----------------|----------------------|------------|-----------------|----------------------|---------------------------|
| 0050 | | 523328.296 | 249449.493 | 523327.741 | 0.555 | 0.308 | 249449.734 | -0.241 | 0.058 | 0.366 |
| 0051 | | 523226.458 | 246489.700 | 523226.479 | -0.021 | 0.000 | 246489.971 | -0.271 | 0.073 | 0.074 |
| 0053 | | 520801.033 | 242488.312 | 520800.337 | 0.696 | 0.484 | 242488.362 | -0.050 | 0.002 | 0.487 |
| 0055 | | 520774.026 | 249593.172 | 520773.471 | 0.555 | 0.308 | 249593.427 | -0.255 | 0.065 | 0.373 |
| 0056 | | 524136.584 | 253294.624 | 524136.836 | -0.252 | 0.064 | 253294.271 | 0.353 | 0.125 | 0.188 |
| 0057 | | 527648.827 | 253366.490 | 527648.474 | 0.353 | 0.125 | 253365.935 | 0.555 | 0.308 | 0.433 |
| 0058 | | 532743.640 | 253471.946 | 532743.388 | 0.252 | 0.064 | 253471.391 | 0.555 | 0.308 | 0.372 |
| 0059 | | 531395.496 | 258284.039 | 531394.941 | 0.555 | 0.308 | 258283.989 | 0.050 | 0.002 | 0.311 |
| 0060 | | 531429.631 | 249047.002 | 531428.702 | 0.929 | 0.863 | 249046.932 | 0.070 | 0.005 | 0.868 |
| 0061 | | 530695.782 | 240192.000 | 530695.227 | 0.555 | 0.308 | 240191.950 | 0.050 | 0.002 | 0.311 |
| 0062 | | 528838.652 | 242869.012 | 528839.106 | -0.454 | 0.206 | 242868.861 | 0.151 | 0.023 | 0.229 |
| 0063 | | 526110.964 | 243268.808 | 526110.611 | 0.353 | 0.125 | 243268.556 | 0.252 | 0.064 | 0.188 |
| 0064 | | 525084.869 | 241436.893 | 525084.517 | 0.352 | 0.124 | 241436.517 | 0.376 | 0.141 | 0.265 |
| 10001 | | 489464.667 | 253293.612 | 489464.549 | 0.118 | 0.014 | 253293.388 | 0.224 | 0.050 | 0.064 |
| 10002 | | 491774.836 | 215908.571 | 491774.520 | 0.316 | 0.100 | 215908.968 | -0.397 | 0.158 | 0.257 |
| 10004 | | 494486.380 | 224692.034 | 494485.976 | 0.404 | 0.163 | 224689.562 | 2.472 | 6.111 | 6.274 |
| 10006 | | 501084.742 | 252092.361 | 501083.979 | 0.763 | 0.582 | 252092.483 | -0.122 | 0.015 | 0.597 |
| 10007 | | 510527.837 | 205771.690 | 510527.917 | -0.080 | 0.006 | 205771.553 | 0.137 | 0.019 | 0.025 |
| 10008 | | 511368.534 | 219156.663 | 511367.006 | 1.528 | 2.335 | 219155.506 | 1.157 | 1.339 | 3.673 |
| 10009 | | 516457.321 | 179683.884 | 516457.241 | 0.080 | 0.006 | 179684.334 | -0.450 | 0.203 | 0.209 |
| 10010 | | 517672.929 | 204099.772 | 517672.538 | 0.391 | 0.153 | 204100.520 | -0.748 | 0.560 | 0.712 |
| 10014 | | 521327.213 | 156114.874 | 521327.241 | -0.028 | 0.001 | 156115.633 | -0.759 | 0.576 | 0.577 |
| 10015 | | 521619.322 | 141991.447 | 521619.114 | 0.208 | 0.043 | 141994.429 | -2.982 | 8.892 | 8.936 |
| 10016 | | 523190.556 | 125185.232 | 523190.459 | 0.097 | 0.009 | 125182.467 | 2.765 | 7.645 | 7.655 |
| 10017 | | 523315.263 | 110253.488 | 523315.942 | -0.679 | 0.461 | 110254.216 | -0.728 | 0.530 | 0.991 |
| 10018 | | 523624.923 | 202703.598 | 523624.965 | -0.042 | 0.002 | 202704.434 | -0.836 | 0.699 | 0.701 |
| 10019 | | 524767.424 | 216225.664 | 524767.033 | 0.391 | 0.153 | 216225.973 | -0.309 | 0.095 | 0.248 |
| 10020 | | 526401.074 | 165081.688 | 526400.637 | 0.437 | 0.191 | 165082.379 | -0.691 | 0.477 | 0.668 |
| 10022 | | 529243.240 | 178497.798 | 529244.429 | -1.189 | 1.414 | 178497.990 | -0.192 | 0.037 | 1.451 |
| 10023 | | 531376.200 | 232064.533 | 531375.479 | 0.721 | 0.520 | 232063.974 | 0.559 | 0.312 | 0.832 |
| 10024 | | 531437.031 | 250601.340 | 531436.516 | 0.515 | 0.265 | 250600.809 | 0.531 | 0.282 | 0.547 |
| 10025 | | 531634.844 | 147328.164 | 531634.189 | 0.655 | 0.429 | 147327.909 | 0.255 | 0.065 | 0.494 |

Contractor: Optimal Geomatics
Owner: Chisago County
Independent Tester: Mn/DOT

Aerial Collection: Spring 2007
Delivery: January 2008

Chisago County
Pilot Area
Horizontal Accuracy Test

| Point Number | Point Description | X From Survey | Y From Survey | X From Map | Difference in X | X-Difference Squared | Y From Map | Difference in Y | Y-Difference Squared | X-Diff. Sq. + Y-Diff. Sq. |
|--------------|-------------------|---------------|---------------|------------|-----------------|----------------------|------------|-----------------|----------------------|---------------------------|
| 10026 | | 532910.520 | 246753.456 | 532910.594 | -0.074 | 0.005 | 246754.035 | -0.579 | 0.335 | 0.341 |
| 10027 | | 533219.522 | 205659.495 | 533218.971 | 0.551 | 0.304 | 205659.460 | 0.035 | 0.001 | 0.305 |
| 10029 | | 533702.642 | 122450.708 | 533703.515 | -0.873 | 0.762 | 122450.963 | -0.255 | 0.065 | 0.827 |
| 10030 | | 537228.717 | 216231.012 | 537228.725 | -0.008 | 0.000 | 216230.742 | 0.270 | 0.073 | 0.073 |
| 10031 | | 537581.256 | 207003.076 | 537583.449 | -2.193 | 4.809 | 207003.481 | -0.405 | 0.164 | 4.973 |
| 10032 | | 539248.344 | 108491.847 | 539248.853 | -0.509 | 0.259 | 108491.229 | 0.618 | 0.382 | 0.641 |
| 10035 | | 542503.878 | 158258.100 | 542503.369 | 0.509 | 0.259 | 158258.500 | -0.400 | 0.160 | 0.419 |
| 10036 | | 543169.582 | 115825.176 | 543169.000 | 0.582 | 0.339 | 115825.212 | -0.036 | 0.001 | 0.340 |
| 10037 | | 544056.039 | 140569.802 | 544054.975 | 1.064 | 1.132 | 140570.202 | -0.400 | 0.160 | 1.292 |
| 10038 | | 544827.777 | 177835.999 | 544828.020 | -0.243 | 0.059 | 177834.978 | 1.021 | 1.042 | 1.101 |
| 10039 | | 547301.726 | 198153.824 | 547301.487 | 0.239 | 0.057 | 198153.980 | -0.156 | 0.024 | 0.081 |
| 10040 | | 547521.589 | 178915.409 | 547520.996 | 0.593 | 0.352 | 178914.983 | 0.426 | 0.181 | 0.533 |
| 10041 | | 550017.142 | 128321.442 | 550018.015 | -0.873 | 0.762 | 128320.751 | 0.691 | 0.477 | 1.240 |
| 10043 | | 551331.590 | 122706.882 | 551331.226 | 0.364 | 0.132 | 122706.555 | 0.327 | 0.107 | 0.239 |
| 10045 | | 551882.858 | 114395.408 | 551882.446 | 0.412 | 0.170 | 114394.475 | 0.933 | 0.870 | 1.040 |
| 10046 | | 552491.832 | 129543.710 | 552491.664 | 0.168 | 0.028 | 129542.910 | 0.800 | 0.640 | 0.668 |
| 10047 | | 552627.266 | 184337.814 | 552626.070 | 1.196 | 1.430 | 184336.991 | 0.823 | 0.677 | 2.108 |
| 10049 | | 561038.934 | 127625.806 | 561039.271 | -0.337 | 0.114 | 127625.595 | 0.211 | 0.045 | 0.158 |
| 10050 | | 561318.731 | 134204.851 | 561319.321 | -0.590 | 0.348 | 134204.809 | 0.042 | 0.002 | 0.350 |
| 10051 | | 562551.085 | 166221.119 | 562551.338 | -0.253 | 0.064 | 166219.308 | 1.811 | 3.280 | 3.344 |
| 10052 | | 568071.520 | 134277.360 | 568071.015 | 0.505 | 0.255 | 134277.149 | 0.211 | 0.045 | 0.300 |
| 10053 | | 568398.468 | 171299.523 | 568397.541 | 0.927 | 0.859 | 171299.649 | -0.126 | 0.016 | 0.875 |
| 10054 | | 568605.674 | 178495.482 | 568605.421 | 0.253 | 0.064 | 178495.019 | 0.463 | 0.214 | 0.278 |
| 10055 | | 571193.555 | 148761.613 | 571194.482 | -0.927 | 0.859 | 148761.655 | -0.042 | 0.002 | 0.861 |
| 10056 | | 572314.839 | 99928.824 | 572313.912 | 0.927 | 0.859 | 99928.950 | -0.126 | 0.016 | 0.875 |
| 10057 | | 575001.784 | 163403.285 | 575001.447 | 0.337 | 0.114 | 163402.902 | 0.383 | 0.147 | 0.260 |
| 10059 | | 579248.426 | 136898.616 | 579247.668 | 0.758 | 0.575 | 136898.827 | -0.211 | 0.045 | 0.619 |
| 10060 | | 581275.381 | 105354.718 | 581275.800 | -0.419 | 0.176 | 105354.423 | 0.295 | 0.087 | 0.263 |
| 10061 | | 584224.063 | 163849.616 | 584223.979 | 0.084 | 0.007 | 163849.995 | -0.379 | 0.144 | 0.151 |
| 10062 | | 586903.276 | 136980.960 | 586904.292 | -1.016 | 1.032 | 136981.086 | -0.126 | 0.016 | 1.048 |
| 10064 | | 594536.922 | 153431.762 | 594536.086 | 0.836 | 0.699 | 153431.611 | 0.151 | 0.023 | 0.722 |

Contractor: Optimal Geomatics
Owner: Chisago County
Independent Tester: Mn/DOT

Aerial Collection: Spring 2007
Delivery: January 2008

Chisago County
Pilot Area
Horizontal Accuracy Test

| Point Number | Point Description | X From Survey | Y From Survey | X From Map | Difference in X | X-Difference Squared | Y From Map | Difference in Y | Y-Difference Squared | X-Diff. Sq. + Y-Diff. Sq. | |
|--------------|-------------------|---------------|---------------|------------|-----------------|----------------------|------------|-----------------|----------------------|---------------------------|-------|
| 10066 | | 595261.586 | 109909.030 | 595261.651 | -0.065 | 0.004 | 109908.851 | 0.179 | 0.032 | 0.036 | |
| 10067 | | 597537.522 | 130964.824 | 597537.739 | -0.217 | 0.047 | 130964.816 | 0.007 | 0.000 | 0.047 | |
| 10068 | | 609958.588 | 144733.626 | 609958.874 | -0.286 | 0.082 | 144732.517 | 1.109 | 1.230 | 1.312 | |
| 10069 | | 610702.160 | 138526.482 | 610702.589 | -0.429 | 0.184 | 138525.946 | 0.536 | 0.287 | 0.471 | |
| | | | | | | | | | | Sum | 67.57 |
| | | | | | | | | | | Average | 1.01 |
| | | | | | | | | | | RMSEr | 1.00 |
| | | | | | | | | | | NSSDA | 1.74 |

 = Pilot Area

67 Total Number of Points

| Point Number | Point Description | Z (Survey) | Z (Map) | Difference in Z | Z-Difference Squared |
|--------------|-------------------|------------|---------|-----------------|----------------------|
| P01 | L1O | 920.93 | 920.89 | 0.04 | 0.00 |
| P02 | L1O | 940.17 | 940.31 | -0.15 | 0.02 |
| P03 | L1O | 930.01 | 930.19 | -0.17 | 0.03 |
| P04 | L1O | 930.63 | 930.39 | 0.23 | 0.06 |
| P05 | L1O | 928.62 | 928.75 | -0.13 | 0.02 |
| 10049 | L1O | 940.73 | 940.43 | 0.29 | 0.09 |
| 10100 | L1O | 994.92 | 995.29 | -0.37 | 0.13 |
| 10101 | L1O | 922.59 | 922.88 | -0.29 | 0.09 |
| 10102 | L1O | 944.56 | 944.75 | -0.19 | 0.04 |
| 10103 | L1O | 921.99 | 921.77 | 0.22 | 0.05 |
| 10104 | L1O | 910.05 | 910.14 | -0.09 | 0.01 |
| 10105 | L1O | 919.03 | 919.08 | -0.05 | 0.00 |
| 10106 | L1O | 909.08 | 909.21 | -0.14 | 0.02 |
| 10107 | L1O | 860.42 | 860.45 | -0.02 | 0.00 |
| 10108 | L1O | 897.82 | 897.81 | 0.01 | 0.00 |
| 10109 | L1O | 904.54 | 904.51 | 0.03 | 0.00 |
| 10110 | L1O | 835.09 | 835.00 | 0.09 | 0.01 |
| 10111 | L1O | 853.61 | 853.56 | 0.05 | 0.00 |
| 10112 | L1O | 834.43 | 834.37 | 0.07 | 0.00 |
| 10113 | L1O | 922.09 | 922.06 | 0.03 | 0.00 |
| 10114 | L1O | 935.83 | 935.62 | 0.21 | 0.04 |
| 10115 | L1O | 896.17 | 895.84 | 0.33 | 0.11 |
| 10116 | L1O | 928.40 | 928.13 | 0.27 | 0.07 |
| 10117 | L1O | 867.32 | 866.80 | 0.52 | 0.28 |
| 10118 | L1O | 935.28 | 935.13 | 0.16 | 0.02 |
| 10119 | L1O | 947.62 | 947.22 | 0.40 | 0.16 |
| 10120 | L1O | 936.12 | 936.00 | 0.12 | 0.01 |
| 10121 | L1O | 983.81 | 983.35 | 0.46 | 0.21 |
| 10122 | L1O | 925.67 | 925.59 | 0.08 | 0.01 |
| 10123 | L1O | 947.21 | 946.82 | 0.39 | 0.15 |
| 10124 | L1O | 859.40 | 859.15 | 0.24 | 0.06 |
| 10125 | L1O | 919.08 | 918.68 | 0.40 | 0.16 |
| 10127 | L1O | 958.96 | 958.57 | 0.39 | 0.15 |
| 10129 | L1O | 914.18 | 914.30 | -0.12 | 0.01 |
| 10130 | L1O | 928.64 | 928.47 | 0.17 | 0.03 |
| P06 | L2T | 926.78 | 926.85 | -0.08 | 0.01 |
| P07 | L2T | 937.44 | 937.68 | -0.23 | 0.05 |
| P08 | L2T | 932.76 | 933.27 | -0.50 | 0.25 |
| P09 | L2T | 932.87 | 933.40 | -0.53 | 0.28 |
| P10 | L2T | 934.43 | 934.35 | 0.08 | 0.01 |
| 10200 | L2T | 978.61 | 979.43 | -0.81 | 0.66 |
| 10201 | L2T | 947.97 | 948.46 | -0.50 | 0.25 |
| 10202 | L2T | 935.93 | 936.34 | -0.40 | 0.16 |
| 10203 | L2T | 934.57 | 935.27 | -0.69 | 0.48 |
| 10204 | L2T | 924.04 | 924.65 | -0.60 | 0.36 |
| 10205 | L2T | 899.99 | 899.87 | 0.12 | 0.01 |
| 10206 | L2T | 900.35 | 901.21 | -0.86 | 0.74 |
| 10207 | L2T | 877.75 | 878.35 | -0.60 | 0.37 |
| 10208 | L2T | 892.70 | 891.97 | 0.73 | 0.53 |
| 10209 | L2T | 911.52 | 911.68 | -0.16 | 0.03 |

*

*

*

*

*

*

| | | | | | |
|-------|-----|--------|--------|-------|------|
| 10210 | L2T | 890.48 | 890.35 | 0.13 | 0.02 |
| 10211 | L2T | 925.11 | 925.19 | -0.08 | 0.01 |
| 10212 | L2T | 897.65 | 897.83 | -0.18 | 0.03 |
| 10213 | L2T | 836.36 | 836.80 | -0.44 | 0.19 |
| 10214 | L2T | 845.61 | 845.56 | 0.04 | 0.00 |
| 10215 | L2T | 904.88 | 904.63 | 0.25 | 0.06 |
| 10216 | L2T | 911.05 | 911.30 | -0.25 | 0.06 |
| 10218 | L2T | 950.23 | 950.18 | 0.05 | 0.00 |
| 10219 | L2T | 863.78 | 863.92 | -0.14 | 0.02 |
| 10220 | L2T | 919.21 | 919.23 | -0.02 | 0.00 |
| 10221 | L2T | 929.77 | 929.24 | 0.53 | 0.28 |
| 10222 | L2T | 955.32 | 955.05 | 0.27 | 0.07 |
| 10224 | L2T | 851.02 | 851.04 | -0.02 | 0.00 |
| 10225 | L2T | 901.94 | 901.87 | 0.07 | 0.01 |
| 10226 | L2T | 921.84 | 921.65 | 0.19 | 0.04 |
| 10228 | L2T | 903.43 | 904.03 | -0.60 | 0.36 |
| 10229 | L2T | 919.60 | 919.66 | -0.06 | 0.00 |
| P11 | L3B | 925.36 | 925.92 | -0.56 | 0.31 |
| P12 | L3B | 943.42 | 943.97 | -0.55 | 0.30 |
| P13 | L3B | 928.98 | 929.71 | -0.73 | 0.53 |
| P14 | L3B | 919.90 | 920.36 | -0.46 | 0.21 |
| P15 | L3B | 938.96 | 938.93 | 0.04 | 0.00 |
| 10300 | L3B | 940.57 | 941.63 | -1.06 | 1.12 |
| 10301 | L3B | 925.57 | 926.06 | -0.49 | 0.24 |
| 10302 | L3B | 933.35 | 933.70 | -0.35 | 0.12 |
| 10303 | L3B | 924.08 | 924.50 | -0.42 | 0.17 |
| 10304 | L3B | 939.78 | 940.35 | -0.57 | 0.33 |
| 10305 | L3B | 891.07 | 892.14 | -1.07 | 1.14 |
| 10306 | L3B | 921.16 | 921.45 | -0.29 | 0.08 |
| 10308 | L3B | 903.79 | 904.12 | -0.33 | 0.11 |
| 10309 | L3B | 887.14 | 887.72 | -0.58 | 0.34 |
| 10310 | L3B | 890.96 | 891.26 | -0.29 | 0.09 |
| 10311 | L3B | 888.32 | 888.41 | -0.09 | 0.01 |
| 10312 | L3B | 849.07 | 849.48 | -0.41 | 0.17 |
| 10314 | L3B | 853.71 | 854.05 | -0.34 | 0.12 |
| 10315 | L3B | 867.49 | 867.80 | -0.31 | 0.10 |
| 10316 | L3B | 905.08 | 904.98 | 0.10 | 0.01 |
| 10317 | L3B | 932.32 | 931.99 | 0.33 | 0.11 |
| 10318 | L3B | 824.05 | 824.48 | -0.43 | 0.18 |
| 10319 | L3B | 871.56 | 871.61 | -0.05 | 0.00 |
| 10320 | L3B | 901.25 | 901.75 | -0.50 | 0.25 |
| 10321 | L3B | 856.45 | 856.55 | -0.10 | 0.01 |
| 10322 | L3B | 932.44 | 932.47 | -0.03 | 0.00 |
| 10324 | L3B | 917.94 | 918.06 | -0.12 | 0.02 |
| P16 | L4F | 924.58 | 924.42 | 0.16 | 0.03 |
| P17 | L4F | 942.66 | 943.12 | -0.46 | 0.22 |
| P18 | L4F | 938.05 | 938.55 | -0.50 | 0.25 |
| P19 | L4F | 932.92 | 933.28 | -0.36 | 0.13 |
| P20 | L4F | 923.93 | 924.21 | -0.28 | 0.08 |
| 10400 | L4F | 963.88 | 964.42 | -0.55 | 0.30 |
| 10401 | L4F | 938.10 | 938.34 | -0.23 | 0.05 |
| 10403 | L4F | 916.83 | 917.43 | -0.60 | 0.36 |

| | | | | | |
|-------|-----|--------|--------|-------|------|
| 10404 | L4F | 884.39 | 884.69 | -0.30 | 0.09 |
| 10405 | L4F | 903.69 | 904.21 | -0.52 | 0.27 |
| 10406 | L4F | 900.65 | 901.31 | -0.66 | 0.43 |
| 10407 | L4F | 913.24 | 913.46 | -0.23 | 0.05 |
| 10408 | L4F | 909.23 | 909.30 | -0.07 | 0.00 |
| 10409 | L4F | 894.50 | 894.82 | -0.32 | 0.10 |
| 10410 | L4F | 829.24 | 829.64 | -0.40 | 0.16 |
| 10411 | L4F | 912.66 | 912.25 | 0.40 | 0.16 |
| 10412 | L4F | 941.18 | 940.82 | 0.36 | 0.13 |
| 10413 | L4F | 926.63 | 926.52 | 0.11 | 0.01 |
| 10414 | L4F | 854.00 | 854.24 | -0.24 | 0.06 |
| 10415 | L4F | 937.57 | 937.62 | -0.05 | 0.00 |
| 10416 | L4F | 926.88 | 926.86 | 0.01 | 0.00 |
| 10418 | L4F | 938.26 | 938.04 | 0.22 | 0.05 |
| 10420 | L4F | 762.83 | 762.70 | 0.12 | 0.01 |
| P21 | L5U | 918.91 | 918.67 | 0.23 | 0.05 |
| P22 | L5U | 915.98 | 916.00 | -0.02 | 0.00 |
| P23 | L5U | 917.66 | 917.61 | 0.04 | 0.00 |
| P24 | L5U | 918.13 | 918.08 | 0.05 | 0.00 |
| P25 | L5U | 916.69 | 916.69 | -0.01 | 0.00 |
| 10001 | L5U | 997.05 | 997.20 | -0.15 | 0.02 |
| 10002 | L5U | 973.53 | 973.78 | -0.24 | 0.06 |
| 10003 | L5U | 987.36 | 987.35 | 0.01 | 0.00 |
| 10004 | L5U | 940.86 | 940.95 | -0.09 | 0.01 |
| 10005 | L5U | 953.44 | 953.65 | -0.21 | 0.05 |
| 10006 | L5U | 922.49 | 922.83 | -0.35 | 0.12 |
| 10007 | L5U | 921.91 | 922.13 | -0.22 | 0.05 |
| 10008 | L5U | 940.53 | 940.71 | -0.17 | 0.03 |
| 10009 | L5U | 915.63 | 915.73 | -0.10 | 0.01 |
| 10010 | L5U | 930.75 | 931.12 | -0.37 | 0.13 |
| 10011 | L5U | 933.75 | 933.83 | -0.08 | 0.01 |
| 10012 | L5U | 924.91 | 924.24 | 0.67 | 0.45 |
| 10013 | L5U | 946.27 | 946.28 | -0.01 | 0.00 |
| 10014 | L5U | 903.65 | 903.63 | 0.01 | 0.00 |
| 10015 | L5U | 911.86 | 911.66 | 0.20 | 0.04 |
| 10016 | L5U | 905.60 | 905.33 | 0.27 | 0.07 |
| 10017 | L5U | 913.88 | 913.57 | 0.31 | 0.09 |
| 10018 | L5U | 911.02 | 911.06 | -0.04 | 0.00 |
| 10019 | L5U | 923.74 | 923.80 | -0.06 | 0.00 |
| 10020 | L5U | 908.09 | 908.28 | -0.19 | 0.04 |
| 10021 | L5U | 917.03 | 917.09 | -0.06 | 0.00 |
| 10022 | L5U | 881.07 | 881.18 | -0.11 | 0.01 |
| 10023 | L5U | 913.92 | 913.69 | 0.23 | 0.05 |
| 10024 | L5U | 930.05 | 929.87 | 0.18 | 0.03 |
| 10025 | L5U | 910.59 | 910.50 | 0.09 | 0.01 |
| 10026 | L5U | 923.48 | 923.31 | 0.16 | 0.03 |
| 10027 | L5U | 912.24 | 912.15 | 0.08 | 0.01 |
| 10028 | L5U | 931.70 | 931.43 | 0.26 | 0.07 |
| 10029 | L5U | 892.08 | 891.67 | 0.40 | 0.16 |
| 10030 | L5U | 868.19 | 867.96 | 0.23 | 0.05 |
| 10031 | L5U | 841.13 | 840.87 | 0.27 | 0.07 |
| 10032 | L5U | 920.17 | 920.02 | 0.14 | 0.02 |

| | | | | | |
|-------|-----|--------|--------|-------|------|
| 10033 | L5U | 837.85 | 837.97 | -0.13 | 0.02 |
| 10034 | L5U | 913.05 | 913.02 | 0.03 | 0.00 |
| 10035 | L5U | 897.54 | 897.48 | 0.06 | 0.00 |
| 10036 | L5U | 927.34 | 927.11 | 0.23 | 0.05 |
| 10037 | L5U | 888.31 | 888.37 | -0.06 | 0.00 |
| 10038 | L5U | 885.39 | 885.25 | 0.14 | 0.02 |
| 10039 | L5U | 851.58 | 851.36 | 0.22 | 0.05 |
| 10040 | L5U | 838.19 | 838.29 | -0.09 | 0.01 |
| 10041 | L5U | 923.03 | 923.03 | 0.00 | 0.00 |
| 10042 | L5U | 849.70 | 849.21 | 0.50 | 0.25 |
| 10043 | L5U | 925.05 | 924.98 | 0.08 | 0.01 |
| 10044 | L5U | 883.80 | 883.58 | 0.22 | 0.05 |
| 10045 | L5U | 932.65 | 932.40 | 0.25 | 0.06 |
| 10046 | L5U | 923.56 | 923.23 | 0.33 | 0.11 |
| 10047 | L5U | 824.51 | 824.40 | 0.11 | 0.01 |
| 10050 | L5U | 934.69 | 934.33 | 0.37 | 0.13 |
| 10051 | L5U | 936.25 | 936.11 | 0.14 | 0.02 |
| 10052 | L5U | 908.25 | 908.01 | 0.24 | 0.06 |
| 10053 | L5U | 965.75 | 965.54 | 0.21 | 0.04 |
| 10054 | L5U | 913.39 | 913.18 | 0.21 | 0.04 |
| 10055 | L5U | 948.97 | 948.91 | 0.07 | 0.00 |
| 10056 | L5U | 952.77 | 952.41 | 0.36 | 0.13 |
| 10057 | L5U | 950.50 | 950.29 | 0.21 | 0.04 |
| 10058 | L5U | 999.94 | 999.65 | 0.28 | 0.08 |
| 10059 | L5U | 936.79 | 936.64 | 0.15 | 0.02 |
| 10060 | L5U | 889.95 | 889.66 | 0.29 | 0.08 |
| 10061 | L5U | 951.76 | 951.44 | 0.32 | 0.10 |
| 10062 | L5U | 952.85 | 952.67 | 0.18 | 0.03 |
| 10063 | L5U | 939.43 | 939.03 | 0.40 | 0.16 |
| 10064 | L5U | 940.93 | 940.70 | 0.23 | 0.05 |
| 10065 | L5U | 914.46 | 914.43 | 0.03 | 0.00 |
| 10066 | L5U | 705.96 | 705.98 | -0.02 | 0.00 |
| 10067 | L5U | 917.38 | 917.01 | 0.38 | 0.14 |
| 10068 | L5U | 915.60 | 915.52 | 0.08 | 0.01 |
| 10069 | L5U | 749.84 | 749.62 | 0.22 | 0.05 |
| 10500 | L5U | 952.74 | 952.67 | 0.07 | 0.00 |
| 10501 | L5U | 968.60 | 968.92 | -0.32 | 0.10 |
| 10502 | L5U | 963.07 | 963.49 | -0.41 | 0.17 |
| 10503 | L5U | 897.80 | 897.97 | -0.17 | 0.03 |
| 10504 | L5U | 902.13 | 902.11 | 0.02 | 0.00 |
| 10505 | L5U | 890.74 | 890.67 | 0.07 | 0.01 |
| 10506 | L5U | 896.10 | 896.09 | 0.01 | 0.00 |
| 10507 | L5U | 895.63 | 895.69 | -0.06 | 0.00 |
| 10508 | L5U | 899.21 | 899.34 | -0.13 | 0.02 |
| 10509 | L5U | 900.49 | 900.39 | 0.11 | 0.01 |
| 10510 | L5U | 916.99 | 917.03 | -0.03 | 0.00 |
| 10511 | L5U | 912.28 | 912.07 | 0.21 | 0.05 |
| 10512 | L5U | 924.18 | 923.77 | 0.41 | 0.17 |
| 10514 | L5U | 870.21 | 870.26 | -0.05 | 0.00 |
| 10515 | L5U | 920.59 | 920.61 | -0.02 | 0.00 |
| 10516 | L5U | 921.67 | 921.71 | -0.04 | 0.00 |
| 10517 | L5U | 823.54 | 823.39 | 0.15 | 0.02 |

| | | | | | |
|-------|-----|--------|--------|------|------|
| 10518 | L5U | 875.64 | 875.26 | 0.38 | 0.15 |
| 10519 | L5U | 939.96 | 939.73 | 0.22 | 0.05 |
| 10520 | L5U | 924.05 | 923.73 | 0.32 | 0.10 |
| 10521 | L5U | 996.81 | 996.43 | 0.38 | 0.15 |
| 10522 | L5U | 991.08 | 990.82 | 0.26 | 0.07 |
| 10523 | L5U | 944.09 | 943.72 | 0.37 | 0.14 |
| 10524 | L5U | 943.97 | 943.59 | 0.37 | 0.14 |
| 10526 | L5U | 749.16 | 749.03 | 0.13 | 0.02 |
| | | | | | |

| | | | | |
|--------------------------|--------------|------|---------|-------|
| | = Pilot Area | | Sum | 21.43 |
| Total Number of Points = | | 214 | Average | 0.10 |
| User-Defined Tolerance = | | 0.60 | RMSEr | 0.32 |
| Chi Square Test : | | | NSSDA | 0.62 |

| Point Number | Point Description | Z (Survey) | Z (Map) | Difference in Z | Z-Difference Squared |
|--------------|-------------------|------------|---------|-----------------|----------------------|
| P01 | L10 | 920.93 | 920.89 | 0.04 | 0.00 |
| P02 | L10 | 940.17 | 940.31 | -0.15 | 0.02 |
| P03 | L10 | 930.01 | 930.19 | -0.17 | 0.03 |
| P04 | L10 | 930.63 | 930.39 | 0.23 | 0.06 |
| P05 | L10 | 928.62 | 928.75 | -0.13 | 0.02 |
| 10049 | L10 | 940.73 | 940.43 | 0.29 | 0.09 |
| 10100 | L10 | 994.92 | 995.29 | -0.37 | 0.13 |
| 10101 | L10 | 922.59 | 922.88 | -0.29 | 0.09 |
| 10102 | L10 | 944.56 | 944.75 | -0.19 | 0.04 |
| 10103 | L10 | 921.99 | 921.77 | 0.22 | 0.05 |
| 10104 | L10 | 910.05 | 910.14 | -0.09 | 0.01 |
| 10105 | L10 | 919.03 | 919.08 | -0.05 | 0.00 |
| 10106 | L10 | 909.08 | 909.21 | -0.14 | 0.02 |
| 10107 | L10 | 860.42 | 860.45 | -0.02 | 0.00 |
| 10108 | L10 | 897.82 | 897.81 | 0.01 | 0.00 |
| 10109 | L10 | 904.54 | 904.51 | 0.03 | 0.00 |
| 10110 | L10 | 835.09 | 835.00 | 0.09 | 0.01 |
| 10111 | L10 | 853.61 | 853.56 | 0.05 | 0.00 |
| 10112 | L10 | 834.43 | 834.37 | 0.07 | 0.00 |
| 10113 | L10 | 922.09 | 922.06 | 0.03 | 0.00 |
| 10114 | L10 | 935.83 | 935.62 | 0.21 | 0.04 |
| 10115 | L10 | 896.17 | 895.84 | 0.33 | 0.11 |
| 10116 | L10 | 928.40 | 928.13 | 0.27 | 0.07 |
| 10117 | L10 | 867.32 | 866.80 | 0.52 | 0.28 |
| 10118 | L10 | 935.28 | 935.13 | 0.16 | 0.02 |
| 10119 | L10 | 947.62 | 947.22 | 0.40 | 0.16 |
| 10120 | L10 | 936.12 | 936.00 | 0.12 | 0.01 |
| 10121 | L10 | 983.81 | 983.35 | 0.46 | 0.21 |
| 10122 | L10 | 925.67 | 925.59 | 0.08 | 0.01 |
| 10123 | L10 | 947.21 | 946.82 | 0.39 | 0.15 |
| 10124 | L10 | 859.40 | 859.15 | 0.24 | 0.06 |
| 10125 | L10 | 919.08 | 918.68 | 0.40 | 0.16 |
| 10127 | L10 | 958.96 | 958.57 | 0.39 | 0.15 |
| 10129 | L10 | 914.18 | 914.30 | -0.12 | 0.01 |
| 10130 | L10 | 928.64 | 928.47 | 0.17 | 0.03 |

| | | | |
|--------------------------|------|---------|------|
| = Pilot Area | | Sum | 2.05 |
| Total Number of Points = | 35 | Average | 0.06 |
| User-Defined Tolerance = | 0.60 | RMSEr | 0.24 |
| Chi Square Test : | | NSSDA | 0.47 |

| Point Number | Point Description | Z (Survey) | Z (Map) | Difference in Z | Z-Difference Squared |
|--------------|-------------------|------------|---------|-----------------|----------------------|
| P06 | L2T | 926.78 | 926.85 | -0.08 | 0.01 |
| P07 | L2T | 937.44 | 937.68 | -0.23 | 0.05 |
| P08 | L2T | 932.76 | 933.27 | -0.50 | 0.25 |
| P09 | L2T | 932.87 | 933.40 | -0.53 | 0.28 |
| P10 | L2T | 934.43 | 934.35 | 0.08 | 0.01 |
| 10200 | L2T | 978.61 | 979.43 | -0.81 | 0.66 |
| 10201 | L2T | 947.97 | 948.46 | -0.50 | 0.25 |
| 10202 | L2T | 935.93 | 936.34 | -0.40 | 0.16 |
| 10203 | L2T | 934.57 | 935.27 | -0.69 | 0.48 |
| 10204 | L2T | 924.04 | 924.65 | -0.60 | 0.36 |
| 10205 | L2T | 899.99 | 899.87 | 0.12 | 0.01 |
| 10206 | L2T | 900.35 | 901.21 | -0.86 | 0.74 |
| 10207 | L2T | 877.75 | 878.35 | -0.60 | 0.37 |
| 10208 | L2T | 892.70 | 891.97 | 0.73 | 0.53 |
| 10209 | L2T | 911.52 | 911.68 | -0.16 | 0.03 |
| 10210 | L2T | 890.48 | 890.35 | 0.13 | 0.02 |
| 10211 | L2T | 925.11 | 925.19 | -0.08 | 0.01 |
| 10212 | L2T | 897.65 | 897.83 | -0.18 | 0.03 |
| 10213 | L2T | 836.36 | 836.80 | -0.44 | 0.19 |
| 10214 | L2T | 845.61 | 845.56 | 0.04 | 0.00 |
| 10215 | L2T | 904.88 | 904.63 | 0.25 | 0.06 |
| 10216 | L2T | 911.05 | 911.30 | -0.25 | 0.06 |
| 10218 | L2T | 950.23 | 950.18 | 0.05 | 0.00 |
| 10219 | L2T | 863.78 | 863.92 | -0.14 | 0.02 |
| 10220 | L2T | 919.21 | 919.23 | -0.02 | 0.00 |
| 10221 | L2T | 929.77 | 929.24 | 0.53 | 0.28 |
| 10222 | L2T | 955.32 | 955.05 | 0.27 | 0.07 |
| 10224 | L2T | 851.02 | 851.04 | -0.02 | 0.00 |
| 10225 | L2T | 901.94 | 901.87 | 0.07 | 0.01 |
| 10226 | L2T | 921.84 | 921.65 | 0.19 | 0.04 |
| 10228 | L2T | 903.43 | 904.03 | -0.60 | 0.36 |
| 10229 | L2T | 919.60 | 919.66 | -0.06 | 0.00 |

*
*
*
*
*
*
*

| | | | |
|--------------------------|------|---------|------|
| = Pilot Area | | Sum | 5.35 |
| Total Number of Points = | 32 | Average | 0.17 |
| User-Defined Tolerance = | 0.60 | RMSEr | 0.41 |
| Chi Square Test : | | NSSDA | 0.80 |

| Point Number | Point Description | Z (Survey) | Z (Map) | Difference in Z | Z-Difference Squared |
|--------------|-------------------|------------|---------|-----------------|----------------------|
| P11 | L3B | 925.36 | 925.92 | -0.56 | 0.31 |
| P12 | L3B | 943.42 | 943.97 | -0.55 | 0.30 |
| P13 | L3B | 928.98 | 929.71 | -0.73 | 0.53 |
| P14 | L3B | 919.90 | 920.36 | -0.46 | 0.21 |
| P15 | L3B | 938.96 | 938.93 | 0.04 | 0.00 |
| 10300 | L3B | 940.57 | 941.63 | -1.06 | 1.12 |
| 10301 | L3B | 925.57 | 926.06 | -0.49 | 0.24 |
| 10302 | L3B | 933.35 | 933.70 | -0.35 | 0.12 |
| 10303 | L3B | 924.08 | 924.50 | -0.42 | 0.17 |
| 10304 | L3B | 939.78 | 940.35 | -0.57 | 0.33 |
| 10305 | L3B | 891.07 | 892.14 | -1.07 | 1.14 |
| 10306 | L3B | 921.16 | 921.45 | -0.29 | 0.08 |
| 10308 | L3B | 903.79 | 904.12 | -0.33 | 0.11 |
| 10309 | L3B | 887.14 | 887.72 | -0.58 | 0.34 |
| 10310 | L3B | 890.96 | 891.26 | -0.29 | 0.09 |
| 10311 | L3B | 888.32 | 888.41 | -0.09 | 0.01 |
| 10312 | L3B | 849.07 | 849.48 | -0.41 | 0.17 |
| 10314 | L3B | 853.71 | 854.05 | -0.34 | 0.12 |
| 10315 | L3B | 867.49 | 867.80 | -0.31 | 0.10 |
| 10316 | L3B | 905.08 | 904.98 | 0.10 | 0.01 |
| 10317 | L3B | 932.32 | 931.99 | 0.33 | 0.11 |
| 10318 | L3B | 824.05 | 824.48 | -0.43 | 0.18 |
| 10319 | L3B | 871.56 | 871.61 | -0.05 | 0.00 |
| 10320 | L3B | 901.25 | 901.75 | -0.50 | 0.25 |
| 10321 | L3B | 856.45 | 856.55 | -0.10 | 0.01 |
| 10322 | L3B | 932.44 | 932.47 | -0.03 | 0.00 |
| 10324 | L3B | 917.94 | 918.06 | -0.12 | 0.02 |

*
*
*

| | | | |
|--------------------------|------|---------|------|
| = Pilot Area | | Sum | 6.09 |
| Total Number of Points = | 27 | Average | 0.23 |
| User-Defined Tolerance = | 0.60 | RMSEr | 0.47 |
| Chi Square Test : | | NSSDA | 0.93 |

| Point Number | Point Description | Z (Survey) | Z (Map) | Difference in Z | Z-Difference Squared |
|--------------|-------------------|------------|---------|-----------------|----------------------|
| P16 | L4F | 924.58 | 924.42 | 0.16 | 0.03 |
| P17 | L4F | 942.66 | 943.12 | -0.46 | 0.22 |
| P18 | L4F | 938.05 | 938.55 | -0.50 | 0.25 |
| P19 | L4F | 932.92 | 933.28 | -0.36 | 0.13 |
| P20 | L4F | 923.93 | 924.21 | -0.28 | 0.08 |
| 10400 | L4F | 963.88 | 964.42 | -0.55 | 0.30 |
| 10401 | L4F | 938.10 | 938.34 | -0.23 | 0.05 |
| 10403 | L4F | 916.83 | 917.43 | -0.60 | 0.36 |
| 10404 | L4F | 884.39 | 884.69 | -0.30 | 0.09 |
| 10405 | L4F | 903.69 | 904.21 | -0.52 | 0.27 |
| 10406 | L4F | 900.65 | 901.31 | -0.66 | 0.43 |
| 10407 | L4F | 913.24 | 913.46 | -0.23 | 0.05 |
| 10408 | L4F | 909.23 | 909.30 | -0.07 | 0.00 |
| 10409 | L4F | 894.50 | 894.82 | -0.32 | 0.10 |
| 10410 | L4F | 829.24 | 829.64 | -0.40 | 0.16 |
| 10411 | L4F | 912.66 | 912.25 | 0.40 | 0.16 |
| 10412 | L4F | 941.18 | 940.82 | 0.36 | 0.13 |
| 10413 | L4F | 926.63 | 926.52 | 0.11 | 0.01 |
| 10414 | L4F | 854.00 | 854.24 | -0.24 | 0.06 |
| 10415 | L4F | 937.57 | 937.62 | -0.05 | 0.00 |
| 10416 | L4F | 926.88 | 926.86 | 0.01 | 0.00 |
| 10418 | L4F | 938.26 | 938.04 | 0.22 | 0.05 |
| 10420 | L4F | 762.83 | 762.70 | 0.12 | 0.01 |

*
*

| | | | |
|--------------------------|------|---------|------|
| = Pilot Area | | Sum | 2.94 |
| Total Number of Points = | 23 | Average | 0.13 |
| User-Defined Tolerance = | 0.60 | RMSEr | 0.36 |
| Chi Square Test : | | NSSDA | 0.70 |

| Point Number | Point Description | Z (Survey) | Z (Map) | Difference in Z | Z-Difference Squared |
|--------------|-------------------|------------|---------|-----------------|----------------------|
| P21 | L5U | 918.91 | 918.67 | 0.23 | 0.05 |
| P22 | L5U | 915.98 | 916.00 | -0.02 | 0.00 |
| P23 | L5U | 917.66 | 917.61 | 0.04 | 0.00 |
| P24 | L5U | 918.13 | 918.08 | 0.05 | 0.00 |
| P25 | L5U | 916.69 | 916.69 | -0.01 | 0.00 |
| 10001 | L5U | 997.05 | 997.20 | -0.15 | 0.02 |
| 10002 | L5U | 973.53 | 973.78 | -0.24 | 0.06 |
| 10003 | L5U | 987.36 | 987.35 | 0.01 | 0.00 |
| 10004 | L5U | 940.86 | 940.95 | -0.09 | 0.01 |
| 10005 | L5U | 953.44 | 953.65 | -0.21 | 0.05 |
| 10006 | L5U | 922.49 | 922.83 | -0.35 | 0.12 |
| 10007 | L5U | 921.91 | 922.13 | -0.22 | 0.05 |
| 10008 | L5U | 940.53 | 940.71 | -0.17 | 0.03 |
| 10009 | L5U | 915.63 | 915.73 | -0.10 | 0.01 |
| 10010 | L5U | 930.75 | 931.12 | -0.37 | 0.13 |
| 10011 | L5U | 933.75 | 933.83 | -0.08 | 0.01 |
| 10012 | L5U | 924.91 | 924.24 | 0.67 | 0.45 |
| 10013 | L5U | 946.27 | 946.28 | -0.01 | 0.00 |
| 10014 | L5U | 903.65 | 903.63 | 0.01 | 0.00 |
| 10015 | L5U | 911.86 | 911.66 | 0.20 | 0.04 |
| 10016 | L5U | 905.60 | 905.33 | 0.27 | 0.07 |
| 10017 | L5U | 913.88 | 913.57 | 0.31 | 0.09 |
| 10018 | L5U | 911.02 | 911.06 | -0.04 | 0.00 |
| 10019 | L5U | 923.74 | 923.80 | -0.06 | 0.00 |
| 10020 | L5U | 908.09 | 908.28 | -0.19 | 0.04 |
| 10021 | L5U | 917.03 | 917.09 | -0.06 | 0.00 |
| 10022 | L5U | 881.07 | 881.18 | -0.11 | 0.01 |
| 10023 | L5U | 913.92 | 913.69 | 0.23 | 0.05 |
| 10024 | L5U | 930.05 | 929.87 | 0.18 | 0.03 |
| 10025 | L5U | 910.59 | 910.50 | 0.09 | 0.01 |
| 10026 | L5U | 923.48 | 923.31 | 0.16 | 0.03 |
| 10027 | L5U | 912.24 | 912.15 | 0.08 | 0.01 |
| 10028 | L5U | 931.70 | 931.43 | 0.26 | 0.07 |
| 10029 | L5U | 892.08 | 891.67 | 0.40 | 0.16 |
| 10030 | L5U | 868.19 | 867.96 | 0.23 | 0.05 |
| 10031 | L5U | 841.13 | 840.87 | 0.27 | 0.07 |
| 10032 | L5U | 920.17 | 920.02 | 0.14 | 0.02 |
| 10033 | L5U | 837.85 | 837.97 | -0.13 | 0.02 |
| 10034 | L5U | 913.05 | 913.02 | 0.03 | 0.00 |
| 10035 | L5U | 897.54 | 897.48 | 0.06 | 0.00 |
| 10036 | L5U | 927.34 | 927.11 | 0.23 | 0.05 |
| 10037 | L5U | 888.31 | 888.37 | -0.06 | 0.00 |
| 10038 | L5U | 885.39 | 885.25 | 0.14 | 0.02 |
| 10039 | L5U | 851.58 | 851.36 | 0.22 | 0.05 |
| 10040 | L5U | 838.19 | 838.29 | -0.09 | 0.01 |
| 10041 | L5U | 923.03 | 923.03 | 0.00 | 0.00 |
| 10042 | L5U | 849.70 | 849.21 | 0.50 | 0.25 |
| 10043 | L5U | 925.05 | 924.98 | 0.08 | 0.01 |
| 10044 | L5U | 883.80 | 883.58 | 0.22 | 0.05 |
| 10045 | L5U | 932.65 | 932.40 | 0.25 | 0.06 |

| | | | | | |
|-------|-----|--------|--------|-------|------|
| 10046 | L5U | 923.56 | 923.23 | 0.33 | 0.11 |
| 10047 | L5U | 824.51 | 824.40 | 0.11 | 0.01 |
| 10050 | L5U | 934.69 | 934.33 | 0.37 | 0.13 |
| 10051 | L5U | 936.25 | 936.11 | 0.14 | 0.02 |
| 10052 | L5U | 908.25 | 908.01 | 0.24 | 0.06 |
| 10053 | L5U | 965.75 | 965.54 | 0.21 | 0.04 |
| 10054 | L5U | 913.39 | 913.18 | 0.21 | 0.04 |
| 10055 | L5U | 948.97 | 948.91 | 0.07 | 0.00 |
| 10056 | L5U | 952.77 | 952.41 | 0.36 | 0.13 |
| 10057 | L5U | 950.50 | 950.29 | 0.21 | 0.04 |
| 10058 | L5U | 999.94 | 999.65 | 0.28 | 0.08 |
| 10059 | L5U | 936.79 | 936.64 | 0.15 | 0.02 |
| 10060 | L5U | 889.95 | 889.66 | 0.29 | 0.08 |
| 10061 | L5U | 951.76 | 951.44 | 0.32 | 0.10 |
| 10062 | L5U | 952.85 | 952.67 | 0.18 | 0.03 |
| 10063 | L5U | 939.43 | 939.03 | 0.40 | 0.16 |
| 10064 | L5U | 940.93 | 940.70 | 0.23 | 0.05 |
| 10065 | L5U | 914.46 | 914.43 | 0.03 | 0.00 |
| 10066 | L5U | 705.96 | 705.98 | -0.02 | 0.00 |
| 10067 | L5U | 917.38 | 917.01 | 0.38 | 0.14 |
| 10068 | L5U | 915.60 | 915.52 | 0.08 | 0.01 |
| 10069 | L5U | 749.84 | 749.62 | 0.22 | 0.05 |
| 10500 | L5U | 952.74 | 952.67 | 0.07 | 0.00 |
| 10501 | L5U | 968.60 | 968.92 | -0.32 | 0.10 |
| 10502 | L5U | 963.07 | 963.49 | -0.41 | 0.17 |
| 10503 | L5U | 897.80 | 897.97 | -0.17 | 0.03 |
| 10504 | L5U | 902.13 | 902.11 | 0.02 | 0.00 |
| 10505 | L5U | 890.74 | 890.67 | 0.07 | 0.01 |
| 10506 | L5U | 896.10 | 896.09 | 0.01 | 0.00 |
| 10507 | L5U | 895.63 | 895.69 | -0.06 | 0.00 |
| 10508 | L5U | 899.21 | 899.34 | -0.13 | 0.02 |
| 10509 | L5U | 900.49 | 900.39 | 0.11 | 0.01 |
| 10510 | L5U | 916.99 | 917.03 | -0.03 | 0.00 |
| 10511 | L5U | 912.28 | 912.07 | 0.21 | 0.05 |
| 10512 | L5U | 924.18 | 923.77 | 0.41 | 0.17 |
| 10514 | L5U | 870.21 | 870.26 | -0.05 | 0.00 |
| 10515 | L5U | 920.59 | 920.61 | -0.02 | 0.00 |
| 10516 | L5U | 921.67 | 921.71 | -0.04 | 0.00 |
| 10517 | L5U | 823.54 | 823.39 | 0.15 | 0.02 |
| 10518 | L5U | 875.64 | 875.26 | 0.38 | 0.15 |
| 10519 | L5U | 939.96 | 939.73 | 0.22 | 0.05 |
| 10520 | L5U | 924.05 | 923.73 | 0.32 | 0.10 |
| 10521 | L5U | 996.81 | 996.43 | 0.38 | 0.15 |
| 10522 | L5U | 991.08 | 990.82 | 0.26 | 0.07 |
| 10523 | L5U | 944.09 | 943.72 | 0.37 | 0.14 |
| 10524 | L5U | 943.97 | 943.59 | 0.37 | 0.14 |
| 10526 | L5U | 749.16 | 749.03 | 0.13 | 0.02 |

| | | | | |
|--------------------------|--------------|------|---------|------|
| | = Pilot Area | | Sum | 5.00 |
| Total Number of Points = | | 97 | Average | 0.05 |
| User-Defined Tolerance = | | 0.60 | RMSEr | 0.23 |

Chi Square Test :



MnMultShot(LIDAR check shots).txt

MnMultShot (2.2.0) Standard Mode English Report 08/21/2007 Page 1
Files:Rush RTK raw photo control.txt

| Point Num | Point Description | X-Coord (f) | Y-Coord (f) | Elev (f) |
|-----------|--------------------------|--------------------|------------------|----------|
| 1 | L1O | 521637.672 | 242737.482 | 920.966 |
| 1 | L1O | 521637.709 | 242737.525 | 920.888 |
| | Mean Computed Coordinate | 521637.690 | 242737.504 | 920.927 |
| | Mean Closure Error: | Horizontal = 0.028 | Vertical = 0.039 | |
| 2 | L1O | 526125.730 | 256023.232 | 940.150 |
| 2 | L1O | 526125.859 | 256023.320 | 940.180 |
| | Mean Computed Coordinate | 526125.795 | 256023.276 | 940.165 |
| | Mean Closure Error: | Horizontal = 0.078 | Vertical = 0.015 | |
| 3 | L1O | 526101.467 | 250132.926 | 930.054 |
| 3 | L1O | 526101.510 | 250132.847 | 930.088 |
| 3 | L1O | 526101.518 | 250132.935 | 929.895 |
| | Mean Computed Coordinate | 526101.498 | 250132.903 | 930.012 |
| | Mean Closure Error: | Horizontal = 0.045 | Vertical = 0.078 | |
| 4 | L1O | 532821.408 | 250593.686 | 930.578 |
| 4 | L1O | 532821.393 | 250593.687 | 930.581 |
| 4 | L1O | 532821.434 | 250593.608 | 930.719 |
| | Mean Computed Coordinate | 532821.412 | 250593.660 | 930.626 |
| | Mean Closure Error: | Horizontal = 0.038 | Vertical = 0.062 | |
| 5 | L1O | 528714.330 | 250790.541 | 928.674 |
| 5 | L1O | 528714.376 | 250790.528 | 928.557 |
| | Mean Computed Coordinate | 528714.353 | 250790.534 | 928.616 |
| | Mean Closure Error: | Horizontal = 0.024 | Vertical = 0.058 | |
| 6 | L2T | 522740.482 | 241189.530 | 926.738 |
| 6 | L2T | 522740.469 | 241189.588 | 926.817 |
| | Mean Computed Coordinate | 522740.476 | 241189.559 | 926.778 |
| | Mean Closure Error: | Horizontal = 0.030 | Vertical = 0.039 | |
| 7 | L2T | 526922.006 | 258213.807 | 937.391 |
| 7 | L2T | 526922.005 | 258213.873 | 937.494 |
| | Mean Computed Coordinate | 526922.006 | 258213.840 | 937.442 |
| | Mean Closure Error: | Horizontal = 0.033 | Vertical = 0.052 | |
| 8 | L2T | 525970.612 | 251929.466 | 932.720 |
| 8 | L2T | 525970.693 | 251929.508 | 932.804 |
| | Mean Computed Coordinate | 525970.652 | 251929.487 | 932.762 |
| | Mean Closure Error: | Horizontal = 0.046 | Vertical = 0.042 | |
| 9 | L2T | 528700.837 | 258173.177 | 932.898 |
| 9 | L2T | 528700.920 | 258173.216 | 932.844 |
| | Mean Computed Coordinate | 528700.879 | 258173.196 | 932.871 |
| | Mean Closure Error: | Horizontal = 0.046 | Vertical = 0.027 | |
| 10 | L2T | 531327.656 | 252614.425 | 934.391 |
| 10 | L2T | 531327.614 | 252614.377 | 934.515 |
| 10 | L2T | 531327.646 | 252614.390 | 934.383 |

MnMultShot(LIDAR check shots).txt

Mean Computed Coordinate 531327.639 252614.397 934.430

Mean Closure Error: Horizontal = 0.025 Vertical = 0.057 □

MnMultShot (2.2.0) Standard Mode English Report 08/21/2007 Page 2

Files:Rush RTK raw photo control.txt

| Point Num | Point Description | X-Coord (f) | Y-Coord (f) | Elev (f) |
|-----------|--------------------------|--------------------|------------------|----------|
| 11 | L3B | 520887.930 | 245559.356 | 925.269 |
| 11 | L3B | 520887.881 | 245559.235 | 925.374 |
| 11 | L3B | 520887.882 | 245559.113 | 925.433 |
| | Mean Computed Coordinate | 520887.898 | 245559.235 | 925.359 |
| | Mean Closure Error: | Horizontal = 0.088 | Vertical = 0.060 | |
| 12 | L3B | 521007.418 | 257398.024 | 943.403 |
| 12 | L3B | 521007.441 | 257398.085 | 943.436 |
| | Mean Computed Coordinate | 521007.429 | 257398.054 | 943.420 |
| | Mean Closure Error: | Horizontal = 0.033 | Vertical = 0.017 | |
| 13 | L3B | 526114.557 | 246716.260 | 929.159 |
| 13 | L3B | 526114.366 | 246716.350 | 928.788 |
| 13 | L3B | 526114.588 | 246716.385 | 929.032 |
| 13 | L3B | 526114.555 | 246716.278 | 928.992 |
| 13 | L3B | 526114.419 | 246716.376 | 928.929 |
| 13 | L3B | 526114.376 | 246716.382 | 928.807 |
| 13 | L3B | 526114.405 | 246716.402 | 928.912 |
| 13 | L3B | 526114.674 | 246716.299 | 929.222 |
| | Mean Computed Coordinate | 526114.493 | 246716.341 | 928.980 |
| | Mean Closure Error: | Horizontal = 0.115 | Vertical = 0.121 | |
| 14 | L3B | 526394.718 | 242793.966 | 919.931 |
| 14 | L3B | 526394.788 | 242794.087 | 919.913 |
| 14 | L3B | 526394.757 | 242794.130 | 919.846 |
| | Mean Computed Coordinate | 526394.754 | 242794.061 | 919.897 |
| | Mean Closure Error: | Horizontal = 0.071 | Vertical = 0.034 | |
| 15 | L3B | 531245.434 | 256999.736 | 938.901 |
| 15 | L3B | 531245.425 | 256999.650 | 938.916 |
| 15 | L3B | 531245.276 | 256999.642 | 939.075 |
| | Mean Computed Coordinate | 531245.378 | 256999.676 | 938.964 |
| | Mean Closure Error: | Horizontal = 0.081 | Vertical = 0.074 | |
| 16 | L4F | 525284.250 | 245206.830 | 924.580 |
| 17 | L4F | 521292.870 | 255196.250 | 942.660 |
| 18 | L4F | 525968.400 | 254571.880 | 938.050 |
| 19 | L4F | 526138.800 | 249860.990 | 932.920 |
| 20 | L4F | 531950.580 | 246903.460 | 923.930 |
| 21 | L5U | 526303.382 | 241204.412 | 918.884 |
| 21 | L5U | 526303.385 | 241204.413 | 918.929 |
| | Mean Computed Coordinate | 526303.384 | 241204.412 | 918.906 |
| | Mean Closure Error: | Horizontal = 0.002 | Vertical = 0.022 | |

MnMultShot(LIDAR check shots).txt

22 L5U 529622.729 241563.830 916.010
 22 L5U 529622.716 241563.857 915.955
 Mean Computed Coordinate 529622.723 241563.844 915.983
 Mean Closure Error: Horizontal = 0.015 Vertical = 0.027 □
 MnMultShot (2.2.0) Standard Mode English Report 08/21/2007 Page 3
 Files:Rush RTK raw photo control.txt

| Point Num | Point Description | X-Coord (f) | Y-Coord (f) | Elev (f) |
|-----------|--------------------------|--------------------|------------------|----------|
| 23 | L5U | 529942.141 | 241104.871 | 917.678 |
| 23 | L5U | 529942.013 | 241104.782 | 917.633 |
| | Mean Computed Coordinate | 529942.077 | 241104.827 | 917.656 |
| | Mean Closure Error: | Horizontal = 0.078 | Vertical = 0.022 | |
| 24 | L5U | 530979.508 | 242193.458 | 918.301 |
| 24 | L5U | 530979.441 | 242193.539 | 918.060 |
| 24 | L5U | 530979.398 | 242193.528 | 918.049 |
| 24 | L5U | 530979.530 | 242193.475 | 918.172 |
| 24 | L5U | 530979.449 | 242193.488 | 918.083 |
| | Mean Computed Coordinate | 530979.465 | 242193.498 | 918.133 |
| | Mean Closure Error: | Horizontal = 0.053 | Vertical = 0.083 | |
| 25 | L5U | 530976.603 | 241634.354 | 916.636 |
| 25 | L5U | 530976.619 | 241634.352 | 916.735 |
| | Mean Computed Coordinate | 530976.611 | 241634.353 | 916.686 |
| | Mean Closure Error: | Horizontal = 0.008 | Vertical = 0.050 | |
| 30 | D51 checkshot | 530613.264 | 241573.475 | 918.118 |
| 30 | D51 checkshot | 530613.327 | 241573.450 | 918.137 |
| 30 | D51 Benchmark | 530613.300 | 241573.460 | 917.977 |
| | Mean Computed Coordinate | 530613.297 | 241573.462 | 918.077 |
| | Mean Closure Error: | Horizontal = 0.024 | Vertical = 0.067 | |

Statistical Summary Of Closure Errors For All Shots:

Horizontal (58 shots): Mean = 0.054 Std. Deviation = 0.042
 Vertical (58 shots): Mean = 0.060 Std. Deviation = 0.051

MnMultShot(picture points).txt

MnMultShot (2.2.0) Standard Mode English Report 08/21/2007 Page 1
Files:picture pointsRAW.txt

| Point Num | Point Description | X-Coord (f) | Y-Coord (f) | Elev (f) |
|-----------|--------------------------|--------------------|------------------|----------|
| 50 | Inside corner target | 523328.288 | 249449.511 | 939.817 |
| 50 | Inside corner target | 523328.303 | 249449.475 | 939.767 |
| | Mean Computed Coordinate | 523328.296 | 249449.493 | 939.792 |
| | Mean Closure Error: | Horizontal = 0.019 | Vertical = 0.025 | |
| 51 | se cor stripe | 523226.456 | 246489.670 | 934.191 |
| 51 | se cor stripe | 523226.459 | 246489.729 | 934.216 |
| | Mean Computed Coordinate | 523226.458 | 246489.700 | 934.204 |
| | Mean Closure Error: | Horizontal = 0.030 | Vertical = 0.012 | |
| 52 | sw cor stripe | 523514.312 | 238522.567 | 922.354 |
| 52 | sw cor stripe | 523514.311 | 238522.539 | 922.307 |
| 52 | sw cor stripe | 523514.348 | 238522.544 | 922.298 |
| | Mean Computed Coordinate | 523514.324 | 238522.550 | 922.320 |
| | Mean Closure Error: | Horizontal = 0.021 | Vertical = 0.023 | |
| 53 | Inside corner target | 520801.047 | 242488.270 | 925.081 |
| 53 | Inside corner target | 520801.019 | 242488.354 | 925.117 |
| | Mean Computed Coordinate | 520801.033 | 242488.312 | 925.099 |
| | Mean Closure Error: | Horizontal = 0.044 | Vertical = 0.018 | |
| 54 | Inside corner target | 520848.226 | 257695.844 | 946.188 |
| 54 | Inside corner target | 520848.228 | 257695.817 | 946.124 |
| | Mean Computed Coordinate | 520848.227 | 257695.830 | 946.156 |
| | Mean Closure Error: | Horizontal = 0.014 | Vertical = 0.032 | |
| 55 | ne cor stripe | 520774.065 | 249593.121 | 937.980 |
| 55 | ne cor stripe | 520773.986 | 249593.224 | 938.000 |
| | Mean Computed Coordinate | 520774.026 | 249593.172 | 937.990 |
| | Mean Closure Error: | Horizontal = 0.065 | Vertical = 0.010 | |
| 56 | ne cor stripe | 524136.588 | 253294.589 | 943.943 |
| 56 | ne cor stripe | 524136.608 | 253294.636 | 943.987 |
| 56 | ne cor stripe | 524136.557 | 253294.647 | 943.807 |
| | Mean Computed Coordinate | 524136.584 | 253294.624 | 943.912 |
| | Mean Closure Error: | Horizontal = 0.032 | Vertical = 0.070 | |
| 57 | nw cor stripe | 527648.828 | 253366.506 | 936.146 |
| 57 | nw cor stripe | 527648.825 | 253366.533 | 936.165 |
| 57 | nw cor stripe | 527648.828 | 253366.431 | 936.016 |
| | Mean Computed Coordinate | 527648.827 | 253366.490 | 936.109 |
| | Mean Closure Error: | Horizontal = 0.039 | Vertical = 0.062 | |
| 58 | ne cor stripe | 532743.629 | 253471.995 | 932.120 |
| 58 | ne cor stripe | 532743.651 | 253471.897 | 932.048 |
| | Mean Computed Coordinate | 532743.640 | 253471.946 | 932.084 |
| | Mean Closure Error: | Horizontal = 0.050 | Vertical = 0.036 | |
| 59 | se cor stripe | 531395.449 | 258284.044 | 938.363 |
| 59 | se cor stripe | 531395.492 | 258284.040 | 938.409 |

MnMultShot(picture points).txt

59 se cor stripe 531395.547 258284.034 938.484
 Mean Computed Coordinate 531395.496 258284.039 938.419
 Mean Closure Error: Horizontal = 0.034 Vertical = 0.044 □
 MnMultShot (2.2.0) Standard Mode English Report 08/21/2007 Page 2
 Files:picture pointsRAW.txt

| Point Num | Point Description | X-Coord (f) | Y-Coord (f) | Elev (f) |
|-----------|--------------------------|--------------------|------------------|----------|
| 60 | nw cor stripe | 531429.639 | 249046.961 | 929.874 |
| 60 | nw cor stripe | 531429.623 | 249047.044 | 929.887 |
| | Mean Computed Coordinate | 531429.631 | 249047.002 | 929.880 |
| | Mean Closure Error: | Horizontal = 0.042 | Vertical = 0.006 | |
| 61 | rr x | 530695.752 | 240191.938 | 917.213 |
| 61 | rr x | 530695.813 | 240192.063 | 917.202 |
| | Mean Computed Coordinate | 530695.782 | 240192.000 | 917.208 |
| | Mean Closure Error: | Horizontal = 0.070 | Vertical = 0.005 | |
| 62 | ne cor concrete | 528838.674 | 242869.021 | 918.089 |
| 62 | ne cor concrete | 528838.630 | 242869.002 | 918.060 |
| | Mean Computed Coordinate | 528838.652 | 242869.012 | 918.074 |
| | Mean Closure Error: | Horizontal = 0.024 | Vertical = 0.015 | |
| 63 | tip arrow | 526110.950 | 243268.830 | 920.041 |
| 63 | tip arrow | 526110.979 | 243268.786 | 920.114 |
| | Mean Computed Coordinate | 526110.964 | 243268.808 | 920.078 |
| | Mean Closure Error: | Horizontal = 0.026 | Vertical = 0.036 | |
| 64 | tip arrow | 525084.852 | 241436.901 | 920.600 |
| 64 | tip arrow | 525084.878 | 241436.888 | 920.792 |
| 64 | tip arrow | 525084.877 | 241436.890 | 920.816 |
| | Mean Computed Coordinate | 525084.869 | 241436.893 | 920.736 |
| | Mean Closure Error: | Horizontal = 0.013 | Vertical = 0.091 | |

Statistical Summary Of Closure Errors For All Shots:

Horizontal (35 shots): Mean = 0.034 Std. Deviation = 0.018
 Vertical (35 shots): Mean = 0.036 Std. Deviation = 0.031

**STATE OF MINNESOTA
JOINT POWERS AGREEMENT
FOR PROFESSIONAL/TECHNICAL SERVICES**

Project Identification: Chisago County LiDAR and Orthophoto Project

This Agreement is between the State of Minnesota, acting through its Commissioner of Transportation ("State") and Chisago County ("Governmental Unit").

Recitals

1. Minnesota Statutes §15.061 authorizes State to engage such assistance as deemed necessary.
2. Minnesota Statutes §471.59 authorizes State and Governmental Unit to enter into this Agreement.
3. State is in need of the Governmental Unit to prepare a Request for Proposal (RFP) for LiDAR and Orthophoto acquisition flights scheduled to begin in the spring of 2007. This project will have countywide coverage and the Governmental Unit will be seeking partners for support of this project. State will be providing partnership dollars and some in-kind services to include surveying (test shot collection), independent accuracy report and expertise (RFP selection committee).
4. Governmental Unit may use the results of the work to create computer software products or systems, which may be protected from disclosure and sold commercially as provided by Minnesota Statutes §375.85.
5. Governmental Unit represents that it is duly qualified and agrees to perform all services described in this Agreement to the satisfaction of State.

Agreement

1 Term of Agreement; Survival of Terms; Incorporation of Exhibits

- 1.1 **Effective date:** This Agreement will be effective on the date State obtains all required signatures under Minnesota Statutes Section §16C.05, subdivision 2.
- 1.2 **Expiration date:** This Agreement will expire on **January 31, 2008**, or when all obligations have been satisfactorily fulfilled, whichever occurs first.
- 1.3 **Survival of Terms:** All clauses which impose obligations continuing in their nature and which must survive in order to give effect to their meaning will survive the expiration or termination of this Agreement, including, without limitation, the following clauses: 6. Liability; 7. State Audits; 8. Government Data Practices; 9. Intellectual Property Rights; and 10. Venue.
- 1.4 **Exhibits:** Exhibit A is attached and incorporated into this Agreement.

2 Scope of Work and Deliverables

This entire scope of work falls under Activity Code 1018

- 2.1 The Governmental Unit is planning to publish an RFP to do orthophotography and a LiDAR collection to create a Digital Elevation Model (DEM). State's cooperation in this multi-government partnership will assure State a copy of the complete data set that can be utilized by both State's Central Office and District 8. This data will be most valuable for pre-design, pre-engineering, hydraulic studies and mapping professionals. The total number of Control Sections covered partially or in whole is nine.
- 2.2 The Governmental Unit will provide the following services with respect to this Agreement:
 - The creation and publication of the RFP in accordance with Minnesota State Statutes
 - Establishment of the vendor selection committee – which will include one member designated by State
 - Project Management – from acquisition through final delivery
 - Invoice payment services to the selected vendor
 - Data storage and dissemination
 - Notification to State should there be an unsatisfactory response to the RFP

2.3 State will provide in-kind services to supplement this project by collecting test point data through its District 8 Surveys Office. The test point data will be within the vicinity of the Trunk Highway system throughout Chisago County. State will also provide an accuracy report and test point analysis through its Photogrammetric Unit. Should the Governmental Unit require specific areas to be tested which fall outside the Trunk Highway vicinity; the Governmental Unit will collect that data and supply it to State's Photogrammetric Unit with a request that the data be included in the accuracy report.

3 Payment

3.1 **Consideration.** State will pay for all services performed by Governmental Unit under this Agreement as follows:

3.1.1 **Compensation.** State will pay Governmental Unit on a Lump Sum basis. The Governmental Unit will submit an invoice, using the format set forth in Exhibit A, for work performed prior to June 30, 2007. Mn/DOT must receive this invoice prior to August 1, 2007.

3.1.2 **Total Obligation.** The total obligation of State for all compensation and reimbursements to Governmental Unit will be \$25,000.00.

3.2 Terms of Payment

3.2.1 **Invoices.** State will promptly pay Governmental Unit after Governmental Unit presents an invoice for the services actually performed and State's Authorized Representative accepts the invoiced services. Governmental Unit will use the format set forth in Exhibit A when submitting Invoices. Invoices must be submitted timely and according to the following schedule:
Prior to August 1, 2007

3.2.2 **Retainage.** Under Minnesota Statutes Section §16C.08, subdivision 5(b), no more than 90% of the amount due under this Agreement may be paid until the final product of this Agreement has been reviewed by State's agency head. The balance due will be paid when State's agency head determines that Governmental Unit has satisfactorily fulfilled all the terms of this Agreement.

3.2.3 **Federal funds.** If federal funds are used Governmental Unit is responsible for compliance with all federal requirements imposed on these funds and accepts full financial responsibility for any requirements imposed by Governmental Unit's failure to comply with federal requirements.

3.3 **License to State.** In consideration of the monetary contribution and in-kind services provide by State, Governmental Unit will provide a license to certain data, and the DEM, as further specified in Article 9.

4 Agreement Personnel

4.1 State's Authorized Representative will be:

Name: Ashley Hartfiel, Contract Administrator
Address: Minnesota Department of Transportation
Consultant Services Section, Mail Stop 680
395 John Ireland Boulevard, St. Paul, Minnesota 55155-1899
Telephone: 651-296-3558
Fax: 651-282-5127
E-Mail: ashley.hartfiel@dot.state.mn.us

State's Authorized Representative, or his/her successor, will monitor Governmental Unit's performance and has the authority to accept or reject the services provided under this Agreement.

4.2 State's Project Manager will be:

Name: Peter Jenkins, Photogrammetric Engineer
Address: Minnesota Department of Transportation
Office of Land Management, Mail Stop 640
395 John Ireland Boulevard, St. Paul, Minnesota 55155-1899

Telephone: 651-296-1079
Fax: 651-297-1521
E-Mail: peter.jenkins@dot.state.mn.us

State's Project Manager, or his/her successor, has the responsibility to monitor Governmental Unit's performance and progress. State's Project Manager will sign progress reports, review billing statements, make recommendations to State's Authorized Representative for acceptance of Governmental Unit's goods or services and make recommendations to State's Authorized Representative for certification for payment of each Invoice submitted for payment.

4.3 Governmental Unit's Authorized Representative will be:

Name: Joe Triplett, Assistant County Engineer
Address: Chisago County Public Works
313 North Main Street, Room 400, Center City, Minnesota 55012
Telephone: 651-213-8700
Fax: 651-213-8772
E-Mail: jktripl@co.chisago.mn.us

5 Assignment, Amendments, Waiver and Contract Complete

- 5.1 **Assignment.** Governmental Unit may neither assign nor transfer any rights or obligations under this Agreement without the prior consent of State and a fully executed Assignment Agreement, executed and approved by the same parties who executed and approved this Agreement, or their successors in office.
- 5.2 **Amendments.** Any Amendment to this Agreement must be in writing and will not be effective until it has been executed and approved by the same parties who executed and approved the Original Agreement, or their successors in office.
- 5.3 **Waiver.** If State fails to enforce any provision of this Agreement, that failure does not waive the provision or its right to subsequently enforce it.
- 5.4 **Contract Complete.** This Agreement contains all prior negotiations and agreements between State and Governmental Unit. No other understanding regarding this Agreement, whether written or oral, may be used to bind either party.

6 Liability

- 6.1 Governmental Unit will indemnify, save and hold State, its agents and employees harmless from any claims or causes of action, including attorney's fees incurred by State, arising from the performance of this Agreement by Governmental Unit, its agents or employees. This clause will not be construed to bar any legal remedies Governmental Unit may have for State's failure to fulfill its obligations under this Agreement.

7 State Audits

- 7.1 Under Minnesota Statutes §16C.05, subdivision 5, Governmental Unit's books, records, documents and accounting procedures and practices relevant to this Agreement are subject to examination by the State and/or the State Auditor or Legislative Auditor, as appropriate, for a minimum of six years from the end of this Agreement.

8 Government Data Practices

- 8.1 Governmental Unit and State must comply with the Minnesota Government Data Practices Act, Minnesota Statutes Chapter 13, as it applies to all data provided by State under this Agreement, and as it applies to all data created, collected, received, stored, used, maintained or disseminated by Governmental Unit under this Agreement. The civil remedies of Minnesota Statutes §13.08 apply to the release of the data referred to in this clause by either Governmental Unit or State.

9 Intellectual Property Rights; License to State

9.1 **Intellectual Property Rights.** Governmental Unit will own all rights, title and interest in all of the intellectual property rights, including copyrights, patents, trade secrets, trademarks and service marks in the Works and Documents created and paid for under its contract with its contractor.

9.2 License

9.2.1 **Grant.** Governmental Unit grants to State a perpetual, irrevocable, non-exclusive, non-transferable and non-assignable license to use the digital orthophotos, lidar data and DEM (collectively the "Licensed Data"). State may grant access to the Licensed Data to its employees, consultants and agents, as necessary for transportation purposes. State will not reproduce or duplicate the Licensed Data for sale licensing or distribution in any manner (except that State may make a reasonable number of backup copies for internal use) and will inform its employees, agents and consultants of such restriction. State, and its employees, agents and consultants, may combine the Licensed Data with other different data to create new and original electronic or hardcopy products that State can use without limitation.

9.2.2 **Governmental Unit's Rights in Data Limited.** Due to changes in land use, the commercial value of the Licensed Data declines over time. At a date that is five years from the date the Licensed Data was delivered to State, the Licensed Data will be deemed "Historical Data". The restrictions on the use of Licensed Data by State, as detailed in Article 9.2.1, will not apply to Historical Data.

9.2.3 **"As Is"; Non-Infringement.** The Licensed Data is provided "as is" and without representation or warranty of accuracy or completeness of the data, or fitness for a particular purpose. Governmental Unit will have no responsibility for State's use of the Licensed Data or Historical Data. Notwithstanding the foregoing, Governmental Unit represents and warrants that the Licensed Data does not infringe upon the intellectual property of another party. If the Licensed Data is determined to infringe upon the intellectual property of another party, Governmental Unit will either replace the data at issue, secure for State the right to use the data despite the infringement, or refund the money paid by State under this Agreement. Governmental Unit's indemnification obligation, as set forth in Article 6, applies to this warranty of non-infringement.

10 Venue

10.1 Venue for all legal proceedings arising out of this Agreement, or its breach, must be in the appropriate state or federal court with competent jurisdiction in Ramsey County, Minnesota.

11 Termination; Suspension

11.1 **Termination.** State or the Commissioner of Administration may terminate this Agreement at any time, with or without cause, upon 30 days' written notice to Governmental Unit.

11.2 **Termination by State for Insufficient Funding.** State may immediately terminate this Agreement if it does not obtain funding from the Minnesota Legislature, or other funding source; or if funding cannot be continued at a level sufficient to allow for the payment of the services covered here. Termination must be by written or fax notice to Governmental Unit. State is not obligated to pay for any services that are provided after notice and effective date of termination. However, Governmental Unit will be entitled to payment, determined on a pro rata basis, for services satisfactorily performed to the extent that funds are available. State will not be assessed any penalty if the agreement is terminated because of the decision of the Minnesota Legislature, or other funding source, not to appropriate funds. State must provide Governmental Unit notice of the lack of funding within a reasonable time of State's receiving that notice.

11.3 **Termination by Governmental Unit for Insufficient Funding.** Governmental Unit's participation is based on a preliminary budget for fiscal year 2007. Governmental Unit may terminate this Agreement if the Chisago County Board does not appropriate sufficient funding to perform the LiDAR and Orthophotography work.

11.3 **Suspension.** State may immediately suspend this Agreement in the event of a total or partial government shutdown due to failure to have an approved budget by the legal deadline. Work performed by Governmental Unit during a period of suspension will be deemed unauthorized and undertaken at risk of non-payment.

12 Additional Provisions

NONE

STATE ENCUMBRANCE VERIFICATION

Individual certifies that funds have been encumbered as required by Minn. Stat. §16A.15 and §16C.05.

Signed: *J. Kellen*

Date: 2.9.2007

CFMS Contract No. A- 96824

DEPARTMENT OF TRANSPORTATION

By: ORIGINAL SIGNED BY
Robert C. Winter
(with delegated authority)

Title: Division Director

Date: 2-9-07

GOVERNMENTAL UNIT*

Governmental Unit certifies that the appropriate person(s) have executed the Agreement on behalf of Governmental Unit as required by applicable articles, bylaws or resolutions.

By: *Mick Palmer*

Title: Chair, County Board

Date: 1/24/2007

COMMISSIONER OF ADMINISTRATION

As delegated to Materials Management Division

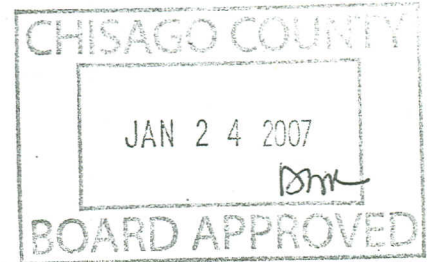
By: *Christine Hayes*

Date: 2/22/07

By: *DeAnn Glatzel*

Title: Clerk, County Board

Date: 1/24/2007



* INCLUDE COPY OF RESOLUTION APPROVING THE AGREEMENT

REVIEWED AS TO FORM BY:

Kirstine Nelson Inge
Asst. County Attorney Date 1/11/07

Mn/DOT Contract Management
[Signature]
Feb 12, 07

FINAL INVOICE

To: Ashley Hartfiel, Authorized Representative
 Minnesota Department of Transportation
 Consultant Services, Mail Stop 680
 395 John Ireland Boulevard, St. Paul, Minnesota 55155

Estimated Completion: _____%

Copy: Peter Jenkins, Project Manager
 Minnesota Department of Transportation
 Office of Land Management, Mail Stop 640
 395 John Ireland Boulevard, St. Paul, Minnesota 55155-1899

Period Ending: _____

Invoice Date: _____

Re: Mn/DOT Agreement No. 90460
 Agreement Expiration Date: January 31, 2008
 Project Description: Chisago County LiDAR and Orthophoto Project

| | Total Contract Amount | Total Billing to Date | Amount Previously Billed | Billed This Invoice |
|---------------------------------------|-----------------------|-----------------------|--------------------------|---------------------|
| 1. Lump Sum Amount: | \$25,000.00 | | | |
| Net Earnings Totals: | \$25,000.00 | | | |
| Total Amount Due This Invoice: | | | | |

| Activity Code | Total Billing to Date | Amount Previously Billed | Billed This Invoice |
|---------------|-----------------------|--------------------------|---------------------|
| 1018 | | | |
| Total* | | | |

*Must Match Net Earnings Total Above

I certify that the above statement is correct and payment has not been received.

Signature: _____

Print Name: _____

Title: _____

Billing Address: Chisago County
 313 North Main Street, Room 400
 Center City, Minnesota 55012

Telephone: 651-213-8700

Approved for Payment: _____

Date: _____

For Consultant Services Use Only



United States Department of the Interior

U.S. GEOLOGICAL SURVEY
Reston, Virginia 20192REPORT OF CALIBRATION
of Aerial Mapping Camera

May 17, 2005

| | | | |
|-----------------------|-----------------------------|--------------------|-------|
| Camera type: | Wild RC30* | Camera serial no.: | 5296 |
| Lens type: | Wild Universal Aviogon /4-S | Lens serial no.: | 13433 |
| Nominal focal length: | 153 mm | Maximum aperture: | f/4 |
| | | Test aperture: | f/4 |

Submitted by: MD Atlantic Technologies, Inc.
Huntsville, Alabama

Reference: MD Atlantic Technologies, Inc. purchase order No. 05PO115,
dated May 18, 2005.

These measurements were made on Agfa glass plates, 0.19 inch thick, with spectroscopic emulsion type APX Panchromatic, developed in D-19 at 68° F for 3 minutes with continuous agitation. These photographic plates were exposed on a multicollimator camera calibrator using a white light source rated at approximately 5200K.

I. Calibrated Focal Length: 153.758 mm

II. Lens Distortion

| Field angle: | 7.5° | 15° | 22.7° | 30° | 35° | 40° |
|-----------------------|------|-----|-------|-----|-----|-----|
| Symmetric radial (um) | -2 | -3 | -3 | -1 | 1 | 3 |
| Decentering (um) | 0 | 0 | 1 | 2 | 3 | 4 |

| <u>Symmetric radial distortion parameters</u> | <u>Decentering distortion parameters</u> | <u>Calibrated principal point</u> |
|---|--|---------------------------------------|
| $K_0 = 0.8279 \times 10^{-4}$ | $P_1 = -0.1152 \times 10^{-6}$ | $x_p = -0.001$ mm |
| $K_1 = -0.1193 \times 10^{-7}$ | $P_2 = -0.1923 \times 10^{-6}$ | $y_p = -0.009$ mm |
| $K_2 = 0.3419 \times 10^{-12}$ | $P_3 = 0.0000$ | |
| $K_3 = 0.0000$ | $P_4 = 0.0000$ | |
| $K_4 = 0.0000$ | | |

The values and parameters for Calibrated Focal Length (CFL), Symmetric Radial Distortion (K_0, K_1, K_2, K_3, K_4), Decentering Distortion (P_1, P_2, P_3, P_4), and Calibrated Principal Point [point of symmetry] (x_p, y_p) were determined through a least-squares Simultaneous Multiframe Analytical Calibration (SMAC) adjustment. The x and y-coordinate measurements utilized in the adjustment of the above parameters have a standard deviation (σ) of ± 3 microns.

* Equipped with Forward Motion Compensation

III. Lens Resolving Power in cycles/mm

Area-weighted average resolution: 111

| Field angle: | 0° | 7.5° | 15° | 22.7° | 30° | 35° | 40° |
|------------------|-----|------|-----|-------|-----|-----|-----|
| Radial Lines | 113 | 134 | 134 | 134 | 113 | 113 | 95 |
| Tangential lines | 113 | 134 | 113 | 113 | 113 | 95 | 80 |

The resolving power is obtained by photographing a series of test bars and examining the resultant image with appropriate magnification to find the spatial frequency of the finest pattern in which the bars can be counted with reasonable confidence. The series of patterns has spatial frequencies from 5 to 288 cycles/mm in a geometric series having a ratio of the 4th root of 2. Radial lines are parallel to a radius from the center of the field, and tangential lines are perpendicular to a radius.

IV. Filter Parallelism

The two surfaces of the Wild 525 No. 7834 filter accompanying this camera are within 10 seconds of being parallel. This filter was used for the calibration.

V. Shutter Calibration

| Indicated time (sec) | Rise time (μ sec) | Fall Time (μ sec) | % width time (ms) | Nom. Speed (sec.) | Efficiency (%) |
|-------------------------|---------------------------|---------------------------|----------------------|----------------------|-------------------|
| 1/125 | 1980 | 1871 | 8.73 | 1/130 | 87 |
| 1/250 | 901 | 891 | 4.25 | 1/270 | 87 |
| 1/500 | 464 | 462 | 2.13 | 1/540 | 87 |
| 1/1000 | 228 | 229 | 1.08 | 1/1070 | 87 |

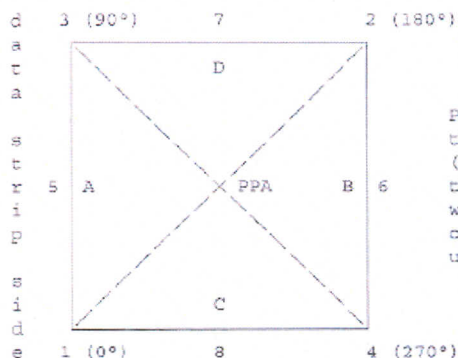
The effective exposure times were determined with the lens at aperture $f/4$. The method is considered accurate within 3 percent. The technique used is described in International Standard ISO 516:1999(E).

VI. Film Platen

The film platen mounted in Wild RC30 drive unit No. 5296-569 does not depart from a true plane by more than 13 μ m (0.0005 in).

This camera is equipped with a platen identification marker that will register "669" in the data strip area for each exposure.

VII. Principal Points and Fiducial Coordinates



Positions of all points are referenced to the principal point of autocollimation (PPA) as origin. The diagram indicates the orientation of the reference points when the camera is viewed from the back, or a contact positive with the emulsion up. The data strip is to the left.

| | X coordinate | Y coordinate |
|---|--------------|--------------|
| Indicated principal point, corner fiducials | 0.004 mm | -0.009 mm |
| Indicated principal point, midside fiducials | 0.002 | -0.006 |
| Principal point of autocollimation (PPA) | 0.0 | 0.0 |
| Calibrated principal point (pt. of sym.) x_p, y_p | -0.001 | -0.009 |

Fiducial Marks

| | | |
|---|-------------|-------------|
| 1 | -105.993 mm | -106.007 mm |
| 2 | 106.001 | 105.990 |
| 3 | -105.994 | 105.989 |
| 4 | 106.003 | -106.007 |
| 5 | -111.997 | -0.006 |
| 6 | 112.001 | -0.007 |
| 7 | 0.000 | 111.992 |
| 8 | 0.003 | -112.023 |

VIII. Distances Between Fiducial Marks

Corner fiducials (diagonals)

1-2: 299.807 mm 3-4: 299.809 mm

Lines joining these markers intersect at an angle of 89° 59' 59"

Midside fiducials

5-6: 223.998 mm 7-8: 224.015 mm

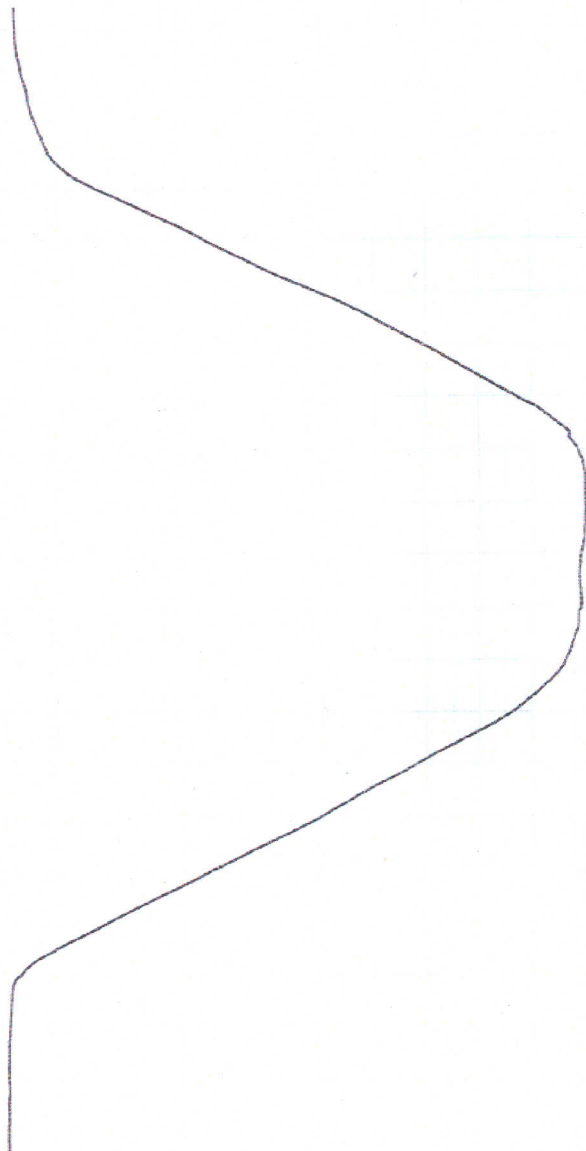
Lines joining these markers intersect at an angle of 90° 00' 03"

Corner fiducials (perimeter)

1-3: 211.996 mm 2-3: 211.996 mm
1-4: 211.996 mm 2-4: 211.997 mm

The method of measuring these distances is considered accurate within 0.003 mm

Note: For GPS applications, the nominal entrance pupil distance from the focal plane is 277 mm.



SX OBS 5-6 .36D WILD 50 λ = 525nm, AV 2x
2MM X. 12MM 5-6 1:1 # U. AVIOGON 14-S 4/12/05 3146
7634 L. 13433
M.D. OPTIC. TECHNOLOGIES.

From: "Michael D. Vessel" <Michael.Vessel@optimalgeo.com>
To: Peter Jenkins <Peter.Jenkins@dot.state.mn.us>
Date: 6/13/2008 8:43:59 AM
Subject: RE: Chisago County Test Points

Pete,

We have taken a look at the points and don't have anything significant to report. Our LiDAR Manager did comment that a couple points may have been impacted by changing landscape between the LiDAR survey and the validation survey. The specific example he provided was one that appeared to be near a lake in a beach area. He stated that the area appeared to be slightly dug out in the LiDAR data compared to the validation point. Either way, we can always probably expect some differences in land cover types like this that are prone to change over time. Do you know the timeframe in which the validation points were collected?

I certainly appreciate you providing the points for us to review. I am definitely happy with the results I have seen thus far from your reporting and look forward to reviewing your final report. It appears that we may be off in the mixed land cover statistic by a couple hundredths of a foot but it sounds like the overall accuracy is quite good.

Regards,
Mike

-----Original Message-----

From: Michael D. Vessel
Sent: Tuesday, June 03, 2008 4:36 PM
To: 'Peter Jenkins'
Subject: RE: Chisago County Test Points

Thanks Pete. I will let you know how our review progresses.

Regards,
Mike

-----Original Message-----

From: Peter Jenkins [mailto:Peter.Jenkins@dot.state.mn.us]
Sent: Tuesday, June 03, 2008 4:31 PM
To: Michael D. Vessel
Subject: RE: Chisago County Test Points

Mike:

I started to work on the report today. I will not be ready for final review until next week or later, so as of today you know my schedule.

Pete

Peter W. Jenkins, LS
Photogrammetric Unit Supervisor
Minnesota Department of Transportation
395 John Ireland Boulevard, MS 640
St. Paul, MN 55155-1899

Phone: 651.366.3457
peter.jenkins@dot.state.mn.us

>>> "Michael D. Vessel" <Michael.Vessel@optimalgeo.com> 6/3/2008 4:10:12 PM >>>

Pete,

Our LiDAR Manager has been out on vacation and has been unavailable to review the check points. I am hoping we can get a look at them in conjunction with the LiDAR data this week but it may slide a bit into next week. I hope that we are not holding you up on your reporting. We will do our best to review these points in the short term.

I am definitely pleased overall with the results from your previous statistics. If we end up with an RMSE that is a couple hundredths out from our target stats but includes mixed land cover, I think that provides a pretty solid overall confidence in the dataset as a whole.

Regards,
Mike

-----Original Message-----

From: Peter Jenkins [mailto:Peter.Jenkins@dot.state.mn.us]
Sent: Tuesday, May 27, 2008 9:49 AM
To: Michael D. Vessel
Subject: RE: Chisago County Test Points

Mike:
Attached is our files.
Pete

Peter W. Jenkins, LS
Photogrammetric Unit Supervisor
Minnesota Department of Transportation
395 John Ireland Boulevard, MS 640
St. Paul, MN 55155-1899

Phone: 651.366.3457
peter.jenkins@dot.state.mn.us

>>> "Michael D. Vessel" <Michael.Vessel@optimalgeo.com> 5/13/2008 10:29 AM >>>
Pete,

We completed our review of the suspect points and are assembling our comments. From an overview perspective, two of the points are in areas on slopes which are not typically good for this type of assessment. Some of the others are in low vegetation where the classification is influencing the result and should be maintained in the statistics. The others are in open locations where we would not expect to see differences quite this high.

If possible, we would like to review some other points in the vicinity of these if possible. Can you send the XY coordinates for the full set of points? If you have a version of your vertical accuracy spreadsheet with XY columns, that would be great.

Regards,
Mike

-----Original Message-----

From: Peter Jenkins [mailto:Peter.Jenkins@dot.state.mn.us]
Sent: Friday, May 09, 2008 8:28 AM
To: Michael D. Vessel
Cc: tgjohns@co.chisago.mn.us
Subject: Chisago County Test Points

Mike:

Attached are two files, one is a coordinate list of points that I feel need to be investigated. The second file is a test run, minus these points. The current condition statistics with these points included show a RMSE = 0.35 and 95% Confidence (NSSDA) = 0.68.

Here is are the current differences:

| | | | | | |
|-------|-----|--------|--------|-------|------|
| 10300 | L3B | 940.57 | 941.63 | -1.05 | 1.11 |
| 10305 | L3B | 891.07 | 892.14 | -1.08 | 1.16 |
| 10307 | L3B | 908.08 | 907.00 | -1.08 | 1.17 |
| 10048 | L5U | 926.51 | 924.99 | 1.52 | 2.32 |
| 10513 | L5U | 916.65 | 915.74 | 0.91 | 0.84 |

The second column is the cover classification, L=Lidar, #=pen or line type, O=Open, T=Tall Grass, B=Brush, F=Forest, U=Urban.

If you could look into the location of these points and give me your judgement as to the suitability of their use as test points I would appreciate it. If they are deemed appropriate, I will have the someone re-observe them as a final check before including them in my report to the County.

Thanks
Pete

Peter W. Jenkins, LS
Photogrammetric Unit Supervisor
Minnesota Department of Transportation
395 John Ireland Boulevard, MS 640
St. Paul, MN 55155-1899

Phone: 651.366.3457
peter.jenkins@dot.state.mn.us

From: "Michael D. Vessel" <Michael.Vessel@optimalgeo.com>
To: Peter Jenkins <Peter.Jenkins@dot.state.mn.us>
Date: 5/14/2008 4:35:42 PM
Subject: FW: Chisago County Test Points

Pete,

Attached below are the specific comments from the review of the suspect points by our LiDAR Manager. My comments are in blue. If you have any questions, please feel free to phone or drop a note.

Regards,

Mike

Point 10300: Appears to be in an area of low vegetation. The LiDAR appears to be sitting on the vegetation. I'd be curious to see other points in the vicinity. I think this should be included in the overall error calculation but should be omitted from the open ground statistic.

Point 10305 appears to be in an area of low vegetation. The LiDAR appears to be sitting on the vegetation. I'd be curious to see other points in the vicinity. I think this should be included in the overall error calculation but should be omitted from the open ground statistic.

Point 10307 appears to sit under a tree and brush at the edge of a transition in the slope of the terrain. Analysis of the points in the vicinity of this check point would lead one to conclude the surface is fitting to better than 1', however, with the transitional slope occurring a simple ping of the TIN will not show this. This is not really considered a very good location for a check point. I think this should be omitted from the overall error calculation.

Point 10402 is sitting in dense forest along a sloping ridgeline. That point is sitting approximately 0.63' which is not unreasonable given the slope and cover. This is not really considered a very good location for a check point. I think this should be omitted from the overall error calculation.

Point 10048 appears to be in an open area near a body of water. I'd be curious to see other points in the vicinity. I think this should be included in the overall error calculation. This point may be a good one to revisit if possible to verify the measurement.

Point 10513 appears to be in an urban area. This is in an area of two overlapping and well fitting flightlines. I'd be curious to see other points in the vicinity. I think this should be included in the overall error calculation. This point may be a good one to revisit if possible to verify the measurement.

Point 10313 appears to be in an area with some vegetation. I think this should be included in the overall error calculation but should be omitted from the open ground statistic.

-----Original Message-----

From: Darrick L. Wagg

Sent: Monday, May 12, 2008 3:29 PM

To: Michael D. Vessel

Subject: RE: Chisago County Test Points

Mike,

Point 10300 appears to be in an area of low vegetation. The LiDAR appears to be sitting on the vegetation. I'd be curious to see other points in the vicinity.

Point 10305 appears to be in an area of low vegetation. The LiDAR appears to be sitting on the vegetation. I'd be curious to see other points in the vicinity.

Point 10307 appears to sit under a tree and brush at the edge of a transition in the slope of the terrain. Analysis of the points in the vicinity of this check point would lead one to conclude the surface is fitting to better than 1', however, with the transitional slope occurring a simple ping of the TIN will not show this. This is not really considered a very good location for a check point.

Point 10402 is sitting in dense forest along a sloping ridgeline. That point is sitting approximately 0.63' which is not unreasonable given the slope and cover. This is not really considered a very good location for a check point.

Point 10048 appears to be in an open area near a body of water. I'd be curious to see other points in the vicinity.

Point 10513 appears to be in an urban area. This is in an area of two overlapping and well fitting flightlines. I'd be curious to see other points in the vicinity.

Point 10313 appears to be in an area with some vegetation.

I can show you these if you'd like to get a better feel, though it looks like only 10307 and 10402 are not suitable locations for check points.

Regards,

Darrick

-----Original Message-----

From: Michael D. Vessel

Sent: Friday, May 09, 2008 8:51 AM

To: Darrick L. Wagg

Cc: Tomas E. Perdomo; Chris Lamons

Subject: FW: Chisago County Test Points

Darrick,

Attached are the specific points requiring evaluation. We may want to supplement the LIDAR review by also taking a look at the orthos or stereo imagery.

When do you think we will be able to look at these? We need to report back no later than Tuesday unless this is not possible for some reason. Please advise.

Regards,

Mike

-----Original Message-----

From: Peter Jenkins [mailto:Peter.Jenkins@dot.state.mn.us]

Sent: Friday, May 09, 2008 8:28 AM

To: Michael D. Vessel

Cc: tgjohns@co.chisago.mn.us

Subject: Chisago County Test Points

Mike:

Attached are two files, one is a coordinate list of points that I feel need to be investigated. The second file is a test run, minus these points. The current condition statistics with these points included show a RMSE = 0.35 and 95% Confidence (NSSDA) = 0.68.

Here is are the current differences:

| | | | | | |
|-------|-----|--------|--------|-------|------|
| 10300 | L3B | 940.57 | 941.63 | -1.05 | 1.11 |
| 10305 | L3B | 891.07 | 892.14 | -1.08 | 1.16 |
| 10307 | L3B | 908.08 | 907.00 | -1.08 | 1.17 |
| 10048 | L5U | 926.51 | 924.99 | 1.52 | 2.32 |
| 10513 | L5U | 916.65 | 915.74 | 0.91 | 0.84 |

The second column is the cover classification, L=Lidar, #=pen or line type, O=Open, T=Tall Grass, B=Brush, F=Forest, U=Urban.

If you could look into the location of these points and give me your judgement as to the suitability of their use as test points I would appreciate it. If they are deemed appropriate, I will have the someone re-observe them as a final check before including them in my report to the County.

Thanks

Pete

Peter W. Jenkins, LS

Photogrammetric Unit Supervisor

Minnesota Department of Transportation

395 John Ireland Boulevard, MS 640

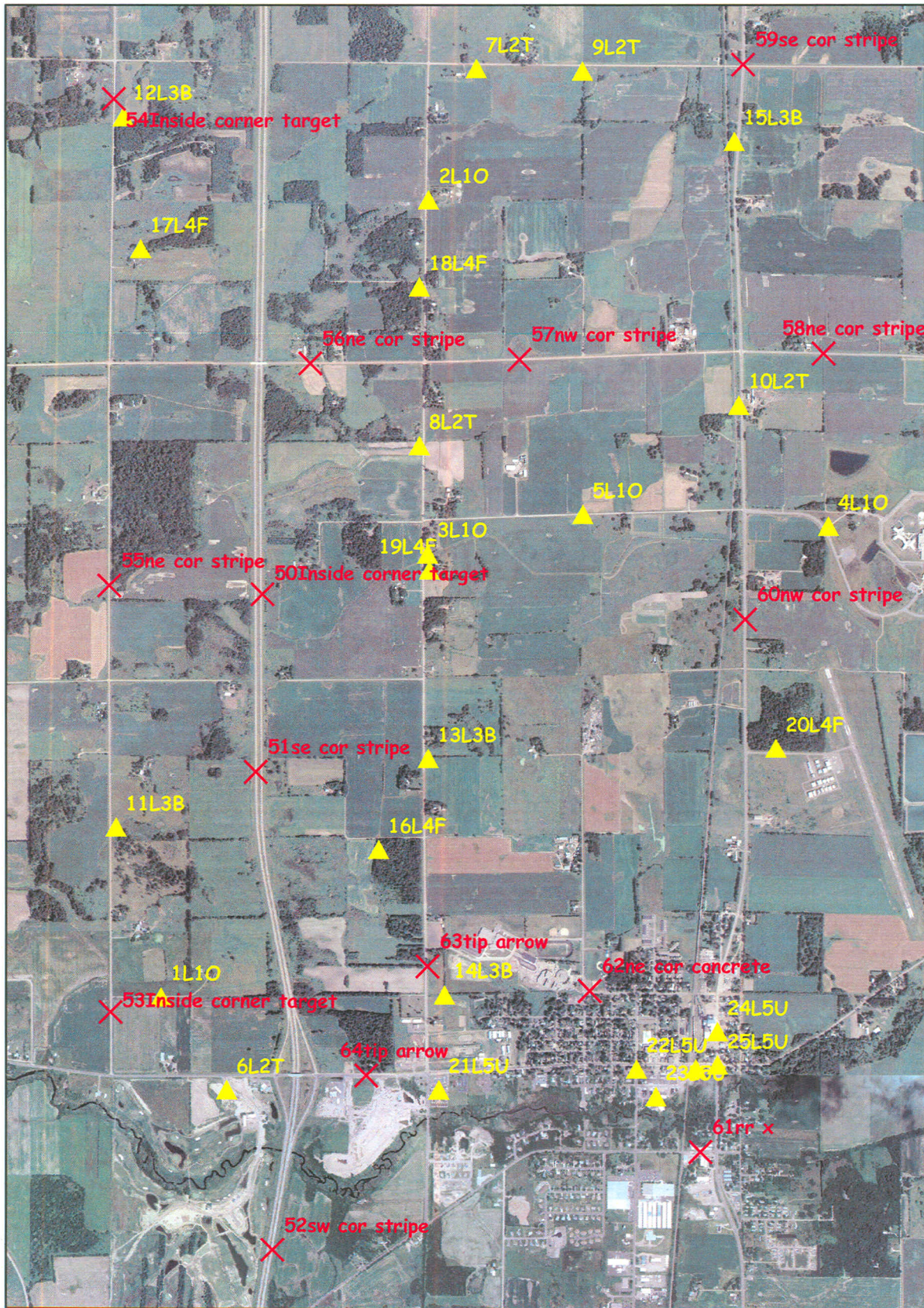
St. Paul, MN 55155-1899

Phone: 651.366.3457

peter.jenkins@dot.state.mn.us

CC: "tgjohns@co.chisago.mn.us" <tgjohns@co.chisago.mn.us>

Rush City LIDAR check shots



APPENDIX A

| NMAS Equivalent Contour Interval | NSSDA RMSE(z) | NSSDA Accuracy (z) | Required Accuracy for Reference Data for "Tested to Meet" |
|----------------------------------|--------------------|---------------------|---|
| 0.5 | 0.15 ft or 4.60 cm | 0.30 ft or 9.10 cm | 0.10 ft |
| 1 | 0.30 ft or 9.25 cm | 0.60 ft or 18.2 cm | 0.20 ft |
| 2 | 0.61 ft or 18.5 cm | 1.19 ft or 36.3 cm | 0.40 ft |
| 4 | 1.22 ft or 37.0 cm | 2.38 ft or 72.6 cm | 0.79 ft |
| 5 | 1.52 ft or 46.3 cm | 2.98 ft or 90.8 cm | 0.99 ft |
| 10 | 3.04 ft or 92.7 cm | 5.96 ft or 181.6 cm | 1.98 ft |

Table 1 Comparison of NMAS/NSSDA Vertical Accuracy

| NMAS Mp Scale | NMAS CMAS 90% | NSSDA RMSE(r) | NSSDA Accuracy (r) 95% confidence level |
|---------------------------|---------------|---------------------|---|
| 1" = 100' or 1:1, 200 | 3.33 ft | 2.20 ft or 67.0 cm | 3.80 ft or 1.159 m |
| 1" = 200' or 1: 2, 400 | 6.67 ft | 4.39 ft or 1.339 m | 7.60 ft or 2.318m |
| 1" = 400' or 1: 4, 800 | 13.33 ft | 8.79 ft or 2.678 m | 15.21 ft or 4.635 m |
| 1" = 500' or 1: 6,000 | 16.67 ft | 10.98 ft or 3.348 m | 19.01 ft or 5.794 m |
| 1: = 1000' or 1: 12, 000 | 33.33 ft | 21.97 ft or 6.695 m | 38.02 ft or 11.588 m |
| 1" = 2000' or 1: 24, 000* | 40.00 ft | 26.36 ft or 8.035m | 45.62 ft or 13.906 m |

Table 2 Comparison of NMAS/NSSDA Horizontal Accuracy