SECTION 2:

FINAL REPORT OF SPECIFIC PURPOSE SURVEY: FY 2007 SWFWMD HERNANDO COUNTY LIDAR (L776) MAPPING PROJECT

Purpose/Type of Survey

To support engineering, hydrologic and environmental studies in the North District (L776), the Southwest Florida Water Management District (DISTRICT) contracted Woolpert, Inc. (Woolpert) to create a digital terrain model (DTM), to support the development of the generation of 2-foot contours meeting National Map Accuracy Standards. The area for the FY 2007 North District LiDAR project encompassed approximately +/-462 square miles of Hernando County, FL (see Exhibit A, 2007 SWFWMD N. District DOI/LiDAR & Polk County DOI/LiDAR Projects Flight Plan and Ground Control Layout). The LiDAR data was collected at an average ground sample distance of 2.1 feet. The end product complies with the Florida Administrative Code 61G17, Minimum Technical Standards for Surveying and Mapping.

As part of this effort, Woolpert also acquired multi-spectral digital imagery of Hernando County using the Leica ADS40/51 sensor (panchromatic, red, green, blue and near infrared) at a ground sample distance of 0.66-foot to support photogrammetric QC and enhancement of the LiDAR DTM, with hydrologically significant features collected as breaklines.

As mutually agreed between the DISTRICT and Woolpert, the DTM accuracy is consistent with the National Map Accuracy Standards for 2' contours at 1"=100' output scale mapping. Supplemental 1' contours were provided for graphical/visualization purpose, only. The 1' contours are for visualization purposes only; it was not the intent of this project to develop high quality cartographic contours.

Two hundred and ten (210) ground survey quality control (QC) checkpoints were surveyed by Woolpert throughout the project area. The ground survey QC checkpoints were used to confirm the accuracy of the LiDAR data. The accuracy analysis was based on methods outlined in the Geospatial Positioning Accuracy Standards, Part 3: National Standards for Spatial Data Accuracy (NSSDA) developed by the Federal Geodetic Data Committee (FGDC-STD-007.3-1998).

Sensor Description

All data was acquired using the Leica ALS50-II LiDAR sensor, serial number 18 and 46. The ALS50 has a laser pulse rate of up to 150 kilohertz, records up to 4 returns per pulse, and records return intensities for 3 laser returns per pulse. The Hernando County LiDAR data was collected at 2,400' above ground level, at an average airspeed of 120 knots.

Dates of Survey

The ground control targeting and observations occurred January 2, 2007 through January 19, 2007. The LiDAR data was acquired January 11, 2007 through January 16, 2007.

Survey Area

The area for the FY 2007 North District LiDAR project encompassed approximately +/-462 square miles of Hernando County, FL.

Map Reference

There are no printed maps for this survey. All map data was delivered to the District in digital form only.

Name of Responsible Surveyor

Savo Slijepcevic CP, PSM
Woolpert, Inc.
11315 Corporate Boulevard, Suite 115
Orlando, Florida 32817-8340
Professional Surveyor and Mapper Number LS-0005438

Name of Company

Woolpert, Inc.
11315 Corporate Boulevard, Suite 115
Orlando, Florida 32817-8340
Florida Certificate of Authorization No. LB-0006777

Abbreviations

2D – Two-Dimensional
3D – Three-Dimensional
ABGPS – Airborne GPS
AGL – Above Ground Level
AT – Aerial Triangulation
CD – Compact Disc or DVD (Digital Video Disc)
DEM – Digital Elevation Model
DISTRICT – Southwest Florida Water Management District
DOI – Digital Orthophoto Imagery or Image Raster Map
FCIR–False Color Infrared
FGCC – Federal Geodetic Control Committee
GeoTIFF – Georeferenced Tag(ged) Image File Format
GPS – Global Positioning System
GSD – Ground Sample Distance
ID – Identification
IMU – Inertial Measurement Unit

Inc. – Incorporated
LiDAR – Light Detection And Ranging
NAD 83-HARN – North American Datum 1983 High Accuracy Reference Network adjustment
NAVD 88 – North American Vertical Datum of 1988
NGS – National Geodetic Survey
NMAS – National Map Accuracy Standards
NOAA – National Oceanic and Atmospheric Administration
NSSDA – National Standards for Spatial Data Accuracy
PSM – Professional Surveyor and Mapper
QA – Quality Assurance
QC – Quality Control
RGB – Red, Green and Blue Bands
RMSE – Root Mean Square Error
RTK – Real Time Kinematic
STD – Standard
TIFF – Tag(ged) Image File Format
TIN – Triangulated Irregular Network
USGS – United States Geological Survey
US – United States
Woolpert, Inc. – Woolpert
Vx – Residual Horizontal Error in the X Direction
Vxy – Residual Horizontal Error in the Y Direction
Vxy – Residual Horizontal Error in the XY Direction (Resultant)
XYZ – Easting, Northing and elevation grid coordinates (ASCII format)

Definitions

GeoTIFF: GeoTIFF refers to TIFF files which have georeferencing information embedded as tags within the TIFF file. The georeferencing information includes projections, coordinate systems, ellipsoids, and datums that can then be used to establish the exact spatial reference for the TIFF image file. The TIFF file structure allows both the georeferencing information and the image data to be encoded into the same file.

Digital Orthophoto Image: A digital orthophoto image (raster) map produced from a series of aerial photographs and/or image strips that have been rectified to correct for aircraft tilt, terrain relief, and camera lens distortion. The resulting image has a consistent scale throughout, allowing the user to take direct measurements such as distances, angles, positions, and areas. The digital raster image is comprised of a digital grid of pixels, or picture elements. Each pixel has a row and column “address” (an X,Y coordinate) and an intensity value ranging from 0 to 255. Each pixel within an RGB image, will have an intensity value for the red, green, and blue bands.

Aerial Triangulation (AT): A method of ground control extension or densification performed mathematically and in conjunction with a limited number of ground control points, ABGPS XYZ coordinates, and aircraft trajectory data from the sensor’s IMU. This method of control extension or densification has been proven to be accurate and is in common use within the photogrammetric mapping community.

Bare Earth Coverage: A set of discrete XYZ values representing the terrain surface.

Obscured Area: An area of the Earth’s surface containing natural or manmade features that

occlude directly imaging or sampling the ground surface with an airborne optical imaging and/or LiDAR sensor. Obscured areas are clearly denoted in digital map files with polygons delineating the area along with a text label. When generating contours within obscured areas, the industry standard calls for the contours to be dashed. Dashed contours should indicate to the user that the accuracy of that spatial data is degraded and/or indeterminate.

Unobscured Area: An area on the Earth's surface that is not totally obscured. Unobscured areas include paved areas, gravel and dirt roads, low grass, low scrub, and low trees. The elevation data captures through remote sensing methods within these areas meet or exceed the defined standards.

Map Data Accuracy

Vertical Feature Accuracy of Unobscured Points: Per contract specifications, the vertical accuracy requirement of the digital terrain model (DTM) is 0.6 foot at 95% confidence level using RMSE(z) x 1.9600 as defined by the National Standard for Spatial Data Accuracy (NSSDA). Based on Woolpert's accuracy analysis (see Appendix G, Accuracy Analysis), the tested **vertical accuracy of the LiDAR data is 0.45-feet at the 95% confidence level for unobscured locations. Therefore, the vertical accuracy of the delivered DTM exceeds the accuracy requirements for this project by 0.15-feet, at unobscured locations.**

Vertical Feature Accuracy of Obscured Points: There are no DISTRICT accuracy specifications for obscured points in the North District project. Additionally, there is not a published National Map Accuracy Standards or industry standards for obscured points, as the ground is not measurable in these areas using photogrammetric methods. Therefore, the used should exercise caution when working with mass points and breaklines within obscured/vegetation polygons as this data may not meet the accuracy requirements as set forth in the FEMA "Guidelines and Specifications for Flood Hazard Mapping Partners" for unobscured points.

Datums/Coordinate Systems

The LiDAR data and breaklines are in reference to the State Plane Coordinate System, Florida West Zone (0902), in units of US Survey Feet. The horizontal datum is NAD83-HARN, and the vertical datum is NAVD88.

Data Sources

Original Control Point Coordinates:	NGS Information Services NOAA, N/NGS12 National Geodetic Survey SSMC-3, #9202 1315 East-West Highway Silver Spring, Maryland 20910-3282 Phone: (301) 713-3242 Fax: (301) 713-4172 Email: info_center@ngs.noaa.gov http://www.ngs.noaa.gov/ Southwest Florida Water Management District Mapping and GIS Section 2379 Broad Street

Brooksville, Florida 34604-6899
Phone: (352) 796-7211 Fax: (352) 384-1185

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Orlando, Florida 32817-8340
Phone: (407) 381-2192 Fax: (407) 384-1185
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Methodology

The purpose of the topographic LiDAR survey was to produce a DTM of sufficient density and accuracy to support the generation of 2-foot contours. Along with the LiDAR data, digital imagery was acquired with a Lecia ADS40/51 at a 0.66' ground sample distance. The imagery was used to photogrammetrically review the LiDAR data, and add breaklines to hydrologically enforce the DTM. The project survey area is approximately +/-462 square miles, of Hernando County.

To support the development of the DTM, 104 flight lines (swaths), of high density LiDAR data (average 2.1' GSD) were obtained at an altitude of 2,400' AGL. Photogrammetric methods were employed to assist in QC and enhancement of the LiDAR data and compilation of breaklines. The digital imagery collected at 0.66' GSD was controlled across the LiDAR project limits. The digital imagery was triangulated and stereomodels were generated for use on a softcopy photogrammetric workstation. Bare earth LiDAR data was imported into the workstation, superimposed over the stereomodels, and reviewed in 3D. Hard and soft breaklines were photogrammetrically captured, and the LiDAR data was stereoscopically verified to be on the ground surface. The addition of the breaklines is to hydrologically enforce the DTM. The DTM was delivered as LiDAR mass points in LAS version 1.1 and the breaklines were delivered in an ArcGIS Personal Geodatabase.

LiDAR Ground Control Survey

The photogrammetric ground control network was comprised of 13 control points located to second-order horizontal and third-order vertical accuracies in Hernando County. Of the 13 control points, 2 new points were established by Woolpert for this project and 11 existing points were used from the 2007 North District Digital Orthophoto project. All control points were targeted prior to imagery acquisition with 8' x 8' x 2' cloth or painted targets. For a detailed overview of the ground control survey, refer to: Woolpert Photogrammetric Ground Control Survey Report, *Minimum Technical Standards, FY2007 North District Orthophoto (B089) and Hernando County LiDAR (L776) Project, Southwest Florida Water Management District, July 5, 2007*.

QC Checkpoint Ground Control Survey

To support the accuracy analysis of the LiDAR, Woolpert acquired 210 new field survey QC checkpoints (see Appendix G: LiDAR Accuracy Checks) with RTK GPS ground survey. The checkpoints were surveyed in 10 groups of 10 points each in areas of varying ground cover, bare earth, urban and brush. Two dense vegetation profiles were surveyed at 1200' in length, 15 points

per profile. Of these points, 197 points were used for the LiDAR QC analysis. The primary report of survey for the ground control surveys is *Minimum Technical Standards FY2007 North District Orthophoto (B089) and Hernando County LiDAR (L776) Mapping Project, Southwest Florida Water Management District, July 5, 2007.*
Within the survey report are location diagrams for all control points established, descriptions of the data adjustments performed, and final adjusted coordinates for the FY2007 project.

Aerial Imagery

The digital image data was acquired using two Leica ADS40/51 digital sensors, serial number 30027 calibrated on September 21, 2004 and serial number 30101 calibrated on January 8, 2007 (see Appendix D: ADS40 Calibration Reports). Both the FCIR and RGB bands were acquired simultaneously. The maximum acquisition ground sampling distance for the LiDAR QC flights was 0.66-foot, and this imagery was used for photogrammetric QC of the LiDAR data and breakline compilation.

LiDAR

The LiDAR data was acquired using a Leica ALS50-II LiDAR sensor. One hundred and four (104) flight lines of LiDAR data were acquired January 11, 2007 through January16, 2007. The average GSD of the raw LiDAR data was 2.1'. One ABGPS base station was used during acquisition. The base station was located on NGS point HERNPORT, located at the Hernando County Airport (BKV).

The ABGPS data was reduced using the GrafNav software package by Waypoint Consulting, Incorporated. The IMU data was reduced using the PosProc software package by Applanix Corporation. The initial LiDAR “point cloud” was derived through the ALS Post Processor software package by Leica Geosystems.

Once the initial LiDAR “point cloud” was derived, Woolpert performed QC to look for any systematic error within the LiDAR flights using proprietary software. After systematic error was identified and removed, the individual LiDAR flights were clipped to remove overlap between adjacent flight lines and provide a homogeneous coverage over the project extents. Using the homogeneous coverage, above ground features were classified and removed using proprietary software to produce the bare-earth coverage.

Aerial Triangulation

Aerial triangulation was performed to extend or densify the network of control points established by the ground control survey. Aerial triangulation provides the proper number and pattern of control points for each stereo model derived from the imagery strips. This data is necessary to orientate the imagery to the ground for the QC of the LiDAR data and breakline compilation. For a detailed overview of the aerial triangulation, refer to: Woolpert Aerial Triangulation Report, *Minimum Technical StandardsFY2007 Digital Orthophoto and Topographic Mapping (B089 and L776)North District One-Foot Orthophoto and LiDAR Work Order 1, Southwest Florida Water Management District February 5, 2008.*

LiDAR QC/Photogrammetric Compilation

The bare-earth LiDAR data was subdivided into stereomodel units derived from the triangulated

ADS40/51 aerial photography over the project area. These units were imported into a softcopy stereoplotter and superimposed over the respective stereomodels. The technician then verified stereoscopically that the LiDAR data was consistent with the ground.

Hard and soft breakline features were compiled, as 2D and 3D features, in the softcopy environment using DATEM's Summit Evolution Capture software on a Pentium IV, quad processor, 3GHz photogrammetric workstation. DATEM, Inc. of Anchorage, Alaska distributes the Summit software. The DTM was delivered as LiDAR mass points in LAS version 1.1 and the breaklines were delivered in an ArcGIS Personal Geodatabase.

Accuracy Checks

The vertical accuracy of the final LiDAR DTM/Mass-Point Data mapping was verified using the field survey qc-data. Results of those field verifications are included in Appendix G.

References

http://rockyweb.cr.usgs.gov/nmpstds/nmas.htm – UGSG Internet Site for National Map Accuracy Standards.

Woolpert Photogrammetric Ground Control Survey Report
Minimum Technical Standards
FY2007 North District Orthophoto (B089) and Hernando County LiDAR (L776) Project
Southwest Florida Water Management District
July 5, 2007

Woolpert Aerial Triangulation Report
Minimum Technical Standards
FY2007 Digital Orthophoto and Topographic Mapping (B089 and L776)
North District One-Foot Orthophoto and LiDAR
Work Order 1, Southwest Florida Water Management District
February 5, 2008

General Notes

1. This report is not complete without the hard drive containing the original DTM/Mass-Point Data and Contours, and vice versa.

2. Intended display scale – This 2-foot contours mapping is intended to be displayed at a scale of 1:2,400 (1"=200') or smaller.

3. This map complies with National Standards for Spatial Data Accuracy.

4. This map complies with the Federal Emergency Management Agency (FEMA) "Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying".

5. **THIS PHOTOGRAMMETRIC MAPPING DATA AND REPORT IS CERTIFIED TO THE SOUTHWEST FLORIDA WATER MANAGEMENT DISTRICT AS MEETING OR EXCEEDING, IN QUALITY AND PRECISION, THE STANDARDS APPLICABLE FOR THIS WORK, AS SET FORTH IN CHAPTER 61G17-6, FLORIDA ADMINISTRATIVE CODE.**

THIS REPORT IS NOT VALID WITHOUT THE SIGNATURE AND RAISED SEAL OF A FLORIDA LICENSED SURVEYOR AND MAPPER IN RESPONSIBLE CHARGE.

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Savo Slijepcevic, CP, PSM Date Seal:
Professional Surveyor and Mapper No. LS-0005438

APPENDIX G: LIDAR ACCURACY CHECKS

The vertical accuracy of the DTM was verified by comparison of the DTM/TIN against the field survey QC points. A total of 210 QC test points were captured across the project. For the FY2007 North District Digital Orthophoto (B089) and Hernando County LiDAR (L776), Woolpert field crews observed and established 3-dimensional coordinates on 210 quality control ground control points. The observations were performed on four different types of terrain, hard surface, short grass, brush, and tree canopy. For the tree canopy ground shots (58 of the 210), Woolpert established a pair of intermediate (traverse) control stations at each location.

Woolpert utilized RTK GPS techniques on all QA/QC points, excluding any tree canopy ground observations, and all intermediate (traverse) control locations. The survey was conducted using a 1-second epoch rate, in a fixed solution RTK mode with each GPS session lasting 60 to 90 seconds each. In order to insure the necessary accuracies were being met for this photogrammetric project, Woolpert field crews used existing control stations as RTK base stations, and then performed quality control checks on existing control stations in the areas they were working. These quality control checks were performed before, during, and after each day of QA/QC observations.

Once the intermediate (inter-visible pairs) control stations were established near the tree canopy locations, a series of ground observations were taken utilizing conventional methods under heavy tree cover at roughly 50-foot intervals at any 1-foot contour change in elevation for approximately 1200 feet.

Each QA/QC ground observation was calculated with 3-dimensional coordinate values and these values were withheld from the Photogrammetry Department until the LiDAR processing was complete. After which, the coordinate values were released for accuracy verifications.

The accuracy analysis itself was based on methods outlined in the Geospatial Positioning Accuracy Standards, Part 3: National Standards for Spatial Data Accuracy (NSSDA) developed by the Federal Geodetic Data Committee (FGDC-STD-007.3-1998). The first step was to generate a TIN from the DTM. Each point along individual profiles was then compared against its corresponding TIN elevation. The difference between ground survey and DTM/TIN elevation represents the residual error (dZ) at that point. A statistical analysis was then performed on the residual errors.

Overall Statistical Summary:					
All Unobscured Points			**All Obscured Points**		
RMSE Z	0.45	ft	RMSE Z	0.32	ft
Stdev	0.37	ft	Stdev	0.32	ft
Avg Error	-0.26	ft	Avg Error	-0.04	ft
Max Error	0.95	ft	Max Error	1.25	ft
Min Error	-1.34	ft	Min Error	-1.28	ft
Count	68		Count	129	

Per contract specifications, the vertical accuracy requirement of the TIN for this project is 0.60-feet

RMSE at the 95% confidence level for well-defined points in inobscured areas. Based on Woolpert's accuracy analysis, the vertical accuracy of the TIN is 0.45-feet at the 95% confidence level for unobscured points, exceeding the project accuracy requirements by 0.15-feet.

Statistical Summary By Class					
All Points			**Bare Earth - Unobs**		
Average	-0.11	ft	Average	-0.31	ft
RMSE	0.37	ft	RMSE	0.48	ft
Stdev	0.35	ft	Stdev	0.38	ft
Max	1.25	ft	Max	0.95	ft
Min	-1.34	ft	Min	-0.85	ft
Count	197		Count	23	
Low Grass - Unobs			**Urban/Hard Surface - Unobs**		
Average	-0.01	ft	Average	-0.28	ft
RMSE	0.35	ft	RMSE	0.44	ft
Stdev	0.38	ft	Stdev	0.35	ft
Max	0.68	ft	Max	0.43	ft
Min	-0.45	ft	Min	-1.34	ft
Count	7		Count	38	
Med Grass/Vegetation - Obs			**Dense Trees/Vegetation - Obs**		
Average	-0.11	ft	Average	0.08	ft
RMSE	0.37	ft	RMSE	0.24	ft
Stdev	0.35	ft	Stdev	0.23	ft
Max	1.25	ft	Max	0.66	ft
Min	-1.28	ft	Min	-0.36	ft
Count	80		Count	49	

The QA/QC points in the following table are organized by unobscured and obscured, and feature class.

DTM Accuracy Analysis								
Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
ND34	1583163.12	511425.02	102.38	101.88	-0.50		Existing Photo Control Point	55003
NW24R	1567181.26	512814.69	104.08	103.49	-0.60		New Photo Point - Reset	55903
NW23	1561171.93	565378.87	91.13	90.70	-0.43		Existing Photo Control Point	56214
NW25	1542618.25	447750.21	3.76	3.38	-0.38		Existing Photo Control Point	57390
ND10	1537686.73	500926.08	81.64	81.61	-0.04		New Photo Point	57701
NW19	1521708.36	472720.09	21.67	20.97	-0.70		Existing Photo Control Point	58595
ND42	1518821.62	574844.64	151.60	151.29	-0.31		Existing Photo Control Point	58915
NW17R	1497496.64	510968.88	66.43	66.46	0.03		Existing Photo Control Point	60103
NW16	1495764.99	566745.76	162.76	162.60	-0.15		Existing Photo Control Point	60114
ND11	1490156.67	450305.67	15.77	15.59	-0.18		New Photo Point	60391
1009	1573910.52	484730.22	49.68	49.82	0.14		300 – Bare Earth	55597
908	1561461.20	545364.59	115.81	115.10	-0.71		300 – Bare Earth	56210
702	1542557.84	447702.21	4.31	3.46	-0.85		300 – Bare Earth	57390
605	1537175.61	528461.93	120.45	121.40	0.95		300 – Bare Earth	57706
10000	1533710.21	475476.99	25.56	25.34	-0.22		300 – Bare Earth	57996
10001	1534129.81	475573.08	25.27	25.38	0.11		300 – Bare Earth	57996
806	1532619.62	480369.37	39.36	38.98	-0.38		300 – Bare Earth	57997
204	1530565.17	492976.32	77.19	76.66	-0.53		300 – Bare Earth	57999
201	1529583.48	492977.94	96.72	96.21	-0.51		300 – Bare Earth	58299
20000	1522954.68	584296.95	73.53	72.96	-0.57		300 – Bare Earth	58617
20001	1522960.43	584961.13	83.51	83.25	-0.26		300 – Bare Earth	58617
305	1517392.72	537538.93	211.76	211.38	-0.38		300 – Bare Earth	58908
222	1507969.13	497610.21	64.73	64.13	-0.60		300 – Bare Earth	59500
102	1519780.08	463662.00	23.99	24.01	0.02		300 – Bare Earth	58893
104	1521172.32	464503.00	9.59	9.62	0.03		300 – Bare Earth	58593
108	1519842.86	464237.76	26.96	27.12	0.16		300 – Bare Earth	58893
111	1518180.44	464411.31	25.64	26.32	0.68		300 – Short Grass	58893
205	1530959.64	492948.76	81.19	80.74	-0.45		300 – Short Grass	57999
208	1532343.71	493030.69	89.73	89.55	-0.18		300 – Short Grass	57999
209	1530942.14	494309.96	72.33	71.98	-0.35		300 – Short Grass	57999
1000	1572371.47	486915.68	59.41	59.62	0.21		300 - Urban	55598
1003	1574094.13	486643.30	79.54	79.78	0.24		300 - Urban	55598
1008	1573745.69	485588.37	51.01	51.26	0.25		300 - Urban	55598
905	1560686.93	544854.73	108.35	107.42	-0.93		300 - Urban	56209
910	1564312.65	559433.36	89.59	88.25	-1.34		300 - Urban	56212
914	1562503.20	559451.46	106.45	105.36	-1.09		300 - Urban	56212
813	1559850.03	487983.91	40.48	40.12	-0.36		300 - Urban	56498

DTM Accuracy Analysis								
Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
815	1559376.74	486911.88	52.13	51.73	-0.40		300 - Urban	56498
818	1559842.12	485589.63	35.51	35.03	-0.48		300 - Urban	56498
821	1559906.99	485585.17	32.86	32.47	-0.39		300 - Urban	56498
902	1548592.54	537289.34	89.27	89.02	-0.25		300 - Urban	57108
704	1540694.63	445937.73	3.81	3.17	-0.64		300 - Urban	57390
802	1536018.12	480301.99	34.90	34.64	-0.27		300 - Urban	57697
604	1537229.42	528488.08	123.03	123.00	-0.03		300 - Urban	57706
606	1539214.60	528084.42	134.50	134.15	-0.35		300 - Urban	57706
607	1539250.10	528102.40	135.26	134.70	-0.56		300 - Urban	57706
611	1539812.11	528456.21	145.28	145.20	-0.08		300 - Urban	57706
612	1537783.47	527228.28	128.62	128.49	-0.13		300 - Urban	57706
804	1534337.14	480334.29	47.35	47.29	-0.06		300 - Urban	57997
810	1531234.96	481325.84	40.43	39.97	-0.46		300 - Urban	57997
207	1532315.54	492959.12	94.39	93.97	-0.42		300 - Urban	57999
210	1530911.79	494297.82	71.65	71.17	-0.48		300 - Urban	57999
105	1521028.42	464559.03	14.84	14.69	-0.15		300 - Urban	58593
106	1520287.39	464279.23	19.55	19.32	-0.23		300 - Urban	58593
101	1519784.02	463622.60	22.00	21.92	-0.08		300 - Urban	58893
109	1518410.17	463503.31	28.94	28.78	-0.16		300 - Urban	58893
308	1518156.32	538780.34	192.75	192.52	-0.23		300 - Urban	58908
310	1517393.71	539522.78	228.56	228.37	-0.19		300 - Urban	58908
405	1517262.10	604844.58	75.29	75.23	-0.06		300 - Urban	58921
407	1517428.74	601962.77	75.62	75.32	-0.30		300 - Urban	58921
411	1518297.66	601645.98	70.19	70.25	0.06		300 - Urban	58921
401	1517050.14	606588.57	75.53	75.30	-0.23		300 - Urban	58922
300	1514228.98	537248.28	218.51	218.94	0.43		300 - Urban	59208
302	1514325.89	537173.88	218.77	218.66	-0.12		300 - Urban	59208
213	1506532.85	497611.68	61.65	61.45	-0.20		300 - Urban	59500
216	1507653.59	497302.65	63.31	62.69	-0.62		300 - Urban	59500
218	1508499.31	496996.92	63.66	63.46	-0.20		300 - Urban	59500
708	1540055.56	445788.19	3.56	3.24	-0.32		300 - Urban	57390
1010	1574019.00	484737.56	51.26	51.34		0.08	300 - Grass	55597
1001	1572429.41	486930.10	57.64	57.73		0.09	300 - Grass	55598
1004	1574086.60	486705.66	74.37	74.42		0.05	300 - Grass	55598
1006	1573790.78	485747.47	44.59	44.59		0.00	300 - Grass	55598
904	1560673.49	544907.35	106.56	106.53		-0.03	300 - Grass	56209
907	1561448.00	545385.73	114.73	114.79		0.06	300 - Grass	56210
911	1564349.50	559419.72	89.50	88.22		-1.28	300 - Grass	56212
913	1562473.51	559467.88	106.99	106.80		-0.19	300 - Grass	56212
814	1559874.57	488056.07	39.92	39.20		-0.72	300 - Grass	56498
817	1559410.24	486926.19	51.34	51.09		-0.25	300 - Grass	56498
820	1559813.54	485503.07	40.30	40.00		-0.30	300 - Grass	56498
901	1548619.72	537343.32	89.80	89.70		-0.10	300 - Grass	57108
701	1542643.53	447707.86	3.60	3.50		-0.10	300 - Grass	57390

DTM Accuracy Analysis								
Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
705	1540612.34	446015.20	3.45	3.56		0.11	300 - Grass	57390
709	1540023.60	445743.46	4.32	3.84		-0.48	300 - Grass	57390
711	1542135.76	446217.12	7.13	6.71		-0.42	300 - Grass	57390
801	1535972.46	480351.57	33.17	33.20		0.03	300 - Grass	57697
601	1537806.36	527193.16	127.70	128.19		0.49	300 - Grass	57706
602	1537809.29	527196.24	128.26	128.33		0.07	300 - Grass	57706
603	1537284.89	528484.79	121.85	121.52		-0.34	300 - Grass	57706
608	1539235.58	528135.18	135.15	134.57		-0.58	300 - Grass	57706
610	1539896.63	528408.08	146.74	146.70		-0.04	300 - Grass	57706
805	1534231.70	480320.43	45.53	45.94		0.41	300 - Grass	57997
807	1532676.85	480362.04	40.94	40.67		-0.27	300 - Grass	57997
304	1517302.83	537574.64	212.38	212.17		-0.21	300 - Grass	58908
809	1531316.72	481282.57	45.98	45.59		-0.39	300 - Grass	57997
202	1529682.13	493006.94	98.97	98.56		-0.41	300 - Grass	58299
307	1518142.49	538806.06	191.61	191.90		0.29	300 - Grass	58908
311	1517422.69	539491.65	226.49	226.30		-0.19	300 - Grass	58908
403	1517198.67	604827.19	75.87	75.94		0.07	300 - Grass	58921
406	1517438.76	601922.09	74.77	74.50		-0.27	300 - Grass	58921
410	1518272.23	601600.93	69.41	69.29		-0.12	300 - Grass	58921
400	1517050.20	606549.51	75.30	75.27		-0.03	300 - Grass	58922
301	1514258.87	537218.54	218.26	218.33		0.07	300 - Grass	59208
214	1506596.70	497645.63	62.43	62.12		-0.31	300 - Grass	59500
215	1507601.29	497353.21	62.69	62.43		-0.26	300 - Grass	59500
219	1508401.56	496986.51	64.20	64.27		0.07	300 - Grass	59500
221	1508011.17	497580.30	64.09	64.01		-0.08	300 - Grass	59500
1011	1574095.45	484781.64	52.40	52.56		0.16	300 - Brush	55597
1002	1572456.85	486893.53	55.44	55.69		0.25	300 - Brush	55598
1005	1573929.07	486682.45	68.10	67.68		-0.42	300 - Brush	55598
1007	1573793.90	485656.71	49.46	49.51		0.05	300 - Brush	55598
903	1560673.46	544933.59	106.90	106.84		-0.06	300 - Brush	56209
906	1561433.46	545414.05	118.21	118.30		0.09	300 - Brush	56210
909	1564319.32	559457.59	86.49	86.07		-0.42	300 - Brush	56212
912	1562438.89	559480.27	109.68	109.07		-0.61	300 - Brush	56212
812	1559870.89	488010.67	40.11	39.91		-0.20	300 - Brush	56498
816	1559377.40	486878.64	51.77	51.48		-0.29	300 - Brush	56498
819	1559856.25	485513.44	38.25	37.94		-0.31	300 - Brush	56498
900	1548629.53	537377.58	89.80	89.90		0.10	300 - Brush	57108
700	1542546.29	447800.36	2.86	2.28		-0.59	300 - Brush	57390
703	1540694.18	445966.72	2.29	2.32		0.03	300 - Brush	57390
706	1540046.40	445954.11	0.83	0.87		0.04	300 - Brush	57390
712	1542108.98	446106.34	3.65	3.58		-0.07	300 - Brush	57390
707	1539976.85	445869.44	3.87	3.02		-0.85	300 - Brush	57690
800	1536055.07	480357.76	27.36	27.51		0.15	300 - Brush	57697
600	1537765.61	527211.83	126.69	127.94		1.25	300 - Brush	57706

DTM Accuracy Analysis								
Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
609	1539866.52	528461.61	146.00	145.58		-0.42	300 - Brush	57706
803	1534352.83	480310.31	45.64	45.76		0.12	300 - Brush	57997
808	1532707.47	480395.26	40.66	40.54		-0.13	300 - Brush	57997
811	1531203.37	481357.08	38.68	38.56		-0.12	300 - Brush	57997
203	1530566.33	492912.99	83.91	83.27		-0.64	300 - Brush	57999
206	1532254.37	492937.66	95.74	95.51		-0.24	300 - Brush	57999
211	1531005.54	494261.43	72.14	71.59		-0.55	300 - Brush	57999
200	1529557.56	493033.86	93.67	93.51		-0.16	300 - Brush	58299
100	1519783.17	463582.38	19.67	19.82		0.15	300 - Brush	58893
103	1521195.06	464571.27	13.22	13.22		0.00	300 - Brush	58593
107	1520198.37	464297.46	19.65	19.20		-0.45	300 - Brush	58593
110	1517558.65	464486.66	30.59	30.54		-0.05	300 - Brush	58893
303	1517234.97	537645.80	212.85	212.78		-0.08	300 - Brush	58908
306	1518186.37	538849.19	187.49	188.04		0.55	300 - Brush	58908
309	1517324.07	539554.22	229.44	229.56		0.12	300 - Brush	58908
404	1517231.85	604789.43	75.27	75.27		0.00	300 - Brush	58921
408	1517348.29	601941.18	73.26	73.66		0.40	300 - Brush	58921
409	1518239.04	601561.77	69.28	69.37		0.09	300 - Brush	58921
402	1517058.05	606617.58	73.90	74.52		0.62	300 - Brush	58922
212	1506470.89	497574.37	62.18	62.32		0.14	300 - Brush	59500
217	1507661.96	497370.28	63.43	63.08		-0.35	300 - Brush	59500
220	1508464.84	497053.09	64.25	64.39		0.14	300 - Brush	59500
223	1508035.14	497628.78	65.59	65.13		-0.46	300 - Brush	59500
10050	1533729.13	475325.61	15.94	16.43		0.49	300 – Tree Canopy	57996
10051	1533784.80	475340.57	17.11	17.10		-0.01	300 – Tree Canopy	57996
10052	1533832.27	475357.07	17.05	17.35		0.30	300 – Tree Canopy	57996
10053	1533885.64	475372.88	17.25	17.75		0.50	300 – Tree Canopy	57996
10054	1533918.59	475382.57	17.56	17.85		0.29	300 – Tree Canopy	57996
10055	1533968.85	475398.85	17.29	17.95		0.66	300 – Tree Canopy	57996
10056	1534014.19	475396.69	18.23	18.48		0.25	300 – Tree Canopy	57996
10057	1534066.29	475406.82	17.61	18.13		0.52	300 – Tree Canopy	57996
10058	1534122.08	475414.17	19.54	19.54		0.00	300 – Tree Canopy	57996
10059	1534163.79	475430.61	19.90	20.03		0.13	300 – Tree Canopy	57996
10060	1534209.72	475441.71	20.94	21.11		0.17	300 – Tree Canopy	57996
10061	1534261.36	475452.18	22.54	22.83		0.29	300 – Tree Canopy	57996
10062	1534311.87	475460.34	24.95	25.36		0.41	300 – Tree Canopy	57996
10063	1534355.43	475473.99	26.55	26.37		-0.18	300 – Tree Canopy	57996
10064	1534400.50	475483.53	28.27	28.15		-0.12	300 – Tree Canopy	57996
10065	1534448.63	475481.17	30.75	30.50		-0.25	300 – Tree Canopy	57996
10066	1534507.39	475483.79	31.18	30.82		-0.36	300 – Tree Canopy	57996
10067	1534542.50	475515.30	29.25	29.07		-0.18	300 – Tree Canopy	57996
10068	1534587.63	475527.47	28.28	28.27		-0.01	300 – Tree Canopy	57996
10069	1534635.27	475530.83	27.98	28.03		0.05	300 – Tree Canopy	57996
10070	1534682.50	475553.86	27.24	26.95		-0.30	300 – Tree Canopy	57996

DTM Accuracy Analysis								
Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
10071	1534761.94	475556.30	29.73	29.71		-0.03	300 – Tree Canopy	57996
10072	1534814.69	475548.23	30.51	30.51		0.00	300 – Tree Canopy	57996
10073	1534858.90	475569.51	29.69	29.76		0.07	300 – Tree Canopy	57996
10074	1534934.36	475591.77	28.72	29.14		0.42	300 – Tree Canopy	57996
10075	1534965.21	475609.58	29.56	29.66		0.10	300 – Tree Canopy	57996
20057	1523063.90	584957.52	79.94	80.15		0.21	300 – Tree Canopy	58617
20058	1523065.39	584909.12	80.27	80.43		0.16	300 – Tree Canopy	58617
20059	1523070.10	584865.30	80.62	81.01		0.39	300 – Tree Canopy	58617
20060	1523070.83	584820.94	80.43	80.60		0.17	300 – Tree Canopy	58617
20061	1523071.76	584774.45	78.85	78.79		-0.06	300 – Tree Canopy	58617
20062	1523070.15	584728.56	76.76	77.01		0.25	300 – Tree Canopy	58617
20063	1523069.51	584683.37	74.54	74.55		0.01	300 – Tree Canopy	58617
20064	1523069.85	584636.14	73.02	72.95		-0.07	300 – Tree Canopy	58617
20065	1523074.14	584587.82	71.21	71.29		0.08	300 – Tree Canopy	58617
20066	1523079.36	584534.22	70.41	70.56		0.15	300 – Tree Canopy	58617
20067	1523076.24	584489.79	70.95	71.06		0.11	300 – Tree Canopy	58617
20068	1523088.17	584443.65	71.17	71.16		-0.01	300 – Tree Canopy	58617
20069	1523072.73	584397.96	72.05	71.80		-0.25	300 – Tree Canopy	58617
20070	1523073.97	584348.01	71.67	71.65		-0.02	300 – Tree Canopy	58617
20071	1523082.04	584303.49	71.33	71.25		-0.08	300 – Tree Canopy	58617
20072	1523080.69	584254.54	70.88	70.92		0.04	300 – Tree Canopy	58617
20073	1523069.09	584211.24	70.70	70.51		-0.19	300 – Tree Canopy	58617
20074	1523075.68	584167.05	69.48	69.31		-0.17	300 – Tree Canopy	58617
20075	1523075.09	584116.73	68.17	68.04		-0.13	300 – Tree Canopy	58617
20076	1523070.83	584064.30	66.23	66.19		-0.04	300 – Tree Canopy	58617
20077	1523075.16	584011.98	64.46	64.56		0.10	300 – Tree Canopy	58617
20078	1523072.13	583969.47	62.94	62.94		0.00	300 – Tree Canopy	58617
20079	1523074.27	583922.63	61.62	61.74		0.12	300 – Tree Canopy	58617

APPENDIX H: CONTOURS/TIN ACCURACY CHECKS

The accuracy of the TIN generated from the contours was verified using field survey methods. The results of the accuracy analysis are as follows:

Overall Statistical Summary:					
All Unobscured Points			**All Obscured Points**		
RMSE Z	0.57	ft	RMSE Z	0.42	ft
Stdev	0.49	ft	Stdev	0.41	ft
Avg Error	-0.31	ft	Avg Error	-0.08	ft
Max Error	1.33	ft	Max Error	1.17	ft
Min Error	-1.59	ft	Min Error	-1.50	ft
Count	68		Count	129	

Statistical Summary By Class					
All Points			**Bare Earth - Unobs**		
Average	-0.16	ft	Average	-0.39	ft
RMSE	0.48	ft	RMSE	0.62	ft
Stdev	0.45	ft	Stdev	0.49	ft
Max	1.33	ft	Max	0.79	ft
Min	-1.59	ft	Min	-1.31	ft
Count	197		Count	23	
Low Grass - Unobs			**Urban/Hard Surface - Unobs**		
Average	0.20	ft	Average	-0.35	ft
RMSE	0.58	ft	RMSE	0.54	ft
Stdev	0.59	ft	Stdev	0.42	ft
Max	1.33	ft	Max	0.45	ft
Min	-0.42	ft	Min	-1.59	ft
Count	7		Count	38	
Med Grass/Vegetation - Obs			**Dense Trees/Vegetation - Obs**		
Average	-0.12	ft	Average	-0.01	ft
RMSE	0.46	ft	RMSE	0.34	ft
Stdev	0.45	ft	Stdev	0.35	ft
Max	1.17	ft	Max	0.75	ft
Min	-1.50	ft	Min	-1.05	ft
Count	80		Count	49	

3D QA/QC Profile Points (Terrain):

Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
ND34	1583163.12	511425.02	102.38	101.88	-0.50		Existing Photo Control Point	55003
NW24R	1567181.26	512814.69	104.08	103.35	-0.74		New Photo Point - Reset	55903
NW23	1561171.93	565378.87	91.13	90.75	-0.38		Existing Photo Control Point	56214
NW25	1542618.25	447750.21	3.76	3.00	-0.76		Existing Photo Control Point	57390
ND10	1537686.73	500926.08	81.64	81.37	-0.27		New Photo Point	57701
NW19	1521708.36	472720.09	21.67	21.18	-0.49		Existing Photo Control Point	58595
ND42	1518821.62	574844.64	151.60	151.27	-0.33		Existing Photo Control Point	58915
NW17R	1497496.64	510968.88	66.43	66.89	0.47		Existing Photo Control Point	60103
NW16	1495764.99	566745.76	162.76	162.37	-0.39		Existing Photo Control Point	60114
ND11	1490156.67	450305.67	15.77	15.00	-0.77		New Photo Point	60391
1009	1573910.52	484730.22	49.68	49.78	0.10		300 - Bare Earth	55597
908	1561461.20	545364.59	115.81	115.00	-0.81		300 - Bare Earth	56210
702	1542557.84	447702.21	4.31	3.00	-1.31		300 - Bare Earth	57390
605	1537175.61	528461.93	120.45	121.24	0.79		300 - Bare Earth	57706
10000	1533710.21	475476.99	25.56	25.00	-0.56		300 - Bare Earth	57996
10001	1534129.81	475573.08	25.27	26.00	0.73		300 - Bare Earth	57996
806	1532619.62	480369.37	39.36	39.00	-0.36		300 - Bare Earth	57997
204	1530565.17	492976.32	77.19	76.64	-0.55		300 - Bare Earth	57999
201	1529583.48	492977.94	96.72	96.16	-0.56		300 - Bare Earth	58299
20000	1522954.68	584296.95	73.53	72.86	-0.67		300 - Bare Earth	58617
20001	1522960.43	584961.13	83.51	83.19	-0.32		300 - Bare Earth	58617
305	1517392.72	537538.93	211.76	211.20	-0.56		300 - Bare Earth	58908
222	1507969.13	497610.21	64.73	64.00	-0.73		300 - Bare Earth	59500
205	1530959.64	492948.76	81.19	80.77	-0.42		300 - Short Grass	57999
208	1532343.71	493030.69	89.73	90.00	0.27		300 - Short Grass	57999
209	1530942.14	494309.96	72.33	71.98	-0.35		300 - Short Grass	57999
104	1521172.32	464503.00	9.59	10.00	0.41		300 - Short Grass	58593
102	1519780.08	463662.00	23.99	24.01	0.02		300 - Short Grass	58893
108	1519842.86	464237.76	26.96	27.11	0.15		300 - Short Grass	58893
111	1518180.44	464411.31	25.64	26.97	1.33		300 - Urban	58893
1000	1572371.47	486915.68	59.41	59.79	0.38		300 - Urban	55598
1003	1574094.13	486643.30	79.54	79.74	0.20		300 - Urban	55598
1008	1573745.69	485588.37	51.01	51.29	0.28		300 - Urban	55598
905	1560686.93	544854.73	108.35	107.46	-0.89		300 - Urban	56209
910	1564312.65	559433.36	89.59	88.00	-1.59		300 - Urban	56212
914	1562503.20	559451.46	106.45	105.35	-1.11		300 - Urban	56212
813	1559850.03	487983.91	40.48	40.14	-0.34		300 - Urban	56498

3D QA/QC Profile Points (Terrain):

Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
815	1559376.74	486911.88	52.13	51.71	-0.42		300 - Urban	56498
818	1559842.12	485589.63	35.51	35.01	-0.50		300 - Urban	56498
821	1559906.99	485585.17	32.86	32.46	-0.40		300 - Urban	56498
902	1548592.54	537289.34	89.27	89.00	-0.27		300 - Urban	57108
704	1540694.63	445937.73	3.81	3.00	-0.81		300 - Urban	57390
708	1540055.56	445788.19	3.56	3.95	0.39		300 - Urban	57390
802	1536018.12	480301.99	34.90	34.62	-0.28		300 - Urban	57697
604	1537229.42	528488.08	123.03	123.00	-0.03		300 - Urban	57706
606	1539214.60	528084.42	134.50	134.00	-0.50		300 - Urban	57706
607	1539250.10	528102.40	135.26	134.46	-0.80		300 - Urban	57706
611	1539812.11	528456.21	145.28	145.00	-0.28		300 - Urban	57706
612	1537783.47	527228.28	128.62	128.00	-0.62		300 - Urban	57706
804	1534337.14	480334.29	47.35	47.00	-0.35		300 - Urban	57997
810	1531234.96	481325.84	40.43	39.95	-0.48		300 - Urban	57997
207	1532315.54	492959.12	94.39	93.96	-0.43		300 - Urban	57999
210	1530911.79	494297.82	71.65	71.14	-0.51		300 - Urban	57999
105	1521028.42	464559.03	14.84	14.26	-0.58		300 - Urban	58593
106	1520287.39	464279.23	19.55	19.15	-0.40		300 - Urban	58593
101	1519784.02	463622.60	22.00	21.87	-0.13		300 - Urban	58893
109	1518410.17	463503.31	28.94	28.70	-0.24		300 - Urban	58893
308	1518156.32	538780.34	192.75	192.48	-0.27		300 - Urban	58908
310	1517393.71	539522.78	228.56	228.24	-0.32		300 - Urban	58908
405	1517262.10	604844.58	75.29	75.00	-0.29		300 - Urban	58921
407	1517428.74	601962.77	75.62	75.00	-0.62		300 - Urban	58921
411	1518297.66	601645.98	70.19	70.00	-0.19		300 - Urban	58921
401	1517050.14	606588.57	75.53	75.00	-0.53		300 - Urban	58922
300	1514228.98	537248.28	218.51	218.96	0.45		300 - Urban	59208
302	1514325.89	537173.88	218.77	218.54	-0.23		300 - Urban	59208
213	1506532.85	497611.68	61.65	62.00	0.35		300 - Urban	59500
216	1507653.59	497302.65	63.31	62.63	-0.68		300 - Urban	59500
218	1508499.31	496996.92	63.66	63.21	-0.45		300 - Urban	59500
1010	1574019.00	484737.56	51.26	51.46		0.20	300 - Grass	55597
1001	1572429.41	486930.10	57.64	57.57		-0.07	300 - Grass	55598
1004	1574086.60	486705.66	74.37	75.00		0.63	300 - Grass	55598
1006	1573790.78	485747.47	44.59	45.00		0.41	300 - Grass	55598
904	1560673.49	544907.35	106.56	106.82		0.26	300 - Grass	56209
907	1561448.00	545385.73	114.73	115.00		0.27	300 - Grass	56210
911	1564349.50	559419.72	89.50	88.00		-1.50	300 - Grass	56212
913	1562473.51	559467.88	106.99	106.82		-0.17	300 - Grass	56212
814	1559874.57	488056.07	39.92	39.20		-0.72	300 - Grass	56498
817	1559410.24	486926.19	51.34	51.09		-0.25	300 - Grass	56498
820	1559813.54	485503.07	40.30	40.00		-0.30	300 - Grass	56498
901	1548619.72	537343.32	89.80	89.00		-0.80	300 - Grass	57108

3D QA/QC Profile Points (Terrain):

Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
701	1542643.53	447707.86	3.60	3.58		-0.02	300 - Grass	57390
705	1540612.34	446015.20	3.45	3.70		0.25	300 - Grass	57390
709	1540023.60	445743.46	4.32	4.00		-0.32	300 - Grass	57390
711	1542135.76	446217.12	7.13	6.00		-1.13	300 - Grass	57390
801	1535972.46	480351.57	33.17	33.17		0.00	300 - Grass	57697
601	1537806.36	527193.16	127.70	128.00		0.30	300 - Grass	57706
602	1537809.29	527196.24	128.26	128.00		-0.26	300 - Grass	57706
603	1537284.89	528484.79	121.85	121.49		-0.36	300 - Grass	57706
608	1539235.58	528135.18	135.15	134.41		-0.74	300 - Grass	57706
610	1539896.63	528408.08	146.74	146.50		-0.24	300 - Grass	57706
805	1534231.70	480320.43	45.53	45.95		0.42	300 - Grass	57997
807	1532676.85	480362.04	40.94	40.69		-0.25	300 - Grass	57997
809	1531316.72	481282.57	45.98	45.56		-0.42	300 - Grass	57997
202	1529682.13	493006.94	98.97	98.00		-0.97	300 - Grass	58299
304	1517302.83	537574.64	212.38	212.16		-0.23	300 - Grass	58908
307	1518142.49	538806.06	191.61	191.89		0.28	300 - Grass	58908
311	1517422.69	539491.65	226.49	226.45		-0.04	300 - Grass	58908
403	1517198.67	604827.19	75.87	75.92		0.05	300 - Grass	58921
406	1517438.76	601922.09	74.77	74.44		-0.33	300 - Grass	58921
410	1518272.23	601600.93	69.41	69.43		0.02	300 - Grass	58921
400	1517050.20	606549.51	75.30	75.23		-0.07	300 - Grass	58922
301	1514258.87	537218.54	218.26	219.00		0.74	300 - Grass	59208
214	1506596.70	497645.63	62.43	62.00		-0.43	300 - Grass	59500
215	1507601.29	497353.21	62.69	63.00		0.31	300 - Grass	59500
219	1508401.56	496986.51	64.20	64.00		-0.20	300 - Grass	59500
221	1508011.17	497580.30	64.09	64.24		0.15	300 - Grass	59500
1011	1574095.45	484781.64	52.40	52.85		0.45	300 - Brush	55597
1002	1572456.85	486893.53	55.44	55.79		0.35	300 - Brush	55598
1005	1573929.07	486682.45	68.10	67.65		-0.45	300 - Brush	55598
1007	1573793.90	485656.71	49.46	49.51		0.05	300 - Brush	55598
903	1560673.46	544933.59	106.90	106.86		-0.04	300 - Brush	56209
906	1561433.46	545414.05	118.21	118.25		0.04	300 - Brush	56210
909	1564319.32	559457.59	86.49	86.49		0.00	300 - Brush	56212
912	1562438.89	559480.27	109.68	109.04		-0.64	300 - Brush	56212
812	1559870.89	488010.67	40.11	40.00		-0.11	300 - Brush	56498
816	1559377.40	486878.64	51.77	51.50		-0.27	300 - Brush	56498
819	1559856.25	485513.44	38.25	37.94		-0.31	300 - Brush	56498
900	1548629.53	537377.58	89.80	89.00		-0.80	300 - Brush	57108
700	1542546.29	447800.36	2.86	2.23		-0.64	300 - Brush	57390
703	1540694.18	445966.72	2.29	2.43		0.14	300 - Brush	57390
706	1540046.40	445954.11	0.83	1.00		0.17	300 - Brush	57390
712	1542108.98	446106.34	3.65	3.53		-0.12	300 - Brush	57390
707	1539976.85	445869.44	3.87	3.01		-0.86	300 - Brush	57690

3D QA/QC Profile Points (Terrain):

Station Name	Survey (US SV FT) Northing	Easting	Elevation	LiDAR Elev. (US SV FT)	Residual Error (US SV FT) Unobscured	Obscured	Feature	Tile
800	1536055.07	480357.76	27.36	27.55		0.19	300 - Brush	57697
600	1537765.61	527211.83	126.69	127.86		1.17	300 - Brush	57706
609	1539866.52	528461.61	146.00	145.47		-0.53	300 - Brush	57706
808	1532707.47	480395.26	40.66	40.50		-0.16	300 - Brush	57997
803	1534352.83	480310.31	45.64	45.79		0.15	300 - Brush	57997
811	1531203.37	481357.08	38.68	38.58		-0.10	300 - Brush	57997
203	1530566.33	492912.99	83.91	83.24		-0.67	300 - Brush	57999
206	1532254.37	492937.66	95.74	95.46		-0.29	300 - Brush	57999
211	1531005.54	494261.43	72.14	71.32		-0.82	300 - Brush	57999
200	1529557.56	493033.86	93.67	93.50		-0.17	300 - Brush	58299
103	1521195.06	464571.27	13.22	13.11		-0.11	300 - Brush	58593
107	1520198.37	464297.46	19.65	19.00		-0.65	300 - Brush	58593
100	1519783.17	463582.38	19.67	19.86		0.19	300 - Brush	58893
110	1517558.65	464486.66	30.59	30.43		-0.16	300 - Brush	58893
303	1517234.97	537645.80	212.85	212.76		-0.09	300 - Brush	58908
306	1518186.37	538849.19	187.49	188.05		0.56	300 - Brush	58908
309	1517324.07	539554.22	229.44	229.50		0.06	300 - Brush	58908
404	1517231.85	604789.43	75.27	75.18		-0.09	300 - Brush	58921
408	1517348.29	601941.18	73.26	73.69		0.43	300 - Brush	58921
409	1518239.04	601561.77	69.28	69.00		-0.28	300 - Brush	58921
402	1517058.05	606617.58	73.90	74.48		0.58	300 - Brush	58922
212	1506470.89	497574.37	62.18	62.35		0.17	300 - Brush	59500
217	1507661.96	497370.28	63.43	63.00		-0.43	300 - Brush	59500
220	1508464.84	497053.09	64.25	64.37		0.12	300 - Brush	59500
223	1508035.14	497628.78	65.59	65.10		-0.49	300 - Brush	59500
10050	1533729.13	475325.61	15.94	16.50		0.56	300 - Tree Canopy	57996
10051	1533784.80	475340.57	17.11	17.27		0.16	300 - Tree Canopy	57996
10052	1533832.27	475357.07	17.05	17.35		0.30	300 - Tree Canopy	57996
10053	1533885.64	475372.88	17.25	18.00		0.75	300 - Tree Canopy	57996
10054	1533918.59	475382.57	17.56	18.00		0.44	300 - Tree Canopy	57996
10055	1533968.85	475398.85	17.29	18.00		0.71	300 - Tree Canopy	57996
10056	1534014.19	475396.69	18.23	18.54		0.31	300 - Tree Canopy	57996
10057	1534066.29	475406.82	17.61	18.13		0.52	300 - Tree Canopy	57996
10058	1534122.08	475414.17	19.54	19.59		0.05	300 - Tree Canopy	57996
10059	1534163.79	475430.61	19.90	20.03		0.13	300 - Tree Canopy	57996
10060	1534209.72	475441.71	20.94	21.11		0.17	300 - Tree Canopy	57996
10061	1534261.36	475452.18	22.54	22.82		0.28	300 - Tree Canopy	57996
10062	1534311.87	475460.34	24.95	25.21		0.26	300 - Tree Canopy	57996
10063	1534355.43	475473.99	26.55	26.36		-0.19	300 - Tree Canopy	57996
10064	1534400.50	475483.53	28.27	28.15		-0.12	300 - Tree Canopy	57996
10065	1534448.63	475481.17	30.75	30.50		-0.25	300 - Tree Canopy	57996
10066	1534507.39	475483.79	31.18	30.80		-0.38	300 - Tree Canopy	57996
10067	1534542.50	475515.30	29.25	29.06		-0.19	300 - Tree Canopy	57996

3D QA/QC Profile Points (Terrain):

Station	Survey (US SV FT)			LiDAR Elev.	Residual Error (US SV FT)			
Name	Northing	Easting	Elevation	(US SV FT)	Unobscured	Obscured	Feature	Tile
10068	1534587.63	475527.47	28.28	28.27		-0.01	300 - Tree Canopy	57996
10069	1534635.27	475530.83	27.98	28.03		0.05	300 - Tree Canopy	57996
10070	1534682.50	475553.86	27.24	26.93		-0.31	300 - Tree Canopy	57996
10071	1534761.94	475556.30	29.73	29.61		-0.13	300 - Tree Canopy	57996
10072	1534814.69	475548.23	30.51	30.31		-0.20	300 - Tree Canopy	57996
10073	1534858.90	475569.51	29.69	29.68		-0.01	300 - Tree Canopy	57996
10074	1534934.36	475591.77	28.72	29.15		0.43	300 - Tree Canopy	57996
10075	1534965.21	475609.58	29.56	29.58		0.02	300 - Tree Canopy	57996
20057	1523063.90	584957.52	79.94	80.00		0.06	300 - Tree Canopy	58617
20058	1523065.39	584909.12	80.27	80.00		-0.27	300 - Tree Canopy	58617
20059	1523070.10	584865.30	80.62	81.00		0.38	300 - Tree Canopy	58617
20060	1523070.83	584820.94	80.43	80.00		-0.43	300 - Tree Canopy	58617
20061	1523071.76	584774.45	78.85	78.80		-0.05	300 - Tree Canopy	58617
20062	1523070.15	584728.56	76.76	77.00		0.24	300 - Tree Canopy	58617
20063	1523069.51	584683.37	74.54	74.57		0.03	300 - Tree Canopy	58617
20064	1523069.85	584636.14	73.02	72.95		-0.07	300 - Tree Canopy	58617
20065	1523074.14	584587.82	71.21	71.00		-0.21	300 - Tree Canopy	58617
20066	1523079.36	584534.22	70.41	70.00		-0.41	300 - Tree Canopy	58617
20067	1523076.24	584489.79	70.95	71.00		0.05	300 - Tree Canopy	58617
20068	1523088.17	584443.65	71.17	71.00		-0.17	300 - Tree Canopy	58617
20069	1523072.73	584397.96	72.05	71.00		-1.05	300 - Tree Canopy	58617
20070	1523073.97	584348.01	71.67	71.00		-0.67	300 - Tree Canopy	58617
20071	1523082.04	584303.49	71.33	71.00		-0.33	300 - Tree Canopy	58617
20072	1523080.69	584254.54	70.88	70.97		0.09	300 - Tree Canopy	58617
20073	1523069.09	584211.24	70.70	70.04		-0.66	300 - Tree Canopy	58617
20074	1523075.68	584167.05	69.48	69.19		-0.29	300 - Tree Canopy	58617
20075	1523075.09	584116.73	68.17	68.04		-0.13	300 - Tree Canopy	58617
20076	1523070.83	584064.30	66.23	66.15		-0.08	300 - Tree Canopy	58617
20077	1523075.16	584011.98	64.46	64.55		0.09	300 - Tree Canopy	58617
20078	1523072.13	583969.47	62.94	62.91		-0.03	300 - Tree Canopy	58617
20079	1523074.27	583922.63	61.62	61.64		0.02	300 - Tree Canopy	58617

APPENDIX I: CERTIFIED DTM Files

CERTIFIED LAS FILES					
FILE NAME	FILE SIZE	DATE	FILE NAME	FILE SIZE	DATE
LID2007_54989.las	87,744,717	1/14/2008	LID2007_58012.las	172,967,113	1/14/2008
LID2007_54990.las	87,761,965	1/14/2008	LID2007_58013.las	183,385,493	1/14/2008
LID2007_54991.las	105,146,061	1/14/2008	LID2007_58014.las	194,429,541	1/14/2008
LID2007_54995.las	170,319,777	1/14/2008	LID2007_58015.las	177,834,213	1/14/2008
LID2007_54996.las	129,311,697	1/14/2008	LID2007_58016.las	218,152,993	1/14/2008
LID2007_54997.las	153,393,601	1/14/2008	LID2007_58017.las	148,413,117	1/14/2008
LID2007_54998.las	139,967,769	1/14/2008	LID2007_58021.las	190,134,825	1/14/2008
LID2007_54999.las	147,891,489	1/14/2008	LID2007_58022.las	179,752,369	1/14/2008
LID2007_55000.las	143,096,769	1/14/2008	LID2007_58289.las	56,915,501	1/14/2008
LID2007_55001.las	148,012,801	1/14/2008	LID2007_58290.las	90,137,977	1/14/2008
LID2007_55002.las	176,226,593	1/14/2008	LID2007_58291.las	131,908,349	1/14/2008
LID2007_55003.las	168,717,273	1/14/2008	LID2007_58292.las	191,784,301	1/14/2008
LID2007_55004.las	157,001,809	1/14/2008	LID2007_58293.las	228,734,713	1/14/2008
LID2007_55289.las	86,940,753	1/14/2008	LID2007_58294.las	172,292,749	1/14/2008
LID2007_55290.las	96,108,409	1/14/2008	LID2007_58295.las	135,906,749	1/14/2008
LID2007_55291.las	126,311,401	1/14/2008	LID2007_58296.las	151,529,109	1/14/2008
LID2007_55292.las	190,876,109	1/14/2008	LID2007_58297.las	156,814,389	1/14/2008
LID2007_55293.las	199,634,381	1/14/2008	LID2007_58298.las	150,527,257	1/14/2008
LID2007_55294.las	204,262,153	1/14/2008	LID2007_58299.las	141,977,785	1/14/2008
LID2007_55295.las	165,345,037	1/14/2008	LID2007_58300.las	145,980,281	1/14/2008
LID2007_55296.las	154,511,333	1/14/2008	LID2007_58301.las	160,870,301	1/14/2008
LID2007_55297.las	162,070,437	1/14/2008	LID2007_58302.las	174,531,557	1/14/2008
LID2007_55298.las	152,064,049	1/14/2008	LID2007_58303.las	186,095,881	1/14/2008
LID2007_55299.las	143,844,661	1/14/2008	LID2007_58304.las	177,092,789	1/14/2008
LID2007_55300.las	132,281,309	1/14/2008	LID2007_58305.las	172,925,093	1/14/2008
LID2007_55301.las	151,548,373	1/14/2008	LID2007_58306.las	175,471,881	1/14/2008
LID2007_55302.las	188,416,937	1/14/2008	LID2007_58307.las	198,219,473	1/14/2008
LID2007_55303.las	162,204,389	1/14/2008	LID2007_58308.las	184,271,429	1/14/2008
LID2007_55304.las	148,466,877	1/14/2008	LID2007_58309.las	192,618,397	1/14/2008
LID2007_55589.las	84,963,225	1/14/2008	LID2007_58310.las	181,376,257	1/14/2008
LID2007_55590.las	94,074,481	1/14/2008	LID2007_58311.las	163,372,661	1/14/2008
LID2007_55591.las	148,874,109	1/14/2008	LID2007_58312.las	137,720,629	1/14/2008
LID2007_55592.las	207,918,561	1/14/2008	LID2007_58313.las	186,346,537	1/14/2008
LID2007_55593.las	208,468,797	1/14/2008	LID2007_58314.las	165,516,677	1/14/2008
LID2007_55594.las	202,127,333	1/14/2008	LID2007_58315.las	178,114,465	1/14/2008
LID2007_55595.las	160,372,189	1/14/2008	LID2007_58316.las	192,384,385	1/14/2008

CERTIFIED LAS FILES					
FILE NAME	FILE SIZE	DATE	FILE NAME	FILE SIZE	DATE
LID2007_55596.las	148,686,285	1/14/2008	LID2007_58317.las	135,759,061	1/14/2008
LID2007_55597.las	164,403,817	1/14/2008	LID2007_58321.las	181,384,557	1/14/2008
LID2007_55598.las	149,829,173	1/14/2008	LID2007_58322.las	184,034,309	1/14/2008
LID2007_55599.las	155,866,337	1/14/2008	LID2007_58323.las	212,443,517	1/14/2008
LID2007_55600.las	142,150,369	1/14/2008	LID2007_58589.las	68,456,737	1/14/2008
LID2007_55601.las	129,466,021	1/14/2008	LID2007_58590.las	117,580,481	1/14/2008
LID2007_55602.las	123,667,541	1/14/2008	LID2007_58591.las	173,617,177	1/14/2008
LID2007_55603.las	156,423,413	1/14/2008	LID2007_58592.las	241,787,317	1/14/2008
LID2007_55604.las	134,705,141	1/14/2008	LID2007_58593.las	212,234,773	1/14/2008
LID2007_55605.las	136,330,793	1/14/2008	LID2007_58594.las	158,760,613	1/14/2008
LID2007_55606.las	133,995,385	1/14/2008	LID2007_58595.las	153,116,109	1/14/2008
LID2007_55607.las	128,467,401	1/14/2008	LID2007_58596.las	146,756,089	1/14/2008
LID2007_55608.las	138,458,849	1/14/2008	LID2007_58597.las	144,618,361	1/14/2008
LID2007_55609.las	161,034,913	1/14/2008	LID2007_58598.las	153,885,393	1/14/2008
LID2007_55610.las	145,999,921	1/14/2008	LID2007_58599.las	142,242,181	1/14/2008
LID2007_55611.las	149,970,489	1/14/2008	LID2007_58600.las	159,518,805	1/14/2008
LID2007_55612.las	144,986,169	1/14/2008	LID2007_58601.las	172,742,189	1/14/2008
LID2007_55613.las	143,762,793	1/14/2008	LID2007_58602.las	177,856,397	1/14/2008
LID2007_55889.las	70,143,925	1/14/2008	LID2007_58603.las	180,256,409	1/14/2008
LID2007_55890.las	72,283,817	1/14/2008	LID2007_58604.las	189,929,513	1/14/2008
LID2007_55891.las	133,858,085	1/14/2008	LID2007_58605.las	163,668,677	1/14/2008
LID2007_55892.las	177,936,397	1/14/2008	LID2007_58606.las	185,547,289	1/14/2008
LID2007_55893.las	183,247,993	1/14/2008	LID2007_58607.las	208,644,041	1/14/2008
LID2007_55894.las	179,264,041	1/14/2008	LID2007_58608.las	162,074,597	1/14/2008
LID2007_55895.las	135,634,497	1/14/2008	LID2007_58609.las	175,770,305	1/14/2008
LID2007_55896.las	128,567,633	1/14/2008	LID2007_58610.las	205,610,565	1/14/2008
LID2007_55897.las	131,101,389	1/14/2008	LID2007_58611.las	163,177,069	1/14/2008
LID2007_55898.las	136,576,241	1/14/2008	LID2007_58612.las	163,056,317	1/14/2008
LID2007_55899.las	131,792,385	1/14/2008	LID2007_58613.las	145,128,617	1/14/2008
LID2007_55900.las	131,952,393	1/14/2008	LID2007_58614.las	160,121,653	1/14/2008
LID2007_55901.las	110,740,445	1/14/2008	LID2007_58615.las	169,460,465	1/14/2008
LID2007_55902.las	118,923,081	1/14/2008	LID2007_58616.las	150,490,213	1/14/2008
LID2007_55903.las	127,835,497	1/14/2008	LID2007_58617.las	165,821,177	1/14/2008
LID2007_55904.las	137,995,029	1/14/2008	LID2007_58621.las	148,604,761	1/14/2008
LID2007_55905.las	123,498,981	1/14/2008	LID2007_58622.las	186,835,353	1/14/2008
LID2007_55906.las	127,051,061	1/14/2008	LID2007_58623.las	216,164,953	1/14/2008
LID2007_55907.las	146,314,733	1/14/2008	LID2007_58624.las	242,989,709	1/14/2008
LID2007_55908.las	157,183,297	1/14/2008	LID2007_58889.las	99,801,993	1/14/2008
LID2007_55909.las	148,469,325	1/14/2008	LID2007_58890.las	124,474,249	1/14/2008

CERTIFIED LAS FILES					
FILE NAME	FILE SIZE	DATE	FILE NAME	FILE SIZE	DATE
LID2007_55910.las	150,141,777	1/14/2008	LID2007_58891.las	235,540,909	1/14/2008
LID2007_55911.las	135,736,969	1/14/2008	LID2007_58892.las	240,316,725	1/14/2008
LID2007_55912.las	130,825,321	1/14/2008	LID2007_58893.las	205,291,477	1/14/2008
LID2007_55913.las	138,005,221	1/14/2008	LID2007_58894.las	156,134,409	1/14/2008
LID2007_56189.las	65,416,741	1/14/2008	LID2007_58895.las	141,453,757	1/14/2008
LID2007_56190.las	78,386,893	1/14/2008	LID2007_58896.las	152,016,925	1/14/2008
LID2007_56191.las	140,654,637	1/14/2008	LID2007_58897.las	147,402,113	1/14/2008
LID2007_56192.las	192,260,301	1/14/2008	LID2007_58898.las	141,757,585	1/14/2008
LID2007_56193.las	202,151,297	1/14/2008	LID2007_58899.las	144,886,173	1/14/2008
LID2007_56194.las	197,629,301	1/14/2008	LID2007_58900.las	156,972,925	1/14/2008
LID2007_56195.las	164,443,193	1/14/2008	LID2007_58901.las	163,934,537	1/14/2008
LID2007_56196.las	137,175,105	1/14/2008	LID2007_58902.las	162,186,817	1/14/2008
LID2007_56197.las	136,843,529	1/14/2008	LID2007_58903.las	144,407,157	1/14/2008
LID2007_56198.las	141,103,241	1/14/2008	LID2007_58904.las	178,165,265	1/14/2008
LID2007_56199.las	142,195,085	1/14/2008	LID2007_58905.las	180,013,005	1/14/2008
LID2007_56200.las	140,053,897	1/14/2008	LID2007_58906.las	171,446,377	1/14/2008
LID2007_56201.las	108,739,509	1/14/2008	LID2007_58907.las	200,814,345	1/14/2008
LID2007_56202.las	131,526,429	1/14/2008	LID2007_58908.las	202,945,649	1/14/2008
LID2007_56203.las	138,866,657	1/14/2008	LID2007_58909.las	194,759,605	1/14/2008
LID2007_56204.las	129,163,605	1/14/2008	LID2007_58910.las	211,206,629	1/14/2008
LID2007_56205.las	141,746,121	1/14/2008	LID2007_58911.las	215,632,521	1/14/2008
LID2007_56206.las	129,962,041	1/14/2008	LID2007_58912.las	182,882,881	1/14/2008
LID2007_56207.las	150,430,649	1/14/2008	LID2007_58913.las	149,841,641	1/14/2008
LID2007_56208.las	129,428,325	1/14/2008	LID2007_58914.las	175,185,021	1/14/2008
LID2007_56209.las	153,145,061	1/14/2008	LID2007_58915.las	159,383,529	1/14/2008
LID2007_56210.las	155,671,213	1/14/2008	LID2007_58916.las	166,342,629	1/14/2008
LID2007_56211.las	146,060,521	1/14/2008	LID2007_58917.las	197,902,289	1/14/2008
LID2007_56212.las	130,571,109	1/14/2008	LID2007_58921.las	158,488,661	1/14/2008
LID2007_56213.las	120,314,205	1/14/2008	LID2007_58922.las	190,244,457	1/14/2008
LID2007_56214.las	119,235,101	1/14/2008	LID2007_58923.las	232,321,213	1/14/2008
LID2007_56489.las	16,220,825	1/14/2008	LID2007_58924.las	242,499,017	1/14/2008
LID2007_56490.las	64,986,345	1/14/2008	LID2007_58925.las	248,116,153	1/14/2008
LID2007_56491.las	154,088,589	1/14/2008	LID2007_58926.las	236,927,009	1/14/2008
LID2007_56492.las	185,106,161	1/14/2008	LID2007_58927.las	219,733,793	1/14/2008
LID2007_56493.las	188,374,505	1/14/2008	LID2007_59189.las	86,378,417	1/14/2008
LID2007_56494.las	179,003,813	1/14/2008	LID2007_59190.las	122,477,949	1/14/2008
LID2007_56495.las	163,959,745	1/14/2008	LID2007_59191.las	190,886,037	1/14/2008
LID2007_56496.las	139,958,977	1/14/2008	LID2007_59192.las	245,869,405	1/14/2008
LID2007_56497.las	129,977,481	1/14/2008	LID2007_59193.las	163,471,389	1/14/2008

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LID2007_56499.las	139,739,401	1/14/2008	LID2007_59195.las	143,446,237	1/14/2008
LID2007_56500.las	128,407,509	1/14/2008	LID2007_59196.las	160,156,833	1/14/2008
LID2007_56501.las	133,409,049	1/14/2008	LID2007_59197.las	140,622,017	1/14/2008
LID2007_56502.las	156,922,217	1/14/2008	LID2007_59198.las	142,325,229	1/14/2008
LID2007_56503.las	148,299,169	1/14/2008	LID2007_59199.las	146,715,553	1/14/2008
LID2007_56504.las	165,744,437	1/14/2008	LID2007_59200.las	144,260,905	1/14/2008
LID2007_56505.las	136,571,033	1/14/2008	LID2007_59201.las	156,832,793	1/14/2008
LID2007_56506.las	164,085,233	1/14/2008	LID2007_59202.las	149,296,145	1/14/2008
LID2007_56507.las	161,437,273	1/14/2008	LID2007_59203.las	153,678,177	1/14/2008
LID2007_56508.las	147,343,333	1/14/2008	LID2007_59204.las	153,659,461	1/14/2008
LID2007_56509.las	143,558,377	1/14/2008	LID2007_59205.las	188,479,309	1/14/2008
LID2007_56510.las	133,294,557	1/14/2008	LID2007_59206.las	200,829,073	1/14/2008
LID2007_56511.las	154,182,657	1/14/2008	LID2007_59207.las	189,590,965	1/14/2008
LID2007_56512.las	150,247,789	1/14/2008	LID2007_59208.las	204,450,929	1/14/2008
LID2007_56513.las	152,083,461	1/14/2008	LID2007_59209.las	198,268,509	1/14/2008
LID2007_56514.las	153,649,705	1/14/2008	LID2007_59210.las	205,384,925	1/14/2008
LID2007_56515.las	153,542,225	1/14/2008	LID2007_59211.las	183,901,477	1/14/2008
LID2007_56789.las	28,543,793	1/14/2008	LID2007_59212.las	180,286,089	1/14/2008
LID2007_56790.las	76,400,853	1/14/2008	LID2007_59213.las	158,994,749	1/14/2008
LID2007_56791.las	160,818,761	1/14/2008	LID2007_59214.las	159,297,009	1/14/2008
LID2007_56792.las	192,387,529	1/14/2008	LID2007_59215.las	146,947,469	1/14/2008
LID2007_56793.las	193,991,313	1/14/2008	LID2007_59216.las	167,515,653	1/14/2008
LID2007_56794.las	172,804,777	1/14/2008	LID2007_59217.las	168,228,225	1/14/2008
LID2007_56795.las	153,077,033	1/14/2008	LID2007_59221.las	169,965,093	1/14/2008
LID2007_56796.las	144,111,433	1/14/2008	LID2007_59222.las	199,470,205	1/14/2008
LID2007_56797.las	143,942,817	1/14/2008	LID2007_59223.las	209,349,181	1/14/2008
LID2007_56798.las	141,388,561	1/14/2008	LID2007_59224.las	215,023,381	1/14/2008
LID2007_56799.las	136,322,437	1/14/2008	LID2007_59225.las	237,972,249	1/14/2008
LID2007_56800.las	134,198,861	1/14/2008	LID2007_59226.las	244,720,597	1/14/2008
LID2007_56801.las	151,086,373	1/14/2008	LID2007_59227.las	196,697,381	1/14/2008
LID2007_56802.las	136,232,793	1/14/2008	LID2007_59489.las	98,354,365	1/14/2008
LID2007_56803.las	92,646,649	1/14/2008	LID2007_59490.las	106,216,905	1/14/2008
LID2007_56804.las	152,261,393	1/14/2008	LID2007_59491.las	151,308,609	1/14/2008
LID2007_56805.las	160,181,725	1/14/2008	LID2007_59492.las	211,134,977	1/14/2008
LID2007_56806.las	142,365,725	1/14/2008	LID2007_59493.las	170,855,969	1/14/2008
LID2007_56807.las	158,415,241	1/14/2008	LID2007_59494.las	164,237,805	1/14/2008
LID2007_56808.las	141,291,749	1/14/2008	LID2007_59495.las	142,202,317	1/14/2008
LID2007_56809.las	139,332,449	1/14/2008	LID2007_59496.las	182,028,081	1/14/2008

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LID2007_56811.las	145,276,905	1/14/2008	LID2007_59498.las	161,393,041	1/14/2008
LID2007_56812.las	150,667,633	1/14/2008	LID2007_59499.las	162,843,881	1/14/2008
LID2007_56813.las	156,488,245	1/14/2008	LID2007_59500.las	150,059,205	1/14/2008
LID2007_56814.las	158,527,325	1/14/2008	LID2007_59501.las	157,217,373	1/14/2008
LID2007_56815.las	160,264,897	1/14/2008	LID2007_59502.las	140,112,173	1/14/2008
LID2007_57090.las	75,079,037	1/14/2008	LID2007_59503.las	146,838,913	1/14/2008
LID2007_57091.las	130,352,129	1/14/2008	LID2007_59504.las	164,772,381	1/14/2008
LID2007_57092.las	181,124,365	1/14/2008	LID2007_59505.las	177,586,469	1/14/2008
LID2007_57093.las	188,933,509	1/14/2008	LID2007_59506.las	181,800,009	1/14/2008
LID2007_57094.las	158,057,457	1/14/2008	LID2007_59507.las	190,147,745	1/14/2008
LID2007_57095.las	128,167,717	1/14/2008	LID2007_59508.las	176,670,253	1/14/2008
LID2007_57096.las	136,816,945	1/14/2008	LID2007_59509.las	186,375,445	1/14/2008
LID2007_57097.las	138,751,589	1/14/2008	LID2007_59510.las	198,886,125	1/14/2008
LID2007_57098.las	135,812,009	1/14/2008	LID2007_59511.las	154,502,109	1/14/2008
LID2007_57099.las	122,011,117	1/14/2008	LID2007_59512.las	174,993,993	1/14/2008
LID2007_57100.las	137,196,961	1/14/2008	LID2007_59513.las	185,054,337	1/14/2008
LID2007_57101.las	131,840,265	1/14/2008	LID2007_59514.las	177,495,677	1/14/2008
LID2007_57102.las	124,133,169	1/14/2008	LID2007_59515.las	155,241,581	1/14/2008
LID2007_57103.las	120,516,605	1/14/2008	LID2007_59516.las	158,407,009	1/14/2008
LID2007_57104.las	129,262,949	1/14/2008	LID2007_59517.las	137,628,881	1/14/2008
LID2007_57105.las	155,922,673	1/14/2008	LID2007_59518.las	144,818,741	1/14/2008
LID2007_57106.las	154,854,417	1/14/2008	LID2007_59524.las	212,376,093	1/14/2008
LID2007_57107.las	173,292,557	1/14/2008	5 LID2007_59525.las	239,523,345	1/14/2008
LID2007_57108.las	152,442,729	1/14/2008	LID2007_59526.las	223,019,661	1/14/2008
LID2007_57109.las	144,131,873	1/14/2008	LID2007_59527.las	202,687,041	1/14/2008
LID2007_57110.las	127,198,173	1/14/2008	LID2007_59788.las	141,458,573	1/14/2008
LID2007_57111.las	145,904,833	1/14/2008	LID2007_59789.las	193,200,649	1/14/2008
LID2007_57112.las	157,419,749	1/14/2008	LID2007_59790.las	275,427,681	1/14/2008
LID2007_57113.las	167,794,149	1/14/2008	LID2007_59791.las	282,036,957	1/14/2008
LID2007_57114.las	155,742,045	1/14/2008	LID2007_59792.las	245,410,065	1/14/2008
LID2007_57115.las	149,117,525	1/14/2008	LID2007_59793.las	218,777,057	1/14/2008
LID2007_57116.las	146,344,441	1/14/2008	LID2007_59794.las	218,993,189	1/14/2008
LID2007_57390.las	81,788,285	1/14/2008	LID2007_59795.las	205,890,857	1/14/2008
LID2007_57391.las	142,539,913	1/14/2008	LID2007_59796.las	197,134,481	1/14/2008
LID2007_57392.las	183,753,981	1/14/2008	LID2007_59797.las	162,423,937	1/14/2008
LID2007_57393.las	169,171,049	1/14/2008	LID2007_59798.las	153,489,529	1/14/2008
LID2007_57394.las	147,163,293	1/14/2008	LID2007_59799.las	160,026,941	1/14/2008
LID2007_57395.las	123,314,105	1/14/2008	LID2007_59800.las	166,599,697	1/14/2008

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LID2007_57396.las	113,997,197	1/14/2008	LID2007_59801.las	177,306,805	1/14/2008
LID2007_57397.las	126,860,117	1/14/2008	LID2007_59802.las	156,546,849	1/14/2008
LID2007_57398.las	124,345,969	1/14/2008	LID2007_59803.las	159,612,905	1/14/2008
LID2007_57399.las	118,049,677	1/14/2008	LID2007_59804.las	175,821,405	1/14/2008
LID2007_57400.las	117,937,665	1/14/2008	LID2007_59805.las	181,772,329	1/14/2008
LID2007_57401.las	131,304,653	1/14/2008	LID2007_59806.las	181,286,725	1/14/2008
LID2007_57402.las	130,750,897	1/14/2008	LID2007_59807.las	192,613,285	1/14/2008
LID2007_57403.las	106,663,449	1/14/2008	LID2007_59808.las	191,489,701	1/14/2008
LID2007_57404.las	117,551,405	1/14/2008	LID2007_59809.las	211,508,553	1/14/2008
LID2007_57405.las	149,501,069	1/14/2008	LID2007_59810.las	175,391,857	1/14/2008
LID2007_57406.las	177,454,449	1/14/2008	LID2007_59811.las	173,615,517	1/14/2008
LID2007_57407.las	167,618,721	1/14/2008	LID2007_59812.las	175,103,801	1/14/2008
LID2007_57408.las	126,293,689	1/14/2008	LID2007_59813.las	180,418,453	1/14/2008
LID2007_57409.las	143,347,357	1/14/2008	LID2007_59814.las	202,346,337	1/14/2008
LID2007_57410.las	147,276,229	1/14/2008	LID2007_59815.las	180,187,305	1/14/2008
LID2007_57411.las	146,911,405	1/14/2008	LID2007_59816.las	162,768,393	1/14/2008
LID2007_57412.las	142,358,773	1/14/2008	LID2007_60088.las	76,773,465	1/14/2008
LID2007_57413.las	156,391,205	1/14/2008	LID2007_60089.las	133,623,713	1/14/2008
LID2007_57414.las	171,862,485	1/14/2008	LID2007_60090.las	208,550,369	1/14/2008
LID2007_57415.las	169,045,349	1/14/2008	LID2007_60091.las	160,058,373	1/14/2008
LID2007_57416.las	173,164,417	1/14/2008	LID2007_60092.las	143,639,249	1/14/2008
LID2007_57417.las	171,815,677	1/14/2008	LID2007_60093.las	146,306,005	1/14/2008
LID2007_57690.las	32,384,757	1/14/2008	LID2007_60094.las	155,800,649	1/14/2008
LID2007_57691.las	160,918,617	1/14/2008	LID2007_60095.las	167,120,021	1/14/2008
LID2007_57692.las	234,901,769	1/14/2008	LID2007_60096.las	162,029,937	1/14/2008
LID2007_57693.las	236,041,797	1/14/2008	LID2007_60097.las	163,479,593	1/14/2008
LID2007_57694.las	177,386,913	1/14/2008	LID2007_60098.las	162,441,865	1/14/2008
LID2007_57695.las	132,876,897	1/14/2008	LID2007_60099.las	158,591,277	1/14/2008
LID2007_57696.las	146,107,413	1/14/2008	LID2007_60100.las	154,391,437	1/14/2008
LID2007_57697.las	146,498,321	1/14/2008	LID2007_60101.las	170,034,149	1/14/2008
LID2007_57698.las	159,050,625	1/14/2008	LID2007_60102.las	182,374,133	1/14/2008
LID2007_57699.las	151,297,473	1/14/2008	LID2007_60103.las	173,565,081	1/14/2008
LID2007_57700.las	140,017,301	1/14/2008	LID2007_60104.las	174,517,313	1/14/2008
LID2007_57701.las	163,239,073	1/14/2008	LID2007_60105.las	175,620,785	1/14/2008
LID2007_57702.las	189,317,685	1/14/2008	LID2007_60106.las	183,477,641	1/14/2008
LID2007_57703.las	171,682,373	1/14/2008	LID2007_60107.las	182,760,057	1/14/2008
LID2007_57704.las	150,890,401	1/14/2008	LID2007_60108.las	185,664,889	1/14/2008
LID2007_57705.las	226,870,657	1/14/2008	LID2007_60109.las	162,533,929	1/14/2008
LID2007_57706.las	216,346,941	1/14/2008	LID2007_60110.las	178,670,581	1/14/2008

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LID2007_57708.las	183,170,257	1/14/2008	LID2007_60112.las	169,768,737	1/14/2008
LID2007_57709.las	219,516,777	1/14/2008	LID2007_60113.las	159,768,249	1/14/2008
LID2007_57710.las	184,626,369	1/14/2008	LID2007_60114.las	171,900,125	1/14/2008
LID2007_57711.las	193,492,205	1/14/2008	LID2007_60115.las	163,161,689	1/14/2008
LID2007_57712.las	190,860,025	1/14/2008	LID2007_60116.las	157,506,465	1/14/2008
LID2007_57713.las	194,698,853	1/14/2008	LID2007_60389.las	169,375,217	1/14/2008
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LID2007_57990.las	72,773,397	1/14/2008	LID2007_60395.las	172,252,665	1/14/2008
LID2007_57991.las	135,390,289	1/14/2008	LID2007_60396.las	163,424,221	1/14/2008
LID2007_57992.las	185,326,349	1/14/2008	LID2007_60397.las	152,497,321	1/14/2008
LID2007_57993.las	226,914,113	1/14/2008	LID2007_60398.las	148,181,401	1/14/2008
LID2007_57994.las	173,780,765	1/14/2008	LID2007_60399.las	165,103,873	1/14/2008
LID2007_57995.las	169,734,933	1/14/2008	LID2007_60400.las	155,995,949	1/14/2008
LID2007_57996.las	149,007,849	1/14/2008	LID2007_60401.las	144,440,321	1/14/2008
LID2007_57997.las	157,672,393	1/14/2008	LID2007_60402.las	182,716,273	1/14/2008
LID2007_57998.las	157,489,925	1/14/2008	LID2007_60403.las	177,119,429	1/14/2008
LID2007_57999.las	160,023,533	1/14/2008	LID2007_60404.las	158,171,445	1/14/2008
LID2007_58000.las	145,305,997	1/14/2008	LID2007_60405.las	185,185,081	1/14/2008
LID2007_58001.las	174,846,697	1/14/2008	LID2007_60406.las	215,396,985	1/14/2008
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LID2007_58003.las	194,336,841	1/14/2008	LID2007_60408.las	182,489,017	1/14/2008
LID2007_58004.las	191,621,917	1/14/2008	LID2007_60409.las	175,751,021	1/14/2008
LID2007_58005.las	178,671,065	1/14/2008	LID2007_60410.las	170,737,949	1/14/2008
LID2007_58006.las	178,622,805	1/14/2008	LID2007_60411.las	170,091,009	1/14/2008
LID2007_58007.las	178,872,705	1/14/2008	LID2007_60412.las	163,178,825	1/14/2008
LID2007_58008.las	193,431,697	1/14/2008	LID2007_60413.las	190,255,337	1/14/2008
LID2007_58009.las	178,492,649	1/14/2008	LID2007_60414.las	184,333,293	1/14/2008
LID2007_58010.las	155,350,773	1/14/2008	LID2007_60415.las	183,570,497	1/14/2008
LID2007_58011.las	139,675,001	1/14/2008	LID2007_60416.las	153,403,129	1/14/2008

APPENDIX J: ALS50 System Calibration Report

Introduction

This Leica ALS50 LiDAR System Calibration Report shall be used to represent confirmation of the LiDAR system specifications, performance, and requirements. The system functionality, elevation, and horizontal accuracy performance shall be demonstrated for calibration purposes. Woolpert completed calibration flights, after the LiDAR acquisition, and prior to post-processing of the LiDAR data.

This report contains various test results and information pertaining to the system. It should be noted that all numbers shown in this report are in **meters** unless otherwise stated. All coordinates stated in the report are in the WGS84 coordinate system with ellipsoidal elevation.

System Model Number: ALS50

Client Name: Southwest Florida Water Management District

Calibration Date July 8, 2006 (SH46)
March 25, 2007 (SH18)

Report Prepared By: Qian Xiao

System Specifications and Requirements

The ALS50 LiDAR systems, built by Leica Geosystems for Woolpert, Inc. have the following specifications:

Nominal	
Operating Altitude	400 – 3,000 meters
Elevation accuracy	15cm single shot
Range Resolution	1 cm
Scan angle	Variable from 0 to 75°
Swath width	Variable from 0 to 1.5 X altitude
Angle resolution	0.01°
Scan frequency	Variable based on scan angle
Horizontal Accuracy	Better than 1/2000 X altitude
Supported GPS receivers	Ashtech Z12, Trimble 7400, Novatel Millenium
Laser repetition rate	58 kHz
Beam divergence	0.3 mrads
Laser classification	Class IV laser product (FDA CFR 21)
Eye safe range	400m single shot depending on laser repetition rate
Power requirements	28 VDC @ 25A
Operating temperature	10-35°C
Humidity	0-95% non-condensing

On Site Antenna Offsets and Location

Aircraft GPS Antenna

The following measurements were calculated for Woolpert's aircraft (both Cessna 404) N404CP and N7079F equipped with LiDAR. The POS/AV and ALS50 processing numbers were calculated from internal measurements completed in Leica's lab, and the positioning of the GPS antenna on the aircraft was field surveyed by Woolpert using a total station.

N7079F: Cessna 404

Reference Point to GPS Antenna	
X	**0.742 m**
Y	**-0.011 m**
Z	**-1.344 m**

N404CP: Cessna 404

Reference Point to GPS Antenna	
X	**0.646 m**
Y	**0.014 m**
Z	**-1.304 m**

The following measurements were calculated in the lab at Leica and will remain constant.

User to IMU Lever Arm (POS/AV) for AIMU	
X	**-0.269 m**
Y	**0.139 m**
Z	**-0.017 m**

User to IMU Lever Arm (POS/AV) for LN200	
X	**-0.273 m**
Y	**0.161 m**
Z	**-0.017 m**

Aircraft N7079F is equipped with AIMU and Aircraft N404CP is equipped with LN200.

Base Station GPS Antenna

Monument Description:	
GPS Receiver Type: Trimble 4700 Antenna Type: Trimble	Epoch Interval: 0.5 sec Elevation Mask: 10 degrees Observation Type: Static
Station Name used in processing the acceptance data: Hernport N 28 28 37.2592 Lat. W 082 27 21.2833 Long. -5.85 Meters Ellipsoidal. HI.	

Flight Calibration Methodology

Data Collection

To accomplish the formal calibration, Woolpert has established a calibration range consisting of an airport runway. The calibration range has been ground surveyed to an accuracy of better than 1 cm. Four flight lines with two different altitudes and opposing headings (see Figure J-3) are required in order to capture pitch, roll, heading (see Figure J-1) and torsion errors (see Figure J-2).

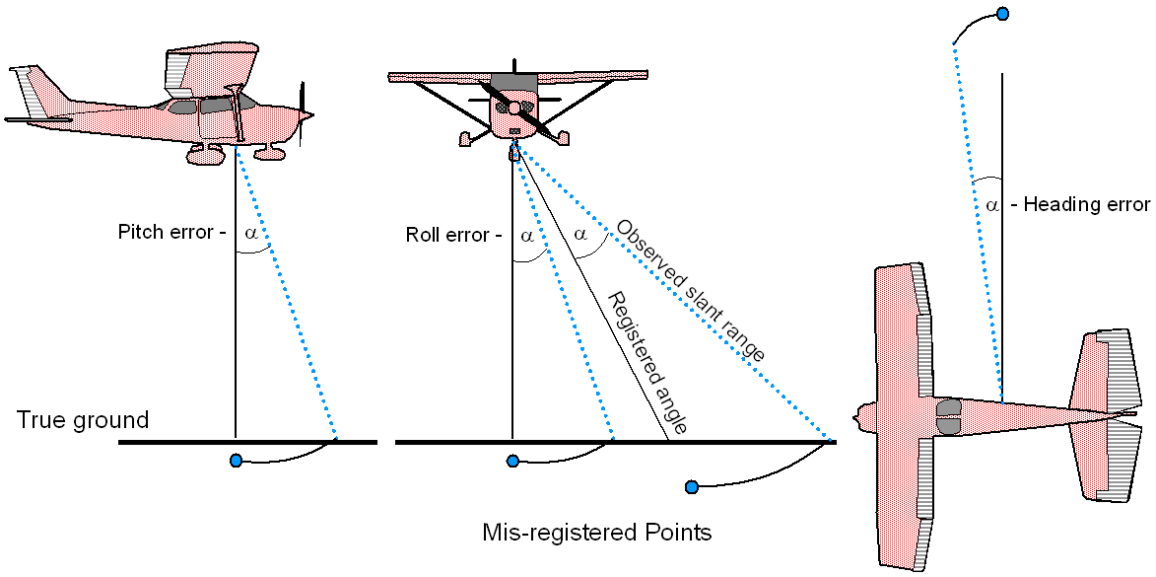

Figure J-1: Misalignment Errors.

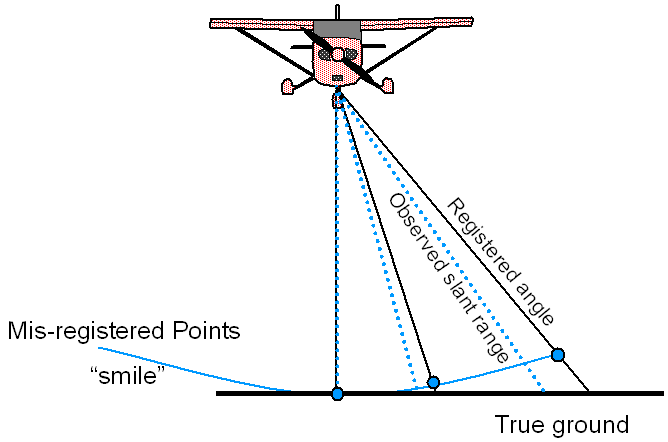

Figure J-2: Torsion Error

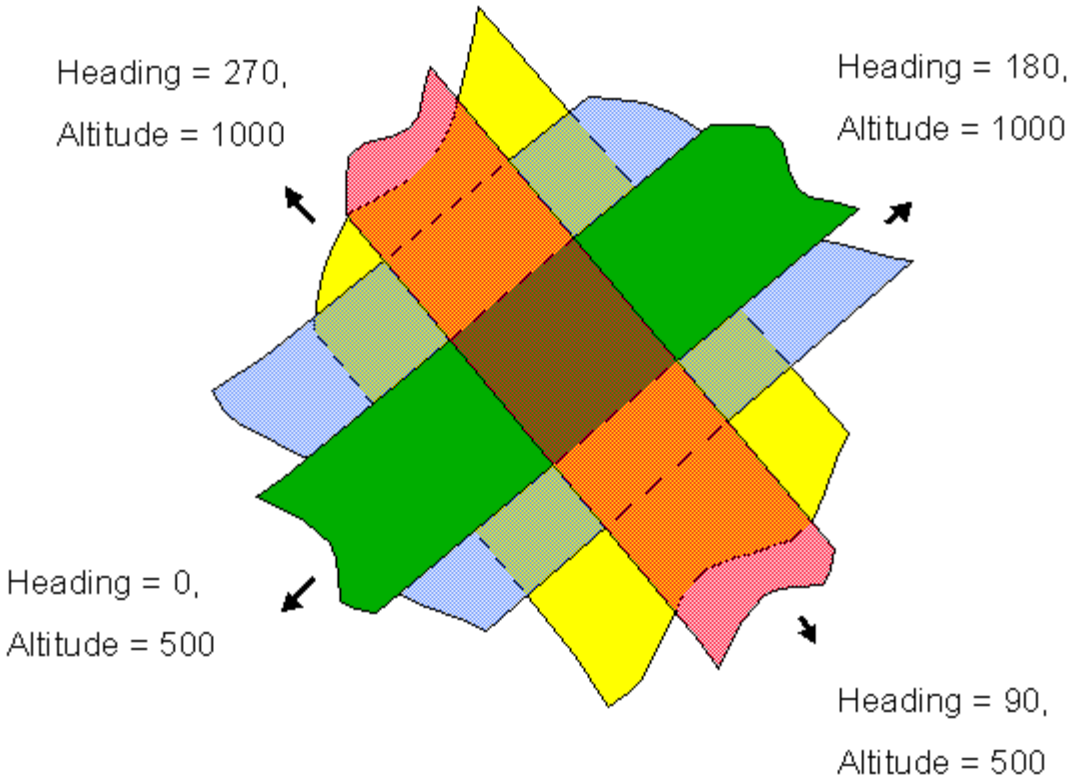

Figure J-3: Optimal Flight Pattern for Calibration

Intensity Images

Four images from LiDAR intensity reflectance are generated in order to pick up tie points (see Figure J-4). A least square adjustment (LSA) is performed using AutoBoresighting software provided by system manufacturer. Pitch, roll, heading, and torsion errors are calculated by LSA.

Figure J-4: Ortho photo generated from LiDAR intensity reflectance.

Ground Control Points

Ground control points were collected along and across an airport runway. A total of 116 runway points were surveyed. The LiDAR collects scan data over the control points and the data is then used to determine the absolute Z accuracy of the system. The distribution of the runway points can be found in Figure J-5.

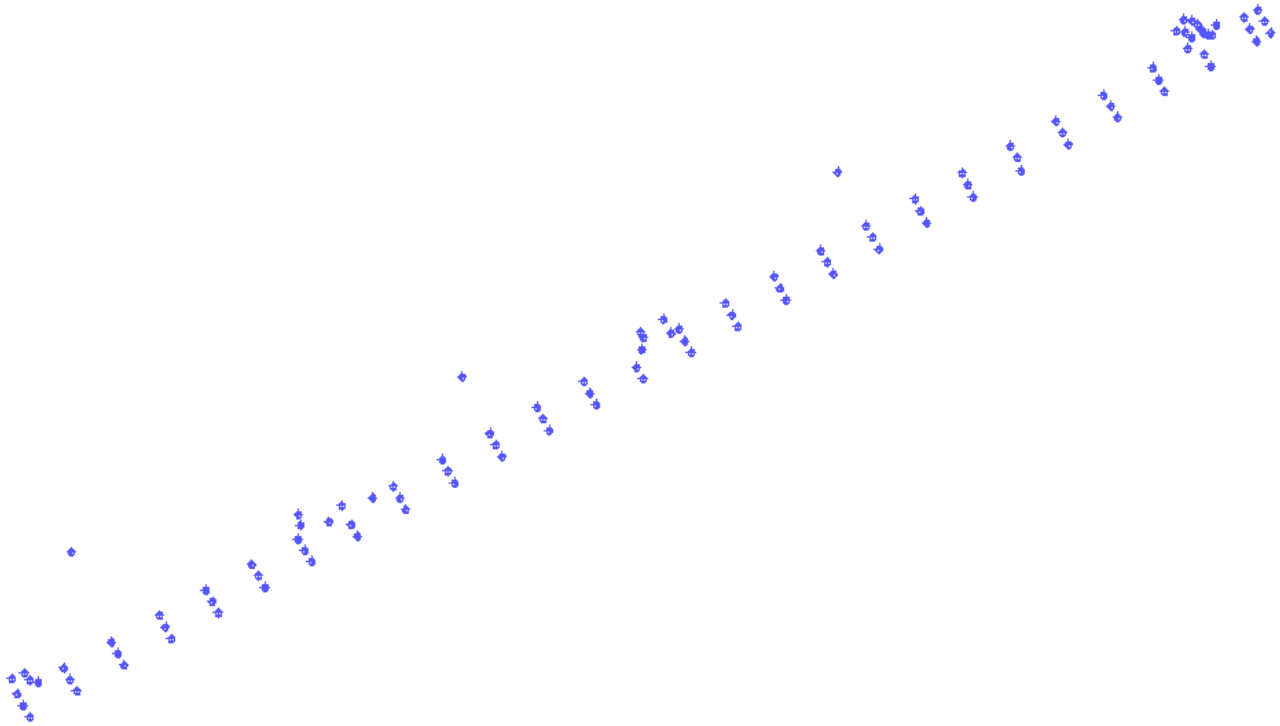

Figure J-5: Ground control points on the runway

Flight over Ground Control Points

Flight lines, flown parallel and perpendicular to the runway control points were used to determine the elevation (Z) error of the LiDAR data as well as pitch, roll, heading, and torsion can be seen in Figure J-6. Each day the runway was flown, multiple overlapping strips were performed to assure that most control points were covered and to increase the likelihood that a laser point would strike within 0.5 meters of a control point.

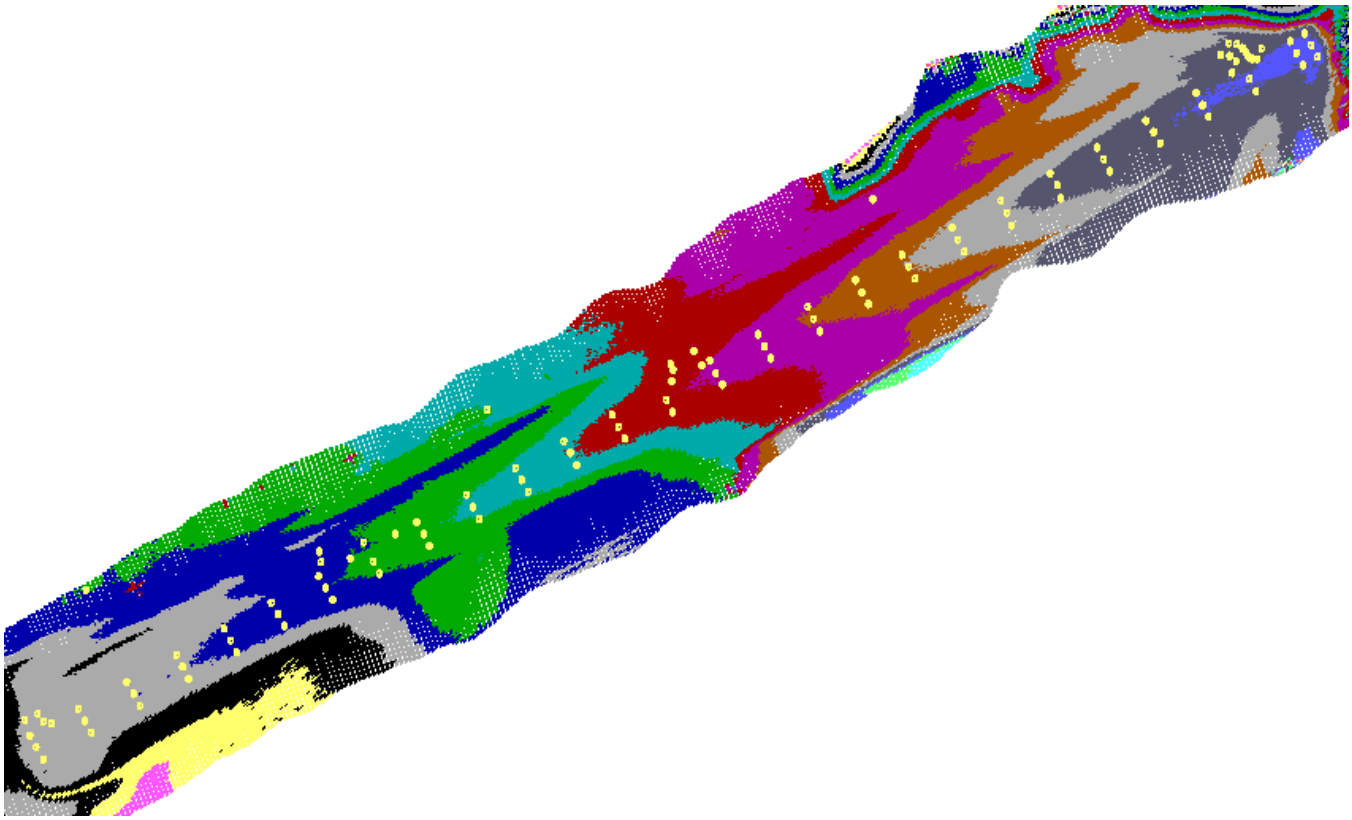

Figure J-6: One flight line parallel to the runway ground control points. The LiDAR data was collected at about 500 meters AGL.

Calibration Results

The following numbers were derived by Leica through lab calibration and also by Woolpert using data acquired over Woolpert's LiDAR calibration site. These parameters might have been refined using data collected for the project.

N7079F: Cessna 404 (Woolpert)

Parameter	Value	Format
Lab fixed parameters		
Range 1 Correction	2.400 m	0.000
Range 2 Correction	2.400 m	0.000
Range 3 Correction	2.400 m	0.000
Encoder Latency	0.00 mcr sec	0.00
Ticks Per Revolution	8401818 ticks	0000000
Attitude		
*Roll (radian)	0.040857800	0.000000000
*Pitch (radian)	-0.002981712	0.000000000
*Heading (radian)	0.001416112	0.000000000
*Scan angle correct	-12613 ticks	00000
Mechanic		
*Torsion (no unit)	-85000	00000

N404CP: Cessna 404 (Woolpert)

Parameter	Value	Format
Lab fixed parameters		
Range 1 Correction	2.446 m	0.000
Range 2 Correction	2.446 m	0.000
Range 3 Correction	2.446 m	0.000
Encoder Latency	0.00 mcr sec	0.00
Ticks Per Revolution	8389996 ticks	0000000
Attitude		
*Roll (radian)	0.002224375	0.000000000
*Pitch (radian)	0.014947456	0.000000000
*Heading (radian)	0.000319404	0.000000000
*Scan angle correct	17500 ticks	00000
Mechanic		
*Torsion (no unit)	23000	00000

*Value calibrated on site from calibration data

Based on the analysis of the LiDAR data the accuracy of the system meets the required specifications.

Approved By:			
Title	**Name**	**Signature**	**Date**
LiDAR Specialist	Qian Xiao		**03/19/2008**

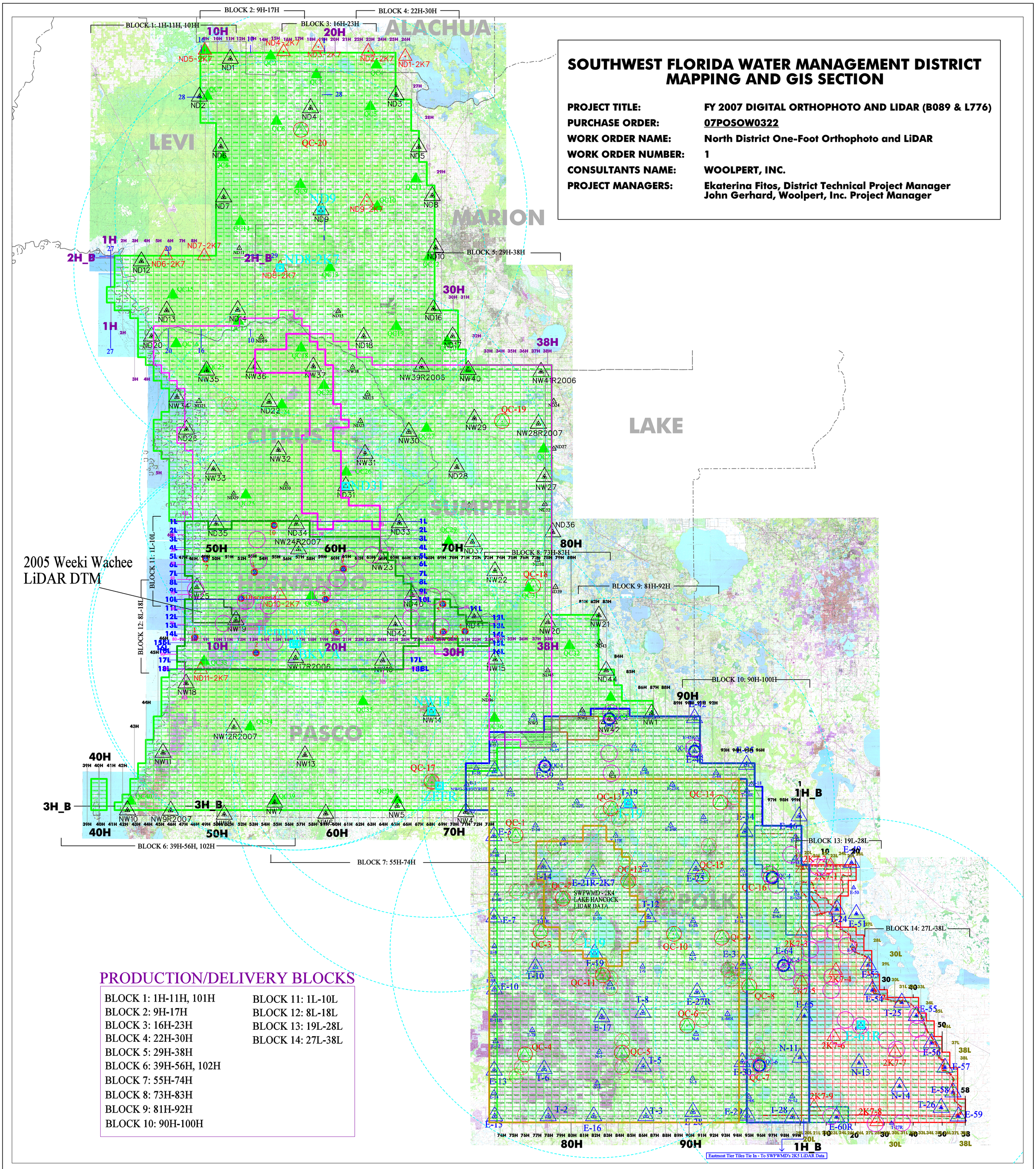

Exhibit A: 2007 SWFWMD N. District DOI/LiDAR & Polk Co. DOI/LiDAR Projects

2007 SWFWMD North District Orthophoto (B089) & LiDAR (L776) Project (#66441)

- North District and Polk County DOI Tile Limits (6,063 Tiles +/- 5,437 Sq. Miles)
- ADS40 **N/S** Flights 1H-102H @ 0.90' GSD @ 4,585 Line Miles; 30% SL
- ADS40 **E/W** Flights 1L-18L @ 0.66' GSD; 598 Line Miles @ 30% SL
- Hernando LiDAR Flights 1-104; 2,400' AGL; 2.1' Average GSD; 3,277 Line Miles
- Levy DEM LiDAR Flights 1-29; 5,000' AGL; 7.0' Average GSD; 698 Line Miles
- 2K7 = 11 New Control Points for 2007
- 100 Existing Woolpert Control Points In North Distirct/Polk County used in 2007
- Hernando Co. 2K7 LiDAR Project Limits
- QC-1>QC-16 Existing 2K5 W's 2D Checkpoints & QC-17>QC-21 sets of 5 Pt's W's 2K6 2D QC Checkpoints Used for 2K7 DOI
- 130 New 2K7 3-D QC Checkpoints: 10 Groups of 10 Points Each in Bare-Earth, Urban and Brush; 2 Dense Vegetation Profiles @ 1,200' X 15 Pt's. Ea.
- Existing 2006 SWFWMD 2-D QC Checkpoints Used For 2K7 DOI
- Existing Polk Co./SWFWMD Control Points not used in 2007
- Existing 2D QC Control Points performed by Polk County
- ABGPS Base Stations w/ a 25 mile radius

2007 Polk County BoCC LiDAR & DOI Mapping Project (#66466)

- Polk Co. BoCC - LiDAR, Contours & Color DOI For Spring 2K7 (424 Tiles, +/-380 Sq Mi's)
- ADS40 Flights 19L-38L @ 0.66' GSD @ 475 Line Miles @ 30% SL
- 2K7 LiDAR Flights 1-58 @ 3.3' GSD
- 2K7 = 9 New Control Points for 2007
- 17 Existing Polk Co./SWFWMD Control Points used in 2007
- 2007 QC Points Areas
- Existing Control Points In North Distirct/Polk County not used in 2007

Add. Info

- 2K5 SWFWM LiDAR Proj. Limits
  - Peace River = #63507
  - Lake Wales = #64891
  - Hampton Tract = #65099
  - Judy Tract = #65735
  - SWFWMD - FY2K7; Remaining Polk District 2K5 LiDAR & Contours (#66661)
  - QC-1>QC-6 = 6 Groups of 21 Pt.'s in Ea. Group = 126 3-D QC Pt.'s for LiDAR Data (21 Pt.'s = 7 points in each of the 3 categories: Urban, Bare Ground/Short Grass & Brush Area/Medium Vegetation)
- 2K6 SWFWM LiDAR Proj. Limits
  - 2006 SWFWMD North District = #64990

NOTE: Marion Co. & Pasco Co. LiDAR DEM Data Provided by SWFWMD

H:\PHP\PROJECTS\66441_North_District_2007\layouts\2007_POLK_and_SWFWMD_Layout_V8.dgn

Project 66441

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