



Grand Canyon Final Project Report

For Contract

DACW43-03-D-0509

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Table of Contents

PROJECT APPROACH	3
Project Name and Location	
Date of Data Acquisition	
Dates of Data Processing	
General Project Information	
Project Area	
Acquisition Systems	
Data Acquisition	
Ground Survey	
GPS/IMU Processing	
Raw Laser Data Processing	
Anomaly Filtering	
QC Assurance	
DATA PROCESSING PROCEDURES	8
Data Processing Methods	
Data Deliverables	
Data Format	
Map Coordinate System and Datum	
PROJECT SUMMARY	11
LIDAR Summary	
LIDAR SYSTEM DATA REPORT	13
LIDAR System Acquisition Parameters	
Accuracy of the Topographic Surface Products	
Project Area	
FLIGHT REPORT	26
Mission Logs	
Ground Truth	
GROUND CONTROL REPORT	39
Base Station Information	
SYSTEM CALIBRATION REPORT	42
System Calibration Summary	
GPS/Calibration Process Summary	
Process Summary Reports	
Satellite Lock, and PDOP Plots	
APPENDIX A- RMSE ANALYSIS	69
APPENDIX B- PREVIOUS REPORTS	83

4/25/2005



PROJECT APPROACH

Project Name and Location

LIDAR Data Acquisition within the Grand Canyon, AZ
Grand Canyon, AZ

Date of Data Acquisition**Pre-Flood:**

November 19, 2004

November 20, 2004

Post-Flood:

December 4, 2004

December 5, 2004

December 9, 2004

Dates of Data Processing

December 10, 2004 through February 18, 2005

General

Spectrum Mapping was tasked by the G&O/3Di joint venture to collect LIDAR data for 7 sites in the Grand Canyon. The sites were Paria, North Canyon, South Canyon, Eminence, Kwagunt, Palisades, and Palisades South. The total project area for the Grand Canyon was approximately 23 linear miles. This project area was flown pre-flood and post-flood. For the pre-flood acquisition the aircraft was equipped with the DATIS III system, including a 36 Khz Laser, an inertial measurement unit (IMU), and a dual frequency GPS receiver and antenna. The post-flood acquisition was conducted using Spectrum Mapping's RAMS system, including a 26 Khz Laser, an inertial measurement unit (IMU), and a dual frequency GPS receiver and antenna.

Project Area

Spectrum ensures that the geographic extent of the project area is collected using the correct mission profiles for the desired products. This is accomplished using TRACK'AIR, a digital mission-planning tool.

Mission planning consists of several steps that ensure proper flight preparation. First and foremost the project boundary for the site is acquired from our customer and imported into our flight planning software. Following this, available information such as elevation data, vegetation coverage and cultural feature extents are reviewed and general assessments are made by our Photogrammetrists to determine proper LIDAR system settings such as FOV (field of view). All LIDAR flight lines are flown with a minimum of 30% side overlap. The Grand Canyon project was flown to have 4x the coverage of typical flights. The contracted effective LIDAR spot data density is to be .56 square meters / sample. Each project area was flown a total of four (4) times, twice during pre-flood conditions and twice during post flood conditions.

Having set the previous parameters, the flight plan is prepared in digital form using our proprietary software. The existing elevation data is then imported and queried to calculate the flight altitudes for each flight line. Once flight planning is complete, waypoints in latitude/longitude and ellipsoid height are output to our flight management system.

GPS differential correction is required for our process. GPS planning software is used to predict PDOP (positional dilution of precision ... i.e. GPS quality) greater than 3.0. Should this

condition occur, laser data acquisition is suspended until the satellite geometry improves. Spectrum's base stations are full wave, dual frequency, GPS receivers that record data at a rate of 1 second. All base station data is recorded to 1GB flash memory cards for immediate use after the mission.

Acquisition Systems

Spectrum Mapping employs a DATIS III and a RAMS LIDAR system. Flight data was logged digitally to a 150Gb removable hard drive array on board the aircraft. GPS base station data was logged to flash memory cards. This allowed for rapid file transfer since tape systems have been eliminated from the process. Drives were downloaded daily, processed, and archived immediately following collection, yielding basic laser data within hours of data collection. Field checks of the data were performed each day to ensure complete coverage of the area flown that day for the laser data.

Data Acquisition

Our flight crew, comprised of a pilot and a system operator, mobilized to the project site ferrying all equipment and digital information required. Recovery of GPS base stations and coordination with the project ground control team were completed to identify correct base station and calibration site information.

A total of 7 base stations were used to collect GPS 1- second epoch data. Spectrum coordinated with the Grand Canyon Research and Monitoring Center for base station data collection

The flight crew was guided by a GPS controlled flight management system, which displays the flight plan; including altitude, heading, cross track deviation and PDOP. The system operator monitors flight management data in addition to laser information. During flight the crew monitors all functions in system operation and guidance ensuring a successful mission.

Ground Survey

Spectrum utilized airborne GPS methods for the production of this project. The GCMRC provided survey control support as required and vertical checkpoint surveys as needed for quality control.

GPS/IMU Processing

Position and orientation data must be processed first in order to resolve laser data, and verify flight coverage. All aircraft trajectory and exterior orientation parameters for imagery are generated during this process. Both horizontal and vertical project coordinate computations are accomplished at this stage. This processing takes approximately two times the actual flight time of the mission.

Raw Laser Data Processing

Laser data is then processed to resolve the range finder, scan angle, and position and orientation system data, using Spectrum's post-processor software. All returns are sorted to best reflect the vegetated and bare earth surfaces. Data are transformed from raw binary format to an LAS file format for filtering and custom projection. The most current NGS models are an integral part of the post-processing software, with custom projection options available.

Laser data are thinned for quick projection of swath coverage. Spectrum's LIDIMAGE™ software is also used at this stage for a rudimentary test of the data validity. LIDIMAGE™ is a fast-generating bitmap utility for rapid viewing of the DEM data. Any seams, holes, or other unwanted artifacts could be quickly identified for potential re-flight areas.

Anomaly Data Filtering

The LIDAR system collects elevation and position information from all reflective surfaces. The task is to identify and remove those features that would be defined as an anomaly (high or low points).

Spectrum houses all laser points in a database LAS (format) that retains information about flight day and time, return number, laser scan angle, and other proprietary information. This data is displayed and manipulated using our proprietary tools and software. The database is reviewed and areas of like characteristics are delineated and flagged. A laser processing group, will determine which type of filtering technique(s) need to be applied to each type of area. Factors that affect this decision are slope, vegetation and cultural features. Each project has unique characteristics that can only be assessed after the data is collected. The data is flagged in the LAS format and as part of the QC process, reviewed to ensure correct depiction.

Data voids may occur from several different causes, including the following:

Natural

- LIDAR pulses may be naturally absorbed by water bodies or areas recently covered with asphalt. Such voids are normally considered to be unavoidable.

Operational

- The LIDAR system may have malfunctioned for some reason.
- Heavy winds, flight navigation system (FNS) error or pilot error may have caused "holidays" between flight lines.

Procedural

- Data points may be un-intentionally removed as part of the bare-earth post-processing to delete points that impinged on the tops of manmade structures or failed to penetrate dense vegetation. This process was not used in the filtering of the LIDAR anomalies for the Grand Canyon project.

Data voids caused by removal of LIDAR data points on manmade structures are acceptable.

As part of the field QC process, data voids caused operational constraints are re-collected if required. No data voids were identified in this project.

Quality Assurance

A rigorous quality assurance program insures that the final data products meet all requirements prior to delivery to the customer. Quality Assurance / Quality Control is embedded into the overall data acquisition and processing steps we use. Quality assurance is inherent in developing the project plan, acquisition, verifying data and processing, and assuring that the final products meet all requirements in accordance with the contract. Spectrum Mapping's quality assurance procedures follow the "FEMA Guidelines and Specifications for Flood Hazard Mapping Partners, Appendix A: Guidance for Aerial Mapping and Surveying" for use of LIDAR mapping technology.

4/25/2005



DATA PROCESSING PROCEDURES

Data Processing Procedures

Data was delivered to Spectrum Mapping's Albuquerque office from the field on external hard drives. The data is cataloged and copied onto the processing computer disk drives. The data is then re-verified for coverage and quality. The data is then ready for calibration. Once the data is calibrated it is sent to the processing department for post processing. The first step in the LIDAR data processing is to produce the x, y, and z laser returns using Spectrum's proprietary LIDAR data processing software. The next step in the laser data processing is to combine the flight lines in a merge process that eliminates any redundant points. For the Grand Canyon project the LIDAR flight lines were not merged. The individual flight lines were cropped to correspond to the project area boundaries. Noise or anomalous returns are filtered from all data during this processing step.

The next step in the post-processing of the DEM data is to perform the ellipsoid to orthometric height conversion using the National Geodetic Survey (NGS) Geoid Model, GEOID03. All elevation data was processed in this way on a point-by-point basis. Datum and coordinate system conversion from WGS84 to NAD83, was undertaken by using the NADCOM standard algorithm. The data is then brought into ArcGIS 8.2 and converted into a hillshade. This allows for better quality control.

The final step was to assemble the DEMs into the correct specified delivery format. Data was delivered in ellipsoid and orthometric heights. The coordinate system is State Plane, Arizona Zone 202. Horizontal reference is NAD83. Vertical control reference datum is NAVD88. Units of measurement are in meters. All the variably-spaced x, y, z DEM points data were converted to ASCII comma delimited point files.

Deliverable DEM Data

Data Deliverables:

First Return
First Return Intensity
Last Return
Multi Return
Metadata

Data Format:

First Return, Variably spaced DEM data, comma delimited ASCII point files
Last Return, Variably spaced DEM data, comma delimited ASCII point files
First Return Intensity, Variably spaced DEM data, comma delimited ASCII point files
Multi Return, Variably spaced DEM data, comma delimited ASCII point files
Metadata – FGDC compliant xml files and project report in MSWord .doc

Map Coordinate System and Datum:

Arizona State Plane, Zone 202, NAD83, NAVD88
Ellipsoid (WGS-84) and Orthometric heights were delivered.

GEOID Used:

Geoid 03

4/25/2005



PROJECT SUMMARY

Project Summary

Spectrum Mapping collected approximately 23 linear miles of data for the Grand Canyon project area. This data was collected in two separate acquisitions. Pre-flood acquisition took place on November 19, 2004 and November 20, 2004. Post-flood acquisition took place on December 4, 5 and December 9, 2004.

There were no problems encountered during the pre-flood acquisition. The seven sites were collected with 4X coverage. During the post-flood acquisition, the DATIS III sensor had an issue with the scanning mirror motor and was not able to finish collection. Spectrum sent out a different sensor RAMS (Leica ALS40) to finish the post collection. This sensor did not have the intensity module the DATIS III sensor included, due to this inconsistency Spectrum agreed to provide Multi-return data. This data was collected on December 4th, 5th. When the data was removed from the hard drive there was an error reading the data off of the device. This caused a few areas to have very small gaps. This data was recollected on December 9th. Spectrum communicated with the Grand Canyon staff to make sure the site acquisitions were acquired at the lowest flow possible. The post flood acquisition was collected to have 4X the coverage using the RAMS system.

There were no problems encountered during the processing of the data.

The data meets contract specifications for vertical accuracy of 15 cm. The DEM accuracy for the pre flood collections was 13 cm RMSE and the post flood collections was 10.3 cm RMSE.

4/25/2005



LIDAR SYSTEM DATA REPORT

General System Acquisition Parameters

DATIS III System Specifications for Grand Canyon Project

Operational Parameter	Quantity	Units
Minimum height difference for distinguishing multiple returns	0.75	Meters
Spot Size	0.46	Meters
Swath Width	844	Meters
Flight Line Spacing	200	Meters
Altitude (Above Ground Level)	1828	Meters
Ground Speed	110	Knots
Scan Half Angle	13	Degrees
Scan Interval	0.035	Seconds
Active Scan	0.023	Seconds
Duty Cycle	66	%
Firing Rate	36500	Hertz
LIDAR Samples Per Scan	840	
Cross-Track LIDAR Spot Spacing	1.01	Meters
In-Track LIDAR Spot Spacing	2.16	Meters
LIDAR Spot Density in a Single Pass	1.99	Square meters / sample
Flight Line Coverage	4X	
Effective LIDAR Spot Data Density	0.56	Square meters / sample

RAMS™ System Specifications

Laser	
Laser Altitude	10,000 feet AGL Max
Laser Swath Width	7,250 feet Max
Laser Scan FOV	45 Degrees Max
Scan Rate	0-35 Hz (FOV dependent)
Laser Pulse Rate	100Hz-15kHz Max
Laser Returns	5 at 15kHz
Cross Track Spacing	0-25 feet
Along Track Spacing	3 feet minimum (Airspeed dependent)
Nominal X/Y Ground Sample Distance	10 feet
X, Y, Z Positional Accuracy	less than 1 foot RMSE absolute

Accuracy of the Topographic Surface Products

The control points below were supplied by GCMRS.

Pre Flood RMSE

Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
Eminence	503	fl041119a_16	218843.25	598504.33	842.88	842.9	0.02	0.0004
Eminence	506	fl041119a_16	219482.25	597348.63	871.15	871.13	-0.02	0.0004
Eminence	503	fl041119a_17	218843.25	598504.33	842.88	842.84	-0.04	0.0016
Eminence	506	fl041119a_17	219482.25	597348.63	871.15	871.19	0.04	0.0016
Eminence	506	fl041119a_18	219482.25	597348.63	871.15	871.13	-0.02	0.0004
Eminence	502	fl041119a_13	217781.56	598278.1	848.02	848.1	0.08	0.0064
Eminence	503	fl041119a_13	218843.25	598504.33	842.88	842.8	-0.08	0.0064
Eminence	506	fl041119a_20	219482.25	597348.63	871.15	871.09	-0.06	0.0036
Eminence	508	fl041119a_20	218767.83	597088.67	860.14	860.2	0.06	0.0036
Eminence	502	fl041119a_14	217781.56	598278.1	848.02	848.03	0.01	1E-04
Eminence	503	fl041119a_14	218843.25	598504.33	842.88	842.73	-0.15	0.0225
Eminence	506	fl041119a_21	219482.25	597348.63	871.15	871.23	0.08	0.0064
Eminence	508	fl041119a_21	218767.83	597088.67	860.14	860.06	-0.08	0.0064
Eminence	502	fl041119a_15	217781.56	598278.1	848.02	848.16	0.14	0.0196
Eminence	503	fl041119a_15	218843.25	598504.33	842.88	842.5	-0.38	0.1444
Eminence	506	fl041119a_22	219482.25	597348.63	871.15	871.09	-0.06	0.0036
Eminence	508	fl041119a_22	218767.83	597088.67	860.14	860.2	0.06	0.0036
Eminence	503	fl041120_17	218843.25	598504.33	842.88	842.88	0	0
Eminence	506	fl041120_17	219482.25	597348.63	871.15	871.15	0	0
Eminence	506	fl041120_18	219482.25	597348.63	871.15	871.15	0	0
Eminence	502	fl041120_13	217781.56	598278.1	848.02	848.04	0.02	0.0004
Eminence	506	fl041120_20	219482.25	597348.63	871.15	870.92	-0.23	0.0529
Eminence	508	fl041120_20	218767.83	597088.67	860.14	860.38	0.24	0.0576
Eminence	502	fl041120_14	217781.56	598278.1	848.02	848.03	0.01	1E-04
Eminence	506	fl041120_21	219482.25	597348.63	871.15	871.16	0.01	1E-04
Eminence	508	fl041120_21	218767.83	597088.67	860.14	860.13	-0.01	1E-04
Eminence	502	fl041120_15	217781.56	598278.1	848.02	847.99	-0.03	0.0009
Eminence	503	fl041120_15	218843.25	598504.33	842.88	842.88	0	0
Eminence	506	fl041120_22	219482.25	597348.63	871.15	871.17	0.02	0.0004
Eminence	508	fl041120_22	218767.83	597088.67	860.14	860.1	-0.04	0.0016
kwagunt	601	fl041119_26	219906.29	585537.9	826.45	826.26	-0.19	0.0361
kwagunt	603	fl041119_26	220398.68	585057.38	822.45	822.78	0.33	0.1089
kwagunt	604	fl041119_26	220538.64	584724.16	832.35	832.16	-0.19	0.0361
kwagunt	606	fl041119_26	220844.44	584516.11	830.18	830.34	0.16	0.0256
kwagunt	607	fl041119_26	220897.34	584403.8	828.31	828.41	0.1	0.01
kwagunt	601	fl041119_25	219906.29	585537.9	826.45	826.29	-0.16	0.0256

Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
kwagunt	602	fl041119_25	220517.31	585158.31	851.17	851.21	0.04	0.0016
kwagunt	603	fl041119_25	220398.68	585057.38	822.45	822.44	-0.01	1E-04
kwagunt	604	fl041119_25	220538.64	584724.16	832.35	832.5	0.15	0.0225
kwagunt	606	fl041119_25	220844.44	584516.11	830.18	830.07	-0.11	0.0121
kwagunt	607	fl041119_25	220897.34	584403.8	828.31	828.26	-0.05	0.0025
kwagunt	608	fl041119_25	220924.74	584376.62	837.47	837.36	-0.11	0.0121
kwagunt	601	fl041119_24	219906.29	585537.9	826.45	826.31	-0.14	0.0196
kwagunt	603	fl041119_24	220398.68	585057.38	822.45	822.65	0.2	0.04
kwagunt	604	fl041119_24	220538.64	584724.16	832.35	832.2	-0.15	0.0225
kwagunt	606	fl041119_24	220844.44	584516.11	830.18	829.98	-0.2	0.04
kwagunt	607	fl041119_24	220897.34	584403.8	828.31	828.28	-0.03	0.0009
kwagunt	608	fl041119_24	220924.74	584376.62	837.47	837.33	-0.14	0.0196
kwagunt	601	fl041119_23	219906.29	585537.9	826.45	826.61	0.16	0.0256
kwagunt	603	fl041119_23	220398.68	585057.38	822.45	822.77	0.32	0.1024
kwagunt	604	fl041119_23	220538.64	584724.16	832.35	832	-0.35	0.1225
kwagunt	606	fl041119_23	220844.44	584516.11	830.18	830.23	0.05	0.0025
kwagunt	607	fl041119_23	220897.34	584403.8	828.31	828.25	-0.06	0.0036
kwagunt	608	fl041119_23	220924.74	584376.62	837.47	837.29	-0.18	0.0324
kwagunt	602	fl041120_26	220517.31	585158.31	851.17	850.74	-0.43	0.1849
kwagunt	603	fl041120_26	220398.68	585057.38	822.45	822.4	-0.05	0.0025
kwagunt	604	fl041120_26	220538.64	584724.16	832.35	832.36	0.01	1E-04
kwagunt	606	fl041120_26	220844.44	584516.11	830.18	830.19	0.01	0.0001
kwagunt	607	fl041120_26	220897.34	584403.8	828.31	828.23	-0.08	0.0064
kwagunt	608	fl041120_26	220924.74	584376.62	837.47	837.58	0.11	0.0121
kwagunt	601	fl041120_25	219906.29	585537.9	826.45	826.6	0.15	0.0225
kwagunt	603	fl041120_25	220398.68	585057.38	822.45	822.59	0.14	0.0196
kwagunt	604	fl041120_25	220538.64	584724.16	832.35	832.31	-0.04	0.0016
kwagunt	606	fl041120_25	220844.44	584516.11	830.18	830.16	-0.02	0.0004
kwagunt	607	fl041120_25	220897.34	584403.8	828.31	828.17	-0.14	0.0196
kwagunt	608	fl041120_25	220924.74	584376.62	837.47	837.44	-0.03	0.0009
kwagunt	601	fl041120_24	219906.29	585537.9	826.45	826.12	-0.33	0.1089
kwagunt	602	fl041120_24	220517.31	585158.31	851.17	851.17	0	0
kwagunt	603	fl041120_24	220398.68	585057.38	822.45	822.5	0.05	0.0025
kwagunt	604	fl041120_24	220538.64	584724.16	832.35	832.65	0.3	0.09
kwagunt	606	fl041120_24	220844.44	584516.11	830.18	830.14	-0.04	0.0016
kwagunt	607	fl041120_24	220897.34	584403.8	828.31	828.37	0.06	0.0036
kwagunt	608	fl041120_24	220924.74	584376.62	837.47	837.64	0.17	0.0289
kwagunt	601	fl041120_23	219906.29	585537.9	826.45	826.48	0.03	0.0009
kwagunt	604	fl041120_23	220538.64	584724.16	832.35	832.5	0.15	0.0225
kwagunt	606	fl041120_23	220844.44	584516.11	830.18	830.05	-0.13	0.0169
kwagunt	607	fl041120_23	220897.34	584403.8	828.31	828.03	-0.28	0.0784
kwagunt	608	fl041120_23	220924.74	584376.62	837.47	837.46	-0.01	1E-04

Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
N Canyon	301	fl041119_9	227418.15	622634.19	894.91	894.96	0.05	0.0025
N Canyon	302	fl041119_9	227495.78	622516.31	884.01	883.67	-0.34	0.1156
N Canyon	303	fl041119_9	227413.45	622409.47	891.99	891.96	-0.03	0.0009
N Canyon	306	fl041119_9	226694.7	620926.19	896.34	896.29	-0.05	0.0025
N Canyon	301	fl041119_8	227418.15	622634.19	894.91	894.81	-0.1	0.01
N Canyon	302	fl041119_8	227495.78	622516.31	884.01	884.32	0.31	0.0961
N Canyon	303	fl041119_8	227413.45	622409.47	891.99	892.1	0.11	0.0121
N Canyon	304	fl041119_8	227010.6	622045.47	888.43	888.63	0.2	0.04
N Canyon	306	fl041119_8	226694.7	620926.19	896.34	896.24	-0.1	0.01
N Canyon	301	fl041119_7	227418.15	622634.19	894.91	894.94	0.03	0.0009
N Canyon	302	fl041119_7	227495.78	622516.31	884.01	884	-0.01	1E-04
N Canyon	303	fl041119_7	227413.45	622409.47	891.99	892.02	0.03	0.0009
N Canyon	304	fl041119_7	227010.6	622045.47	888.43	888.35	-0.08	0.0064
N Canyon	306	fl041119_7	226694.7	620926.19	896.34	896.3	-0.04	0.0016
N Canyon	301	fl041119_6	227418.15	622634.19	894.91	895.05	0.14	0.0196
N Canyon	302	fl041119_6	227495.78	622516.31	884.01	883.82	-0.19	0.0361
N Canyon	303	fl041119_6	227413.45	622409.47	891.99	892.2	0.21	0.0441
N Canyon	304	fl041119_6	227010.6	622045.47	888.43	888.34	-0.09	0.0081
N Canyon	306	fl041119_6	226694.7	620926.19	896.34	896.19	-0.15	0.0225
N Canyon	301	fl041119b_9	227418.15	622634.19	894.91	894.87	-0.04	0.0016
N Canyon	302	fl041119b_9	227495.78	622516.31	884.01	883.99	-0.02	0.0004
N Canyon	303	fl041119b_9	227413.45	622409.47	891.99	892.12	0.13	0.0169
N Canyon	304	fl041119b_9	227010.6	622045.47	888.43	888.24	-0.19	0.0361
N Canyon	306	fl041119b_9	226694.7	620926.19	896.34	896.21	-0.13	0.0169
N Canyon	301	fl041119b_8	227418.15	622634.19	894.91	894.9	-0.01	1E-04
N Canyon	302	fl041119b_8	227495.78	622516.31	884.01	883.9	-0.11	0.0121
N Canyon	303	fl041119b_8	227413.45	622409.47	891.99	891.99	0	0
N Canyon	304	fl041119b_8	227010.6	622045.47	888.43	888.24	-0.19	0.0361
N Canyon	306	fl041119b_8	226694.7	620926.19	896.34	896.36	0.02	0.0004
N Canyon	301	fl041119b_7	227418.15	622634.19	894.91	894.93	0.02	0.0004
N Canyon	303	fl041119b_7	227413.45	622409.47	891.99	891.99	0	0
N Canyon	304	fl041119b_7	227010.6	622045.47	888.43	888.41	-0.02	0.0004
N Canyon	306	fl041119b_7	226694.7	620926.19	896.34	896.32	-0.02	0.0004
N Canyon	301	fl041119b_6	227418.15	622634.19	894.91	894.85	-0.06	0.0036
N Canyon	302	fl041119b_6	227495.78	622516.31	884.01	884.01	0	0
N Canyon	303	fl041119b_6	227413.45	622409.47	891.99	892.06	0.07	0.0049
N Canyon	304	fl041119b_6	227010.6	622045.47	888.43	888.33	-0.1	0.01
Palisades	708	fl041119_31	222887	572445.98	805.04	805.07	0.03	0.0009
Palisades	710	fl041119_31	222431.22	570862.6	798.82	798.94	0.12	0.0144
Palisades	711	fl041119_31	222474.86	570248.81	804.94	805.09	0.15	0.0225
Palisades	708	fl041119_30	222887	572445.98	805.04	804.94	-0.1	0.01
Palisades	709	fl041119_30	222355.12	571224.11	812.99	812.88	-0.11	0.0121

Palisades	710	fl041119_30	222431.22	570862.6	798.82	798.77	-0.05	0.0025
Palisades	711	fl041119_30	222474.86	570248.81	804.94	805.05	0.11	0.0121
Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
Palisades	707	fl041119_29	222736.85	573323.13	807.51	807.55	0.04	0.0016
Palisades	708	fl041119_29	222887	572445.98	805.04	804.91	-0.13	0.0169
Palisades	709	fl041119_29	222355.12	571224.11	812.99	813.03	0.04	0.0016
Palisades	710	fl041119_29	222431.22	570862.6	798.82	798.9	0.08	0.0064
Palisades	711	fl041119_29	222474.86	570248.81	804.94	805.06	0.12	0.0144
Palisades	707	fl041119_28	222736.85	573323.13	807.51	807.26	-0.25	0.0625
Palisades	709	fl041119_28	222355.12	571224.11	812.99	812.91	-0.08	0.0064
Palisades	710	fl041119_28	222431.22	570862.6	798.82	798.83	0.01	1E-04
Palisades	711	fl041119_28	222474.86	570248.81	804.94	805.2	0.26	0.0676
Palisades	709	fl041119_27	222355.12	571224.11	812.99	812.99	0	0
Palisades	707	fl041120_31	222736.85	573323.13	807.51	807.53	0.02	0.0004
Palisades	708	fl041120_31	222887	572445.98	805.04	804.86	-0.18	0.0324
Palisades	710	fl041120_31	222431.22	570862.6	798.82	799.01	0.19	0.0361
Palisades	711	fl041120_31	222474.86	570248.81	804.94	804.91	-0.03	0.0009
Palisades	708	fl041120_30	222887	572445.98	805.04	805.19	0.15	0.0225
Palisades	709	fl041120_30	222355.12	571224.11	812.99	812.84	-0.15	0.0225
Palisades	707	fl041120_29	222736.85	573323.13	807.51	807.43	-0.08	0.0064
Palisades	708	fl041120_29	222887	572445.98	805.04	805.01	-0.03	0.0009
Palisades	709	fl041120_29	222355.12	571224.11	812.99	812.99	0	0
Palisades	710	fl041120_29	222431.22	570862.6	798.82	798.85	0.03	0.0009
Palisades	711	fl041120_29	222474.86	570248.81	804.94	805.01	0.07	0.0049
Palisades	707	fl041120_28	222736.85	573323.13	807.51	807.66	0.15	0.0225
Palisades	709	fl041120_28	222355.12	571224.11	812.99	813.13	0.14	0.0196
Palisades	710	fl041120_28	222431.22	570862.6	798.82	798.56	-0.26	0.0676
Palisades	709	fl041120_27	222355.12	571224.11	812.99	812.98	-0.01	1E-04
Paria	204	fl041119_5	240138.59	648023.3	934.35	934.3	-0.05	0.0025
Paria	205	fl041119_5	239986.46	647866.57	927.01	927.02	0.01	1E-04
Paria	202	fl041119_4	241029.63	648956.71	926.15	926.08	-0.07	0.0049
Paria	204	fl041119_4	240138.59	648023.3	934.35	934.35	0	0
Paria	205	fl041119_4	239986.46	647866.57	927.01	927.04	0.03	0.0009
Paria	202	fl041119_3	241029.63	648956.71	926.15	925.93	-0.22	0.0484
Paria	203	fl041119_3	240122.41	648730.6	923.38	923.38	0	0
Paria	204	fl041119_3	240138.59	648023.3	934.35	934.37	0.02	0.0004
Paria	205	fl041119_3	239986.46	647866.57	927.01	927.16	0.15	0.0225
Paria	203	fl041119_2	240122.41	648730.6	923.38	923.26	-0.12	0.0144
Paria	204	fl041119_2	240138.59	648023.3	934.35	934.43	0.08	0.0064
Paria	203	fl041119_1	240122.41	648730.6	923.38	923.38	0	0
Paria	202	fl041119b_5	241029.63	648956.71	926.15	926.03	-0.12	0.0144
Paria	204	fl041119b_5	240138.59	648023.3	934.35	934.44	0.09	0.0081
Paria	205	fl041119b_5	239986.46	647866.57	927.01	927.01	0	0

Paria	202	fl041119b_4	241029.63	648956.71	926.15	926.13	-0.02	0.0004
Paria	204	fl041119b_4	240138.59	648023.3	934.35	934.2	-0.15	0.0225
Paria	205	fl041119b_4	239986.46	647866.57	927.01	927.16	0.15	0.0225
Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
Paria	204	fl041119b_3	240138.59	648023.3	934.35	934.28	-0.07	0.0049
Paria	205	fl041119b_3	239986.46	647866.57	927.01	927.09	0.08	0.0064
Paria	203	fl041119b_2	240122.41	648730.6	923.38	923.05	-0.33	0.1089
Paria	204	fl041119b_2	240138.59	648023.3	934.35	934.4	0.05	0.0025
Paria	203	fl041119b_1	240122.41	648730.6	923.38	923.38	0	0
S Canyon	401	fl041119_12	220750.04	613409.54	863	863.03	0.03	0.0009
S Canyon	402	fl041119_12	220210.67	612992.09	864.44	864.47	0.03	0.0009
S Canyon	406	fl041119_12	219668.6	611819.05	860.57	860.59	0.02	0.0004
S Canyon	408	fl041119_12	218920.93	610758.26	858.22	857.86	-0.36	0.1296
S Canyon	409	fl041119_12	218637.67	610295.85	866.65	866.67	0.02	0.0004
S Canyon	401	fl041119_11	220750.04	613409.54	863	863.11	0.11	0.0121
S Canyon	402	fl041119_11	220210.67	612992.09	864.44	864.33	-0.11	0.0121
S Canyon	404	fl041119_11	219729.55	612327.43	859.2	859.14	-0.06	0.0036
S Canyon	406	fl041119_11	219668.6	611819.05	860.57	860.59	0.02	0.0004
S Canyon	408	fl041119_11	218920.93	610758.26	858.22	858.21	-0.01	1E-04
S Canyon	409	fl041119_11	218637.67	610295.85	866.65	866.66	0.01	1E-04
S Canyon	402	fl041119_10	220210.67	612992.09	864.44	864.48	0.04	0.0016
S Canyon	404	fl041119_10	219729.55	612327.43	859.2	859.35	0.15	0.0225
S Canyon	406	fl041119_10	219668.6	611819.05	860.57	860.52	-0.05	0.0025
S Canyon	408	fl041119_10	218920.93	610758.26	858.22	857.99	-0.23	0.0529
S Canyon	409	fl041119_10	218637.67	610295.85	866.65	866.7	0.05	0.0025
S Canyon	401	fl041119b_12	220750.04	613409.54	863	863.02	0.02	0.0004
S Canyon	402	fl041119b_12	220210.67	612992.09	864.44	864.29	-0.15	0.0225
S Canyon	406	fl041119b_12	219668.6	611819.05	860.57	860.67	0.1	0.01
S Canyon	408	fl041119b_12	218920.93	610758.26	858.22	858.18	-0.04	0.0016
S Canyon	409	fl041119b_12	218637.67	610295.85	866.65	866.55	-0.1	0.01
S Canyon	401	fl041119b_11	220750.04	613409.54	863	863.01	0.01	1E-04
S Canyon	402	fl041119b_11	220210.67	612992.09	864.44	864.27	-0.17	0.0289
S Canyon	404	fl041119b_11	219729.55	612327.43	859.2	859.09	-0.11	0.0121
S Canyon	406	fl041119b_11	219668.6	611819.05	860.57	860.43	-0.14	0.0196
S Canyon	408	fl041119b_11	218920.93	610758.26	858.22	858.38	0.16	0.0256
S Canyon	409	fl041119b_11	218637.67	610295.85	866.65	866.78	0.13	0.0169
S Canyon	402	fl041119b_10	220210.67	612992.09	864.44	864.43	-0.01	0.0001
S Canyon	404	fl041119b_10	219729.55	612327.43	859.2	859.12	-0.08	0.0064
S Canyon	408	fl041119b_10	218920.93	610758.26	858.22	858.15	-0.07	0.0049
S Canyon	409	fl041119b_10	218637.67	610295.85	866.65	866.73	0.08	0.0064
Total							-3.07	3.4541
Avg. Error							-0.02	0.0172

Points / RMSE | 201.00 | 0.1311

Post Flood RMSE

Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
Eminence	506	fl041204a_21	219482.25	597348.63	871.15	871.12	-0.03	0.0009
Eminence	508	fl041204a_21	218767.83	597088.67	860.14	860.13	-0.01	1E-04
Eminence	503	fl041204a_15	218843.25	598504.33	842.88	842.9	0.02	0.0004
Eminence	508	fl041204a_22	218767.83	597088.67	860.14	860.07	-0.07	0.0049
Eminence	503	fl041204a_16	218843.25	598504.33	842.88	842.91	0.03	0.0009
Eminence	506	fl041204a_16	219482.25	597348.63	871.15	871.19	0.04	0.0016
Eminence	506	fl041204a_17	219482.25	597348.63	871.15	871.15	0	0
Eminence	506	fl041205_17	219482.25	597348.63	871.15	871.29	0.14	0.0196
Eminence	503	fl041205_16	218843.25	598504.33	842.88	843	0.12	0.0144
Eminence	506	fl041205_16	219482.25	597348.63	871.15	871.37	0.22	0.0484
Eminence	502	fl041209a_13	217781.56	598278.1	848.02	847.99	-0.03	0.0009
Eminence	506	fl041209a_20	219482.25	597348.63	871.15	871.15	0	0
Eminence	501	fl041209a_14	217285.58	597960.36	860.94	861.14	0.2	0.04
Eminence	502	fl041209a_14	217781.56	598278.1	848.02	848.18	0.16	0.0256
Eminence	506	fl041209a_21	219482.25	597348.63	871.15	871.12	-0.03	0.0009
Eminence	508	fl041209a_21	218767.83	597088.67	860.14	860.2	0.06	0.0036
Eminence	501	fl041209a_15	217285.58	597960.36	860.94	860.95	0.01	1E-04
Eminence	502	fl041209a_15	217781.56	598278.1	848.02	848.04	0.02	0.0004
Eminence	503	fl041209a_15	218843.25	598504.33	842.88	842.76	-0.12	0.0144
Eminence	506	fl041209a_22	219482.25	597348.63	871.15	871.1	-0.05	0.0025
Eminence	508	fl041209a_22	218767.83	597088.67	860.14	860.06	-0.08	0.0064
Eminence	503	fl041209a_15	218843.25	598504.33	842.88	843.06	0.18	0.0324
Eminence	501	fl041209a_13	217285.58	597960.36	860.94	861	0.06	0.0036
Eminence	502	fl041209a_13	217781.56	598278.1	848.02	848.01	-0.01	1E-04
Eminence	506	fl041209b_17	219482.25	597348.63	871.15	871.11	-0.04	0.0016
Eminence	506	fl041209b_21	219482.25	597348.63	871.15	871.13	-0.02	0.0004
Eminence	508	fl041209b_21	218767.83	597088.67	860.14	859.84	-0.3	0.09
Eminence	501	fl041209b_14	217285.58	597960.36	860.94	860.89	-0.05	0.0025
Eminence	502	fl041209b_14	217781.56	598278.1	848.02	848.17	0.15	0.0225
Eminence	503	fl041209b_14	218843.25	598504.33	842.88	842.9	0.02	0.0004
Kwagunt	601	fl041204_24	219906.29	585537.9	826.45	826.26	-0.19	0.0361
Kwagunt	604	fl041204_24	220538.64	584724.16	832.35	832.41	0.06	0.0036
Kwagunt	601	fl041204_25	219906.29	585537.9	826.45	826.5	0.05	0.0025
Kwagunt	602	fl041204_25	220517.31	585158.31	851.17	851.17	0	0
Kwagunt	603	fl041204_25	220398.68	585057.38	822.45	822.37	-0.08	0.0064
Kwagunt	604	fl041204_25	220538.64	584724.16	832.35	832.28	-0.07	0.0049

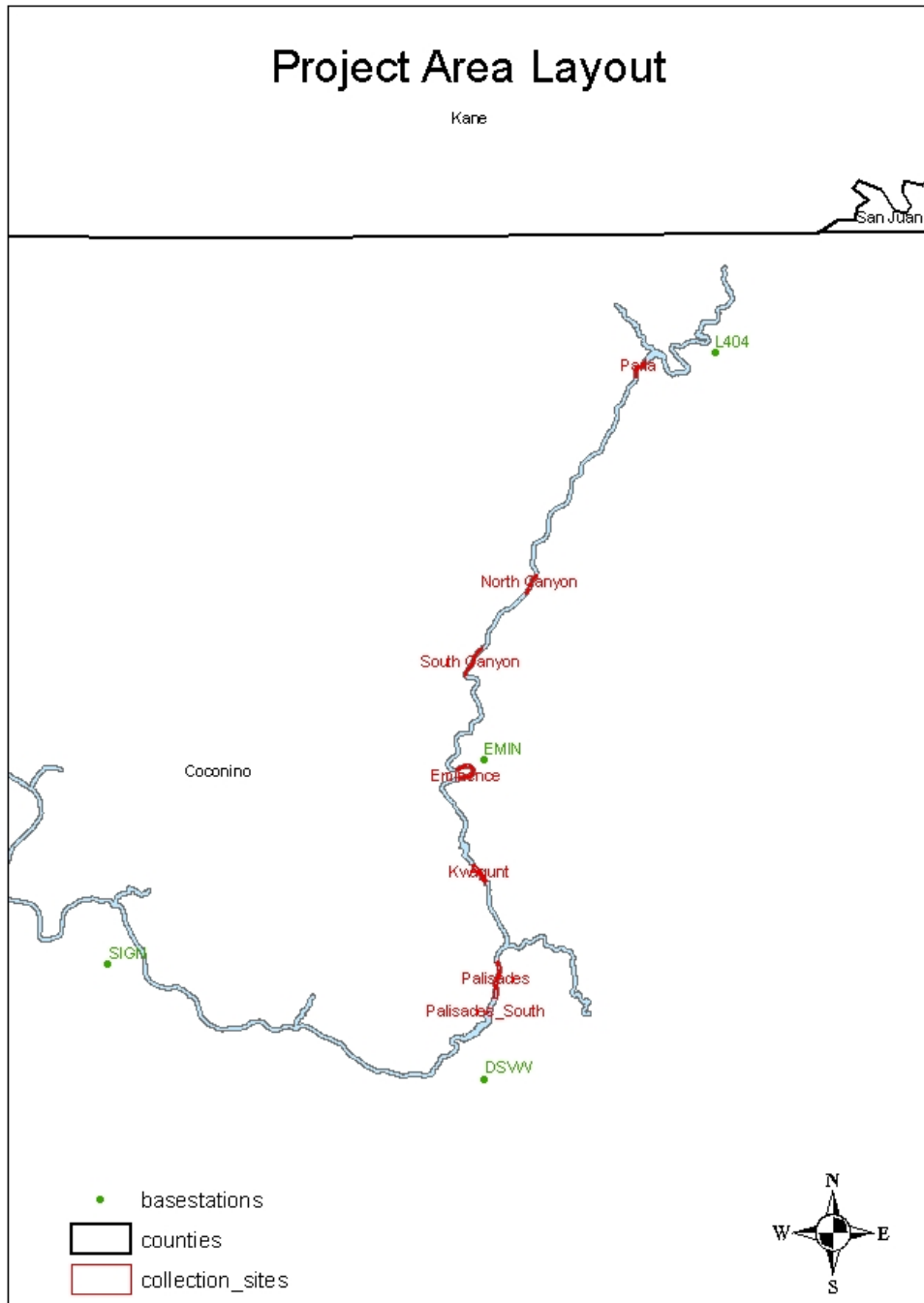
Kwagunt	606	fl041204_26	220844.44	584516.11	830.18	830.26	0.08	0.0064
Kwagunt	607	fl041204_26	220897.34	584403.8	828.31	828.3	-0.01	1E-04
Kwagunt	608	fl041204_26	220924.74	584376.62	837.47	837.45	-0.02	0.0004
Kwagunt	602	fl041204_26_1	220517.31	585158.31	851.17	851.25	0.08	0.0064
Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
Kwagunt	603	fl041204_26_1	220398.68	585057.38	822.45	822.45	0	0
Kwagunt	606	fl041204_26_1	220844.44	584516.11	830.18	830.17	-0.01	1E-04
Kwagunt	607	fl041204_26_1	220897.34	584403.8	828.31	828.33	0.02	0.0004
Kwagunt	608	fl041204_26_1	220924.74	584376.62	837.47	837.7	0.23	0.0529
Kwagunt	601	fl041204_25	219906.29	585537.9	826.45	826.48	0.03	0.0009
Kwagunt	602	fl041204_25	220517.31	585158.31	851.17	851.11	-0.06	0.0036
Kwagunt	603	fl041204_25	220398.68	585057.38	822.45	822.81	0.36	0.1296
Kwagunt	604	fl041204_25	220538.64	584724.16	832.35	832.35	0	0
Kwagunt	606	fl041204_25	220844.44	584516.11	830.18	830.28	0.1	0.01
Kwagunt	607	fl041204_25	220897.34	584403.8	828.31	828.37	0.06	0.0036
Kwagunt	608	fl041204_25	220924.74	584376.62	837.47	837.59	0.12	0.0144
Kwagunt	601	fl041204_24	219906.29	585537.9	826.45	826.39	-0.06	0.0036
Kwagunt	603	fl041204_24	220398.68	585057.38	822.45	822.45	0	0
Kwagunt	604	fl041204_24	220538.64	584724.16	832.35	832.46	0.11	0.0121
Kwagunt	601	fl041209_25	219906.29	585537.9	826.45	826.36	-0.09	0.0081
Kwagunt	602	fl041209_25	220517.31	585158.31	851.17	851.21	0.04	0.0016
Kwagunt	603	fl041209_25	220398.68	585057.38	822.45	822.77	0.32	0.1024
Kwagunt	604	fl041209_25	220538.64	584724.16	832.35	832.43	0.08	0.0064
Kwagunt	606	fl041209_25	220844.44	584516.11	830.18	830.12	-0.06	0.0036
Kwagunt	607	fl041209_25	220897.34	584403.8	828.31	828.36	0.05	0.0025
Kwagunt	608	fl041209_25	220924.74	584376.62	837.47	837.33	-0.14	0.0196
Kwagunt	602	fl041209_26	220517.31	585158.31	851.17	851.17	0	0
Kwagunt	606	fl041209_26	220844.44	584516.11	830.18	830.14	-0.04	0.0016
Kwagunt	601	fl041209_25	219906.29	585537.9	826.45	826.38	-0.07	0.0049
Kwagunt	602	fl041209_25	220517.31	585158.31	851.17	851.19	0.02	0.0004
Kwagunt	603	fl041209_25	220398.68	585057.38	822.45	822.76	0.31	0.0961
Kwagunt	604	fl041209_25	220538.64	584724.16	832.35	832.63	0.28	0.0784
Kwagunt	606	fl041209_25	220844.44	584516.11	830.18	830.26	0.08	0.0064
Kwagunt	607	fl041209_25	220897.34	584403.8	828.31	828.46	0.15	0.0225
Kwagunt	608	fl041209_25	220924.74	584376.62	837.47	837.44	-0.03	0.0009
N Canyon	301	fl041204_7	227418.15	622634.19	894.9	894.9	0	0
N Canyon	303	fl041204_7	227413.45	622409.47	891.98	891.98	0	0
N Canyon	306	fl041204_7	226694.7	620926.19	896.29	896.29	0	0
N Canyon	301	fl041204_8	227418.15	622634.19	894.9	895.04	0.14	0.0196
N Canyon	303	fl041204_8	227413.45	622409.47	891.98	891.96	-0.02	0.0004
N Canyon	306	fl041204_8	226694.7	620926.19	896.29	896.32	0.03	0.0009
N Canyon	301	fl041209_7	227418.15	622634.19	894.9	894.89	-0.01	1E-04
N Canyon	303	fl041209_7	227413.45	622409.47	891.98	891.98	0	0

N Canyon	301	fl041209_8	227418.15	622634.19	894.9	895.11	0.21	0.0441
N Canyon	303	fl041209_8	227413.45	622409.47	891.98	891.87	-0.11	0.0121
Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
N Canyon	306	fl041209_8	226694.7	620926.19	896.29	896.43	0.14	0.0196
Palisades	708	fl041204_31	222887	572445.98	805.04	805.11	0.07	0.0049
Palisades	707	fl041204_30	222736.85	573323.13	807.51	807.6	0.09	0.0081
Palisades	708	fl041204_30	222887	572445.98	805.04	805.08	0.04	0.0016
Palisades	710	fl041204_30	222431.22	570862.6	798.82	798.86	0.04	0.0016
Palisades	711	fl041204_30	222474.86	570248.81	804.94	805.1	0.16	0.0256
Palisades	707	fl041204_29	222736.85	573323.13	807.51	807.46	-0.05	0.0025
Palisades	709	fl041204_29	222355.12	571224.11	812.99	812.98	-0.01	1E-04
Palisades	709	fl041204_28	222355.12	571224.11	812.99	813.03	0.04	0.0016
Palisades	707	fl041204b_29	222736.85	573323.13	807.51	807.52	0.01	1E-04
Palisades	709	fl041204b_29	222355.12	571224.11	812.99	813.07	0.08	0.0064
Palisades	710	fl041204b_29	222431.22	570862.6	798.82	798.99	0.17	0.0289
Palisades	711	fl041204b_29	222474.86	570248.81	804.94	805.01	0.07	0.0049
Palisades	708	fl041204b_31	222887	572445.98	805.04	805.05	0.01	1E-04
Palisades	707	fl041209_28	222736.85	573323.13	807.51	807.52	0.01	1E-04
Palisades	709	fl041209_28	222355.12	571224.11	812.99	813.18	0.19	0.0361
Palisades	707	fl041209_29	222736.85	573323.13	807.51	807.52	0.01	1E-04
Palisades	709	fl041209_29	222355.12	571224.11	812.99	813.08	0.09	0.0081
Palisades	710	fl041209_29	222431.22	570862.6	798.82	798.95	0.13	0.0169
Palisades	711	fl041209_29	222474.86	570248.81	804.94	804.94	0	0
Palisades	707	fl041209b_28	222736.85	573323.13	807.51	807.69	0.18	0.0324
Palisades	709	fl041209b_28	222355.12	571224.11	812.99	813.28	0.29	0.0841
Palisades	710	fl041209b_28	222431.22	570862.6	798.82	798.89	0.07	0.0049
Palisades	707	fl041209b_29	222736.85	573323.13	807.51	807.48	-0.03	0.0009
Palisades	709	fl041209b_29	222355.12	571224.11	812.99	812.86	-0.13	0.0169
Palisades	710	fl041209b_29	222431.22	570862.6	798.82	798.94	0.12	0.0144
Palisades	711	fl041209b_29	222474.86	570248.81	804.94	805.05	0.11	0.0121
Palisades	708	fl041209b_30	222887	572445.98	805.04	805.15	0.11	0.0121
Palisades	710	fl041209b_30	222431.22	570862.6	798.82	798.83	0.01	1E-04
Palisades	711	fl041209b_30	222474.86	570248.81	804.94	804.99	0.05	0.0025
Palisades	708	fl041209b_31	222887	572445.98	805.04	805.1	0.06	0.0036
Palisades	707	fl041209_29_1	222736.85	573323.13	807.51	807.38	-0.13	0.0169
Palisades	708	fl041209_29_1	222887	572445.98	805.04	805.06	0.02	0.0004
Palisades	709	fl041209_29_1	222355.12	571224.11	812.99	813.06	0.07	0.0049
Palisades	710	fl041209_29_1	222431.22	570862.6	798.82	798.91	0.09	0.0081
Palisades	711	fl041209_29_1	222474.86	570248.81	804.94	805.04	0.1	0.01
Paria	203	fl041204_1	240122.41	648730.6	923.38	923.4	0.02	0.0004
Paria	203	fl041204_2	240122.41	648730.6	923.38	923.34	-0.04	0.0016
Paria	201	fl041204_3	241496.16	650118.38	969.02	969.02	0	0
Paria	204	fl041204_3	240138.59	648023.3	934.35	934.41	0.06	0.0036

Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
Paria	205	fl041204_3	239986.46	647866.57	927.01	927.12	0.11	0.0121
Paria	LFRG	fl041204_3	241496.16	650118.39	968.95	968.94	-0.01	1E-04
Paria	201	fl041204_4	241496.16	650118.38	969.02	968.99	-0.03	0.0009
Paria	202	fl041204_4	241029.63	648956.71	926.15	926.24	0.09	0.0081
Paria	204	fl041204_4	240138.59	648023.3	934.35	934.34	-0.01	1E-04
Paria	205	fl041204_4	239986.46	647866.57	927.01	926.94	-0.07	0.0049
Paria	LFRG	fl041204_4	241496.16	650118.39	968.95	968.99	0.04	0.0016
Paria	202	fl041204_5	241029.63	648956.71	926.15	926.19	0.04	0.0016
Paria	202	fl041204b_5	241029.63	648956.71	926.15	926.18	0.03	0.0009
Paria	201	fl041204b_4	241496.16	650118.38	969.02	969.02	0	0
Paria	202	fl041204b_4	241029.63	648956.71	926.15	926.22	0.07	0.0049
Paria	204	fl041204b_4	240138.59	648023.3	934.35	934.35	0	0
Paria	205	fl041204b_4	239986.46	647866.57	927.01	927.02	0.01	1E-04
Paria	LFRG	fl041204b_4	241496.16	650118.39	968.95	968.97	0.02	0.0004
Paria	201	fl041205_3	241496.16	650118.38	969.02	969.01	-0.01	1E-04
Paria	204	fl041205_3	240138.59	648023.3	934.35	934.23	-0.12	0.0144
Paria	205	fl041205_3	239986.46	647866.57	927.01	926.87	-0.14	0.0196
Paria	LFRG	fl041205_3	241496.16	650118.39	968.95	969.01	0.06	0.0036
Paria	203	fl041209_2	240122.41	648730.6	923.38	923.38	0	0
Paria	203	fl041209_1	240122.41	648730.6	923.38	923.36	-0.02	0.0004
Paria	201	fl041209b_1	241496.16	650118.38	969.02	968.89	-0.13	0.0169
Paria	204	fl041209b_1	240138.59	648023.3	934.35	934.37	0.02	0.0004
Paria	205	fl041209b_1	239986.46	647866.57	927.01	926.89	-0.12	0.0144
Paria	LFRG	fl041209b_1	241496.16	650118.39	968.95	968.89	-0.06	0.0036
S Canyon	402	fl041204_10	220210.67	612992.09	864.44	864.29	-0.15	0.0225
S Canyon	404	fl041204_10	219729.55	612327.43	859.2	859.21	0.01	1E-04
S Canyon	408	fl041204_10	218920.93	610758.26	858.22	858.22	0	0
S Canyon	409	fl041204_10	218637.67	610295.85	866.65	866.64	-0.01	1E-04
S Canyon	401	fl041204_12	220750.04	613409.54	863	863.02	0.02	0.0004
S Canyon	406	fl041204_12	219668.6	611819.05	860.57	860.56	-0.01	0.0001
S Canyon	406	fl041204b_12	219668.6	611819.05	860.57	860.6	0.03	0.0009
S Canyon	408	fl041204b_12	218920.93	610758.26	858.22	858.22	0	0
S Canyon	409	fl041204b_12	218637.67	610295.85	866.65	866.65	0	0
S Canyon	401	fl041204b_11	220750.04	613409.54	863	862.93	-0.07	0.0049
S Canyon	402	fl041204b_11	220210.67	612992.09	864.44	864.4	-0.04	0.0016
S Canyon	404	fl041204b_11	219729.55	612327.43	859.2	859.2	0	0
S Canyon	406	fl041204b_11	219668.6	611819.05	860.57	860.61	0.04	0.0016
S Canyon	408	fl041204b_11	218920.93	610758.26	858.22	858.16	-0.06	0.0036
S Canyon	409	fl041204b_11	218637.67	610295.85	866.65	866.66	0.01	1E-04
S Canyon	402	fl041209_10	220210.67	612992.09	864.44	864.43	-0.01	0.0001
S Canyon	404	fl041209_10	219729.55	612327.43	859.2	859.15	-0.05	0.0025
S Canyon	408	fl041209_10	218920.93	610758.26	858.22	858.36	0.14	0.0196

S Canyon	409	fl041209_10	218637.67	610295.85	866.65	866.67	0.02	0.0004
Project Area	Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
S Canyon	401	fl041209_11	220750.04	613409.54	863	862.99	-0.01	1E-04
S Canyon	402	fl041209_11	220210.67	612992.09	864.44	864.33	-0.11	0.0121
S Canyon	404	fl041209_11	219729.55	612327.43	859.2	859.24	0.04	0.0016
S Canyon	406	fl041209_11	219668.6	611819.05	860.57	860.57	0	0
S Canyon	408	fl041209_11	218920.93	610758.26	858.22	858.16	-0.06	0.0036
S Canyon	409	fl041209_11	218637.67	610295.85	866.65	866.6	-0.05	0.0025
S Canyon	401	fl041209_12	220750.04	613409.54	863	862.96	-0.04	0.0016
S Canyon	406	fl041209_12	219668.6	611819.05	860.57	860.5	-0.07	0.0049
S Canyon	408	fl041209_12	218920.93	610758.26	858.22	858.27	0.05	0.0025
S Canyon	409	fl041209_12	218637.67	610295.85	866.65	866.68	0.03	0.0009
S Canyon	401	fl041209b_11	220750.04	613409.54	863	863.08	0.08	0.0064
S Canyon	402	fl041209b_11	220210.67	612992.09	864.44	864.28	-0.16	0.0256
S Canyon	404	fl041209b_11	219729.55	612327.43	859.2	859.08	-0.12	0.0144
S Canyon	406	fl041209b_11	219668.6	611819.05	860.57	860.48	-0.09	0.0081
S Canyon	408	fl041209b_11	218920.93	610758.26	858.22	857.91	-0.31	0.0961
S Canyon	409	fl041209b_11	218637.67	610295.85	866.65	866.61	-0.04	0.0016
Total							3.63	1.8169
Avg. Error							0.02	0.0108
# Points / RMSE							179.00	0.1037

Project Area



4/25/2005



FLIGHT REPORT

Mission Logs

The Mission logs document the individual mission's date, time, flight altitude, airspeed, laser settings, and any pertinent notes taken while the flight was occurring.

MISSION RECORD SHEET- Mission 041119a

Flight Record

Project	Grand Canyon	Date	11/19/2004 a
Pilot	Tom Kuehn	Takeoff	9:28:00
Navigator	Bob Harkin	Land	2:00:00
		GPS BS Location	PGA ARP

Laser Settings

FOV	D3
Scan Rate	D3
Atten	D3
Gate	D3

Camera Settings

Camera Lens	NA	MM
Filter	NA	
Shutter	NA	M/S
Exposure	NA	AP/GAIN
Interval	NA	M/S

FOV ACT.	D3
Base Ht	1.478 Meters

Disks

Camera Drive		
Capacity	Images	
Laser Drive		
	IMU Drive:	2
	File Name:	Pag19Nov
	First File#	0.001
	Last File#	0.032

RUN	MISSION #	LASER START	LASER END	Direction	MSL	NOTES
5	93221	9:34	9:34	South	9,100	speed 99
4	93914	9:39	9:40	North	9,000	109
3	94621	9:46	9:48	South	9,000	91
3	95308	9:53	9:54	North	9,000	108
1	95957	9:59	10:01	South	9,000	95
9	101019	10:10	10:12	South	9,000	93
8	101737	10:17	10:19	North	9,000	103
7	102520	10:25	10:27	South	9,100	95
6	103306	10:33	10:34	North	9,100	104
12	104013	10:40	10:42	South	9,100	97
11	104735	10:47	10:49	North	9,100	102
10	105526	10:55	10:57	South	9,100	99
16	110047	11:00	11:02	South	9,100	99
17	110709	11:07	11:08	North	9,000	100
18	111345	11:13	11:15	South	9,000	100
19	111936	11:19	11:20	North	9,200	96

13	112459	11:24	11:26	West	9,000	99
20	113057	11:30	11:32	East	9,000	105
14	113726	11:37	11:38	West	9,000	94
21	114429	11:44	11:45	East	9,000	103
15	115037	11:50	11:51	West	9,000	100
22	115650	11:56	11:58	East	9,000	106
26	120324	12:03	12:05	South	8,900	103
25	120911	12:09	12:11	North	9,000	92
24	121608	12:16	12:17	South	9,000	103
23	122257	12:22	12:24	North	9,000	94
31	123140	12:31	12:34	South	8,800	92
30	123841	12:38	12:41	North	8,800	105
29	124603	12:46	12:48	South	8,800	87
28	125339	12:53	12:55	North	8,800	103
27	130132	1:01	1:03	South	8,800	88
32	130406	1:04	1:04	South	8,700	86
33	130948	1:09	1:10	North	8,800	108
34 Cal	133403	1:34	1:35	North	10,500	103
34 Cal	134122	1:41	1:42	South		104

MISSION RECORD SHEET- Mission 041119b

Flight Record

Project	Grand Canyon	Date	11/19/2004 b
Pilot	Tom Kuehn	Takeoff	3:10:00
Navigator	Bob Harkin	Land	5:13:00
		GPS BS Location	PGA ARP

Laser Settings

FOV	D3
Scan Rate	D3
Atten	D3
Gate	D3
FOV ACT.	D3
Ant Ht	1.478 M

Camera Settings

Camera Lens	NA	MM
Filter	NA	
Shutter	NA	M/S
Exposure	NA	AP/GAIN
Interval	NA	MS

Disks

Camera Drive		
Capacity	Images	
Laser Drive		
	IMU Drive:	2
	File Name:	Pag19Nov
	First File#	0.035
	Last File#	0.049

RUN	MISSION #	LASER START	LASER END	Direction	MSL	NOTES
5	150813	15:08	15:09	South	9,200	Gnd Spd 102
4	151436	15:14	15:16	North	9,000	100
3	152204	15:22	15:23	South	9,200	99
2	152812	15:28	15:29	North	8,900	1100
1	153436	15:34	15:35	South	8,900	95
9	154402	15:44	15:45	South	9,200	104
8	154946	15:49	15:51	North	9,000	104
7	155749	15:57	15:59	South	9,000	103
6	160502	16:05	16:06	North	9,000	101
12	161120	16:11	16:13	South	8,900	90
11	161727	16:17	16:19	North	9,200	99
10	162444	16:24	16:26	South	9,000	108
34 Cal	164304	16:43	16:44	North	10,600	95
34 Cal	164950	16:49	16:51	South	10,600	109

MISSION RECORD SHEET – Mission 041120

Flight Record

Project	Grand Canyon	Date	11/20/2004
Pilot	Tom Kuehn	Takeoff	8:15:00
Navigator	Bob Harkin	Land	11:37:00
		GPS BS Location	PGA ARP

Laser Settings

FOV	D3
Scan Rate	D3
Atten	D3
Gate	D3

Camera Settings

Camera Lens	NA	MM
Filter	NA	
Shutter	NA	M/S
Exposure		NA/AP/GAIN
Interval		NA/MS

Ant Ht	1.547 M
FOV ACT.	D3

Disks

Camera Drive		
Capacity	Images	
Laser Drive		
	IMU Drive:	2
	File Name:	Pag20Nov
	First File#	0.003
	Last File#	0.027

RUN	MISSION #	LASER START	LASER END	Direction	MSL	NOTES
16	82652	8:26	8:28	South	8,900	10 Gnd Spd 5
17	83308	8:33	8:34	North		93
18	83949	8:39	8:40	South		10 4
19	84610	8:46	8:47	North	9,000	95
13	85237	8:52	8:53	West		95
20	85829	8:58	8:59	East	8,900	10 7
14	90534	9:05	9:06	West	9,000	87
21	91112	9:11	9:12	East	8,900	10 8
15	91833	9:18	9:20	West	9,000	75
22	92520	9:25	9:26	East	8,900	10 5
26	93238	9:32	9:34	South		99
25	93947	9:39	9:41	North	9,000	86
24	94703	9:47	9:48	South		10 7

23	95312	9:53	9:55	North			99
31	100128	10:01	10:03	South			101
30	100802	10:08	10:10	North	8,800		109
29 **	101559	10:15	10:18	South	8,900		101
28	102454	10:24	10:27	North	8,800	Range Locked-up REFLY	106
27	103228	10:32	10:34	South			100
32	103452	10:34	10:35	South	8,900		105
33	103934	10:39	10:40	North	8,800		107
29	104725	10:47	10:49	South	9,000		97
34 Cal	111143	11:11	11:13	North	10,600		109
34 Cal	111724	11:17	11:18	South	10,600		101

MISSION RECORD SHEET – Mission 041204a

Flight Record	
Project	Grand Canyon
Pilot	Tom Kuehn
Navigator	Chad Poole

Date	12/4/2004 a
Takeoff	8:45:00
Land	3:15:00
GPS BS Location	PGA ARP
GPS BS Height	1.473 Meters

Laser Settings	
FOV	10
Scan Rate	35
Atten	Full
Gate	912
FOV ACT.	13.7

Camera Settings		
Camera Lens	NA	MM
Filter	NA	
Shutter	NA	M/S
Exposure		NA AP/GAIN
Interval		NA MS

Disks	
Camera Drive	
Capacity	Images
Laser Drive	
IMU Drive:	2
File Name:	Pag19Nov
First File#	0.001
Last File#	0.045

RUN	MISSION #	Status Dec 7	Status Dec 7	AREA	Direction	MSL	NOTES
34 Cal	160748	OK			South	9,500	calibration line
34 Cal	161615	OK			North	9,500	calibration line
1	162335	OK		Area 2	South	8,500	
2	162931	OK			North	8,500	
3	163624	OK			South	8,500	
4	164333	OK			North	8,500	



5	165101	OK			South	8,500	
6	170140	OK		Area 3	South	8,500	
7	180637	OK			South	8,500	Gap SCN 12 1-11 & 13-14 OK
8	181335		Gap		North	8,500	Gap SCN 5 1-4 & 6-8 OK
9	182025	OK			South	8,500	Gap SCN 35 1-34 & 36-37 OK 1-10 Needed
10	182948	OK		Area 4	South	8,500	Gap SCN 1 & 12 2-11 & 13 OK
11	183719		Gap		North	8,500	Gap SCN 6 1-5 & 7-10 OK
12	184423		Gap		South	8,500	Gap SCN 11 1-10 & 12-14 OK
13	185152		Gap	Area 5	West	8,500	Gap SCN 6 1-5 & 7-8 OK
20	185729	OK			East	8,500	Gap SCN 1 & 5 2-4 & 6-8 OK
14	190230	OK			West	8,500	Gap SCN 8 1-7 & 9 OK
21	190747	OK			East	8,500	
15	191451		Gap		West	8,500	Gap SCN 8 1-7 & 9 OK
22	192236	OK			East	8,500	
16	193016	OK			North	8,500	
17	193727	OK			South	8,500	
18	194446	OK			North	8,500	
19	195336	OK			South	8,500	
23	195924	OK		Area 6	South	8,500	
24	200722	OK			North	8,500	
25	201710		Gap		South	8,500	Gap SCN 10 1-9 & 11-13 OK
26	202520		Gap		North	8,500	Gap SCN 7 1-6 & 8-10 OK
31	203546	OK		Area 7	South	8,500	Gap SCN 15 1-14 & 16 OK
30	204839	OK			North	8,500	Gap SCN 10 1-9 & 11-13 OK
29	205645		Gap		South	8,500	Gap SCN 10 1-9 & 11 OK
28	210254		Gap		North	8,500	Gap SCN 11 1-10 & 12-13 OK
27	211108		Gap		South	8,500	Gap SCN 8 1-7 & 9-11 OK
33	211339	OK		Area 7	South	8,500	
32	211723	OK			North	8,500	
32	212158	OK		Area 7	South	8,500	Second Flight
33	213012	OK		Area 7	North	8,500	
29	213620		Gap	Area 7	South	8,500	Gap SCN 12 1-11 & 13 OK
31	214223		Gap	Area 7	North	8,500	Gap SCN 10 2-10 & 11-12 OK
26	214634	OK		Area 6	North	8,500	Gap SCN 1 2-10 OK
19	215051	OK		Area 5	North	8,500	
12	215428	OK		Area 4	North	8,500	Gap SCN 8 1-7 & 9-11 OK
9	215818	OK		Area 3	North	8,500	
5	220623	OK		Area 2	North	8,500	Gap SCN 7 1-6 & 8 OK



MISSION RECORD SHEET- Mission 041204b

Flight Record	
Project	Grand Canyon
Pilot	Tom Kuehn
Navigator	Chad Poole

Date	12/4/2004 b
Takeoff	3:55:00
Land	6:15:00
GPS BS Location	PGA ARP
GPS BS Height	1.473 Meters

Laser Settings

FOV	10
Scan Rate	35
Atten	Full
Gate	912
FOV ACT.	13.7

Camera Settings

Camera Lens	NA	MM
Filter	NA	
Shutter	NA	M/S
Exposure		NA/AP/GAIN
Interval		NA/MS

MISSION 2

Disks

Camera Drive		
Capacity	Images	
Laser Drive		
IMU Drive:		2
File Name:	Pag19Nov	
First File#	0.047	
Last File#	0.062	

RUN	MISSION #	Status Dec 7	Status Dec 7	Area	Direction	MSL	NOTES
4	232446	OK		Area 2	South	8,500	
8	233444	OK		Area 3	South	8,500	
11	233832	OK		Area 4	South	8,500	
18	234425		Gap	Area 5	South	8,500	Gap SCN 8 1-7 & 9 OK
25	234906	OK		Area 6	North	8,500	
24	235648	OK			South	8,500	Clouds in Area 6 @ 8,000 ft
23	217		Gap		North	8,000	FOV 13 Gap SCN 7 1-6 & 8 OK



17	848		Gap	Area 5	South	8,000	Gap SCN 6 1-5 & 7 OK
16	1530	OK			North	8,000	
10	2116		Gap	Area 4	North	8,000	Gap SCN 5 1-4 & 6-11 OK
7	2518		Gap	Area 3	North	8,000	Gap SCN 5 1-4 & 6-9 OK
6	3157	OK			South	8,000	Gap SCN 11 1-10 & 12 OK
3	4909	OK		Area 2	South	8,000	
2	5404		Gap	Area 2	North	8,000	Laser Record Not Stopped Gap SCN 4 1-3 & 5-43
34 Cal	5404	OK		Cal PGA	North	8,000	Gap SCN 4 1-3 5-43 OK Use 35-43 for Cal
34 Cal	10716	OK		Cal PGA	South	8,000	calibration line

MISSION RECORD SHEET – Mission 041209a

Flight Record		Date	12/9/2004 a
Project	Grand Canyon	Takeoff	9:05:00
Pilot	Tom Kuehn	Land	10:30:00
Navigator	Chad Poole	GPS BS Location	PGA ARP
		GPS BS Height	1.353

Laser Settings

FOV	11
Scan Rate	35
Atten	Full
Gate	600
FOV ACT.	15.5

Camera Settings

Camera Lens	NA	MM
Filter	NA	
Shutter	NA	M/S
Exposure		NA AP/GAIN
Interval		NA MS

Disks

Camera Drive	
Capacity	Images
Laser Drive	
IMU Drive:	2
File Name:	GC9Dec
First File#	0.067
Last File#	0.075

MISSION 1

RUN	MISSION #		Area	Direction	MSL	NOTES
2	163754		2	North	8,500	
1	164524		2	South		
7	165420		3	South		
8	170407		3	North		Engin Running Rough - Offline - Return to PGA



MISSION RECORD SHEET – Mission 041209b

Flight Record			
Project	Grand Canyon	Date	12/9/2004 b
Pilot	Tom Kuehn	Takeoff	11:00:00
Navigator	Chad Poole	Land	4:15:00
		GPS BS Location	PGA ARP
		GPS BS Height	1.353

Laser Settings

FOV	11
Scan Rate	35
Atten	Full
Gate	600
FOV ACT.	15.5

Camera Settings

Camera Lens	NA	MM
Filter	NA	
Shutter	NA	M/S
Exposure		NA AP/GAIN
Interval		NA MS

MISSION 2

Disks

Camera Drive		
Capacity	Images	
Laser Drive		
	IMU Drive:	2
	File Name:	GC9Dec
	First File#	0.077
	Last File#	0.111

RUN	MISSION #		Area	Direction	MSL	NOTES
8	183606		3	South	8,500	
10	183932		4	South	8,500	
11	184641		4	North	8,500	
12	185408		4	South	8,500	
13	190342		5	East	8,500	
20	190914		5	West	8,500	
14	191430		5	East	8,500	
21	192045		5	West	8,500	
15	192611		5	East	8,500	

22	193548		5	West	8,500	
15	194634		5	East	8,200	FOV12
13	195306		5	West	8,100	
17	200121		5	South	8,500	FOV 11
18	200724		5	North	8,500	
19	201440		5	South	8,500	
23	201632		6	South	8,500	
27	202314		7	South	8,500	
28	202910		7	North	8,500	
25	203450		6	North	8,500	
26	204247		6	South	8,500	
29	204632		7	South	8,500	
27	205406		7	North	8,500	
28	210052		7	South	8,500	
29	210721		7	North	8,500	
30	211522		7	South	8,500	
31	212439		7	North	8,500	
32	214953		7	North	10,500	Center line of each aera
29	215709		7	North	10,500	
25	220232		6	North	10,500	
21	221445		5	East	10,500	
14	222104		5	West	10,500	
18	222750		5	North	10,500	
11	223226		4	North	10,500	
7	224601		3	North	10,500	
3	224601		2	North	10,500	
34	224601		PGA	North	9,000	
34	225744		PGA	South	9,000	

Ground Truth

The GCMRC provided Spectrum Mapping with survey control to use for ground truth verification. Below are the points provided.

Point Number	X	Y	Z (m)
501	217285.58	597960.36	860.94
502	217781.56	598278.1	848.02
503	218843.25	598504.33	842.88
506	219482.25	597348.63	871.15
508	218767.83	597088.67	860.14
601	219906.29	585537.9	826.45
602	220517.31	585158.31	851.17
603	220398.68	585057.38	822.45
604	220538.64	584724.16	832.35
606	220844.44	584516.11	830.18
607	220897.34	584403.8	828.31
608	220924.74	584376.62	837.47
301	227418.15	622634.19	894.91
302	227495.78	622516.31	884.01
303	227413.45	622409.47	891.99
304	227010.6	622045.47	888.43
306	226694.7	620926.19	896.34
707	222736.85	573323.13	807.51
708	222887	572445.98	805.04
709	222355.12	571224.11	812.99
710	222431.22	570862.6	798.82
711	222474.86	570248.81	804.94
201	241496.16	650118.38	969.02
202	241029.63	648956.71	926.15
203	240122.41	648730.6	923.38
204	240138.59	648023.3	934.35
205	239986.46	647866.57	927.01
401	220750.04	613409.54	863
402	220210.67	612992.09	864.44

4/25/2005



406	219668.6	611819.05	860.57
408	218920.93	610758.26	858.22
409	218637.67	610295.85	866.65
404	219729.55	612327.43	859.2
LFRG	241496.16	650118.39	968.95

GROUND CONTROL REPORT

4/25/2005



Base Station Information

All base station information, notes, GPS station monument names and stability

PID - DG5953
 Designation – LFRG
 Stability – C = May hold, but of the type commonly subject to surface motion

Point DG5953 is horizontal order A and third order class II ellipsoid order.

DG5953 DESIGNATION - LFRG

DG5953 PID - DG5953

DG5953 STATE/COUNTY- AZ/COCONINO

DG5953 USGS QUAD - LEES FERRY (1985)

DG5953

DG5953 *CURRENT SURVEY CONTROL

DG5953

DG5953* NAD 83(1992)- 36 51 40.44281(N) 111 36 04.00607(W) ADJUSTED

DG5953* NAVD 88 - 992.3 (meters) 3256. (feet) GPS OBS

DG5953

DG5953 X - -1,881,216.565 (meters) COMP

DG5953 Y - -4,751,141.067 (meters) COMP

DG5953 Z - 3,805,664.431 (meters) COMP

DG5953 LAPLACE CORR- -2.76 (seconds) DEFLEC99

DG5953 ELLIP HEIGHT- 968.95 (meters) (06/28/04) GPS OBS

DG5953 GEOID HEIGHT- -23.34 (meters) GEOID03

DG5953

DG5953 HORZ ORDER - A

DG5953 ELLP ORDER - THIRD CLASS II

DG5953

DG5953.The horizontal coordinates were established by GPS observations

DG5953.and adjusted by the National Geodetic Survey in June 2004.

DG5953

DG5953.The orthometric height was determined by GPS observations and a

DG5953.high-resolution geoid model.

DG5953

DG5953.The X, Y, and Z were computed from the position and the ellipsoidal ht.

DG5953

DG5953.The Laplace correction was computed from DEFLEC99 derived deflections.

DG5953

DG5953.The ellipsoidal height was determined by GPS observations

DG5953.and is referenced to NAD 83.

DG5953

DG5953.The geoid height was determined by GEOID03.

DG5953

DG5953; North East Units Scale Factor Converg.

DG5953;SPC AZ C - 650,118.386 241,496.164 MT 0.99990975 +0 11 21.5

DG5953;UTM 12 - 4,079,647.414 446,418.032 MT 0.99963537 -0 21 38.2

DG5953

DG5953! - Elev Factor x Scale Factor = Combined Factor

DG5953!SPC AZ C - 0.99984796 x 0.99990975 = 0.99975773

DG5953!UTM 12 - 0.99984796 x 0.99963537 = 0.99948339

DG5953

SUPERSEDED SURVEY CONTROL

DG5953

DG5953.No superseded survey control is available for this station.

DG5953

DG5953_U.S. NATIONAL GRID SPATIAL ADDRESS: 12SVF4641879647(NAD 83)

DG5953_MARKER: DO = NOT SPECIFIED OR SEE DESCRIPTION

DG5953_SETTING: 35 = SPLINED REBAR

DG5953_STAMPING: NO STAMPING

DG5953_MAGNETIC: I = MARKER IS A STEEL ROD

DG5953_STABILITY: C = MAY HOLD, BUT OF TYPE COMMONLY SUBJECT TO

DG5953+STABILITY: SURFACE MOTION

DG5953_SATELLITE: THE SITE LOCATION WAS REPORTED AS SUITABLE FOR

DG5953+SATELLITE: SATELLITE OBSERVATIONS - 2003

DG5953

DG5953 HISTORY - Date Condition Report By

DG5953 HISTORY - 2003 MONUMENTED GRANCN

DG5953

STATION DESCRIPTION

DG5953

DG5953'DESCRIBED BY GRAND CANYON MONITORING AND RESEARCH 2003 (FMG)

DG5953'FROM THE U.S. POST OFFICE IN MARBLE CANYON LODGE, FOLLOW THE ROAD TO

DG5953'LEE'S FERRY FOR 5 MILES TO THE RANGER STATION ON THE LEFT AT THE LARGE

DG5953'WATER TOWER. TURN RIGHT ON THE ROAD THAT LEADS TO THE RESIDENTIAL AREA

DG5953'FOR LEE'S FERRY PARK EMPLOYEES. FOLLOW ROAD TO ITS END ON THE SOUTH

DG5953'SIDE OF THE RESIDENTIAL AREA. THE STATION IS 43 METERS SOUTH OF THE

DG5953'SW FENCE CORNER AND 35 METERS SW OF THE NORTHERLY OF 2 MANHOLES.

DG5953'

DG5953'THE STATION IS A ONE-HALF INCH SPLINED REBAR WITH A 1-INCH STEEL CAP,

DG5953'CEMENTED TO A DEPTH OF 10 INCHES.

4/25/2005



SYSTEM CALIBRATION REPORT

System Calibration

The Spectrum RAMS LIDAR system uses multiple layers of system calibration. The initial instrument calibration is accomplished during the system fabrication. All critical components (IMU, LIDAR, Camera, and Scanner) are optically aligned to a common optical bench using NIST traceable optical collimators and optical flats. This alignment is initially carried out to 2 arc seconds. In addition to the optical bench calibration, the LIDAR system is operated against a series of known targets to determine both scale factor and bias accuracy. All system timing is derived from GPS.

On any aircraft installation the critical factor is location of the GPS antenna and IMU positioning with respect to the RAMS optical reference. This is accomplished through a differential GPS survey. After installation in the aircraft, the system is then flown against a ground test range that was developed using high accuracy GPS points from a licensed surveyor. This range provides several hundred points that are used to statistically verify the in flight calibration.

One of the benefits of a LIDAR system is that the calibration of the system is verified each time two or more flight lines are combined. This is a result of taking measurements on a common point from multiple locations (i.e. the ground point is fixed and each flight line that sees this is a different instrument location). When multiple flight lines can be combined with no artifacts then the calibration of the system is validated in terms of range and angular accuracies. Our standard practice requires that at least one flight line within the project be flown in both directions for calibration verification of range and angular accuracy.

Another important area of quality control is edge matching. All edge matching discrepancies in LIDAR DEM data occur between two flight lines. Identification of edge matching discrepancies is performed by overlaying either the contour or the shaded relief model representation of the original DEM. If edge artifacts are found in the overlap area between two flight lines then this represents an edge discrepancy. The GPS / IMU data is then reevaluated to check for any possible errors in the post processing or a spike in the PDOP at the time of data acquisition. Usually this type of problem is resolved by reprocessing the GPS / IMU.

For accuracy verification, static survey points are collected, using static benchmarks where available. These survey points within the project boundary are selected to allow a statistical absolute elevation verification of the data. This data set is then statistically compared to the project LIDAR DEM data after the combination of flight lines to verify accuracy both horizontal and vertical. The RMSE (Root Mean Square Error) of the LIDAR DEM will be calculated using the ground GPS data to ensure that the vertical error is less than 0.15 m and the horizontal is less than 0.5 m.

GPS / Calibration Processing Summary

All GPS phase data was post-processed with continuous kinematic survey techniques using “On the Fly” (OTF) integer ambiguity resolution. The GPS data was processed with forward and reverse processing algorithms. The results from each process were combined to yield a single fixed integer phase differential solution of the aircraft trajectory. Plots of altitude and the forward and reverse GPS solution residuals (RMS and DOP) are attached for each day of flight. Spikes in the vertical component of these plots occur in turns and ferrying to and from collection sites, and do not affect the integrity of the solution. The RMS separation values (25%-75% weighting) for all flights are summarized below.

The Processing Summary provides statistics about the final solution. The processing summary includes details such as solution type, baseline distances, number of epochs in total, epochs not processed, and epochs with bad C/A code and L1 phase measurements.

Statistics such as RMS values of the C/A code, L1 phase, L1 Doppler measurements, quality number percentages, estimated position standard deviations calculated from the Kalman filtering, and percentages of epochs having double difference DOPs over 10, provide a quick, convenient method of assessing processed solutions. The forward/reverse separation RMS values for Easting (E), Northing(N), and Heighting (H) are listed, and the forward/reverse separation RMS values of E,N, and H for 25%-75% weighting.

The latter RMS values take into account the weighting of the forward/reverse combined solution only in the region of 25%-75% where the float solution has had time to converge to a lower value of error since the larger error values occur at the beginning of the processing direction. The same can be said for a Kinematic Ambiguity Resolution (KAR) fixed solution as well. The RMS values for the 25%-75% weighting of the combined solution are generally lower than the RMS values from the forward/reverse separation because if one solution has high error values, most of the weighting will go to the other processing direction.

The following is checked in the Processing Summary:

The forward/reverse separation RMS values of E,N, and H are generally low if a fixed integer solution has been obtained. The values should be less than 0.05 meters, but no greater than 0.10 meters.

The Quality Number Percentages should almost all be Quality 1. This number is typically close to 100%, with 1% in Quality 2 for a fixed integer solution.

Processing Summary Information

Program: POSGPS
Version: 4.11
FI041119a

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file:	33816
No processed position:	0
Missing Fwd or Rev:	0
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0233 (m)
C/A Code:	3.48 (m)
L1 Doppler:	0.035 (m/s)

Fwd/Rev Separation RMS Values:

East:	0.027 (m)
North:	0.042 (m)
Height:	0.129 (m)

Quality Number Percentages:

Q 1:	99.7 %
Q 2:	0.3 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 79.2 %

0.10 - 0.30 m: 20.8 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 103.116 (km)

Minimum: 0.052 (km)

Average: 35.673 (km)

First Epoch: 0.243 (km)

Last Epoch: 23.380 (km)

Program: POSGPS
Version: 4.11
FI041119b

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file:	15575
No processed position:	0
Missing Fwd or Rev:	0
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0262 (m)
C/A Code:	4.09 (m)
L1 Doppler:	0.042 (m/s)

Fwd/Rev Separation RMS Values:

East:	0.210 (m)
North:	0.128 (m)
Height:	0.180 (m)

Quality Number Percentages:

Q 1:	99.3 %
Q 2:	0.7 %
Q 3:	0.0 %
Q 4:	0.0 %
Q 5:	0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 81.4 %

0.10 - 0.30 m: 18.6 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 65.225 (km)

Minimum: 0.052 (km)

Average: 21.240 (km)

First Epoch: 28.545 (km)

Last Epoch: 24.480 (km)

Program: POSGPS
Version: 4.11
FL041120

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 25391
No processed position: 12
Missing Fwd or Rev: 0
With bad C/A code: 0
With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0254 (m)
C/A Code: 4.39 (m)
L1 Doppler: 0.083 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.032 (m)
North: 0.044 (m)
Height: 0.080 (m)

Quality Number Percentages:

Q 1: 99.6 %
Q 2: 0.4 %
Q 3: 0.0 %
Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 59.2 %

0.10 - 0.30 m: 40.8 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 103.061 (km)

Minimum: 0.052 (km)

Average: 39.425 (km)

First Epoch: 0.624 (km)

Last Epoch: 0.277 (km)

Program: POSGPS
Version: 4.11
Flt 041204a

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 46839
No processed position: 23423
Missing Fwd or Rev: 0
With bad C/A code: 0
With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0184 (m)
C/A Code: 1.17 (m)
L1 Doppler: 0.055 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.045 (m)
North: 0.041 (m)
Height: 0.080 (m)

Quality Number Percentages:

Q 1: 100.0 %
Q 2: 0.0 %
Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 89.9 %

0.10 - 0.30 m: 10.1 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 47.799 (km)

Minimum: 1.018 (km)

Average: 18.116 (km)

First Epoch: 28.978 (km)

Last Epoch: 24.692 (km)

Program: POSGPS
Version: 4.11
FI041204b

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file: 16674
No processed position: 8335
Missing Fwd or Rev: 0
With bad C/A code: 0
With bad L1 Phase: 0

Measurement RMS Values:

L1 Phase: 0.0182 (m)
C/A Code: 0.89 (m)
L1 Doppler: 0.028 (m/s)

Fwd/Rev Separation RMS Values:

East: 0.034 (m)
North: 0.022 (m)
Height: 0.086 (m)

Quality Number Percentages:

Q 1: 100.0 %
Q 2: 0.0 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 94.0 %

0.10 - 0.30 m: 6.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 39.949 (km)

Minimum: 1.285 (km)

Average: 18.572 (km)

First Epoch: 24.181 (km)

Last Epoch: 26.895 (km)

Program: POSGPS
Version: 4.11
FI041209a

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file:	36005
No processed position:	18005
Missing Fwd or Rev:	0
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0165 (m)
C/A Code:	0.92 (m)
L1 Doppler:	0.030 (m/s)

Fwd/Rev Separation RMS Values:

East:	0.023 (m)
North:	0.025 (m)
Height:	0.070 (m)

Quality Number Percentages:

Q 1:	100.0 %
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Q 2: 0.0 %

Q 3: 0.0 %

Q 4: 0.0 %

Q 5: 0.0 %

Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 89.0 %

0.10 - 0.30 m: 11.0 %

0.30 - 1.00 m: 0.0 %

1.00 - 5.00 m: 0.0 %

5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

Baseline Distances:

Maximum: 44.456 (km)

Minimum: 3.561 (km)

Average: 20.962 (km)

First Epoch: 26.179 (km)

Last Epoch: 23.269 (km)

Program: POSGPS
Version: 4.11
FI041209b

Solution Type: Combined Fwd/Rev

Number of Epochs:

Total in GPB file:	36005
No processed position:	18005
Missing Fwd or Rev:	0
With bad C/A code:	0
With bad L1 Phase:	0

Measurement RMS Values:

L1 Phase:	0.0165 (m)
C/A Code:	0.92 (m)
L1 Doppler:	0.030 (m/s)

Fwd/Rev Separation RMS Values:

East:	0.023 (m)
North:	0.025 (m)
Height:	0.070 (m)

Quality Number Percentages:

Q 1: 100.0 %
Q 2: 0.0 %
Q 3: 0.0 %
Q 4: 0.0 %
Q 5: 0.0 %
Q 6: 0.0 %

Position Standard Deviation Percentages:

0.00 - 0.10 m: 89.0 %
0.10 - 0.30 m: 11.0 %
0.30 - 1.00 m: 0.0 %
1.00 - 5.00 m: 0.0 %
5.00 m + over: 0.0 %

Percentages of epochs with DD_DOP over 10.00:

DOP over Tol: 0.0 %

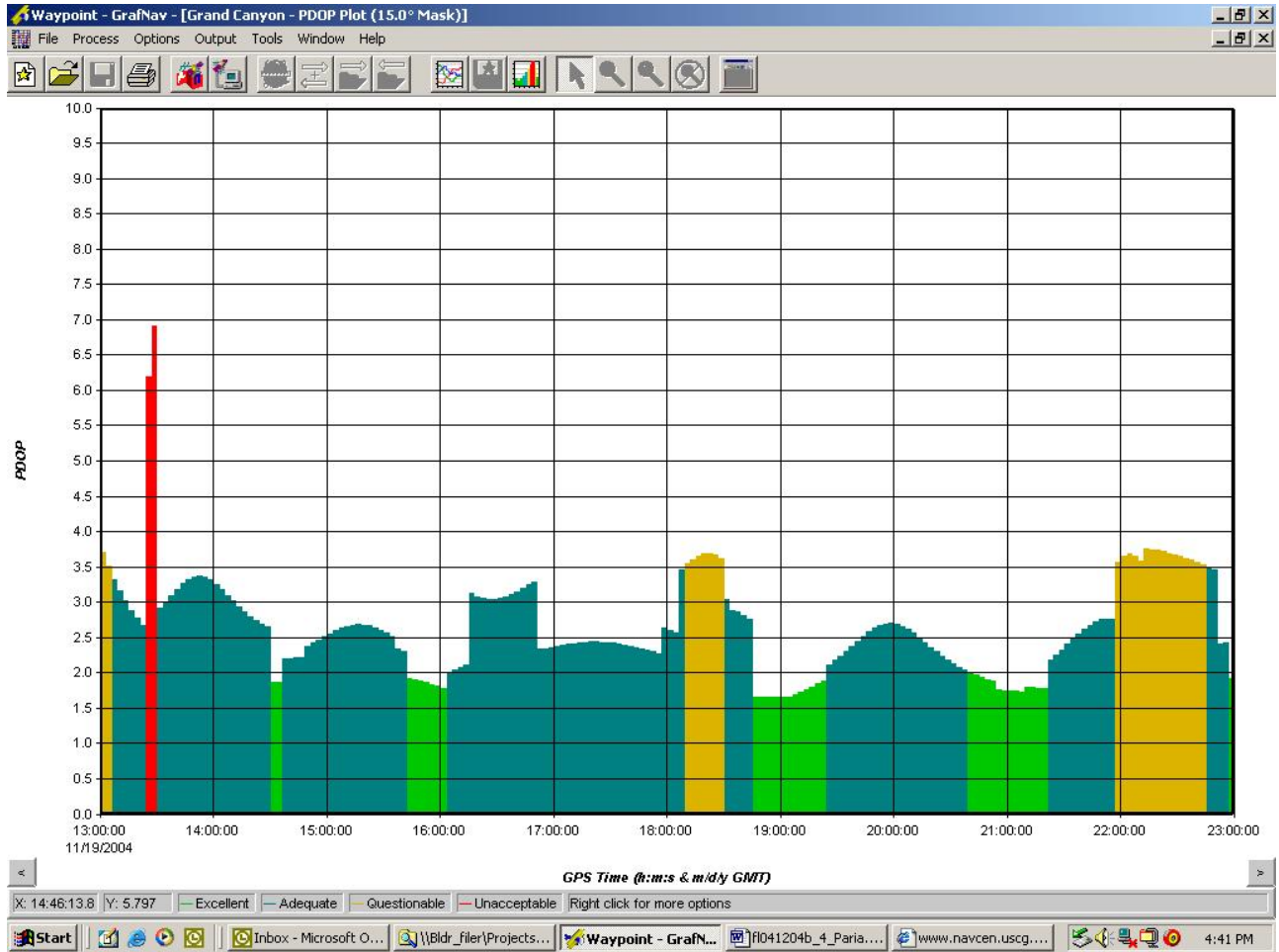
Baseline Distances:

Maximum: 44.456 (km)
Minimum: 3.561 (km)
Average: 20.962 (km)
First Epoch: 26.179 (km)
Last Epoch: 23.269 (km)

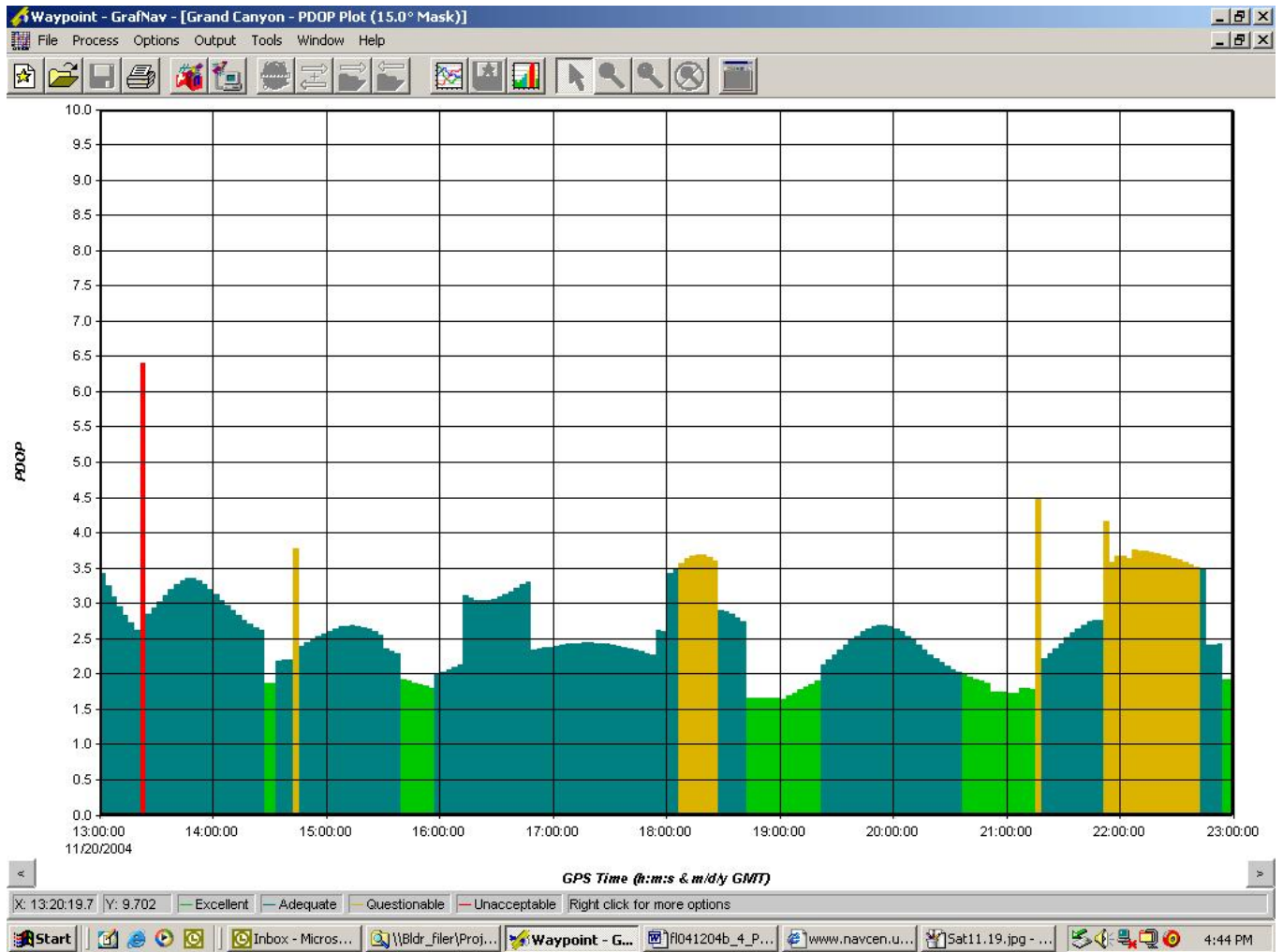
PDOP

The DOP values are measures of satellite geometry, which changes with time due to satellite motion. PDOP values of less than 3 are considered excellent, which combines the HDOP and VDOP. The user should watch for spikes in this plot, as it could signify sudden changes in the satellite constellation (for example, if several satellites are obstructed temporarily the DOP values should suddenly increase).

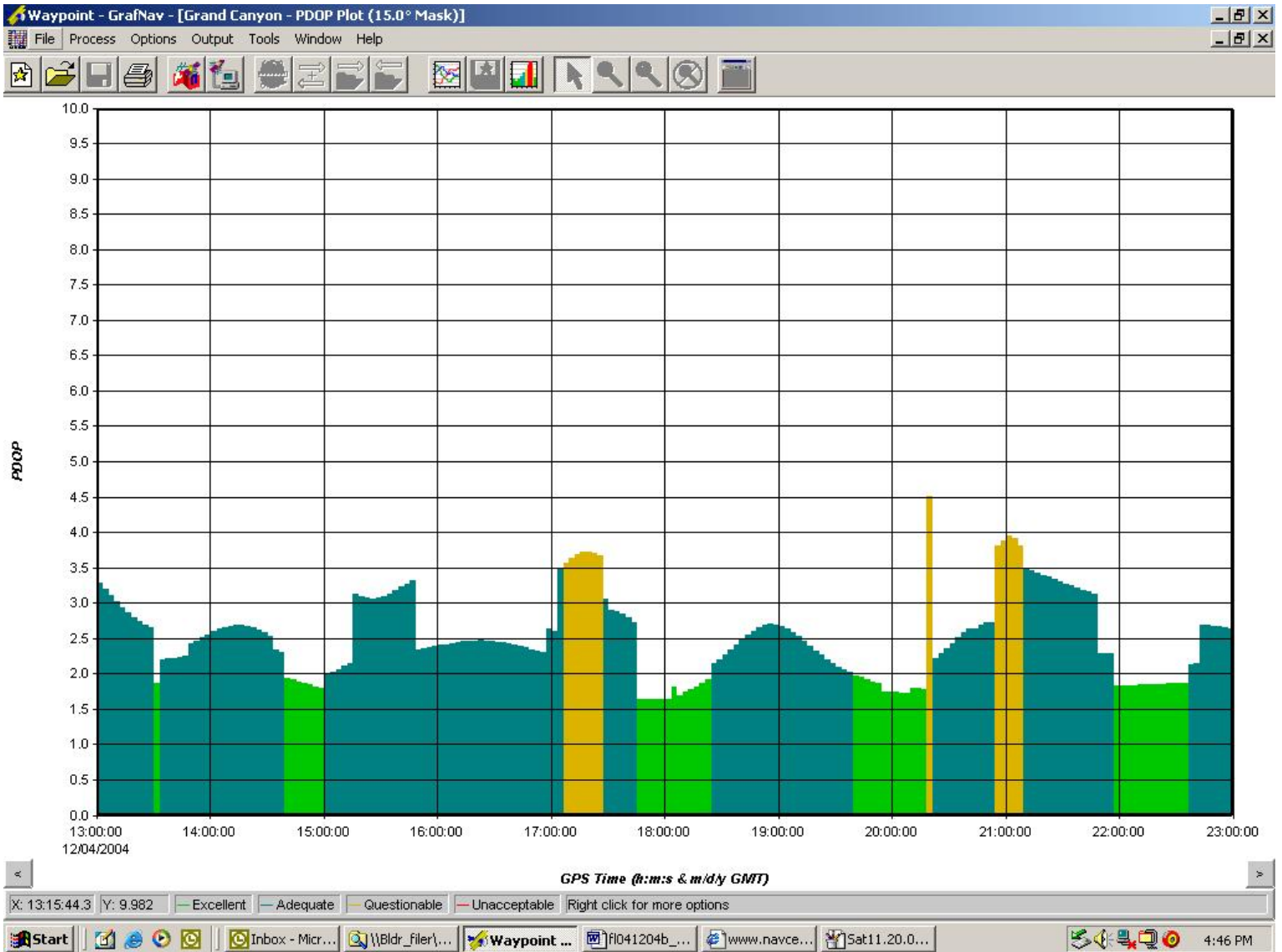
November 19, 2004 Mission a and b



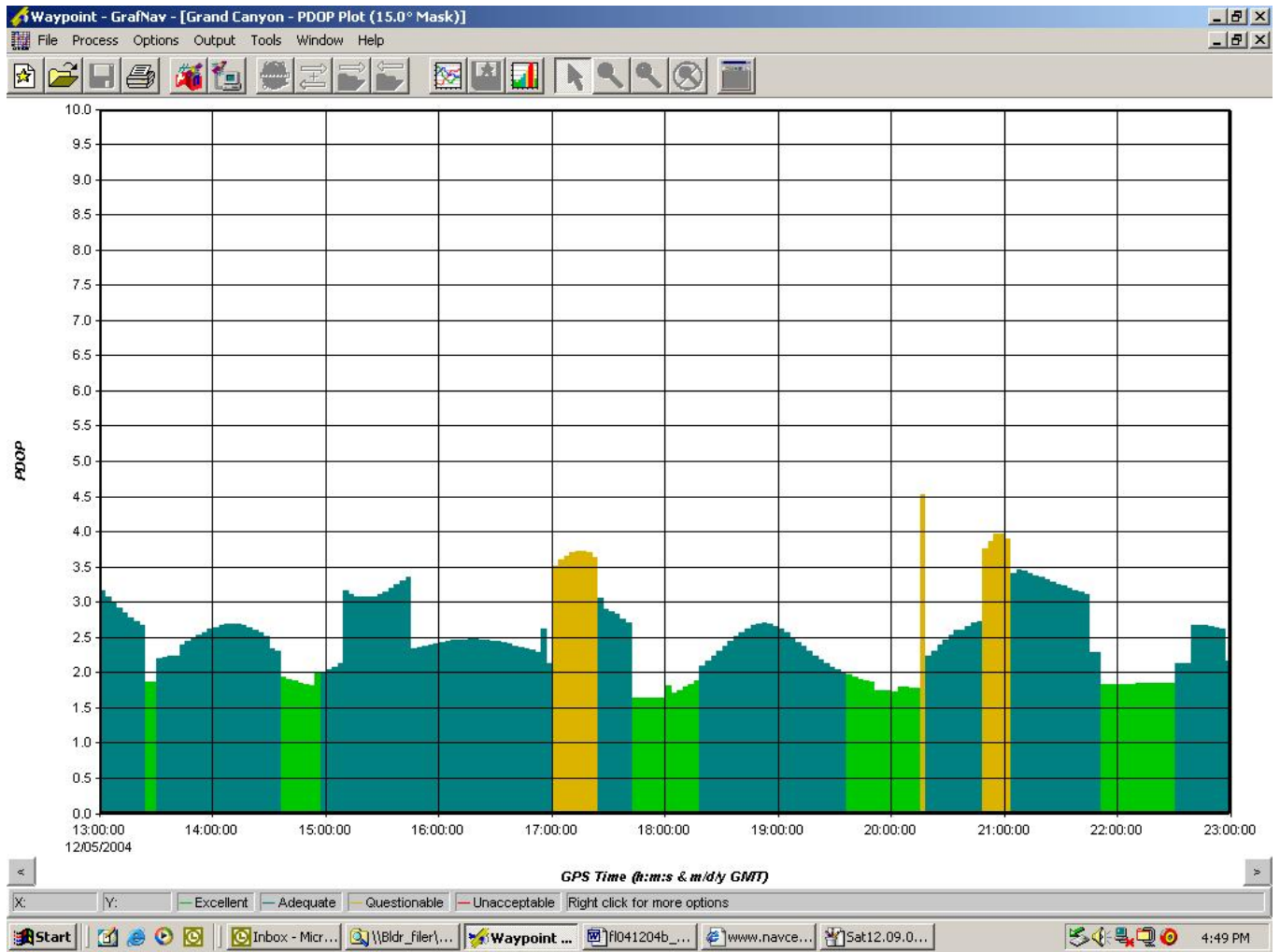
November 20, 2004



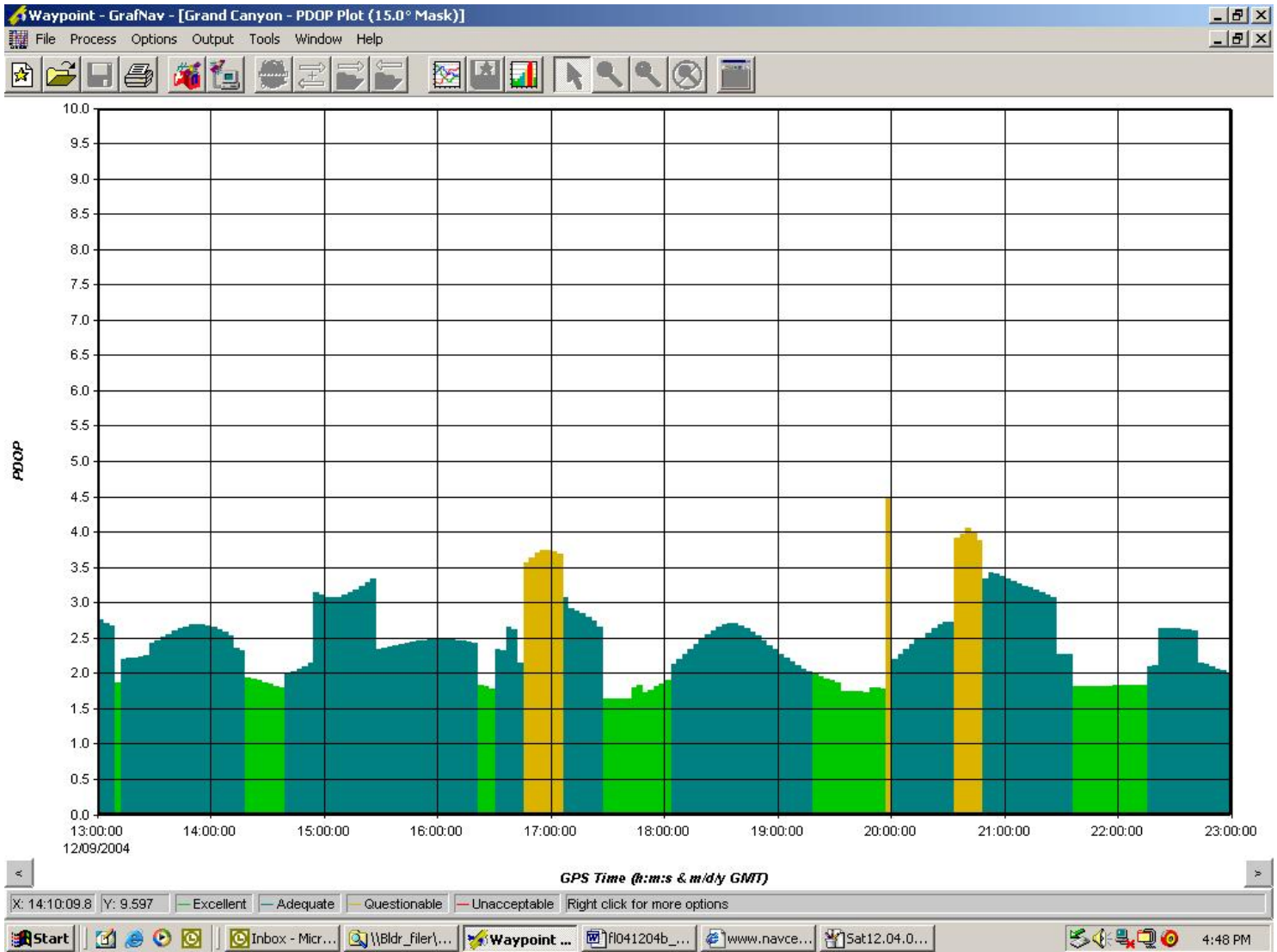
December 4, 2004 Mission a and b



December 5, 2004



December 9, 2004 missions a and b

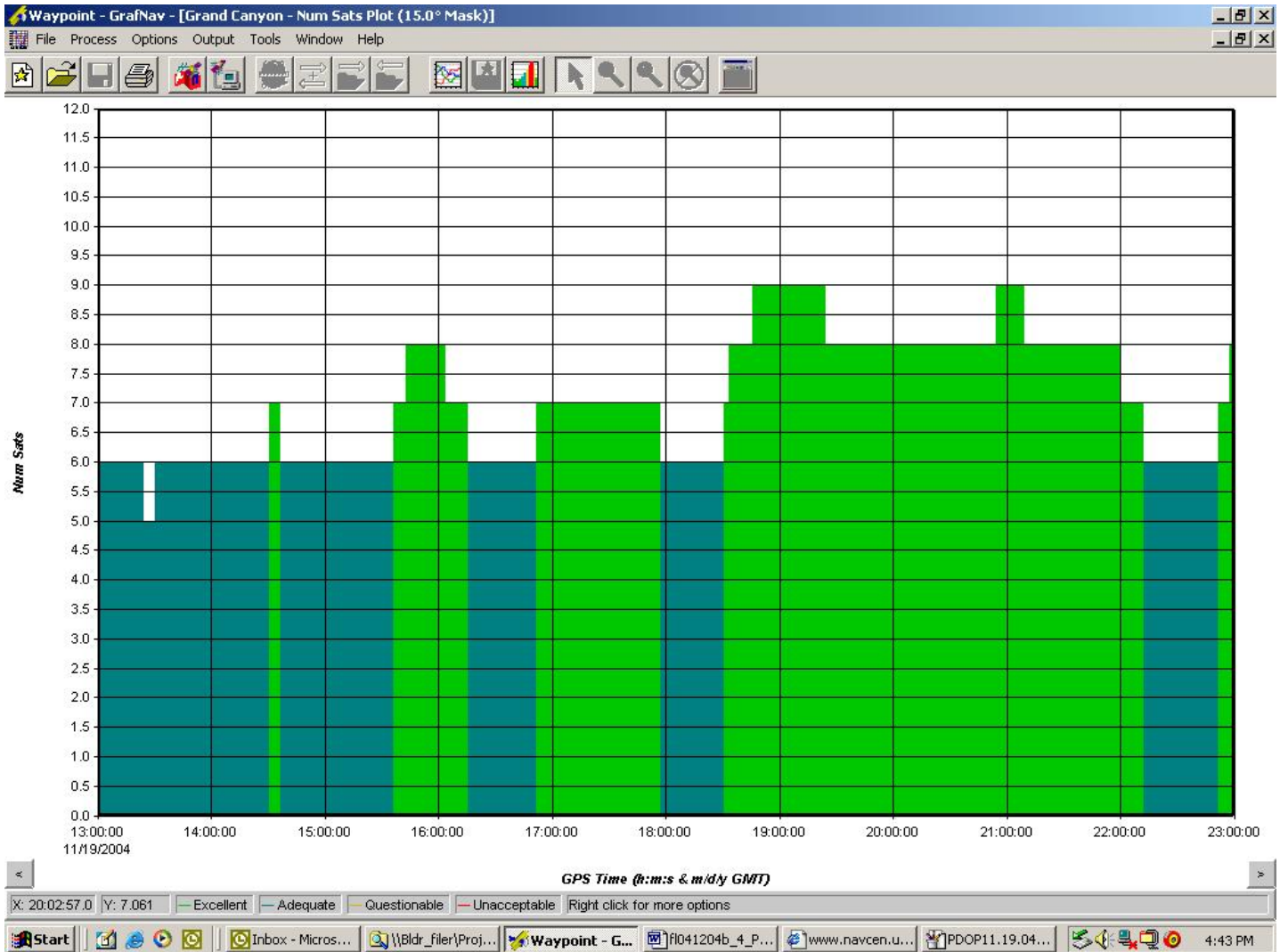


Satellite Lock

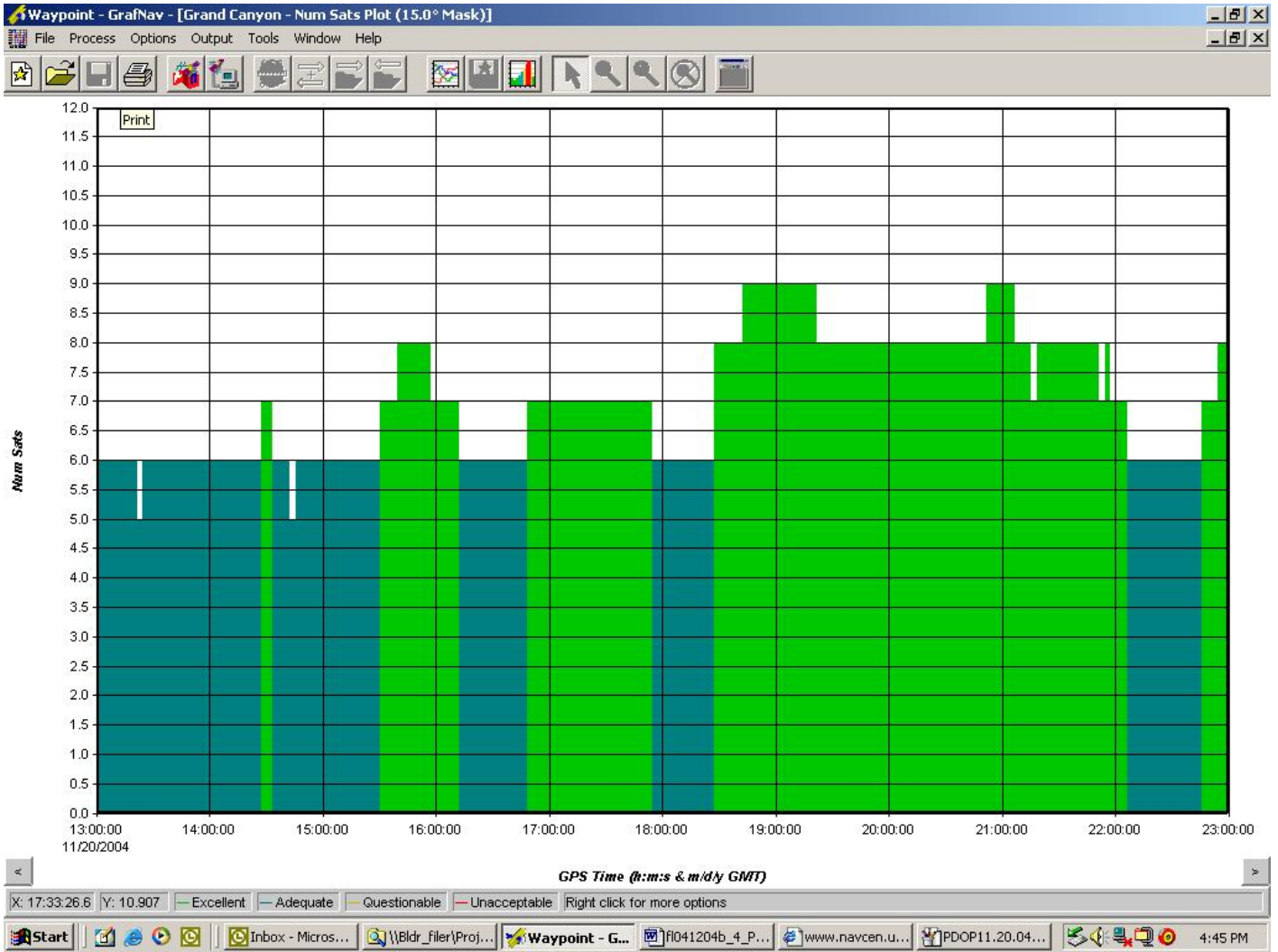
Plotting the number of satellites tracked during the survey is a good way to determine where data gaps occur due to total loss of lock. It also serves to identify areas of the survey that may

not be as accurately or reliably determined as others. For example, KAR requires a minimum of five satellites to engage; therefore you know those periods of less than five satellites may not have an integer fixed solution.

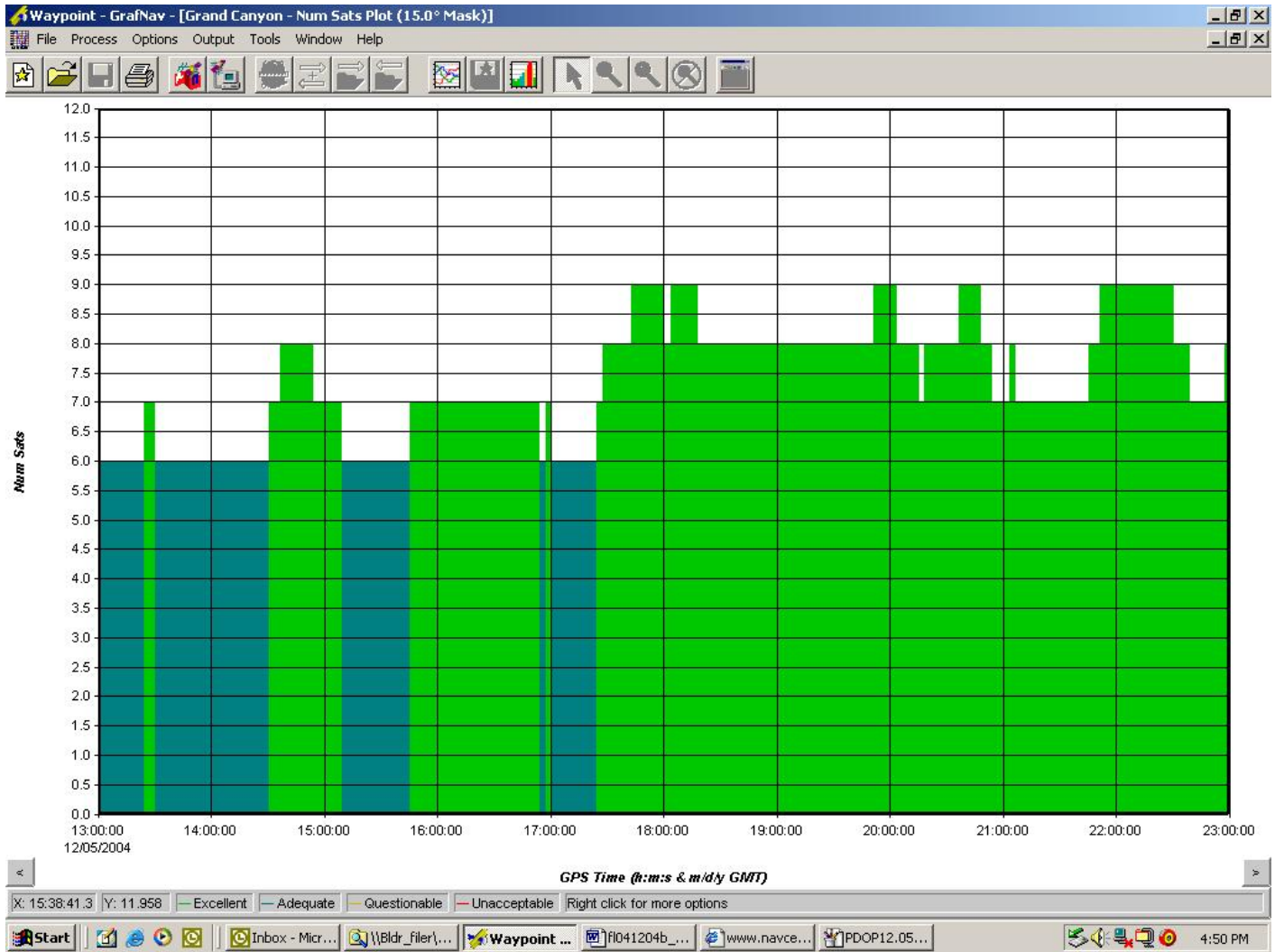
November 19, 2004 Mission a and b



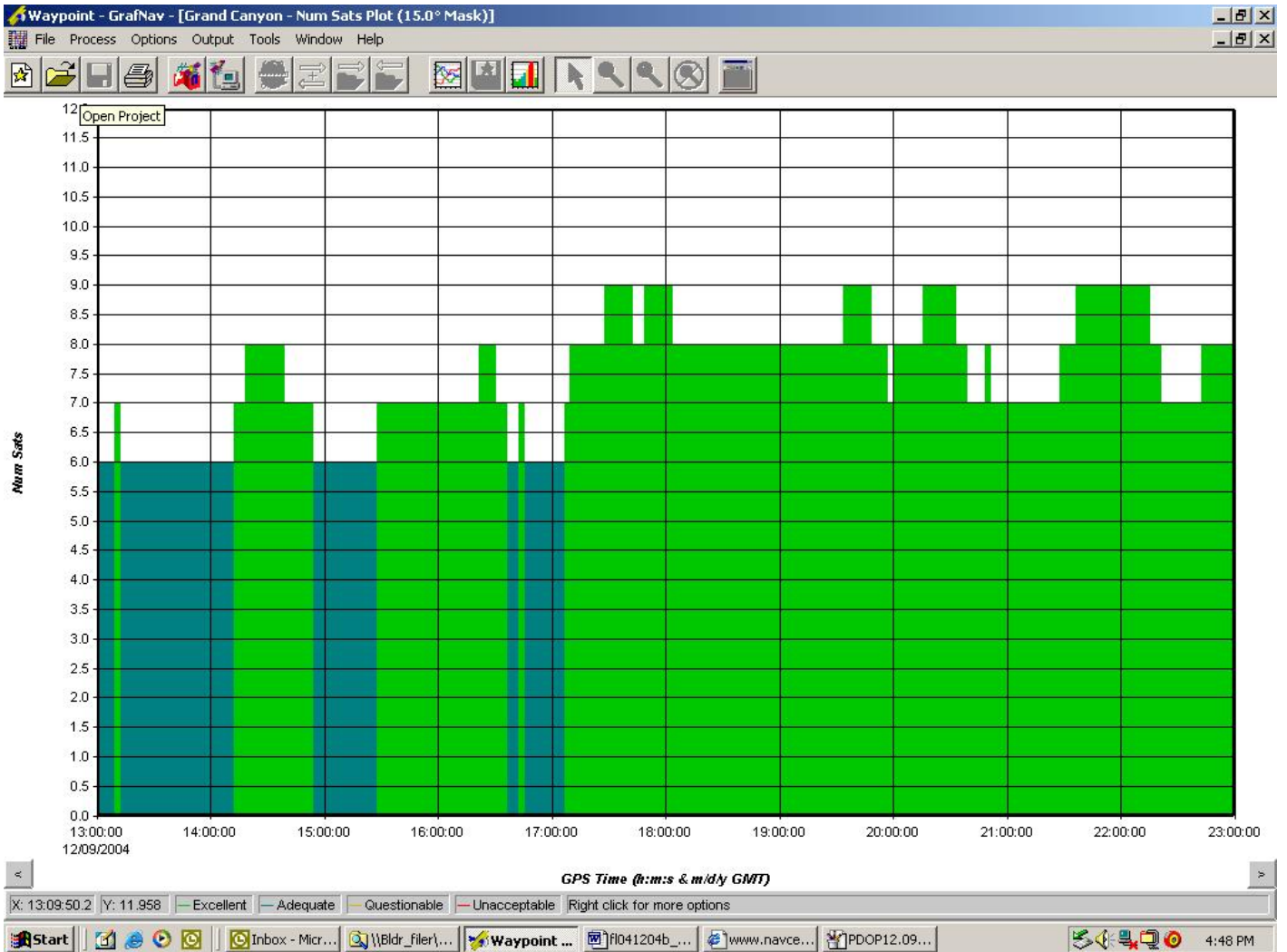
November 20, 2004



December 4, 2004 - Mission a and b



December 9, 2004 missions a and b



APPENDIX A- RMSE ANALYSIS

Below list the individual project area's RMSE. These are separated by pre flood and post flood.

Pre_Flood Eminence

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
503	f1041119a_16	218843.25	598504.333	842.88	842.9	0.02	0.0004
506	f1041119a_16	219482.25	597348.634	871.15	871.13	-0.02	0.0004
503	f1041119a_17	218843.25	598504.333	842.88	842.84	-0.04	0.0016
506	f1041119a_17	219482.25	597348.634	871.15	871.19	0.04	0.0016
506	f1041119a_18	219482.25	597348.634	871.15	871.13	-0.02	0.0004
502	f1041119a_13	217781.56	598278.101	848.02	848.1	0.08	0.0064
503	f1041119a_13	218843.25	598504.333	842.88	842.8	-0.08	0.0064
506	f1041119a_20	219482.25	597348.634	871.15	871.09	-0.06	0.0036
508	f1041119a_20	218767.83	597088.673	860.14	860.2	0.06	0.0036
502	f1041119a_14	217781.56	598278.101	848.02	848.03	0.01	1E-04
503	f1041119a_14	218843.25	598504.333	842.88	842.73	-0.15	0.0225
506	f1041119a_21	219482.25	597348.634	871.15	871.23	0.08	0.0064
508	f1041119a_21	218767.83	597088.673	860.14	860.06	-0.08	0.0064
502	f1041119a_15	217781.56	598278.101	848.02	848.16	0.14	0.0196
503	f1041119a_15	218843.25	598504.333	842.88	842.5	-0.38	0.1444
506	f1041119a_22	219482.25	597348.634	871.15	871.09	-0.06	0.0036
508	f1041119a_22	218767.83	597088.673	860.14	860.2	0.06	0.0036
503	f1041120_17	218843.25	598504.333	842.88	842.88	0	0
506	f1041120_17	219482.25	597348.634	871.15	871.15	0	0
506	f1041120_18	219482.25	597348.634	871.15	871.15	0	0
502	f1041120_13	217781.56	598278.101	848.02	848.04	0.02	0.0004
506	f1041120_20	219482.25	597348.634	871.15	870.92	-0.23	0.0529
508	f1041120_20	218767.83	597088.673	860.14	860.38	0.24	0.0576
502	f1041120_14	217781.56	598278.101	848.02	848.03	0.01	1E-04
506	f1041120_21	219482.25	597348.634	871.15	871.16	0.01	1E-04
508	f1041120_21	218767.83	597088.673	860.14	860.13	-0.01	1E-04
502	f1041120_15	217781.56	598278.101	848.02	847.99	-0.03	0.0009
503	f1041120_15	218843.25	598504.333	842.88	842.88	0	0
506	f1041120_22	219482.25	597348.634	871.15	871.17	0.02	0.0004
508	f1041120_22	218767.83	597088.673	860.14	860.1	-0.04	0.0016
Total						0.06	0.0108
Avg. Error						0.01	0.0018
# Points / RMSE						6.00	0.0424

Pre_Flood Kwagunt

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
601	fl041119_26	219906.29	585537.903	826.45	826.26	-0.19	0.0361
603	fl041119_26	220398.68	585057.384	822.45	822.78	0.33	0.1089
604	fl041119_26	220538.64	584724.163	832.35	832.16	-0.19	0.0361
606	fl041119_26	220844.44	584516.111	830.18	830.34	0.16	0.0256
607	fl041119_26	220897.34	584403.803	828.31	828.41	0.1	0.01
601	fl041119_25	219906.29	585537.903	826.45	826.29	-0.16	0.0256
602	fl041119_25	220517.31	585158.312	851.17	851.21	0.04	0.0016
603	fl041119_25	220398.68	585057.384	822.45	822.44	-0.01	1E-04
604	fl041119_25	220538.64	584724.163	832.35	832.5	0.15	0.0225
606	fl041119_25	220844.44	584516.111	830.18	830.07	-0.11	0.0121
607	fl041119_25	220897.34	584403.803	828.31	828.26	-0.05	0.0025
608	fl041119_25	220924.74	584376.623	837.47	837.36	-0.11	0.0121
601	fl041119_24	219906.29	585537.903	826.45	826.31	-0.14	0.0196
603	fl041119_24	220398.68	585057.384	822.45	822.65	0.2	0.04
604	fl041119_24	220538.64	584724.163	832.35	832.2	-0.15	0.0225
606	fl041119_24	220844.44	584516.111	830.18	829.98	-0.2	0.04
607	fl041119_24	220897.34	584403.803	828.31	828.28	-0.03	0.0009
608	fl041119_24	220924.74	584376.623	837.47	837.33	-0.14	0.0196
601	fl041119_23	219906.29	585537.903	826.45	826.61	0.16	0.0256
603	fl041119_23	220398.68	585057.384	822.45	822.77	0.32	0.1024
604	fl041119_23	220538.64	584724.163	832.35	832	-0.35	0.1225
606	fl041119_23	220844.44	584516.111	830.18	830.23	0.05	0.0025
607	fl041119_23	220897.34	584403.803	828.31	828.25	-0.06	0.0036
608	fl041119_23	220924.74	584376.623	837.47	837.29	-0.18	0.0324
602	fl041120_26	220517.31	585158.312	851.17	850.74	-0.43	0.1849
603	fl041120_26	220398.68	585057.384	822.45	822.4	-0.05	0.0025
604	fl041120_26	220538.64	584724.163	832.35	832.36	0.01	1E-04
606	fl041120_26	220844.44	584516.111	830.18	830.19	0.01	0.0001
607	fl041120_26	220897.34	584403.803	828.31	828.23	-0.08	0.0064
608	fl041120_26	220924.74	584376.623	837.47	837.58	0.11	0.0121
601	fl041120_25	219906.29	585537.903	826.45	826.6	0.15	0.0225
603	fl041120_25	220398.68	585057.384	822.45	822.59	0.14	0.0196
604	fl041120_25	220538.64	584724.163	832.35	832.31	-0.04	0.0016
606	fl041120_25	220844.44	584516.111	830.18	830.16	-0.02	0.0004
607	fl041120_25	220897.34	584403.803	828.31	828.17	-0.14	0.0196
608	fl041120_25	220924.74	584376.623	837.47	837.44	-0.03	0.0009
601	fl041120_24	219906.29	585537.903	826.45	826.12	-0.33	0.1089
602	fl041120_24	220517.31	585158.312	851.17	851.17	0	0
603	fl041120_24	220398.68	585057.384	822.45	822.5	0.05	0.0025
604	fl041120_24	220538.64	584724.163	832.35	832.65	0.3	0.09
606	fl041120_24	220844.44	584516.111	830.18	830.14	-0.04	0.0016



Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
607	f1041120_24	220897.34	584403.803	828.31	828.37	0.06	0.0036
608	f1041120_24	220924.74	584376.623	837.47	837.64	0.17	0.0289
601	f1041120_23	219906.29	585537.903	826.45	826.48	0.03	0.0009
604	f1041120_23	220538.64	584724.163	832.35	832.5	0.15	0.0225
606	f1041120_23	220844.44	584516.111	830.18	830.05	-0.13	0.0169
607	f1041120_23	220897.34	584403.803	828.31	828.03	-0.28	0.0784
608	f1041120_23	220924.74	584376.623	837.47	837.46	-0.01	1E-04
Total						0.05	0.2423
Avg. Error						0.01	0.0404
# Points / RMSE						6.00	0.2010

Pre_Flood North Canyon

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
301	fl041119_9	227418.15	622634.188	894.91	894.96	0.05	0.0025
302	fl041119_9	227495.78	622516.314	884.01	883.67	-0.34	0.1156
303	fl041119_9	227413.45	622409.47	891.99	891.96	-0.03	0.0009
306	fl041119_9	226694.7	620926.19	896.34	896.29	-0.05	0.0025
301	fl041119_8	227418.15	622634.188	894.91	894.81	-0.1	0.01
302	fl041119_8	227495.78	622516.314	884.01	884.32	0.31	0.0961
303	fl041119_8	227413.45	622409.47	891.99	892.1	0.11	0.0121
304	fl041119_8	227010.6	622045.47	888.43	888.63	0.2	0.04
306	fl041119_8	226694.7	620926.19	896.34	896.24	-0.1	0.01
301	fl041119_7	227418.15	622634.188	894.91	894.94	0.03	0.0009
302	fl041119_7	227495.78	622516.314	884.01	884	-0.01	1E-04
303	fl041119_7	227413.45	622409.47	891.99	892.02	0.03	0.0009
304	fl041119_7	227010.6	622045.47	888.43	888.35	-0.08	0.0064
306	fl041119_7	226694.7	620926.19	896.34	896.3	-0.04	0.0016
301	fl041119_6	227418.15	622634.188	894.91	895.05	0.14	0.0196
302	fl041119_6	227495.78	622516.314	884.01	883.82	-0.19	0.0361
303	fl041119_6	227413.45	622409.47	891.99	892.2	0.21	0.0441
304	fl041119_6	227010.6	622045.47	888.43	888.34	-0.09	0.0081
306	fl041119_6	226694.7	620926.19	896.34	896.19	-0.15	0.0225
301	fl041119b_9	227418.15	622634.188	894.91	894.87	-0.04	0.0016
302	fl041119b_9	227495.78	622516.314	884.01	883.99	-0.02	0.0004
303	fl041119b_9	227413.45	622409.47	891.99	892.12	0.13	0.0169
304	fl041119b_9	227010.6	622045.47	888.43	888.24	-0.19	0.0361
306	fl041119b_9	226694.7	620926.19	896.34	896.21	-0.13	0.0169
301	fl041119b_8	227418.15	622634.188	894.91	894.9	-0.01	1E-04
302	fl041119b_8	227495.78	622516.314	884.01	883.9	-0.11	0.0121
303	fl041119b_8	227413.45	622409.47	891.99	891.99	0	0
304	fl041119b_8	227010.6	622045.47	888.43	888.24	-0.19	0.0361
306	fl041119b_8	226694.7	620926.19	896.34	896.36	0.02	0.0004
301	fl041119b_7	227418.15	622634.188	894.91	894.93	0.02	0.0004
303	fl041119b_7	227413.45	622409.47	891.99	891.99	0	0
304	fl041119b_7	227010.6	622045.47	888.43	888.41	-0.02	0.0004
306	fl041119b_7	226694.7	620926.19	896.34	896.32	-0.02	0.0004
301	fl041119b_6	227418.15	622634.188	894.91	894.85	-0.06	0.0036
302	fl041119b_6	227495.78	622516.314	884.01	884.01	0	0
303	fl041119b_6	227413.45	622409.47	891.99	892.06	0.07	0.0049
304	fl041119b_6	227010.6	622045.47	888.43	888.33	-0.1	0.01
Total						-0.16	0.2276
Avg. Error						-0.03	0.0379

# Points / RMSE	6.00	0.1948
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Pre_Flood Palisades

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
708	fl041119_31	222887	572445.977	805.04	805.07	0.03	0.0009
710	fl041119_31	222431.22	570862.597	798.82	798.94	0.12	0.0144
711	fl041119_31	222474.86	570248.807	804.94	805.09	0.15	0.0225
708	fl041119_30	222887	572445.977	805.04	804.94	-0.1	0.01
709	fl041119_30	222355.12	571224.111	812.99	812.88	-0.11	0.0121
710	fl041119_30	222431.22	570862.597	798.82	798.77	-0.05	0.0025
711	fl041119_30	222474.86	570248.807	804.94	805.05	0.11	0.0121
707	fl041119_29	222736.85	573323.133	807.51	807.55	0.04	0.0016
708	fl041119_29	222887	572445.977	805.04	804.91	-0.13	0.0169
709	fl041119_29	222355.12	571224.111	812.99	813.03	0.04	0.0016
710	fl041119_29	222431.22	570862.597	798.82	798.9	0.08	0.0064
711	fl041119_29	222474.86	570248.807	804.94	805.06	0.12	0.0144
707	fl041119_28	222736.85	573323.133	807.51	807.26	-0.25	0.0625
709	fl041119_28	222355.12	571224.111	812.99	812.91	-0.08	0.0064
710	fl041119_28	222431.22	570862.597	798.82	798.83	0.01	1E-04
711	fl041119_28	222474.86	570248.807	804.94	805.2	0.26	0.0676
709	fl041119_27	222355.12	571224.111	812.99	812.99	0	0
707	fl041120_31	222736.85	573323.133	807.51	807.53	0.02	0.0004
708	fl041120_31	222887	572445.977	805.04	804.86	-0.18	0.0324
710	fl041120_31	222431.22	570862.597	798.82	799.01	0.19	0.0361
711	fl041120_31	222474.86	570248.807	804.94	804.91	-0.03	0.0009
708	fl041120_30	222887	572445.977	805.04	805.19	0.15	0.0225
709	fl041120_30	222355.12	571224.111	812.99	812.84	-0.15	0.0225
707	fl041120_29	222736.85	573323.133	807.51	807.43	-0.08	0.0064
708	fl041120_29	222887	572445.977	805.04	805.01	-0.03	0.0009
709	fl041120_29	222355.12	571224.111	812.99	812.99	0	0
710	fl041120_29	222431.22	570862.597	798.82	798.85	0.03	0.0009
711	fl041120_29	222474.86	570248.807	804.94	805.01	0.07	0.0049
707	fl041120_28	222736.85	573323.133	807.51	807.66	0.15	0.0225
709	fl041120_28	222355.12	571224.111	812.99	813.13	0.14	0.0196
710	fl041120_28	222431.22	570862.597	798.82	798.56	-0.26	0.0676
709	fl041120_27	222355.12	571224.111	812.99	812.98	-0.01	1E-04
Total						0.04	0.0624
Avg. Error						0.01	0.0104
# Points / RMSE						6.00	0.1020

Pre_Flood Paria

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
204	fl041119_5	240138.59	648023.3	934.35	934.3	-0.05	0.0025
205	fl041119_5	239986.46	647866.573	927.01	927.02	0.01	1E-04
202	fl041119_4	241029.63	648956.707	926.15	926.08	-0.07	0.0049
204	fl041119_4	240138.59	648023.3	934.35	934.35	0	0
205	fl041119_4	239986.46	647866.573	927.01	927.04	0.03	0.0009
202	fl041119_3	241029.63	648956.707	926.15	925.93	-0.22	0.0484
203	fl041119_3	240122.41	648730.595	923.38	923.38	0	0
204	fl041119_3	240138.59	648023.3	934.35	934.37	0.02	0.0004
205	fl041119_3	239986.46	647866.573	927.01	927.16	0.15	0.0225
203	fl041119_2	240122.41	648730.595	923.38	923.26	-0.12	0.0144
204	fl041119_2	240138.59	648023.3	934.35	934.43	0.08	0.0064
203	fl041119_1	240122.41	648730.595	923.38	923.38	0	0
202	fl041119b_5	241029.63	648956.707	926.15	926.03	-0.12	0.0144
204	fl041119b_5	240138.59	648023.3	934.35	934.44	0.09	0.0081
205	fl041119b_5	239986.46	647866.573	927.01	927.01	0	0
202	fl041119b_4	241029.63	648956.707	926.15	926.13	-0.02	0.0004
204	fl041119b_4	240138.59	648023.3	934.35	934.2	-0.15	0.0225
205	fl041119b_4	239986.46	647866.573	927.01	927.16	0.15	0.0225
204	fl041119b_3	240138.59	648023.3	934.35	934.28	-0.07	0.0049
205	fl041119b_3	239986.46	647866.573	927.01	927.09	0.08	0.0064
203	fl041119b_2	240122.41	648730.595	923.38	923.05	-0.33	0.1089
204	fl041119b_2	240138.59	648023.3	934.35	934.4	0.05	0.0025
203	fl041119b_1	240122.41	648730.595	923.38	923.38	0	0
Total						-0.30	0.0568
Avg. Error						-0.05	0.0095
# Points / RMSE						6.00	0.0973

Pre Flood South Canyon

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
401	fl041119_12	220750.04	613409.538	863	863.03	0.03	0.0009
402	fl041119_12	220210.67	612992.094	864.44	864.47	0.03	0.0009
406	fl041119_12	219668.6	611819.049	860.57	860.59	0.02	0.0004
408	fl041119_12	218920.93	610758.256	858.22	857.86	-0.36	0.1296
409	fl041119_12	218637.67	610295.851	866.65	866.67	0.02	0.0004
401	fl041119_11	220750.04	613409.538	863	863.11	0.11	0.0121
402	fl041119_11	220210.67	612992.094	864.44	864.33	-0.11	0.0121
404	fl041119_11	219729.55	612327.426	859.2	859.14	-0.06	0.0036
406	fl041119_11	219668.6	611819.049	860.57	860.59	0.02	0.0004
408	fl041119_11	218920.93	610758.256	858.22	858.21	-0.01	1E-04
409	fl041119_11	218637.67	610295.851	866.65	866.66	0.01	1E-04
402	fl041119_10	220210.67	612992.094	864.44	864.48	0.04	0.0016
404	fl041119_10	219729.55	612327.426	859.2	859.35	0.15	0.0225
406	fl041119_10	219668.6	611819.049	860.57	860.52	-0.05	0.0025
408	fl041119_10	218920.93	610758.256	858.22	857.99	-0.23	0.0529
409	fl041119_10	218637.67	610295.851	866.65	866.7	0.05	0.0025
401	fl041119b_12	220750.04	613409.538	863	863.02	0.02	0.0004
402	fl041119b_12	220210.67	612992.094	864.44	864.29	-0.15	0.0225
406	fl041119b_12	219668.6	611819.049	860.57	860.67	0.1	0.01
408	fl041119b_12	218920.93	610758.256	858.22	858.18	-0.04	0.0016
409	fl041119b_12	218637.67	610295.851	866.65	866.55	-0.1	0.01
401	fl041119b_11	220750.04	613409.538	863	863.01	0.01	1E-04
402	fl041119b_11	220210.67	612992.094	864.44	864.27	-0.17	0.0289
404	fl041119b_11	219729.55	612327.426	859.2	859.09	-0.11	0.0121
406	fl041119b_11	219668.6	611819.049	860.57	860.43	-0.14	0.0196
408	fl041119b_11	218920.93	610758.256	858.22	858.38	0.16	0.0256
409	fl041119b_11	218637.67	610295.851	866.65	866.78	0.13	0.0169
402	fl041119b_10	220210.67	612992.094	864.44	864.43	-0.01	0.0001
404	fl041119b_10	219729.55	612327.426	859.2	859.12	-0.08	0.0064
408	fl041119b_10	218920.93	610758.256	858.22	858.15	-0.07	0.0049
409	fl041119b_10	218637.67	610295.851	866.65	866.73	0.08	0.0064
Total						-0.15	0.1443
Avg. Error						-0.03	0.0241
# Points / RMSE						6.00	0.1551

Eminence Post Flood

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
506	fl041204a_21	219482.25	597348.634	871.15	871.12	-0.03	0.0009
508	fl041204a_21	218767.83	597088.673	860.14	860.13	-0.01	1E-04
503	fl041204a_15	218843.25	598504.333	842.88	842.9	0.02	0.0004
508	fl041204a_22	218767.83	597088.673	860.14	860.07	-0.07	0.0049
503	fl041204a_16	218843.25	598504.333	842.88	842.91	0.03	0.0009
506	fl041204a_16	219482.25	597348.634	871.15	871.19	0.04	0.0016
506	fl041204a_17	219482.25	597348.634	871.15	871.15	0	0
506	fl041205_17	219482.25	597348.634	871.15	871.29	0.14	0.0196
503	fl041205_16	218843.25	598504.333	842.88	843	0.12	0.0144
506	fl041205_16	219482.25	597348.634	871.15	871.37	0.22	0.0484
502	fl041209a_13	217781.56	598278.101	848.02	847.99	-0.03	0.0009
506	fl041209a_20	219482.25	597348.634	871.15	871.15	0	0
501	fl041209a_14	217285.58	597960.359	860.94	861.14	0.2	0.04
502	fl041209a_14	217781.56	598278.101	848.02	848.18	0.16	0.0256
506	fl041209a_21	219482.25	597348.634	871.15	871.12	-0.03	0.0009
508	fl041209a_21	218767.83	597088.673	860.14	860.2	0.06	0.0036
501	fl041209a_15	217285.58	597960.359	860.94	860.95	0.01	1E-04
502	fl041209a_15	217781.56	598278.101	848.02	848.04	0.02	0.0004
503	fl041209a_15	218843.25	598504.333	842.88	842.76	-0.12	0.0144
506	fl041209a_22	219482.25	597348.634	871.15	871.1	-0.05	0.0025
508	fl041209a_22	218767.83	597088.673	860.14	860.06	-0.08	0.0064
503	fl041209a_15	218843.25	598504.333	842.88	843.06	0.18	0.0324
501	fl041209a_13	217285.58	597960.359	860.94	861	0.06	0.0036
502	fl041209a_13	217781.56	598278.101	848.02	848.01	-0.01	1E-04
506	fl041209b_17	219482.25	597348.634	871.15	871.11	-0.04	0.0016
506	fl041209b_21	219482.25	597348.634	871.15	871.13	-0.02	0.0004
508	fl041209b_21	218767.83	597088.673	860.14	859.84	-0.3	0.09
501	fl041209b_14	217285.58	597960.359	860.94	860.89	-0.05	0.0025
502	fl041209b_14	217781.56	598278.101	848.02	848.17	0.15	0.0225
503	fl041209b_14	218843.25	598504.333	842.88	842.9	0.02	0.0004
Total						-0.02	0.0088
Avg. Error						0.00	0.0015
# Points / RMSE						6.00	0.0383

Post_Flood Kwagunt

Control Point Number	Flight line	x	y	Elevation Ft	Lidar Elevation Ft	Difference Ft	Squared
601	fl041204_24	219906.29	585537.903	826.45	826.26	-0.19	0.0361
604	fl041204_24	220538.64	584724.163	832.35	832.41	0.06	0.0036
601	fl041204_25	219906.29	585537.903	826.45	826.5	0.05	0.0025
602	fl041204_25	220517.31	585158.312	851.17	851.17	0	0
603	fl041204_25	220398.68	585057.384	822.45	822.37	-0.08	0.0064
604	fl041204_25	220538.64	584724.163	832.35	832.28	-0.07	0.0049
606	fl041204_26	220844.44	584516.111	830.18	830.26	0.08	0.0064
607	fl041204_26	220897.34	584403.803	828.31	828.3	-0.01	1E-04
608	fl041204_26	220924.74	584376.623	837.47	837.45	-0.02	0.0004
602	fl041204_26_1	220517.31	585158.312	851.17	851.25	0.08	0.0064
603	fl041204_26_1	220398.68	585057.384	822.45	822.45	0	0
606	fl041204_26_1	220844.44	584516.111	830.18	830.17	-0.01	1E-04
607	fl041204_26_1	220897.34	584403.803	828.31	828.33	0.02	0.0004
608	fl041204_26_1	220924.74	584376.623	837.47	837.7	0.23	0.0529
601	fl041204_25	219906.29	585537.903	826.45	826.48	0.03	0.0009
602	fl041204_25	220517.31	585158.312	851.17	851.11	-0.06	0.0036
603	fl041204_25	220398.68	585057.384	822.45	822.81	0.36	0.1296
604	fl041204_25	220538.64	584724.163	832.35	832.35	0	0
606	fl041204_25	220844.44	584516.111	830.18	830.28	0.1	0.01
607	fl041204_25	220897.34	584403.803	828.31	828.37	0.06	0.0036
608	fl041204_25	220924.74	584376.623	837.47	837.59	0.12	0.0144
601	fl041204_24	219906.29	585537.903	826.45	826.39	-0.06	0.0036
603	fl041204_24	220398.68	585057.384	822.45	822.45	0	0
604	fl041204_24	220538.64	584724.163	832.35	832.46	0.11	0.0121
601	fl041209_25	219906.29	585537.903	826.45	826.36	-0.09	0.0081
602	fl041209_25	220517.31	585158.312	851.17	851.21	0.04	0.0016
603	fl041209_25	220398.68	585057.384	822.45	822.77	0.32	0.1024
604	fl041209_25	220538.64	584724.163	832.35	832.43	0.08	0.0064
606	fl041209_25	220844.44	584516.111	830.18	830.12	-0.06	0.0036
607	fl041209_25	220897.34	584403.803	828.31	828.36	0.05	0.0025
608	fl041209_25	220924.74	584376.623	837.47	837.33	-0.14	0.0196
602	fl041209_26	220517.31	585158.312	851.17	851.17	0	0
606	fl041209_26	220844.44	584516.111	830.18	830.14	-0.04	0.0016
601	fl041209_25	219906.29	585537.903	826.45	826.38	-0.07	0.0049
602	fl041209_25	220517.31	585158.312	851.17	851.19	0.02	0.0004

603	fl041209_25	220398.68	585057.384	822.45	822.76	0.31	0.0961
604	fl041209_25	220538.64	584724.163	832.35	832.63	0.28	0.0784
606	fl041209_25	220844.44	584516.111	830.18	830.26	0.08	0.0064
607	fl041209_25	220897.34	584403.803	828.31	828.46	0.15	0.0225
608	fl041209_25	220924.74	584376.623	837.47	837.44	-0.03	0.0009
Total						-0.23	0.0535
Avg. Error						-0.04	0.0089
# Points / RMSE						6.00	0.0944

Post_Flood North Canyon

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
301	fl041204_7	227418.15	622634.188	894.9	894.9	0	0
303	fl041204_7	227413.45	622409.47	891.98	891.98	0	0
306	fl041204_7	226694.7	620926.19	896.29	896.29	0	0
301	fl041204_8	227418.15	622634.188	894.9	895.04	0.14	0.0196
303	fl041204_8	227413.45	622409.47	891.98	891.96	-0.02	0.0004
306	fl041204_8	226694.7	620926.19	896.29	896.32	0.03	0.0009
301	fl041209_7	227418.15	622634.188	894.9	894.89	-0.01	1E-04
303	fl041209_7	227413.45	622409.47	891.98	891.98	0	0
301	fl041209_8	227418.15	622634.188	894.9	895.11	0.21	0.0441
303	fl041209_8	227413.45	622409.47	891.98	891.87	-0.11	0.0121
306	fl041209_8	226694.7	620926.19	896.29	896.43	0.14	0.0196
Total						0.15	0.0209
Avg. Error						0.03	0.0035
# Points / RMSE						6.00	0.0590

Post_Flood Palisades

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
708	fl041204_31	222887	572445.977	805.04	805.11	0.07	0.0049
707	fl041204_30	222736.85	573323.133	807.51	807.6	0.09	0.0081
708	fl041204_30	222887	572445.977	805.04	805.08	0.04	0.0016
710	fl041204_30	222431.22	570862.597	798.82	798.86	0.04	0.0016
711	fl041204_30	222474.86	570248.807	804.94	805.1	0.16	0.0256
707	fl041204_29	222736.85	573323.133	807.51	807.46	-0.05	0.0025
709	fl041204_29	222355.12	571224.111	812.99	812.98	-0.01	1E-04
709	fl041204_28	222355.12	571224.111	812.99	813.03	0.04	0.0016
707	fl041204b_29	222736.85	573323.133	807.51	807.52	0.01	1E-04
709	fl041204b_29	222355.12	571224.111	812.99	813.07	0.08	0.0064
710	fl041204b_29	222431.22	570862.597	798.82	798.99	0.17	0.0289
711	fl041204b_29	222474.86	570248.807	804.94	805.01	0.07	0.0049
708	fl041204b_31	222887	572445.977	805.04	805.05	0.01	1E-04
707	fl041209_28	222736.85	573323.133	807.51	807.52	0.01	1E-04
709	fl041209_28	222355.12	571224.111	812.99	813.18	0.19	0.0361
707	fl041209_29	222736.85	573323.133	807.51	807.52	0.01	1E-04
709	fl041209_29	222355.12	571224.111	812.99	813.08	0.09	0.0081
710	fl041209_29	222431.22	570862.597	798.82	798.95	0.13	0.0169
711	fl041209_29	222474.86	570248.807	804.94	804.94	0	0
707	fl041209b_28	222736.85	573323.133	807.51	807.69	0.18	0.0324
709	fl041209b_28	222355.12	571224.111	812.99	813.28	0.29	0.0841
710	fl041209b_28	222431.22	570862.597	798.82	798.89	0.07	0.0049
707	fl041209b_29	222736.85	573323.133	807.51	807.48	-0.03	0.0009
709	fl041209b_29	222355.12	571224.111	812.99	812.86	-0.13	0.0169
710	fl041209b_29	222431.22	570862.597	798.82	798.94	0.12	0.0144
711	fl041209b_29	222474.86	570248.807	804.94	805.05	0.11	0.0121
708	fl041209b_30	222887	572445.977	805.04	805.15	0.11	0.0121
710	fl041209b_30	222431.22	570862.597	798.82	798.83	0.01	1E-04
711	fl041209b_30	222474.86	570248.807	804.94	804.99	0.05	0.0025
708	fl041209b_31	222887	572445.977	805.04	805.1	0.06	0.0036
707	fl041209_29_1	222736.85	573323.133	807.51	807.38	-0.13	0.0169
708	fl041209_29_1	222887	572445.977	805.04	805.06	0.02	0.0004
709	fl041209_29_1	222355.12	571224.111	812.99	813.06	0.07	0.0049
710	fl041209_29_1	222431.22	570862.597	798.82	798.91	0.09	0.0081



711	fl041209_29_1	222474.86	570248.807	804.94	805.04	0.1	0.01	
						Total	0.35	0.0443
						Avg. Error	0.06	0.0074
						# Points / RMSE	6.00	0.0859

Post_Flood Paria

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared	
203	fl041204_1	240122.41	648730.595	923.38	923.4	0.02	0.0004	
203	fl041204_2	240122.41	648730.595	923.38	923.34	-0.04	0.0016	
201	fl041204_3	241496.16	650118.377	969.02	969.02	0	0	
204	fl041204_3	240138.59	648023.3	934.35	934.41	0.06	0.0036	
205	fl041204_3	239986.46	647866.573	927.01	927.12	0.11	0.0121	
LFRG	fl041204_3	241496.16	650118.386	968.95	968.94	-0.01	1E-04	
201	fl041204_4	241496.16	650118.377	969.02	968.99	-0.03	0.0009	
202	fl041204_4	241029.63	648956.707	926.15	926.24	0.09	0.0081	
204	fl041204_4	240138.59	648023.3	934.35	934.34	-0.01	1E-04	
205	fl041204_4	239986.46	647866.573	927.01	926.94	-0.07	0.0049	
LFRG	fl041204_4	241496.16	650118.386	968.95	968.99	0.04	0.0016	
202	fl041204_5	241029.63	648956.707	926.15	926.19	0.04	0.0016	
202	fl041204b_5	241029.63	648956.707	926.15	926.18	0.03	0.0009	
201	fl041204b_4	241496.16	650118.377	969.02	969.02	0	0	
202	fl041204b_4	241029.63	648956.707	926.15	926.22	0.07	0.0049	
204	fl041204b_4	240138.59	648023.3	934.35	934.35	0	0	
205	fl041204b_4	239986.46	647866.573	927.01	927.02	0.01	1E-04	
LFRG	fl041204b_4	241496.16	650118.386	968.95	968.97	0.02	0.0004	
201	fl041205_3	241496.16	650118.377	969.02	969.01	-0.01	1E-04	
204	fl041205_3	240138.59	648023.3	934.35	934.23	-0.12	0.0144	
205	fl041205_3	239986.46	647866.573	927.01	926.87	-0.14	0.0196	
LFRG	fl041205_3	241496.16	650118.386	968.95	969.01	0.06	0.0036	
203	fl041209_2	240122.41	648730.595	923.38	923.38	0	0	
203	fl041209_1	240122.41	648730.595	923.38	923.36	-0.02	0.0004	
201	fl041209b_1	241496.16	650118.377	969.02	968.89	-0.13	0.0169	
204	fl041209b_1	240138.59	648023.3	934.35	934.37	0.02	0.0004	
205	fl041209b_1	239986.46	647866.573	927.01	926.89	-0.12	0.0144	
LFRG	fl041209b_1	241496.16	650118.386	968.95	968.89	-0.06	0.0036	
						Total	0.10	0.0794
						Avg. Error	0.00	0.0033
						# Points / RMSE	24.00	0.0575

South Canyon Post Flood RMSE

Control Point Number	Flight line	x	y	Elevation m	Lidar Elevation m	Difference m	Squared
402	fl041204_10	220210.67	612992.094	864.44	864.29	-0.15	0.0225
404	fl041204_10	219729.55	612327.426	859.2	859.21	0.01	1E-04
408	fl041204_10	218920.93	610758.256	858.22	858.22	0	0
409	fl041204_10	218637.67	610295.851	866.65	866.64	-0.01	1E-04
401	fl041204_12	220750.04	613409.538	863	863.02	0.02	0.0004
406	fl041204_12	219668.6	611819.049	860.57	860.56	-0.01	0.0001
406	fl041204b_12	219668.6	611819.049	860.57	860.6	0.03	0.0009
408	fl041204b_12	218920.93	610758.256	858.22	858.22	0	0
409	fl041204b_12	218637.67	610295.851	866.65	866.65	0	0
401	fl041204b_11	220750.04	613409.538	863	862.93	-0.07	0.0049
402	fl041204b_11	220210.67	612992.094	864.44	864.4	-0.04	0.0016
404	fl041204b_11	219729.55	612327.426	859.2	859.2	0	0
406	fl041204b_11	219668.6	611819.049	860.57	860.61	0.04	0.0016
408	fl041204b_11	218920.93	610758.256	858.22	858.16	-0.06	0.0036
409	fl041204b_11	218637.67	610295.851	866.65	866.66	0.01	1E-04
402	fl041209_10	220210.67	612992.094	864.44	864.43	-0.01	0.0001
404	fl041209_10	219729.55	612327.426	859.2	859.15	-0.05	0.0025
408	fl041209_10	218920.93	610758.256	858.22	858.36	0.14	0.0196
409	fl041209_10	218637.67	610295.851	866.65	866.67	0.02	0.0004
401	fl041209_11	220750.04	613409.538	863	862.99	-0.01	1E-04
402	fl041209_11	220210.67	612992.094	864.44	864.33	-0.11	0.0121
404	fl041209_11	219729.55	612327.426	859.2	859.24	0.04	0.0016
406	fl041209_11	219668.6	611819.049	860.57	860.57	0	0
408	fl041209_11	218920.93	610758.256	858.22	858.16	-0.06	0.0036
409	fl041209_11	218637.67	610295.851	866.65	866.6	-0.05	0.0025
401	fl041209_12	220750.04	613409.538	863	862.96	-0.04	0.0016
406	fl041209_12	219668.6	611819.049	860.57	860.5	-0.07	0.0049
408	fl041209_12	218920.93	610758.256	858.22	858.27	0.05	0.0025
409	fl041209_12	218637.67	610295.851	866.65	866.68	0.03	0.0009
401	fl041209b_11	220750.04	613409.538	863	863.08	0.08	0.0064
402	fl041209b_11	220210.67	612992.094	864.44	864.28	-0.16	0.0256
404	fl041209b_11	219729.55	612327.426	859.2	859.08	-0.12	0.0144
406	fl041209b_11	219668.6	611819.049	860.57	860.48	-0.09	0.0081

4/25/2005



408	f1041209b_11	218920.93	610758.256	858.22	857.91	-0.31	0.0961	
409	f1041209b_11	218637.67	610295.851	866.65	866.61	-0.04	0.0016	
						Total	-0.27	0.0759
						Avg. Error	-0.01	0.0032
						# Points / RMSE	24.00	0.0562

APPENDIX B – PREVIOUS PROJECT REPORTS

Previous Project Reports

Airborne LiDAR Data Acquisition – Grand Canyon, Arizona

Contract number: DACW43-03-D-0509

Task Order Number: 0005

Report #1: November 2004 – January 2005

Submitted to:

Mr. Kurt Allen

PhotoScience

9001 Edmonston road, Suite G100

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Project tasks completed in November 2004

Grand Canyon Data Acquisition – Pre Flood

- Pre flood acquisition of all 6 LTMS. Data was collected to have 4x point density.
- Flights occurred on November 19th and 20th with the DATIS III sensor.
- Data has gone through initial GPS/IMU post processing to ensure coverage.
- Currently confirming data collect with project control.

Project tasks completed in December 2004

Grand Canyon Data Acquisition - Post Flood

- Post flood acquisition of all 6 LTMS. Data was collected to have 4x the point density.
- Full coverage for all sites with ALS40 (RAMS) sensor.
- Data collected on December 4th and 9th.
- Data has gone through initial GPS/IMU post processing to ensure coverage

Project tasks completed in January 2005

Grand Canyon Data Processing

- Post flood acquisition has been processed with all base station data, QC'd, and calibrated.
- Post flood data has been processed to remove anomalies.
- Pre flood acquisition has been processed with all base station data, QC'd and calibrated.

Problems encountered to date

Acquisition

- The project had a very tight collection window. Pre flood data needed to be collected November 17th through the 20th and post flood collections were to take place November 27th through the 30th.
- Pre flood data was acquired using the DATIS III sensor.
- Spectrum was onsite with the DATIS III sensor for post collect when there was a problem with the DATIS III sensor. Spectrum proposed to collect the project areas using the ALS40 sensor (RAMS). This was approved and system was mobilized to finish collection.
- Spectrum finished collection of the 7 reaches on December 4th.
- Spectrum had a hard drive issue when pulling data off of hard drive that was stored in aircraft. We had to recollect small areas where data was deleted from the hard drive.
- Data was recollected on December 9th. Sites 2, 5 and 7 were collected to coincide with the low flow (8,000 cfs) previously collected over Dec 4-5.

Project tasks remaining

- Confirmation of Pre-flood acquisition data. Currently validating with control.
- Processing of Pre-flood data.
- Metadata and report compilation.
- Tiling and naming of data.

Schedule

- Delivery of first and last return LIDAR data is anticipated to be complete by February 21, 2005
- Delivery of metadata and flight index maps is anticipated to be complete by February 28, 2005

Data to be delivered in Arizona State Plane, zone 202, NAD83, meters (ellipsoid and orthometric heights), Geoid03