PROJECT REPORT

Terrapoint #: 2010-105-U
Task Order #001 – Channel Islands ARRA LiDAR
Originally submitted: Monday, January 31, 2011

Presented to:

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Tampa Bay, Florida

Submitted by:

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EXECUTIVE SUMMARY

This LiDAR project is to provide high accuracy calibrated multiple returns LiDAR for 197 square miles (510 square kilometers) representing Dewberry's Channel Islands ARRA LiDAR Task Order, off the shore of Santa Barbara, California.

The LiDAR data was acquired and processed by Terrapoint USA. The deliverable products were calibrated raw LiDAR points and associated reports. All elevation products were acquired and processed to meet: ***"U.S. Geological Survey National Geospatial Program Base LiDAR Specifications, Version 12".***

All data delivered will meet and exceed Terrapoint's deliverable product requirements as set out by Terrapoint's I-PROVE program.

The elevation data was verified internally, prior to delivery, to ensure it met fundamental accuracy requirements when compared to McGee Static GPS checkpoints. Below is the summary of the test for all islands:

- The LiDAR dataset was tested to 0.067m vertical accuracy at 95 percent confidence level, based on consolidated $RMSE_z$ (0.034m x 1.960) when compared to 25 GPS static check points.

Please note that this report focuses solely on the Terrapoint activities pertaining to the LiDAR component of this project.

All data delivered meets or exceeds Terrapoint's deliverable product requirements as set out by Terrapoint's I-PROVE program.

CHANNEL ISLANDS ARRA LIDAR PROJECT REPORT

1. Introduction

LiDAR data is remotely sensed high-resolution elevation data collected by an airborne collection platform. By positioning laser range finding with the use of 1 second GPS with 100 Hz inertial measurement unit corrections; Terrapoint's LiDAR instruments are able to make highly detailed geospatial elevation products of the ground, man-made structures and vegetation.

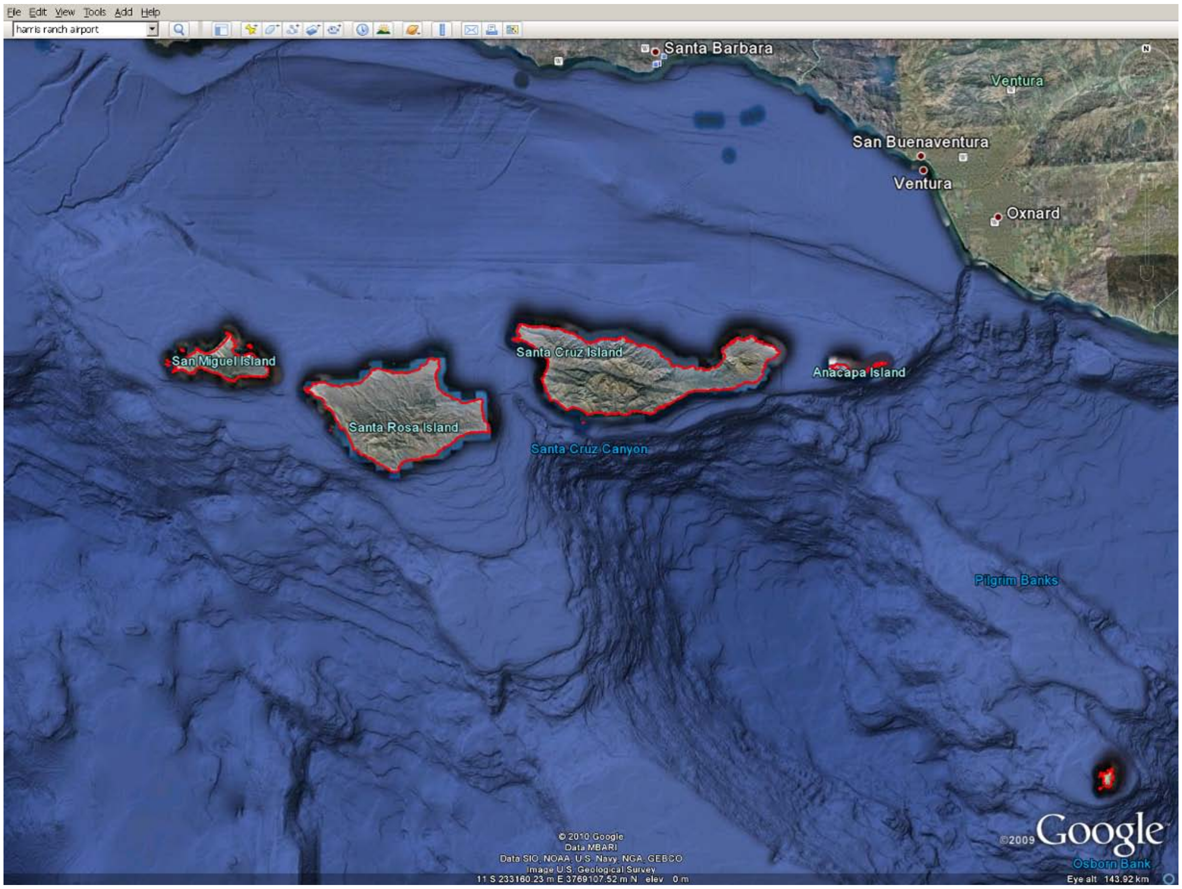
The LiDAR ground extraction process takes place by building an iterative surface model. This surface model is generated using three main parameters: building size, iteration angle and iteration distance.

The purpose of this LiDAR data was to produce high accuracy 3D terrain geospatial products for flood mapping.

This report covers the mission parameters and details, processing step outlines and deliverables.

Please note that this report focuses solely on the Terrapoint activities pertaining to the LiDAR component of this project.

2. Project Boundary



3. LiDAR Acquisition

3.1. Riegl LMS-Q560 Helicopter LiDAR System

Terrapoint used our latest helicopter-based LiDAR sensor. The Riegl LMS-Q560 helicopter-mounted system is designed specifically for small block sites and corridor applications and integrated with the most advanced remote sensing technologies available.

3.1.1. System Details

- Riegl LMS-Q560 Laser Scanner
  - Measurement rate up to 133kHz
  - Full Waveform Recorded for Each Pulse
  - 0.5 mRad Beam Divergence
  - Class 1 eye safe laser
  - 2 to 1000 metres AGL operation
- NovaTel DL-4 L1/L2 GPS Receiver
- IMAR IMU for Precise Georeferencing

3.1.2. The Laser Scanner

The full-waveform Riegl LMS-Q560 is a high-performance eye-safe 2D laser scanner yielding superior density and evenly-distributed ground coverage. Unlike discrete laser sensors, full-waveform analysis gives access to an almost unlimited number of returns per shot and high multiple-target resolution. In other words, features typically not detected by traditional laser scanners are more likely to be detected using the full-waveform as the entirety of each pulse return is recorded to a data recorder. Full waveform LiDAR is also excellent for characterizing vegetation.

Technical Data of *RIEGL* LMS-Q560

Range Measurement Performance

Maximum Measurement Range[1]	*@ Laser PRR*	*50 kHz*	*100 kHz*	*200 kHz*
natural target $\rho \geq$ *20 %*		1200 m	1000 m	700 m
natural target $\rho \geq$ *60 %*		1800 m	1200 m	700 m

Minimum Range	30 m
Accuracy[2]	20 mm
Precision[2]	10 mm
Laser Pulse Repetition Rate[3]	up to 200 000 Hz
Effective Measurement Rate	up to 100 kHz @ 45 deg scan angle up to 133 kHz @ 60 deg scan angle
Laser Wavelength	near infrared
Laser Beam Divergence[4]	$\leq$ 0.5 mrad
Number of targets per pulse	unlimited for digitized waveform[5], first pulse or last pulse in online monitoring data
Eye Safety Class	CLASS 1 LASER PRODUCT according to IEC60825-1:1993+A1:1997+A2:2001 The following clause applies for instruments delivered into the United States: Complies with 21 CFR 1040.10 and 1040.11 except for deviations pursuant to Laser Notice No. 50, dated July 26, 2001.

Scanner Performance

Scanning Mechanism	rotating polygon mirror
Scan Pattern	parallel scanning lines
Scan Angle Range[6]	± 22.5 deg = 45 deg total
Scan Speed	10 - 160 scans/sec
Angle Step Width $\Delta \vartheta$[3] between consecutive laser shots	$\Delta \vartheta \geq$ 0.004 deg (@ PRR 100 000 Hz[7])
Angle Readout Resolution	0.001 deg

Intensity Measurement

For each echo signal, high-resolution 16-bit intensity information is provided which can be used for target discrimination and/or identification/classification.

3.1.3. Positioning and Attitude Systems

The Novatel DL-4 is a high performance, high accuracy, GPS receiver with fast data update rates and integrated memory for data logging. The DL-4 is capable of receiving and tracking the L1 C/A code, L1 and L2 carrier phase and L2 P-Code (or encrypted Y-Code) of up to 12 satellites. Patented Pulsed Aperture Correlator (PAC) technology combined with a powerful microprocessor make possible multipath-resistant processing and excellent acquisition and re-acquisition times.

Unlike other positioning and attitude sensors, the iMAR IMU allows our engineers and scientists access to raw inertial data. Commercially available positioning and attitude systems are designed as a "black box" solutions, and the accuracy and quality of the solution is left to the mercy of the "black box" post-processing software. In combination with the iMAR IMU data and our proprietary GPS-INS post processing software, aircraft trajectories can be generated using a combination of approaches, weighting GPS and INS measurements according to their quality in tightly-coupled or loosely-coupled Kalman filters.

3.1.4. LiDAR System Parameter Overview

Scan Settings Point Spacing	PRF (kHz)	(kHz)	100
	Effective	(kHz)	67
	Optimal Height AGL	(m)	600
	Aircraft Speed	(kts)	50
	Scan Angle	(Degrees)	60
	Scan Rate	(Scans/Sec)	50
	Swath Width	(m)	692
	Flight Line Spacing	(m)	343
	Laser Spot Diameter	(m)	0.3
Scan Settings	Along Track	(m)	0.51
	Across Track	(m)	0.52
	PRF (kHz)	(kHz)	100
Point Density	Nominal Single Swath	(Pts/m2)	3
	With 50% overlap	(Pts/m2)	7

3.2. Aircraft

The aircraft used for the survey was a Bell 206 Jet Ranger, registration N49643 with an endurance of approximately 3 hours.

3.3. Base Station and Control GPS Receivers

California Continuously Operating Reference Stations (CGPS) stations were used exclusively to support the airborne operations of this survey and to establish the GPS control network.

3.4. Missions Statistics

Block	Origin	Mission Name	Calendar Date	Number of LiDAR Production Lines
Santa Barbara/Anacapa	**BAR1/ANA1**	M110070A	11-Mar	11
Anacapa	**ANA1**	M110071A	12-Mar	6
Santa Cruz	**CRU1**	M110071B	12-Mar	10
San Miguel	**MIG1**	M110073A	14-Mar	20
San Miguel	**MIG1**	M110074A	15-Mar	8
Santa Rosa	**SRS1**	M110074B	15-Mar	12
Santa Rosa	**SRS1**	M110075A	16-Mar	5
Santa Rosa	**SRS1**	M110075B	16-Mar	8
Santa Rosa	**SRS1**	M110076A	17-Mar	9
Santa Rosa	**SRS1**	M110077A	18-Mar	4
Santa Rosa	**SRS1**	M110079A	20-Mar	5
Santa Rosa	**SRS1**	M110080A	21-Mar	10
Santa Cruz	**CRU1**	M110081A	22-Mar	3
Santa Cruz	**CRU1**	M110081B	22-Mar	11
Santa Cruz	**CRU1**	M110082A	23-Mar	9
Santa Cruz	**CRU1**	M110085A	26-Mar	4
Santa Cruz	**CRU1**	M110085B	26-Mar	6
Santa Rosa	**SRS1**	M110086A	27-Mar	9
Santa Cruz	**CRU1**	M110087A	28-Mar	9
Santa Cruz	**CRU1**	M110092A	02-Apr	4
Santa Cruz	**CRU1**	M110096A	06-Apr	6
Santa Rosa	**SRS1**	M110097A	07-Apr	1
San Miguel	**MIG1**	M110097B	07-Apr	4
Santa Cruz	**CRU1**	M110098A	08-Apr	23
			LiDAR missions	197
Totals			**LiDAR Production Lines**	24

LiDAR flightlines were flown in a multiple orientation block designed to best optimize flying time considering the layout for the islands. A graphical representation of the planned flightlines and trajectories are located in Appendix A. A copy of the mission logs can be found in Appendix C

3.5. Horizontal and Vertical Reference Coordinate System Used

Five CGPS were observed in a GPS control network by McGee Surveying and used to control all flight missions and McGee Surveying static ground surveys. The published horizontal datum of the stations is

NAD83 (2007 Epoch) and the vertical datum is NAVD88. The following are the final coordinates of the control points used in this project:

Block	Station	Latitude (D M S Hem)	Longitude (D M S Hem)	H-Ell (m)
Santa Barbara	**BAR1**	33.480451	-119.029735	14.8146
Anacapa	**ANA1**	34.015005	-119.363468	22.4411
Santa Cruz	**CRU1**	34.029259	-119.78481	702.1957
Santa Rosa	**SRS1**	34.004335	-120.065219	68.2316
San Miguel	**MIG1**	34.038258	-120.35139	130.9455

The projection used for all deliverables was UTM 10 and 11 (Natural Zone) and units are meters. The breakdown of zones per island is as follows:

Block	UTM Zone
Santa Barbara	11
Anacapa	11
Santa Cruz	11
Santa Rosa	10 + 11 (two complete deliverable sets)
San Miguel	10

3.6. Geoid Model Used

All elevations were referenced to the GEOID09 model, published by the National Geodetic Survey (NGS), was used to reduce all ellipsoidal heights to orthometric.

3.7. Data Coverage

On a mission and project level, a daily coverage check is performed in the field as per Terrapoint I-Prove requirements.

4. LiDAR Processing

4.1. Airborne GPS Kinematic

Airborne GPS kinematic data was processed on-site using GrafNav kinematic On-The-Fly (OTF) software. Flights were flown with a minimum of 6 satellites in view (13° above the horizon) and with a

PDOP of better than 4. Distances from base station to aircraft were kept to a maximum of 20km.

For all flights, the GPS data can be classified as excellent, with GPS residuals of 3cm average or better but no larger than 10cm being recorded.

4.2. Generation and Calibration of Laser Points (raw data)

The initial step of calibration is to verify availability and status of all needed GPS and Laser data against field notes and compile any data if not complete.

Laser data points are generated using Terrapoint's proprietary laser post-processing software. This software combines the raw laser range and angle data file with the finalized GPS/IMU information. The resulting point cloud has been projected into the desired coordinate system in LAS binary format. All missions are validated against the adjoining missions for relative vertical biases and collected GPS kinematic and static ground truthing points for absolute vertical accuracy purposes.

On a project level, a supplementary coverage check is carried out, to ensure no slivers not found or reported by Field Operation are present.

4.3. Vertical Bias Resolution

The following vertical biases were detected in LiDAR data when compared to the GPS kinematic and static points.

Mission	Lines	Vertical Adjustment
m110073a	All lines	+0.07m
m110074a	All lines	+0.05m
m110075a	line 7404	+0.05m
m110077a	All lines	+0.05m

4.4. Data Classification and Editing

The data was processed using the software TerraScan, and following the methodology described herein. The initial step is the setup of the TerraScan project, which is done by importing project defined tile boundary index encompassing the entire project areas. The acquired 3D laser point clouds, in LAS binary format, were imported into the TerraScan project and divided into file size optimized tiles. Once tiled, the laser points were classified using a proprietary routine in TerraScan. This routine removes any obvious outliers from the dataset following which the ground layer is extracted from the point cloud. The ground extraction process encompassed in this routine takes place by building an iterative surface model.

This surface model is generated using three main parameters: building size, iteration angle and iteration distance. The initial model is based on low points being selected by a "roaming window" with the assumption is that these are the ground points. The size of this roaming window is determined by the building size parameter. The low points are triangulated and the remaining points are evaluated and subsequently added to the model if they meet the iteration angle and distance constraints. This process is repeated until no additional points are added within iteration.

A second critical parameter is the maximum terrain angle constraint, which determines the maximum terrain angle allowed within the classification model.

4.5. Deliverable Product Generation

4.5.1. Deliverable Tiling Scheme

LiDAR deliverables were provided in a 2000mX2000m tiling scheme with a total of 280 tiles (75 duplicates due to Santa Rosa being delivered in both UTm10 and 11).

4.5.2. LAS files

Once the data has been quality controlled and considered complete, the LAS format 1.0 format points are converted to LAS 1.2 Point Data Record Format 1 and the classification scheme, retiled from the USGS Quarter Quad subdivided tiles to the client 2000m x 2000m tiles and converted to the required ASPRS classification scheme (1=Unclassified) from Terrapoint Proprietary classification scheme.

- The following fields within the LAS files are populated to the following precision: Adjusted GPS Time as defined as standard GPS time minus $1*10^9$ (0.000001 second precision), Easting (0.01 foot precision), Northing (0.01 foot precision), Elevation (0.01 foot precision), Intensity (integer value - 12 bit dynamic range), Number of Returns (integer - range of 1-4), Return number (integer range of 1-4), Scan Direction Flag (integer - range 0-1), Classification (integer), Scan Angle Rank (integer), Edge of flight line (integer, range 0-1), User bit field (integer - flight line information encoded).

The LAS file also contains a Variable length record in the file header.

Please note that no automated and manual classification was performed on these LAS files from Terrapoint.

The LAS data tiles were also delivered in strips.

4.5.3. Waveform files

The waveform files were provided in Terrapoint's proprietary format TWF for all missions. A copy of the waveform file structure can be found in Appendix D.

5. Quality Control

5.1. Quality Control for Data Acquisition

The acquisition of overlapping calibration lines for every mission is key to the QC process since it helps identify any systematic issues in data acquisition or failures on the part of the GPS, IMU or other equipment that may not have been evident to the LiDAR operator during the mission.

Ground truth validation is used to assess the data quality and consistency over sample areas of the project. To facilitate a confident evaluation, existing survey control is used to validate the LiDAR data. Published survey control, where the orthometric height (elevation) has been determined by precise differential levelling or GPS observation, is deemed to be suitable.

Ground truth validation points may be collected for each of the terrain categories to establish RMSE accuracies for the LiDAR project. These points must be gathered in flat or uniformly sloped terrain (<20% slope) away from surface features such as stream banks, bridges or embankments. If collected, these points will be used during data processing to test the $RMSE_z$ accuracy of the final LiDAR data products.

The Field Project Manager performs kinematic post-processing of the aircraft GPS data in conjunction with the data collected at the Reference Station. Double difference phase processing of the GPS data is used to achieve the greatest accuracy. The GPS position accuracy is assessed by comparison of forward and reverse processing solutions and a review of the computational statistics. Any data anomalies are identified and the necessary corrective actions are implemented prior to the next mission.

The quality control of LiDAR data and data products has proven to be a key concern by Terrapoint's clients. Many specifications detail how to measure the quality of LiDAR data given RMSE statistical methods to a 95% confidence level. In order to assure meeting all levels of QC concerns, Terrapoint has quality control and assurance steps in both the data acquisition phase and the data processing phase. Any acquired data sets that fail these checks are flagged for re-acquisition.

5.1.1. System Logger – Power Up Health Checks

The system logging software performs automatic system and subsystem tests on power-up to verify proper functionality of the entire data acquisition system. Any anomalies are immediately investigated and corrected by the LiDAR operator if possible. Any persistent problems are referred to the engineering staff, which can usually resolve the issue by telephone and/or email. In the unlikely event that these steps do not resolve the problem, a trained engineer is immediately dispatched to the project site with the appropriate test equipment and spare parts needed to repair the system.

5.1.2. System Logger – Real Time Acquisition Checks

The system logging software continuously monitors the health and performance of all subsystems. Any anomalies are recorded in the System Log and reported to the LiDAR operator for resolution. If the operator is unable to correct the problem, the engineering staffs are immediately notified. They provide the operator with instructions or on-site assistance as needed to resolve the problem.

If any aspect of the data does not appear to be acceptable, the operator will review system settings to determine if an adjustment could improve the data quality. Navigation aids are provided to alert both the pilot and operator to any line following errors that could potentially compromise the data integrity. The pilot and operator review the data and determine whether an immediate re-flight of the line is required.

5.1.3. Post Acquisition Data Check

After the mission is completed, raw LiDAR and imagery data on the removable disk drive is transferred to the Field PC at the field operations staging area. An automated QA/QC program scans the System Log as well as the raw data files to detect potential errors. Any problems identified are reported to the operator for further analysis. Data is also retrieved from all GPS Reference Stations, which were active during the mission and transferred to the Field PC. The GPS data is processed and tested for internal consistency and overall quality. Any errors or limit violations are reported to the operator for more detailed evaluation.

5.1.4. Data Viewer Analysis

The Field Project Manager utilizes a data viewer installed on the Field PC to review selected portions of the acquired LiDAR and imagery data, this permits a more thorough and detailed analysis of the data corrupted files or problems in the data itself are noted. If the data indicates improper settings or operation of the LiDAR sensor and camera, the Field Project Manager determines the appropriate corrective actions needed prior to the next mission.

5.1.5. Data Backup with Redundancy

All LiDAR, imagery and GPS data is copied from the Field PC onto two separate removable hard drives: one for transfer to Calibration, and one for local backup. Each hard drive is reviewed to ensure data completeness and readability.

5.2. Quality Control for Data Processing

Quality assurance and quality control procedures for the raw LiDAR data and processed deliverables for the DEM and derivative products are performed in an iterative fashion through the entire data processing cycle. All final products pass through a six-step QC control check to verify that the data meets the criteria specified by Terrapoint.

The following list provides a step-by-step explanation of the process used by Terrapoint to review the data prior to customer delivery.

5.2.1. LiDAR Calibration

5.2.1.1. Calibration Setup and Data Inventory

Data collected by the LiDAR unit is reviewed for completeness and to make sure all data is captured without errors or corrupted values. In addition, all GPS, aircraft trajectory, mission information, and ground control files are reviewed and logged into a database.

5.2.1.2. Boresight

The LiDAR data is post processed and calibrated as a preliminary step for product delivery initially with default values from the LiDAR system manufacturer or the last mission calibrated for the system. The initial point generation for each mission calibration is inspected for flight line errors, flight line overlap, slivers or gaps in the data, point data minimums, or issues with the LiDAR unit or GPS. If a calibration error greater than the project specification is observed within the mission, the roll, pitch and scanner scale corrections that need to be applied are calculated. The missions with the new calibration values are regenerated and validated internally once again to ensure quality. Flight line swath overlap is confirmed to the adjacent flight lines at the tolerance specified by the client for overlap throughout the project area thus enabling an evaluation of data reproducibility throughout the areas.

5.2.2. Calibrated Ground Truth Validation

A preliminary $RMSE_z$ error check is performed at this stage of the project life cycle in the raw LiDAR dataset against GPS static and kinematic data and compared to $RMSE_z$ project specifications. The LiDAR data is examined in open, flat areas away from breaks and under specified vegetation categories. This step is repeated in production against the final bare earth LiDAR model.

5.3. LiDAR Production

5.3.1. Production Setup Quality Control

Once the data enters the bare earth extraction stage, a checklist verifying all the components of the project have been received in good order.

5.3.2. Automated Bare Earth Ground Truth Validation

RMSEz is inspected in the automated bare earth model and compared to project specifications. RMSEz is examined in open, flat areas away from breaks and under specified vegetation categories. All accuracy results are reported to the 95% confidence interval for the different categories as available and required. A point comparison of a recently acquired or existing high confidence ground survey point to a TIN generated from the bare earth LiDAR surface. The tolerance for comparisons of control data to the LiDAR TIN elevation is that all sides of the TIN triangle must not be longer than 4.5m to ensure an accurate comparison of surface to the discrete points.

6. Positional Accuracy

6.1. Vertical Positional Accuracy

Prior to delivery the elevation data was verified internally to ensure it met fundamental accuracy requirements when compared to McGee static GPS checkpoints.

- The LiDAR dataset was tested to 0.067m vertical accuracy at 95 percent confidence level, based on consolidated $RMSE_z$ (0.034m x 1.960) when compared to 25 GPS static check points.

6.2. Horizontal Positional Accuracy

Compiled to meet 3.5 foot horizontal accuracy at the 95% confidence level (2 sigma = RMSE * 1.96) in all but extremely hilly terrain.

7. Issues and Resolutions

7.1. Acquisition

7.1.2. Sensor Malfunction

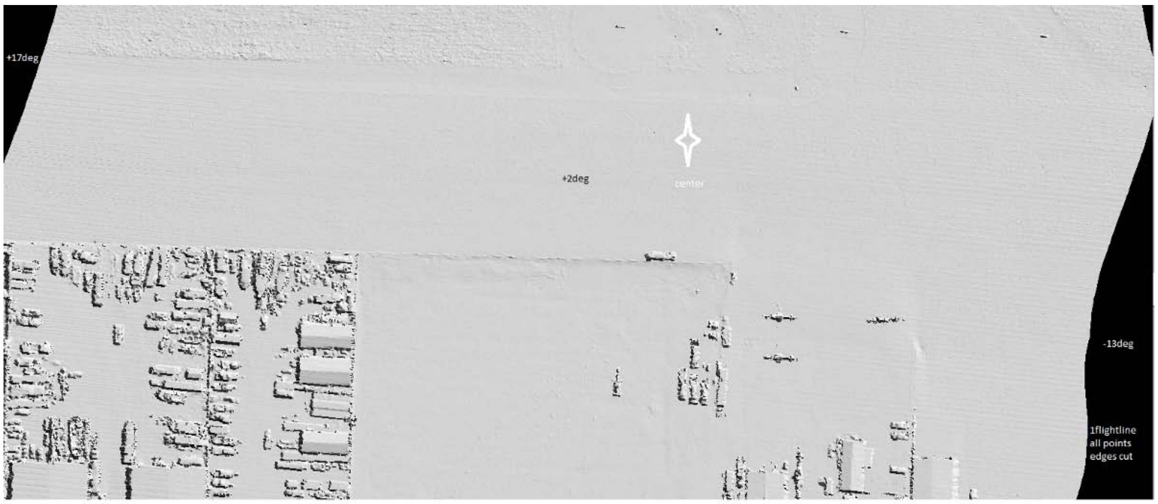
Terrapoint began observing some slight inconsistencies in the mid-range sensor data from Channel Islands, which we believe may be due to a minute change in the characteristics of the laser scanner. Terrapoint has since been monitoring the data quality very closely to ensure it meets the project accuracy requirements. As such, we believe the situation has not degraded since it was discovered, and that the data is meeting the required project specifications.

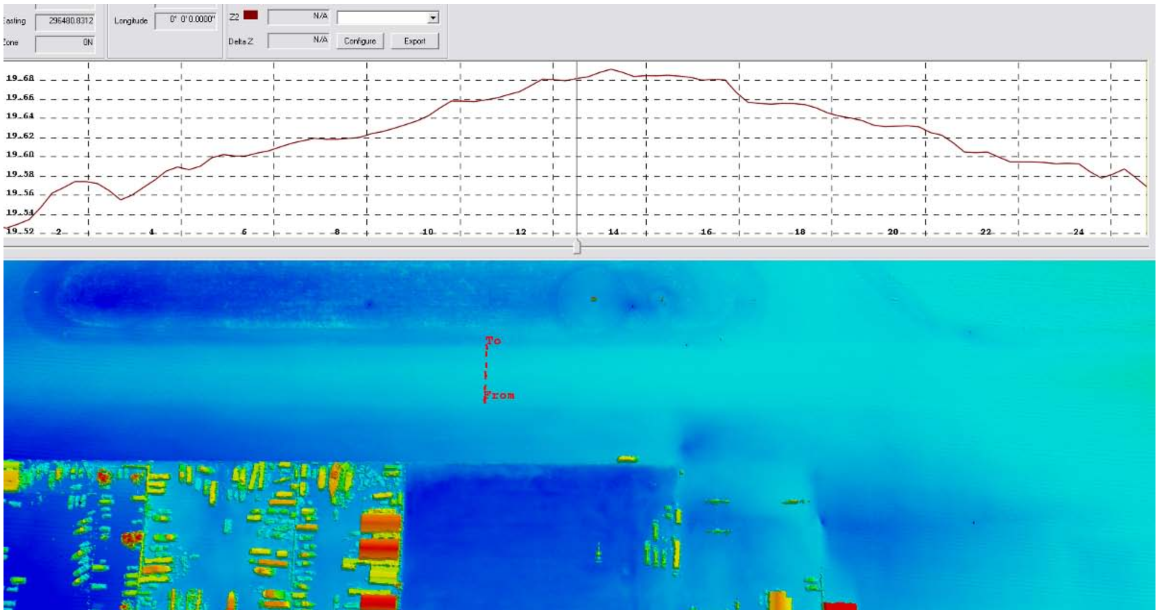
In summary, Terrapoint has observed instances of "cornrows" in the Channel Island data with the following characteristics:

- The cornrow amplitude is within the 7cm RMSEz specification
- No cornrows greater than 10cm observed
- Observed on all sites throughout the project, however it is only visible on 75% of the terrain
- The cornrows are less visible in Santa Barbara and Anacapa due to steep relief
- More obvious on flat terrain (such as the calibration site at the airport and flat areas of the islands)

Otherwise the data meets the other accuracy requirements of the project:

- Flightline to flightline relative accuracy is better than the required 7cm RMSEz specification requirement
- Absolute accuracy tested at 3cm RMSEz
    - Intensity looks good

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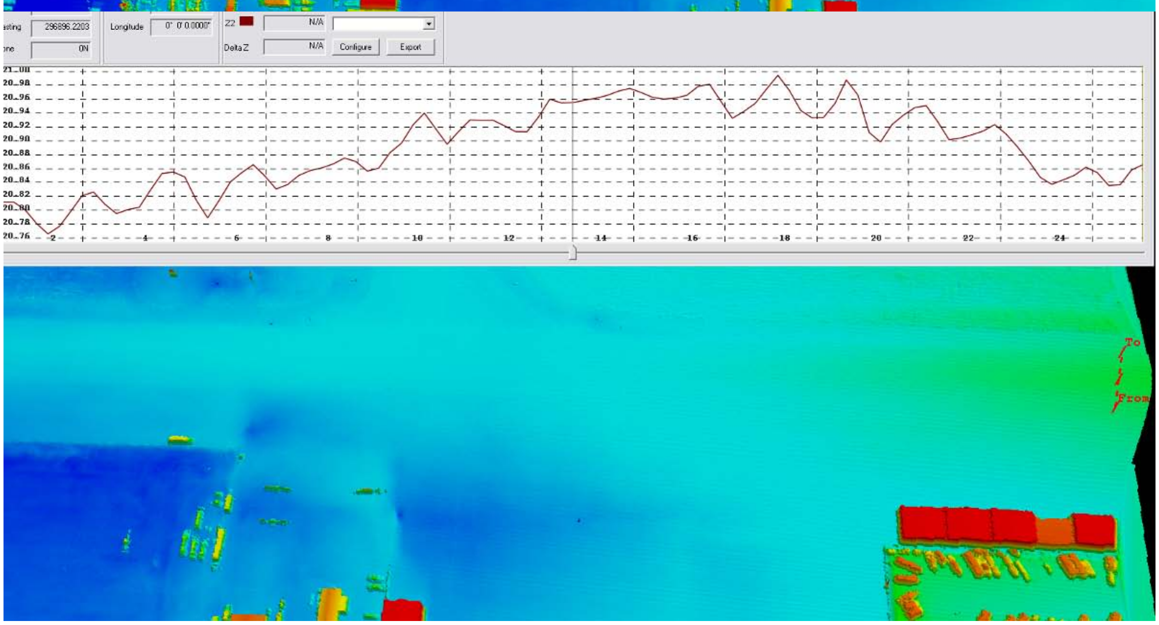
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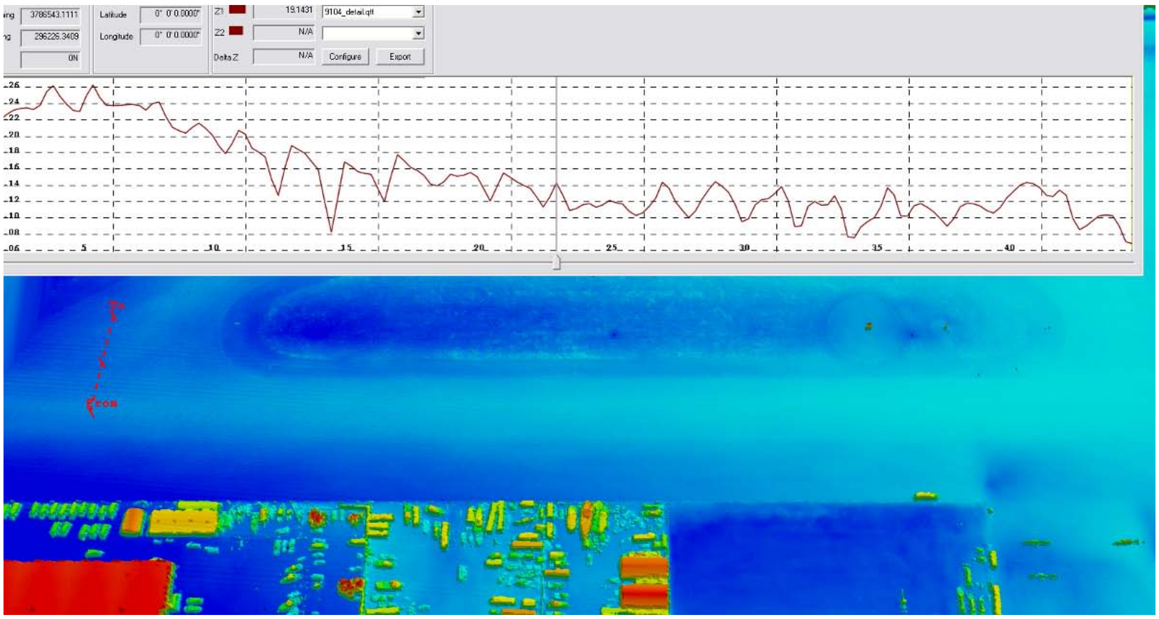


The system has since been serviced by Riegl and found The laser polygonal mirror coefficients were off hence the laser required a new internal calibration. It doesn't appear that the laser beam itself degraded. At the time of report submission, Terrapoint has received the repaired system and we are presently in the process of testing the system to ensure no cornrows are being observed.

7.1.3. Project Timeline

The project acquisition stage was longer due to circumstances outside of Terrapoint's control, hence cost overruns were encountered to complete this project; in summary:

At the onset of the project

- this project was priced using our Optech sensor and we changed to the mid-range sensor during the planning phase; this would increase our costs (post contract signing with no opportunity to renegotiate)
- this project was planned without tide restrictions, as discussed during the discovery and proposal/pricing stage of the project (that is, only San Francisco had the tide restrictions)

During the Acquisition Stage of the project

- the tide restrictions precluded long missions, and resulted in more missions to calibrate and process
- the terrain played a factor in acquisition efficiency

- the winds and general weather conditions often precluded flights and/or caused shortened or aborted missions
- extended ferry times increased helicopter costs (no fuel stores on the islands)
- due to the bird migrations etc, we could not land or refuel on the islands, nor fly as low as we would have liked

7.2. Calibration

7.2.2. Project Timeline

Due to the circumstances outlined above in the problems with project acquisition stage; the calibration timelines were also longer due to circumstances mainly outside of Terrapoint's control, hence cost overruns were encountered to complete this project; in summary:

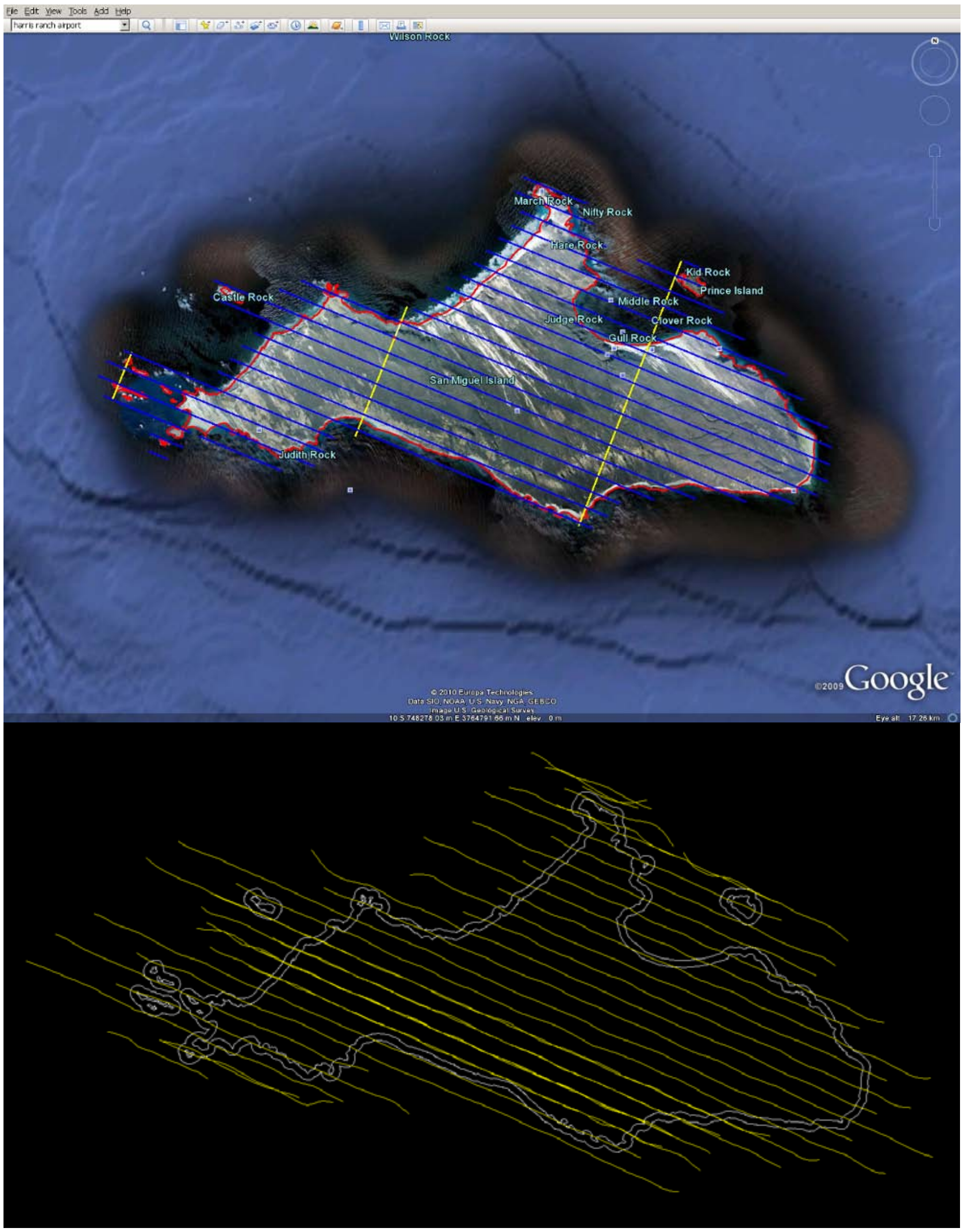
- there were a lot more missions than anticipated due to flight restrictions/shortened missions (see above)
- again, terrain
- calibration hours quadrupled looking into the data issues we found

8. Conclusion

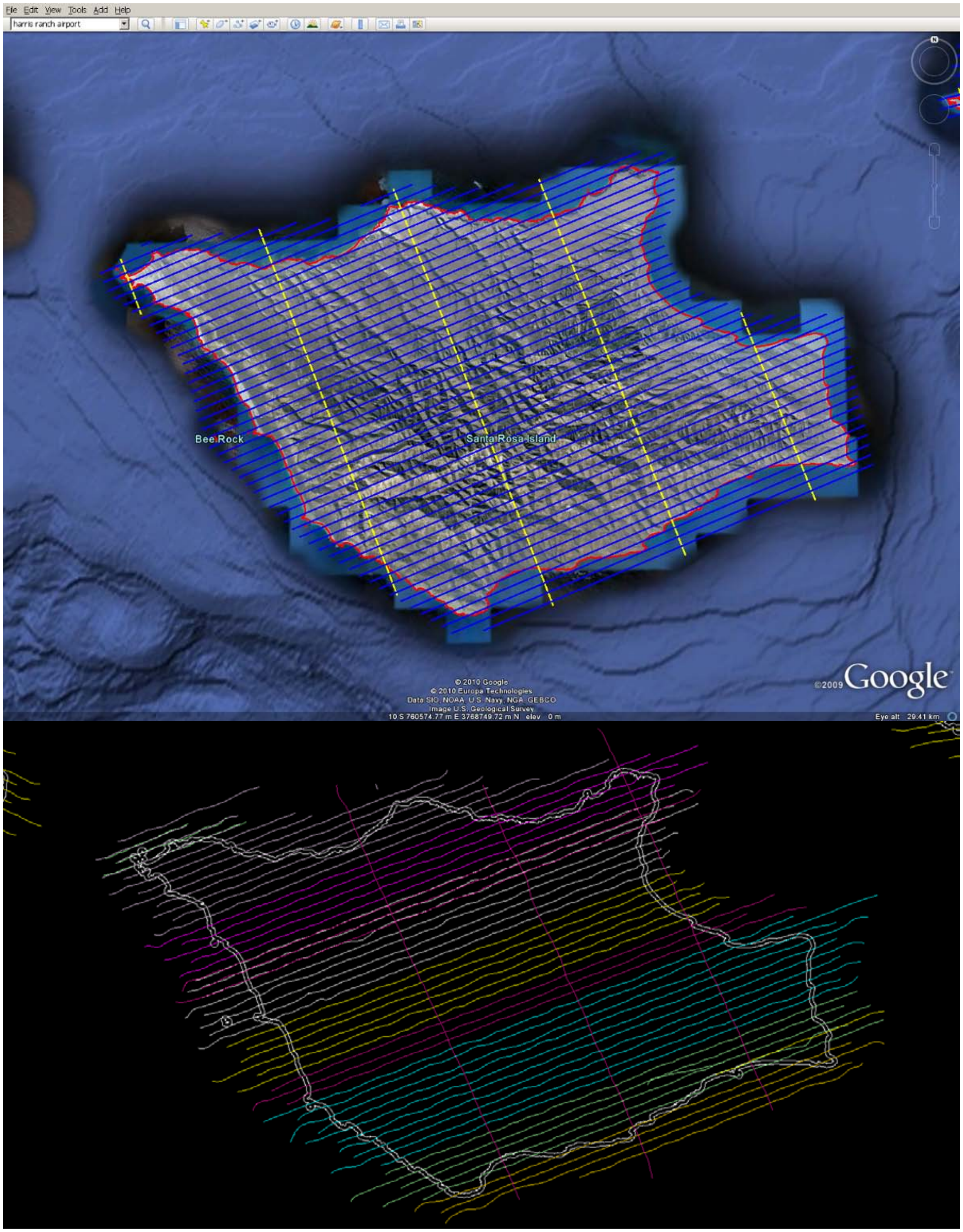
Overall, the LiDAR data products submitted to Dewberry meet or exceed both the absolute and relative accuracy requirements set out in the Statement of Work for this project. The quality control requirements of Terrapoint's I-PROVE program were adhered to throughout the project cycle to ensure product quality.

Appendix A Planned Flight Lines and Trajectories

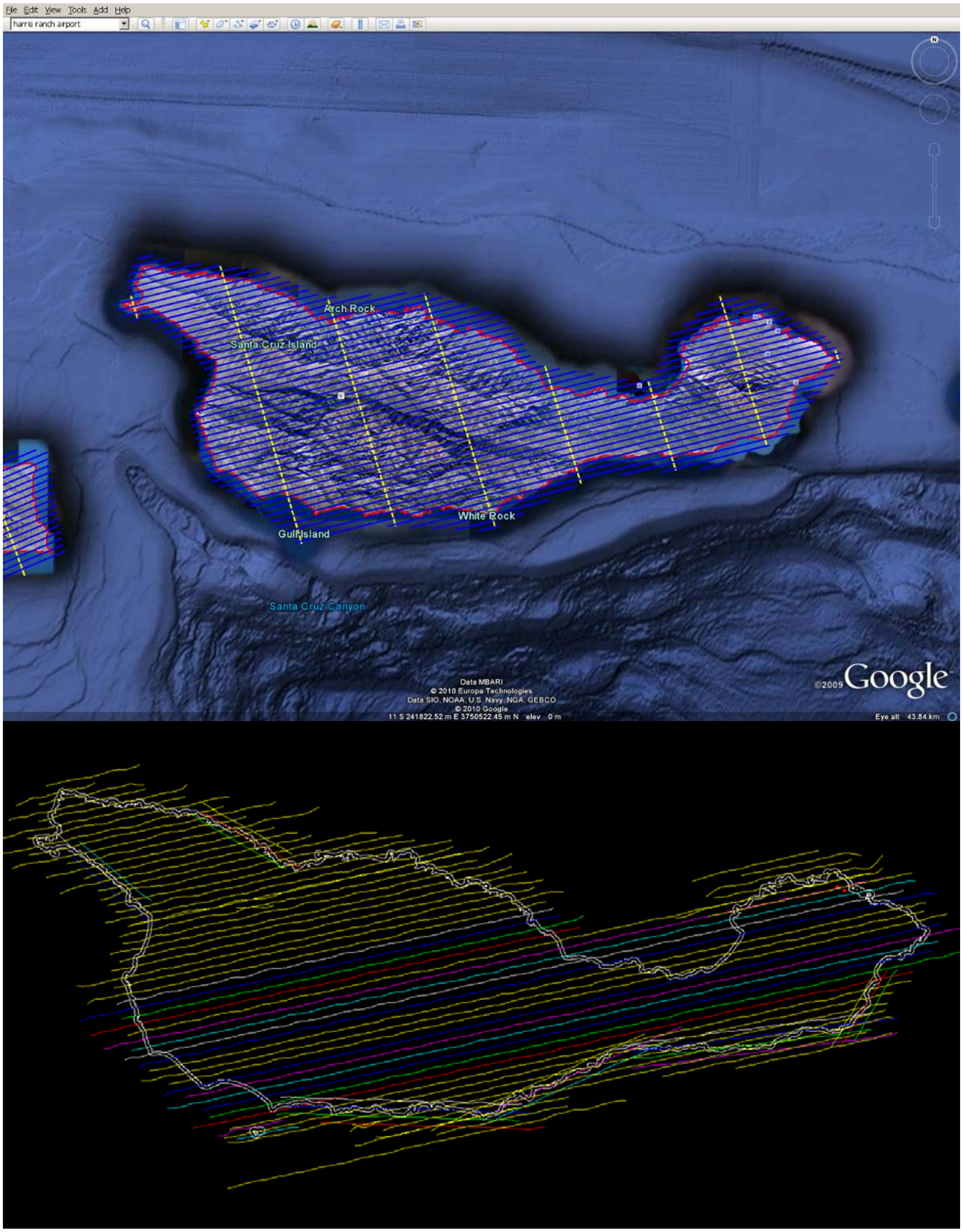
The top image represents the planned flighlines. Production flightlines are in blue atop the project boundary in red. Terrapoint acquired a minimum of 1 cross lines per island in yellow for validation purposes. The bottom images represent the actual trajectories color coded by missions.



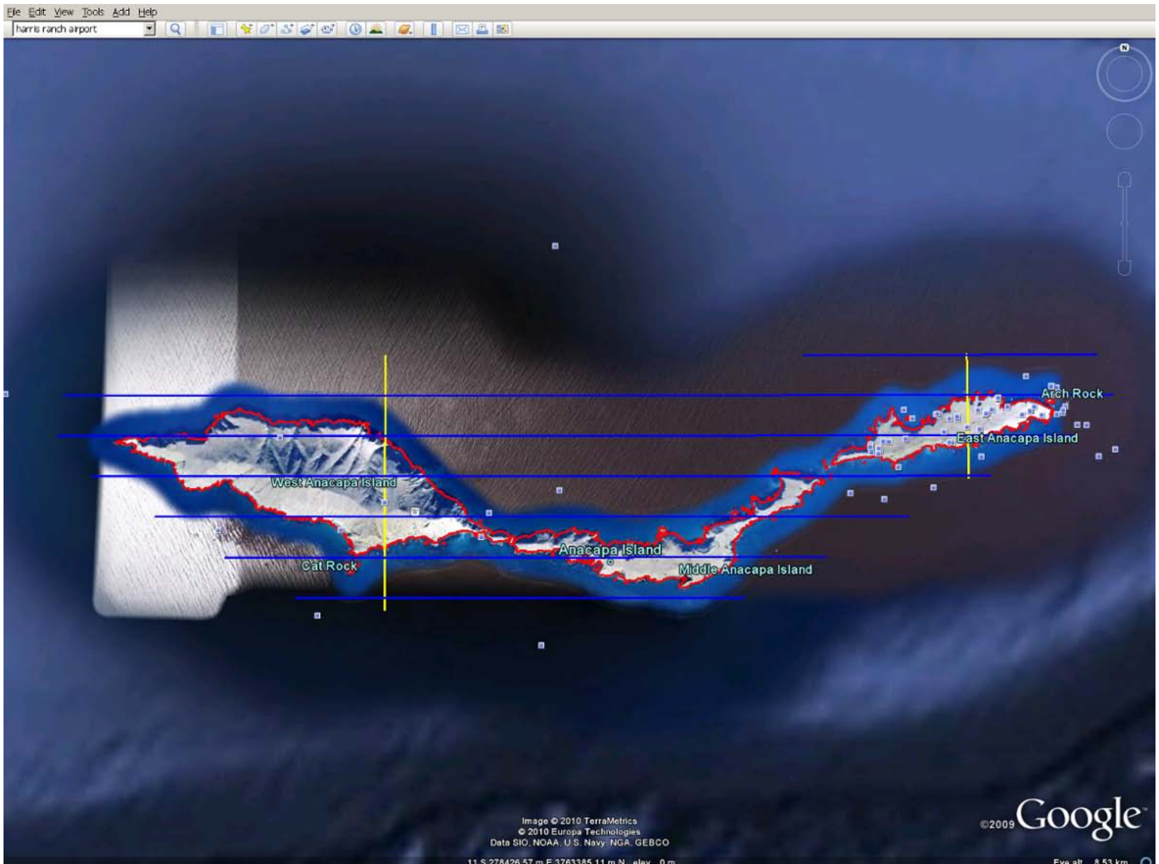
San Miguel Island

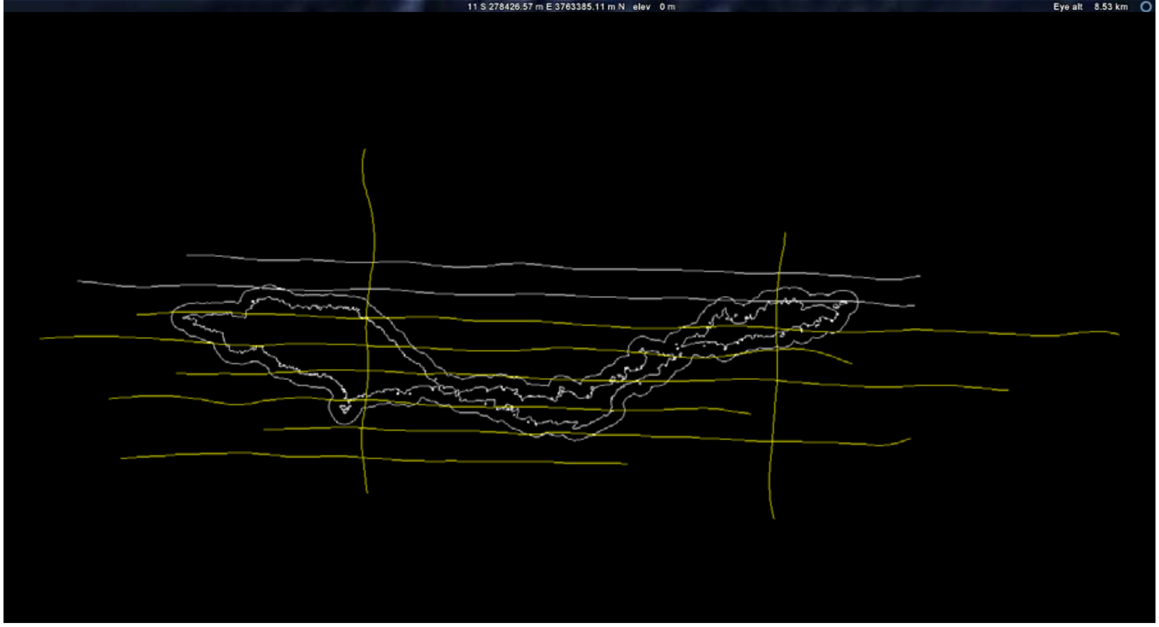


Santa Rosa Island

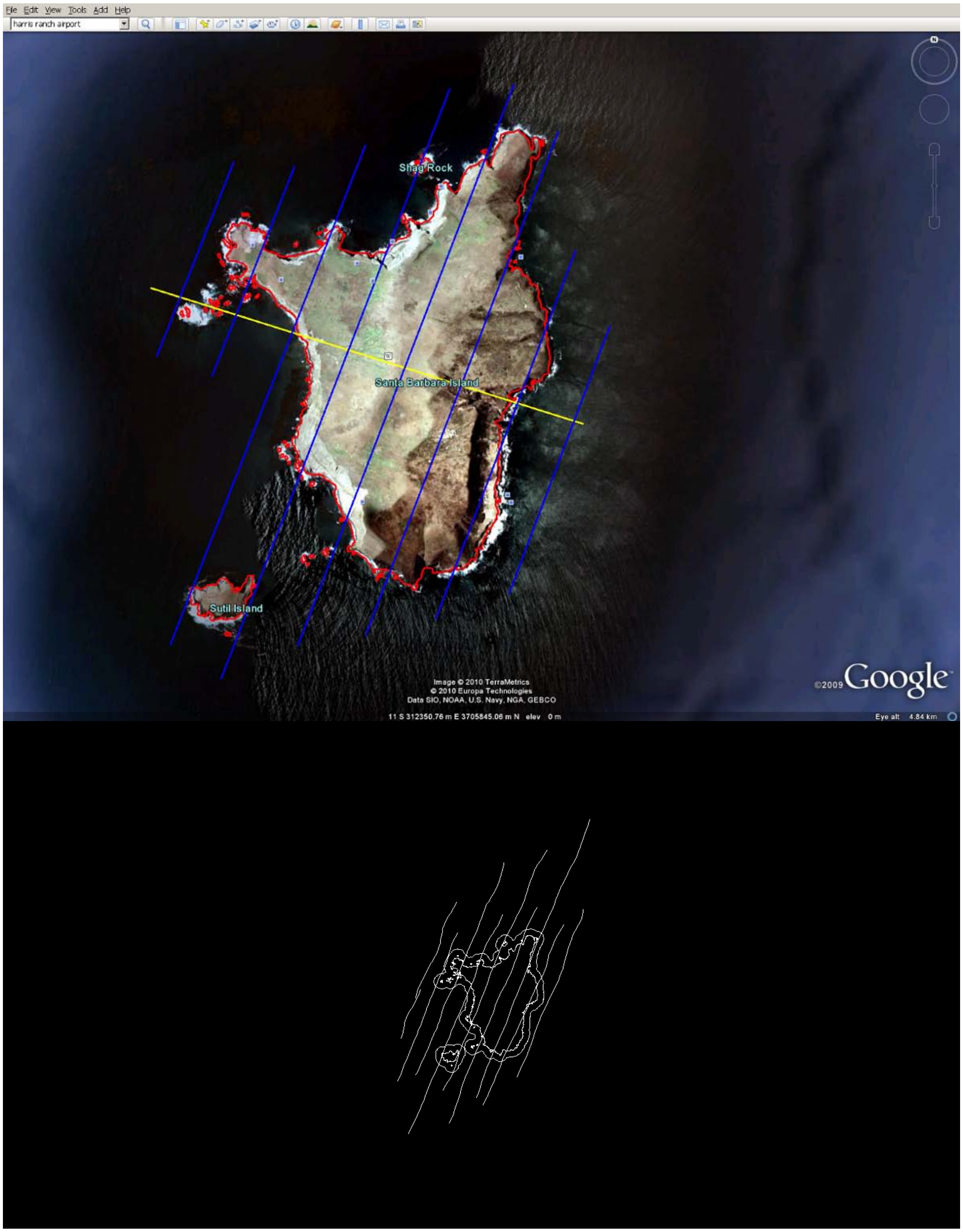


Santa Cruz Island





Anacapa Island



Santa Barbara Island

Appendix B Validation Points

Embedded below as file objects are the McGee static GPS checkpoints comparison results:

santa_rosa_ground_class_gt.txt

santa_cruz_ground_class_gt.txt

san_miguel_ground_gt.txt

anacapa_GT_autoclean.txt

santa_barbara_GT_autoclean.txt

Appendix C Mission Logs

Project# 10105U Session M110070A **Flight Log** Terrapoint

Date	MARCH 11 2010	Julian Day	070
Project	10105U	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N49634
Survey Block	SANTA BARBARA	Pilot	BARRY
Lines Complete	1-81, 1-11	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech, System #, Laser Scanner, Camera/Lens SN, Shutter Speed, Photo Freq., IMU, GPS Rx, Data Drive

Additional Notes:
Outside Temp @ TO: 16 C Outside Pressure @ TO: 3016
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
10:33 AM	1035	10:39 AM
Engine Off (Hobbs)	**Ramp In**	**Landing**
1:35 PM	1335	1:37 PM
Total hrs (Hobbs)	**Total hrs**	**Total hrs**

Mission Plan

Flying Height AGL	Scan Angle (Optech)
675 m	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100KHZ

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	~~410936~~ 410938	411585
KAR Base	415415	415720
KAR Base	419494	419844
Post Mission	423700	424000

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments
1	100311_193120	25	415898	415950			CLOUDS
81	100311_193546	280	416160	416330			GOOD
71	100311_194034	25	416419	416630			GOOD
61	100311_194623	280	416798	417077			GOOD
51	100311_195258	25	417192	417400			GOOD
41	100311_195801	280	417500	417740			GOOD
31	100311_200351	25	417846	418070			GOOD
21	100311_200853	280	418151	418375			GOOD
11	100311_201419	25	418480	418638			GOOD
1	100311_201813	280	418707	418809			GOOD

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Project# 10103U **Session** A110070A

Flight Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens / Comments Please periodically record: Outside Temp: Laser Temp: Cabin Temp: Output (Watts):
			Start	End	Time	NM to End	
K PASS	100311-202200	100	418434	419115			GOOD
X PASS	100311-202634	280	419209	419420			GOOD
			421400	421984			ANACAPA KAR
1	100311-210917	270	412775	412132			GOOD
2	100311-211657	90	422232	422640			GOOD
							ANACAPA KAR-NO TRUE

Page 1 of 2

Project 101050 **Session** M110071A **Flight Log** Terrapoint

Date	MARCH 12TH	Julian Day	071
Project	10105U	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	
Survey Block	ANACAPA	Pilot	JIM
Lines Complete	21-71	Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq	
IMU	
GPS Rx	
Data Drive	

Additional Notes: AG NAV FREEZE

Outside Temp @ TO: 15°C Outside Pressure @ TO: 3015
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff 10:45 AM
Engine Off (Hobbs)	Ramp In	Landing 12:55 PM
Total hrs (Hobbs)	Total hrs	Total hrs

Mission Plan

Flying Height AGL 600m	Scan Angle (Optech) 60
Ground Speed 50 KTS	Mirror Scan Rate 50
First/Last/Alternating Return	Laser Pulse Rate 100 KHz

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	497600	498360
KAR Base	500620	501050
KAR Base	505955	506300
Post Mission	507620	507895

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp, Laser Temp, Cabin Temp, Output (Watts))
21	100312_192038	270	501655	502150			GOOD
31	100312_193330	90	502424	502825			GOOD
41	100312_194542	270	503160	503560			GOOD
51	100312_195614	90	503790	504090			GOOD
61	100312_200514	270	504330	504650			GOOD
71	100312_201424	90	[illegible]	505090			GOOD
X PASS	100312_202114	0	505300	505245			GOOD
Y PASS	100312_202634	180	505623	505780			GOOD
X	X		~~505955~~	~~506300~~			~~ANACAPA KAR~~
X	X						~~SANTA CRUZ KAR~~

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Projec... | 10105U | Session | M100713 — **F.ght Log** — Terrapoint

Date	MARCH 12	Julian Day	071
Project	10105U	Aircraft	JET RANGER
Staging	SANTA CRUZ	Call Sign	N49613
Survey Block	SANTA CRUZ	Pilot	JEA
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:
560_Logger FROZE

Outside Temp @ TO: 15°C Outside Pressure @ TO: 5005
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
2:10 PM		2:10 PM
Engine Off (Hobbs)	**Ramp In**	**Landing**
4:13		4:12 PM
Total hrs (Hobbs)	**Total hrs**	**Total hrs**

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 m	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 kHz

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	510800	511560
KAR Base	512280	512929
KAR Base	517666	517985
Post Mission	519475	

Flight Plan Line #	LiDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp; Cabin Temp; Laser Temp; Dute & Weather)
1	100312_223426	26	513282	513440			GOOD
11	100312_223914	100	513573	513700			GOOD
21	100312-224350	260	513848	514025			GOOD
31	100312-224910	100	514143	514330			GOOD
41	100312_225131	260	514488	514765			GOOD
51	100312-230245	100	514979	515293			GOOD
61	100312-231037	260	515450	515777			GOOD
71	100312_231916	100	515910	516330			GOOD
81	100312-232706	260	516441	516870			GOOD
91	100312-233742	100	517085	517475			GOOD

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Projec.. 10105U **Session M110073A** **F..ght Log** **Terrapoint**

Date	August 14	Julian Day	073
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N4356
Survey Block	SAN MIGUEL	Pilot	CHARLIE
Lines Complete	1-181	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens S#	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:
ERROR WHEN COPYING IMU DATA

Outside Temp @ TO: 18°C Outside Pressure @ TO: 5010
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☒ Times confirmed with pilot

Engine On (Hobbs) 38.10	Ramp Out	Takeoff 1:29
Engine Off (Hobbs) 40.12	Ramp In	Landing 5:12
Total hrs (Hobbs) 4.2	Total hrs	Total hrs 3:43

Mission Plan

Flying Height AGL 600 m	Scan Angle (Optech) 60
Ground Speed 50 KTS	Mirror Scan Rate 50
First/Last/Alternating Return	Laser Pulse Rate 100 KHZ

Static & KAR GPS // INS Alignment

Time	Start	End
Pre Mission		74100
KAR Base	78333	75660
KAR Base	86100	86333
Post Mission	87230	87515

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp, Cabin Temp, Laser Temp, Output (Watts))
1	100314_210431	290	75885	75961			OFF LINE
1	100314_210847	110	76144	76190			OFF LINE
1	100314_211159	290	76354	76421			GOOD
11	100314_211519	[illegible]	76533	76655			GOOD
21	100314_211905	110	76759	76936			STOPPED EARLY
21	100314_212332	110	77033	77105			POSSIBLY BAD
21	100314_212642	290	77216	77460			GOOD
31	100314_213249	110	77585	77817			GOOD
41	100314_213937	290	77951	78206			GOOD
51	100314_214548	110	78362	78650			GOOD

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Project 100050 **Session** M100073A **F..ght Log**

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens / Comments (Please periodically record: Outside Temp; Laser Temp; Cabin Temp; Output (Watts))
			Start	End	Time	NM to End	
61	100314_215246	290	78780	79122			GOOD
71	100314_220105	110	79280	79632			GOOD
81	100314_220926	290	79788	80134			GOOD
91	100314_221804	110	80298	80690			GOOD
101	100314_222617	290	80790	81190			GOOD
111	100314_223541	110	81355	81804			GOOD
121	100314_224516	290	81930	82460			GOOD
131	100314_225639	110	82616	83112			GOOD
141	100314_230706	290	83240	83770			GOOD
151	100314_231757	110	83891	84410			GOOD
161	100314_232742	290	84500	84900			GOOD
171	100314_233623	110	85007	85412			GOOD
181	100314_234424	290	85475	85843			GOOD

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Projec... 101050 | Session A1100744A | F..ght Log — Terrapoint

Date	MARCH 15	Julian Day	074
Project	101050	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N49643
Survey Block	SAN MIGUEL	Pilot	JIM
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens S#	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 25C — Outside Pressure @ TO: 3017
Outside Temp @ LA: 25C — Outside Pressure @ LA:

Aircraft Block Time ☒ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
12:23 PM		12:25 PM
Engine Off (Hobbs)	**Ramp In**	**Landing**
3:06 PM		3:04 PM
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		2:41 PM

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 M	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHZ

Static & KAR GPS // INS Alignment

Time DGPS	Start	End
Pre Mission	154368	155200
KAR Base	159511	159540
KAR Base	16464	164900
Post Mission	165995	166427

Flight Plan Line #	LiDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments (Please periodically record: Outside Temp; Laser Temp; Cabin Temp; Output Models)
19	100315_202436	110	159591	160366			GOOD
20	100315_203516	290	160530	160910			GOOD
21	100315_204607	110	161179	161444			GOOD
22	100315_205506	290	161600	161850			GOOD
23	100315_210106	110	162020	162320			GOOD
24	100315_210650	290	162424	16253			GOOD ?
25	100315_211034	110	162650	162770			GOOD
27	100315_211410	290	162865	163000			GOOD
17	100315_211805	110	163100	163505			GOOD
X PASS	100315_212903	15	163757	164025			GOOD

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Projec.. 101050 **Session** M110074A

F..ght Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens / Comments Please periodically record: Outside Temp: Laser Temp: Cable Temp: Output (Watts)
			Start	End	Time	NM to End	
XPASS	100315-213616	200	164195	164487			GOOD

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Projec... 101050 | Session M1100?HB — **F..ght Log** — Terrapoint

Date	MARCH 15	Julian Day	074
Project	CHANNEL ISLAN	Aircraft	JET RANGER
Staging	SANTA ROSA	Call Sign	N49645
Survey Block	SANTA ROSA	Pilot	BARRY
Lines Complete	411-521	Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens S#	
Shutter Speed	
Photo Freq	
IMU	
GPS Rx	
Data Drive	

Additional Notes: I HAD TO END THE SESSION, CONFIG THE LASER AND THEN START A NEW SESSION.

Outside Temp @ TO: 25°C Outside Pressure @ TO: 3020
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☒ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
4:09 PM		4:14 PM
Engine Off (Hobbs)	**Ramp In**	**Landing**
7:05 PM		7:02 PM
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		2.9

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600m	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHz

Static & KAR GPS // INS Alignment

Time CGPS	Start	End
Pre Mission	168940	169609
KAR Base	1706.0	170847
KAR Base	178000	178252
Post Mission		

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp: Laser Temp: Cabin Temp: Output (Watts):)
521	100315_233353	65	171229	171440			GOOD
511	100315_233830	65	171524	171166			GOOD
501	100315_234350	295	171845	172047			GOOD
491	100315_234913	65	172168	172390			GOOD
481	100315_235465	295	172564	172808			GOOD
471	100316_000116	65	172890	173240			GOOD
461			173429	[illegible]			ERROR "UNABLE TO [illegible]"
461	100316_[illegible]	295	173939	174154			GOOD
451	100316_002853	65	174555	175070			GOOD
441	100315_003411	295	175165	175665			GOOD

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Projec. 10105U **Session** M11307HB

F ght Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Events / Comments Please periodically record: Outside Temp: Cabin Temp: Laser Temp: Output (Watts):
			Start	End	Time	NM to End	
2151	100316_004943	65	175800	176352			GOOD
4121	100316_010108	295	176485	177085			GOOD
411	100316_011233	65	177200	177919			GOOD

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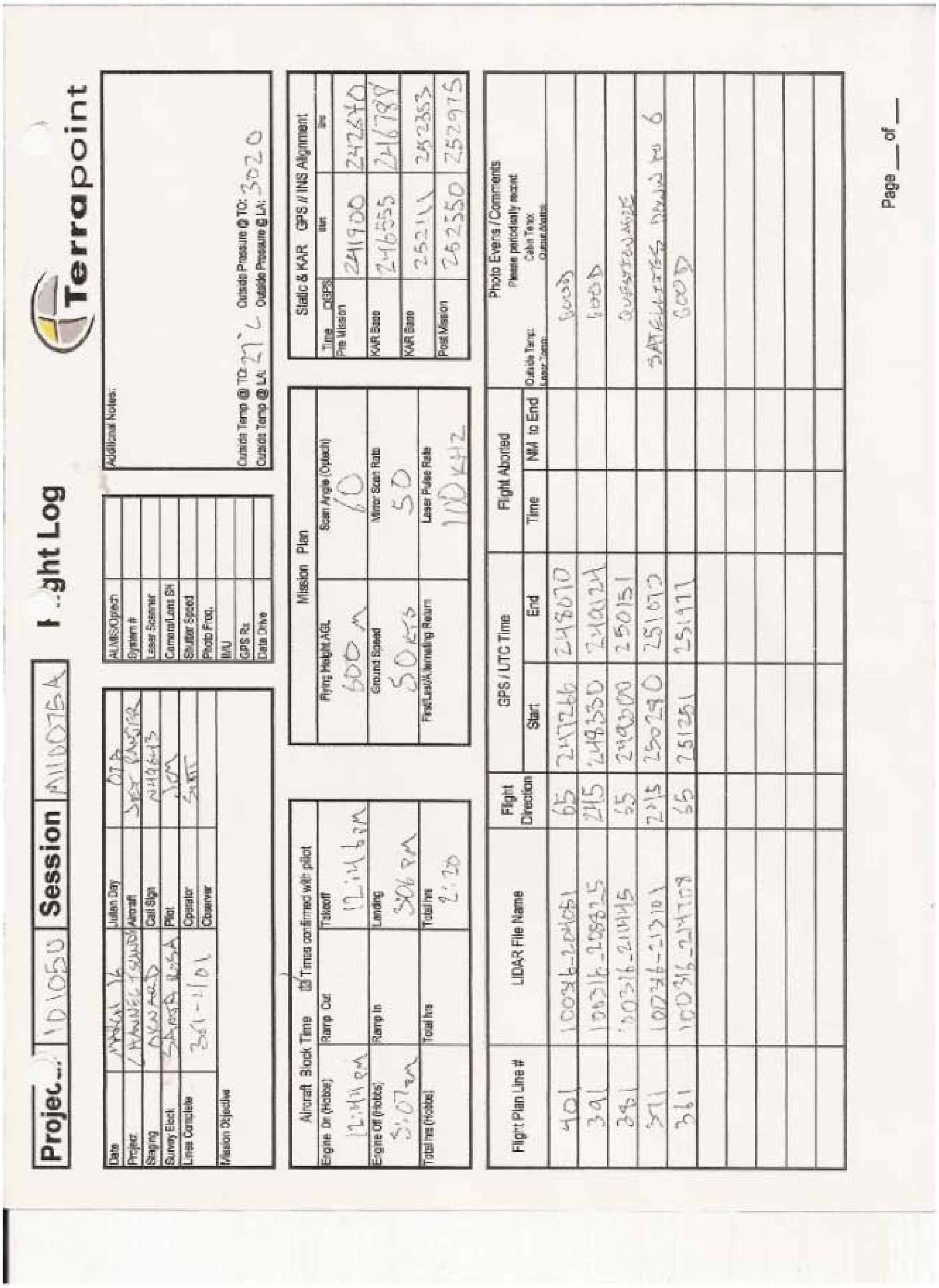


Project: 101050 | Session: A100076A | Flight Log | Terrapoint

Date	MARCH 16	Julian Day	076
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N49643
Survey Block	SANTA ROSA	Pilot	JCM
Lines Complete	361-401	Operator	Scott
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 27 °C Outside Pressure @ TO: 3020
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☒ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
12:44 PM		12:46 PM
Engine Off (Hobbs)	Ramp In	Landing
3:07 PM		3:06 PM
Total hrs (Hobbs)	Total hrs	Total hrs
		2:20

Mission Plan

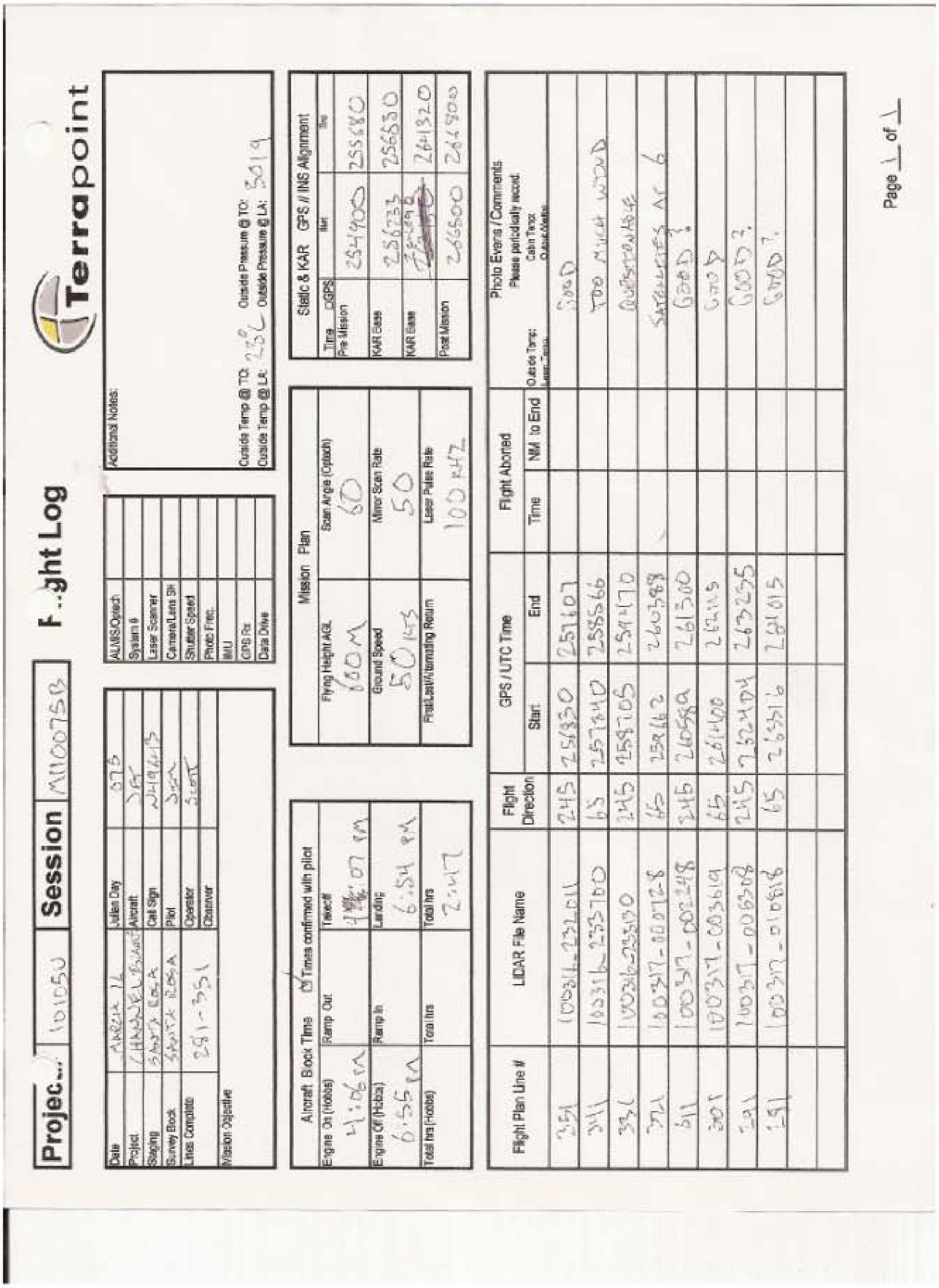
Flying Height AGL	Scan Angle (Optech)
600 m	60
Ground Speed	Mirror Scan Rate
50 KTS	50
First/Last/Alternating Return	Laser Pulse Rate
	100 KHZ

Static & KAR GPS // INS Alignment

Time DGPS	Start	End
Pre Mission	241900	242640
KAR Base	246555	246788
KAR Base	252111	252353
Post Mission	252550	252975

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments (Please periodically record: Outside Temp; Laser Temp; Cabin Temp; Output Watts)
401	100316-204051	65	247266	248070			GOOD
391	100316-208825	245	248350	249124			GOOD
381	100316-211445	65	249300	250151			QUESTIONABLE
371	100316-213101	245	250290	251070			SATELLITES DOWN TO 6
361	100316-214708	65	251251	251977			GOOD

Page ___ of ___



Project 101050 | Session M100758 | Flight Log | Terrapoint

Date	MARCH 16	Julian Day	075
Project	CHANNEL ISLAND	Aircraft	JET
Staging	SANTA ROSA	Call Sign	N4964B
Survey Block	SANTA ROSA	Pilot	JIM
Lines Complete	251-351	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech, System #, Laser Scanner, Camera/Lens SN, Shutter Speed, Photo Freq., IMU, GPS Rx, Data Drive

Additional Notes:

Outside Temp @ TO: 22°C Outside Pressure @ TO:
Outside Temp @ LA: 23C Outside Pressure @ LA: 3019

Aircraft Block Time ☑ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
4:06 PM		4:07 PM
Engine Off (Hobbs)	**Ramp In**	**Landing**
6:55 PM		6:54 PM
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		2:47

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 M	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHZ

Static & KAR GPS // INS Alignment

Time DGPS	Start	Stop
Pre Mission	254900	255680
KAR Base	256233	256830
KAR Base	[illegible]	264320
Post Mission	266500	266800

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments
351	100316_232011	245	256830	257607			GOOD
341	100316_233700	65	257840	258566			TOO MUCH WIND
331	100316-235300	245	258705	259470			QUESTIONABLE
321	100317-000728	65	259662	260388			SATELLITES AT 6
311	100317-002248	245	260589	261300			GOOD ?
301	100317-003619	65	261400	262115			GOOD
291	100317-006308	245	262404	263235			GOOD ?
251	100317-010818	65	263316	264015			GOOD ?

Photo Events / Comments: Please periodically record: Outside Temp; Laser Temp; Cabin Temp; Output Voltage

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Project 10105U **Session** M100076A

Flight Log

Terrapoint

Date	MARCH 17	Julian Day	076
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	SANTA ROSA	Call Sign	N49143
Survey Block	SANTA ROSA	Pilot	BARRY
Lines Complete	191 - 271	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

RED LOS LIGHT AT START UP AGAIN!!!

HARD DRIVE ERROR, SEE BELOW

Outside Temp @ TO: 21°C Outside Pressure @ TO: 3015
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
2:25 PM		2:26 PM
Engine Off (Hobbs)	Ramp In	Landing
5:47 PM		5:45 PM
Total hrs (Hobbs)	Total hrs	Total hrs
		3.19

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 M	60
Ground Speed	Mirror Scan Rate
50 KTS	50
First/Last/Alternating Return	Laser Pulse Rate
	100 KHZ

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	~~334???~~ 335433	336175
KAR Base	336715	337137
KAR Base	345757	346015
Post Mission	348494	348888

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp, Cabin Temp, Laser Temp, Output (Watts))
271	100317_214030	245	337223	337970			GOOD
261	100317_215440	65	338100	338800			GOOD
251	100317_220759	245	338893	339650			GOOD
241	= HD ???	65	339748	340588			GOOD
231	= HD ????	245	340666	341391			GOOD
221	= HD	65	341446	342275			GOOD
			[illegible]				CHANGED HARD DRIVES
211	100317_231959	245	342915	343659			GOOD
201	100317_232906	65	343766	344598			GOOD
191	100317_234327	245	344622	345382			GOOD

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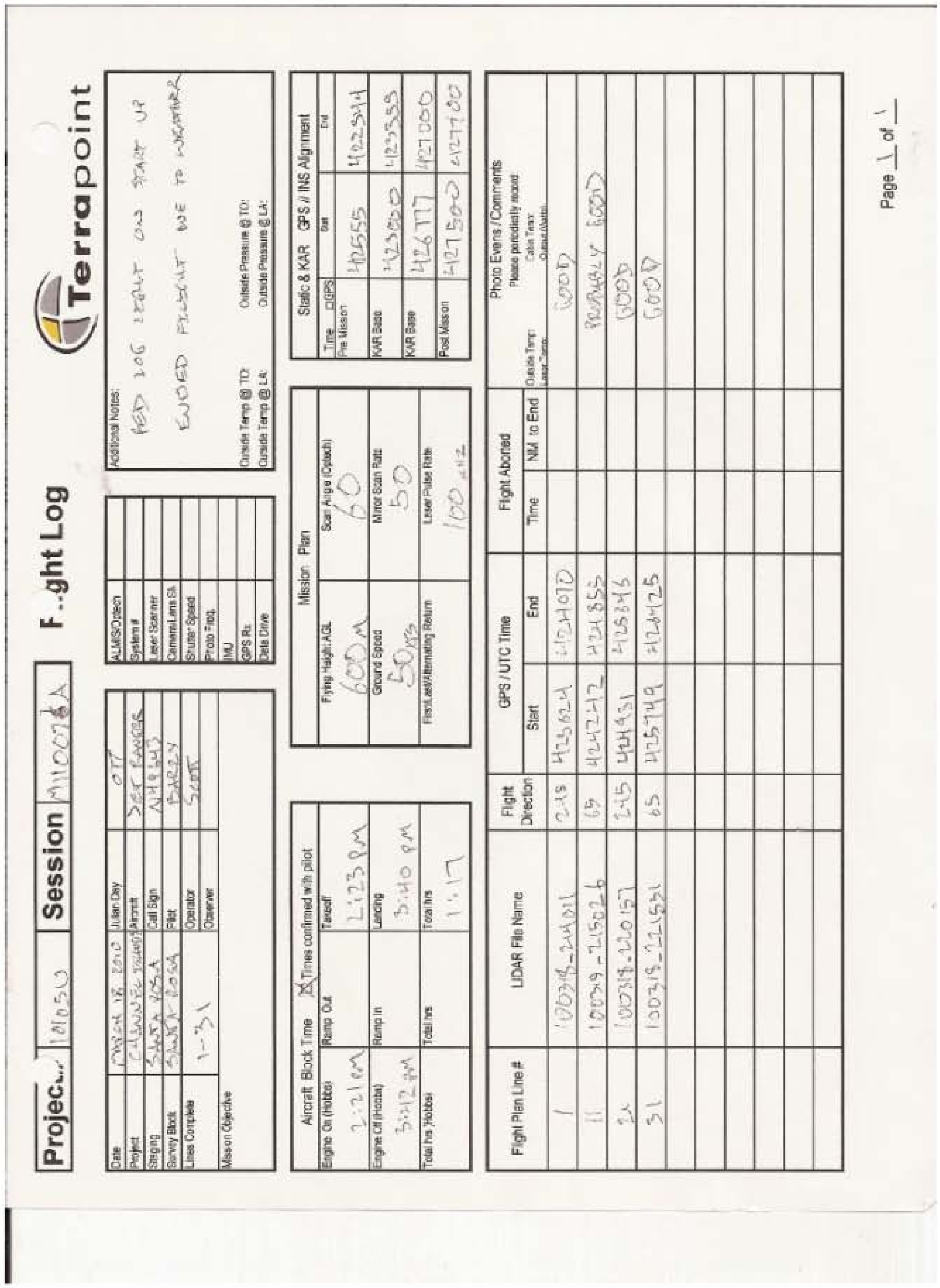

Project: 101050 | Session: M100786A | Flight Log | Terrapoint

Date	MARCH 18 2010	Julian Day	077
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	SANTA ROSA	Call Sign	N49643
Survey Block	SANTA ROSA	Pilot	BARRY
Lines Complete	1-31	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:
RED LOG LIGHT ON START UP
ENDED FLIGHT DUE TO WEATHER

Outside Temp @ TO: Outside Pressure @ TO:
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☒ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
2:21 PM		2:23 PM
Engine Off (Hobbs)	**Ramp In**	**Landing**
3:42 PM		3:40 PM
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		1:17

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 m	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHZ

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	422555	422544
KAR Base	423000	423333
KAR Base	426777	427000
Post Mission	427500	427700

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp: Laser Temp: Cabin Temp: Output (Watts))
1	100318_214011	245	423624	424070			GOOD
11	100319_215026	65	424242	424855			PROBABLY GOOD
21	100318_220157	245	424951	425346			GOOD
31	100319_221531	65	425749	426425			GOOD

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Project#	10105U	Session	A110079A

Flight Log

Terrapoint

Date	MARCH 20	Julian Day	079
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N219(?)3
Survey Block	SANTA ROSA	Pilot	[illegible]
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Option	
System #	
Laser Scanner	
Camera/Lens S/N	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 11°C
Outside Temp @ LA: 11°C
Outside Pressure @ TO: 3015
Outside Pressure @ LA:

Aircraft Block Time	☐ Times confirmed with pilot	
Engine On (Hobbs)	Ramp Out	Takeoff
7:32 AM		7:34 AM
Engine Off (Hobbs)	Ramp In	Landing
10:42 AM		10:40 AM
Total hrs (Hobbs)	Total hrs	Total hrs
		3:06

Mission Plan	
Flying Height AGL	Scan Angle (Cptech)
600 M	60
Ground Speed	Mirror Scan Rate
50 KTS	50
First/Last/Alternating Return	Laser Pulse Rate
	100 KHZ

Static & KAR GPS // INS Alignment		
Time LiGPS	Start	End
Pre Mission	569666	570470
KAR Base	573940	574180
KAR Base	580900	581064
Post Mission	582200	582500

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp: Cabin Temp: Laser Temp: Output Watts:)
41	100320_153506	245	574520	575222			GOOD
51	100320_155052	65	575469	576250			MAYBE OFF ZONE
61	100320_160625	245	576420	577215			GOOD
71	100320_162315	65	577410	578030			OFF ZONE
71	100320_163713	65	578247	587532			COMPLETED
81	100320_164440	245	578697	479425			ONE SMALL CLOUD AT WEST END
511	100320_170359	65	579455	579959			GOOD
501	100320_170817	245	580111	580239			GOOD
491	100320_171255	65	580590	580602			GOOD

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Project	101050	Session	A100080A

Flight Log

Terrapoint

Date	MARCH 21	Julian Day	080
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	SANTA ROSA	Call Sign	N49645
Survey Block	SANTA ROSA	Pilot	CHARLIE
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes: 560_LOGGER FROZE

Outside Temp @ TO: 20°C Outside Pressure @ TO: 3018
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time	☐ Times confirmed with pilot	
Engine On (Hobbs): 9:47 AM	Ramp Out:	Takeoff: 9:49 AM
Engine Off (Hobbs): 2:08 PM	Ramp In:	Landing: 2:06 PM
Total hrs (Hobbs):	Total hrs:	Total hrs: 4:17

Mission Plan	
Flying Height AGL: 600 M	Scan Angle (Optech): 10
Ground Speed: 50 KTS	Mirror Scan Rate: 50
First/Last/Alternating Return:	Laser Pulse Rate: 100 kHz

Static & KAR GPS // INS Alignment	Start	End
Pre Mission	59300	60160
KAR Base	60950	61414
KAR Base	71500	71860
Post Mission	75900	76500

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments
91	100321_170802	245	61695	62355			GOOD
101	100321_172054	65	62468	63238			MAYBE OFF LINE
111	100321_173530	245	63347	64164			GOOD
121	100321_175121	65	64300	65105			GOOD
131	100321_180702	245	65243	66080			GOOD
141	100321_182436	65	66294	67120			GOOD
151	100321_184000	245	67222	68155			GOOD
161	100321_185802	65	68300	69135			GOOD
171	100321_191348	245	69243	70180			GOOD
181	100321_193236	65	70371	71229			GOOD

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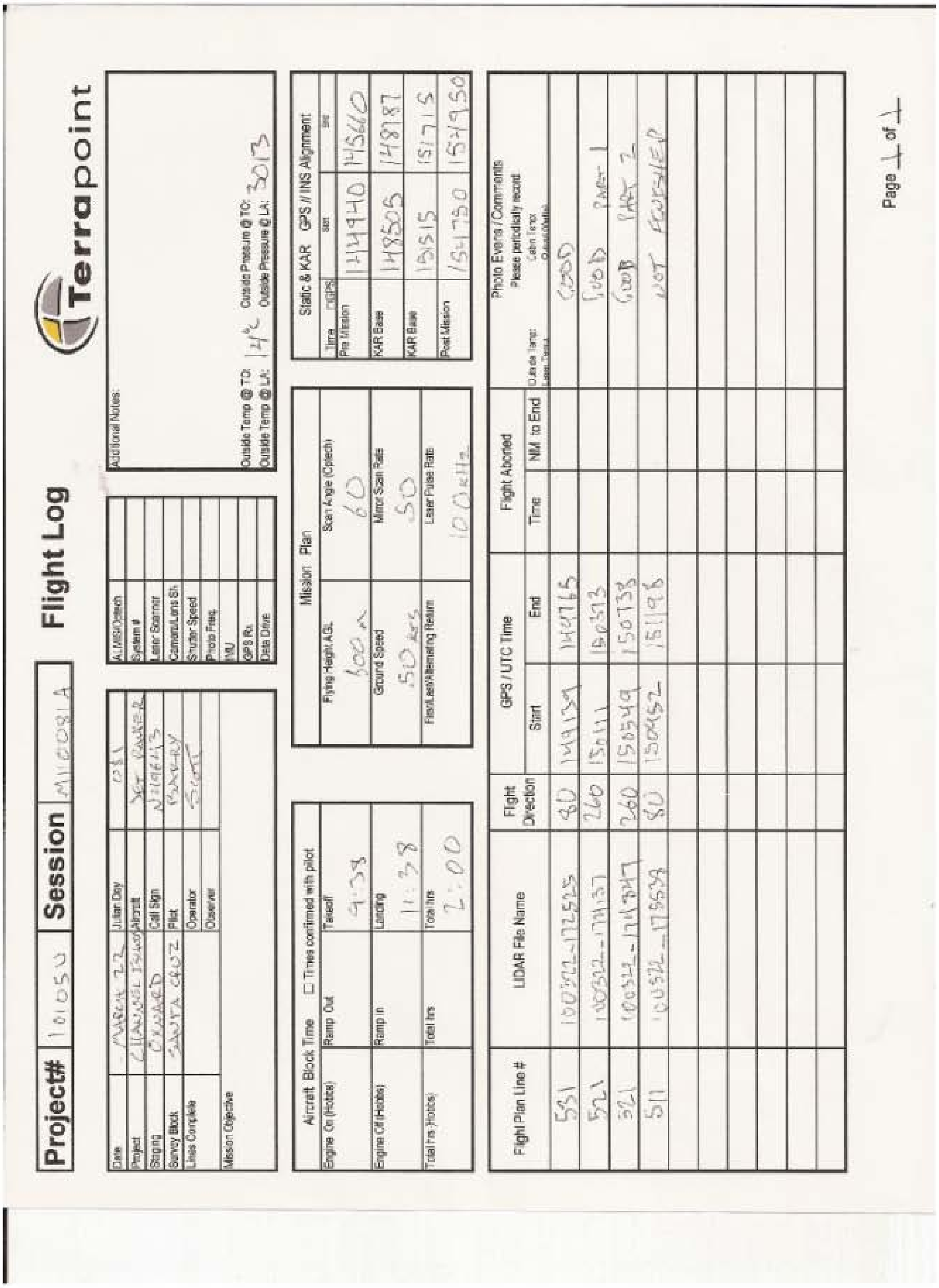

Project# 10105U **Session** M1100081A

Flight Log

Terrapoint

Date	MARCH 22	Julian Day	081
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N2196MS
Survey Block	SANTA CRUZ	Pilot	BARRY
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens S/N	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 14°C Outside Pressure @ TO: 3013
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
		9:38
Engine Off (Hobbs)	**Ramp in**	**Landing**
		11:38
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		2:00

Mission Plan

Flying Height AGL	Scan Angle (Cptech)
600 m	60
Ground Speed	**Mirror Scan Rate**
50 kts	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 kHz

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	144940	145660
KAR Base	148505	148787
KAR Base	151515	151715
Post Mission	154750	154950

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments
531	100322-172525	80	149139	149765			GOOD
521	100322-174137	260	150111	150313			GOOD PART 1
321	100322-174847	260	150549	150738			GOOD PART 2
511	100322-175539	80	150452	151198			NOT FINISHED

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Project# 101050 **Session** M100813

Flight Log

Terrapoint

Date	MARCH 22	Julian Day	081
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N49643
Survey Block	SANTA CRUZ	Pilot	BARRY
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: Outside Pressure @ TO: 2998
Outside Temp @ LA: 17°C Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
		14:25 / 16:00
Engine Off (Hobbs)	**Ramp In**	**Landing**
		16:20 / 18:58
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		4:13

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 m	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHZ

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	160985	161705
KAR Base	165450	165725
KAR Base	178368	178540
Post Mission	180129	180425

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments (Please periodically record: Outside Temp; Cabin Temp; Laser Temp; Data # (Watts))
101	100322_220519	255	165433	166318			GOOD
111	100322_221300	75	166395	166784			GOOD
121	100322_[illegible]	255	166871	167211			GOOD
131	100322_222758	75	167292	167733			GOOD
141	100322_223714	255	1678[illegible]	168310			GOOD
			168600	168800			KAR FOR PDOP WINDOW
			170855	171188			KAR FOR PDOP WINDOW
511	100322_233715	75	171449	171792			GOOD PART 1
521	100322_234439	75	171989	172249			GOOD PART 2
501	100322_235201	255	172335	173145			GOOD

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Projec... 101053U **Session** A1100818

F..ght Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens / Comments Please periodically record: Outside Temp: Laser Temp: Cabin Temp: Circuit (Watts):
			Start	End	Time	NM to End	
491	100323_000746		—	—			AG NAV FROZE
491	100323_001116	75	173493	174378			GOOD
481	100323_002735	255	174469	175645			GOOD ✗
471	100323_004842	75	175737	176862			GOOD
461	100323_010848	255	176949	178080			GOOD

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Flight Log

Project# 10105U **Session** M1100 82A

Terrapoint

Date	March 23 2010	Julian Day	82
Project	Channel Islands	Aircraft	Jet 206
Staging	Oxnard	Call Sign	N49643
Survey Block	Santa Cruz	Pilot	Charlie
Lines Complete		Operator	Errol
		Observer	
Mission Objective			

ALMIS/Optech	Mid
System #	H1
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes: Windy

Outside Temp @ TO: 18°C Outside Pressure @ TO: 30.01Hg
Outside Temp @ LA: 18°C Outside Pressure @ LA: 30.02Hg

Aircraft Block Time ☒ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
17:51		17:54
Engine Off (Hobbs)	**Ramp In**	**Landing**
20:50		20:47
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
2:59		2:53

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600m	60°
Ground Speed	**Mirror Scan Rate**
50 kts	50Hz
First/Last/Alternating Return	**Laser Pulse Rate**
	100 kHz

Static & KAR GPS // INS Alignment

Time GPS	Start	End
Pre Mission	235794	236500
KAR Base	239115	239560
KAR Base	246890	247300
Post Mission		

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp; Cabin Temp; Laser Temp; Output (Watts))
15	100323_183501	W	239718	240225			Cloud East (overwater)
16	100323_184601	E	240376	240933			
17	100323_185830	W	241125	241692			Off Line East...?
18	100323_191001	E	241817	242517			
19	100323_192343	W	242640	243289			
201-1	100323_193508	E	243323	243606			Off Line 1/2
201-2	100323_194215	E	243750	244184			Should be good 2/2
21	100323_195124	W	244302	244969			
22	100323_200506	E	245123	245848			
23	100323_201948	W	246003	246690			

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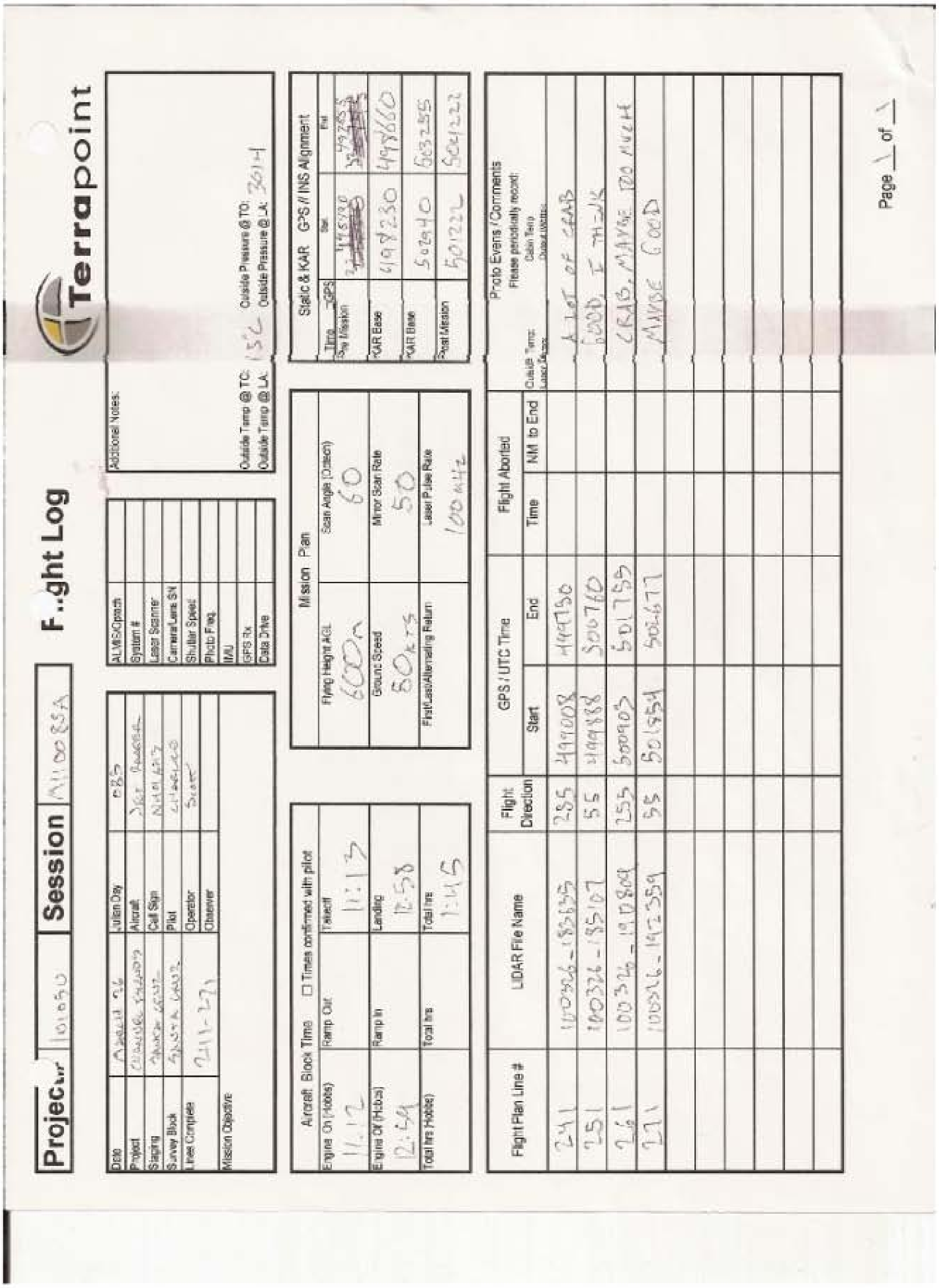

Project 101050 **Session** M1008SA **Flight Log**

Terrapoint

Date	March 26	Julian Day	085
Project	Channel Islands	Aircraft	Jet Ranger
Staging	Santa Cruz	Call Sign	N141AT7
Survey Block	Santa Cruz	Pilot	Charlie
Lines Complete	241-271	Operator	Scott
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 15°C Outside Pressure @ TO: 30.1
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
11.12		11:13
Engine Off (Hobbs)	**Ramp In**	**Landing**
12:59		12:58
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		1:45

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600m	60
Ground Speed	**Mirror Scan Rate**
80kts	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 kHz

Static & KAR GPS // INS Alignment

Time GPS	Start	End
Pre Mission	495920	497455
KAR Base	498230	498660
KAR Base	502940	503255
Post Mission	501222	504222

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp, Laser Temp, Cabin Temp, Output Wattage)
241	100326_183635	235	499008	499730			A LOT OF CRAB
251	100326_185107	55	499888	500760			GOOD, I THINK
261	100326_190809	255	500903	501755			CRAB, MAYBE TOO MUCH
271	100326_192359	55	501854	502677			MAYBE GOOD

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Project 10105C **Session** AK0085B

Flight Log

Terrapoint

Date	MARCH 26	Julian Day	085
Project	CHANNEL IS.	Aircraft	JET RANGER
Staging	SANTA CRUZ	Call Sign	N4[illegible]543
Survey Block	SANTA CRUZ	Pilot	CHARLIE
Lines Complete	281-331 WEST	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 17°C Outside Pressure @ TO:
Outside Temp @ LA: Outside Pressure @ LA: 3013

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
14:17		14:18
Engine Off (Hobbs)	**Ramp In**	**Landing**
15:55		15:54
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		1:36

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 m	60
Ground Speed	**Mirror Scan Rate**
50 kts	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 kHz

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	507727	509931
KAR Base	509211	509550
KAR Base	512733	513013
Post Mission	514700	514845

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp, Cabin Temp, Laser Temp, Output Wattage)
281	100326_214001	55	510025	510235			GOOD (WEST END)
291	100326_214340	255	510354	510560			GOOD (WEST END)
301	100326_215105	55	510679	510938			GOOD (WEST END)
311	100326_215715	255	511054	511356			GOOD (WEST END)
321	100326_220445	55	511500	511848			GOOD (WEST END)
331	100326_221257	255	511995	512347			GOOD (WEST END)

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Project	10105U	Session	MU0086A

Flight Log

Date	MARCH 27	Julian Day	086
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N49613
Survey Block	SANTA ROSA	Pilot	CHARLIE
Lines Complete	SANTA ROSA RE-FLIGHT	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens S/N	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes: NO TIME FOR FINAL KAR DUE TO WEATHER ALL OVER BUT FINAL STATIC WAS NEAR THE GROUND POINT.

Outside Temp @ TO: 22°C Outside Pressure @ TO: 3012
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
13:15		13:16
Engine Off (Hobbs)	**Ramp In**	**Landing**
16:59		16:58
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		3:42

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 M	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHZ

Static & KAR GPS // INS Alignment

Time LIGPS	Start	Stop
Pre Mission		
KAR Base	593454	593690
KAR Base	~~[illegible]~~	—
Post Mission	604670	604750

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments (Please periodically record: Outside Temp; Laser Temp; Cabin Temp; Output Wattage)
191	100327_205901	250	593961	594009			OFF LINE
191	100327_210410	250	594265	598080			GOOD
201	100327_211941	65	595195	596095			GOOD
211	100327_213643	250	596222	596941			GOOD
351	100327_215240	65	597175	598011			GOOD
341	100327_220916	250	598713	598945			GOOD
331	100327_222433	65	599088	599915			GOOD
KAR			599916	600245			
KAR			601208	601601			
X PASS		150	601812	602474			GOOD

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Projec 10105U **Session** A10032?A

F ght Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens / Comments Please periodically record: Outside Temp: Laser Temp: Cabin Temp: Output (Watts):
			Start	End	Time	NM to End	
X PASS	100327-232333		602640	603290			GOOD
X PASS	100327_233717		603460	604260			GOOD

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Project 101050 | Session M100872A | Flight Log | Terrapoint

Date	MARCH 28	Julian Day	087
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N49643
Survey Block	SANTA CRUZ	Pilot	BARRY
Lines Complete	281-361	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: Outside Pressure @ TO:
Outside Temp @ LA: 21 °C Outside Pressure @ LA: 3016

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff VARIOUS
Engine Off (Hobbs)	Ramp In	Landing VARIOUS
Total hrs (Hobbs)	Total hrs	Total hrs 5:18

Mission Plan

Flying Height AGL 600 m	Scan Angle (Optech) 60
Ground Speed 50 kts	Mirror Scan Rate 50
First/Last/Alternating Return	Laser Pulse Rate 100 kHz

Static & KAR GPS // INS Alignment

Time DGPS	Start	End
Pre Mission	65525	66500
KAR Base	68948	69090
KAR Base	86896	87070
Post Mission	88725	88825

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments
281	100328_191559	255	69372	70095			GOOD
291	100328_192942	60	70196	71065			GOOD
301	100328_194536	255	71160	71960			GOOD
311	100328_200035	60	72048	72914			GOOD
KAR			73151	73551			
KAR			75717	76000			
321	100328_411458	255	76512	77733			GOOD
351	100328_213657	60	77830	149140			GOOD
341	100328_220017	255	79230	80565			GOOD
KAR			80858	81058			

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Projec 101050 | Session A100827A

F ght Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens / Comments Please periodically record: Outside Temp: Cabin Temp: Laser Temp: Output (Watts):
			Start	End	Time	NM to End	
KAR			83583	83583			
351	100328-231742		83875	815151			GOOD
361	100328-234015		85229	85670			GOOD

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Flight Log

Terrapoint

Project	101050	Session	M100091A

Date	APRIL 1	Julian Day	091
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N49643
Survey Block	CALIBRATION	Pilot	CHARLIE
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 11°C Outside Pressure @ TO: 3003 [illegible]
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
		10:07
Engine Off (Hobbs)	**Ramp In**	**Landing**
		10:52
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		:45

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 m	10
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHZ

Static & KAR GPS // INS Alignment

Time UGPS	Start	End
Pre Mission	406100	406900
KAR Base	407950	407870
KAR Base	409409	409620
Post Mission	410200	410260

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evans / Comments (Please periodically record: Outside Temp; Cabin Temp; Laser Temp; Output Watts)
20	100401_172156		408140	408550			GOOD, 30 KTS
10	100401_172755		408490	408632			GOOD
30	100401_173503		408925	409005			GOOD
40	100401_173854		409148	409305			GOOD

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Project 10105U **Session** M100924

Flight Log

Terrapoint

Date	APRIL 2	Julian Day	092
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N419AH3
Survey Block	SANTA CRUZ	Pilot	BARRY
Lines Complete	371-391, 481	Operator	SCOTT
		Observer	

Mission Objective

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq	
MU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 8°C Outside Pressure @ TO: 3005
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
7:26		7:27
Engine Off (Hobbs)	**Ramp In**	**Landing**
10:19		10:18
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		2:51

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 M	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHz

Static & KAR GPS // INS Alignment

Time ☐GPS	Start	End
Pre Mission	483050	484060
KAR Base	486200	486435
KAR Base	492717	492900
Post Mission	494600	494800

Flight Plan Line #	LiDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments (Please periodically record: Outside Temp; Cabin Temp)
481	100402_151242	70	486180	487875			GOOD
371	100402_153346	255	488041	489480			GOOD
381	100402_155925	70	489581	490915			GOOD
391	100402_162317	255	491011	492408			GOOD

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Flight Log

Terrapoint

Project	10105U	Session	M110096A

Date	APRIL 6	Julian Day	096
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N496H3
Survey Block	SANTA CRUZ	Pilot	BARRY
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens S#	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 16°C Outside Pressure @ TO: 3020
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time	☐ Times confirmed with pilot	
Engine On (Hobbs)	Ramp Out	Takeoff VARIOUS
Engine Off (Hobbs)	Ramp In	Landing VARIOUS
Total hrs (Hobbs)	Total hrs	Total hrs 4:45

Mission Plan	
Flying Height AGL 600m	Scan Angle (Optech) 60
Ground Speed 50kts	Mirror Scan Rate 50
First/Last/Alternating Return	Laser Pulse Rate 100kHz

Static & KAR GPS // INS Alignment		
Time DGPS	Start	End
Pre Mission	233900	[illegible]234700
KAR Base	237310	237827
KAR Base	251454	251600
Post Mission	254255	254555

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments (Please periodically record: Outside Temp, Cabin Temp, Laser Temp, Output (Watts))
401	100406_180341	75	237825	239138			GOOD
411	100406_182740	255	239275	240575			GOOD
421	100406_185058	75	240675	242200			GOOD
X PASS	100406_191717	340	242251	242650			GOOD
KAR			243090	243333			
KAR			245800	246000			
431	100406_202401	75	246257	247485			GOOD
441	100406_204556	255	247570	248830			GOOD
451	100406_210504	75	248901	251135			GOOD
191	100406_[illegible]213639	255	250614	251200			GOOD

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Projec 11030 | Session M100092A

F ght Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens / Comments Please periodically record: Outside Temp: Cabin Temp: Laser Temp: Dub/Wette:
			Start	End	Time	NM to End	
~~KAR~~							
X PASS	100406_215547		251765	252222			AFTER FINAL KAR
KAR			252485	252646			EXTRA KAR OUTSIDE OF PROP

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Flight Log

Terrapoint

Project#	10105U	Session	1100971A

Date	APRIL 7	Julian Day	097
Project	CHANNEL ISLANDS	Aircraft	SPS RANGER
Staging	OXNARD	Call Sign	N919 6113
Survey Block	SANTA ROSA	Pilot	BARRY
Lines Complete	51	Operator	SCOTT
		Observer	
Mission Objective			

ALMIS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 24°C Outside Pressure @ TO:
Outside Temp @ LA: Outside Pressure @ LA: 3011

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Ramp Out	Takeoff
10:04		10:05
Engine Off (Hobbs)	**Ramp In**	**Landing**
11:11		11:10
Total hrs (Hobbs)	**Total hrs**	**Total hrs**
		1:05

Mission Plan

Flying Height AGL	Scan Angle (Optech)
600 m	60
Ground Speed	**Mirror Scan Rate**
50 KTS	50
First/Last/Alternating Return	**Laser Pulse Rate**
	100 KHZ

Static & KAR GPS // INS Alignment

Time ☐GPS	Str:	Fnd:
Pre Mission		
KAR Base	322870	323150
KAR Base	324080	324325
Post Mission	324777	325144

Flight Plan Line #	LiDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments (Please periodically record: Outside Temp; Cabin Temp; Laser Temp; Output Wattage)
51	100407_175318		323620	323868			GOOD

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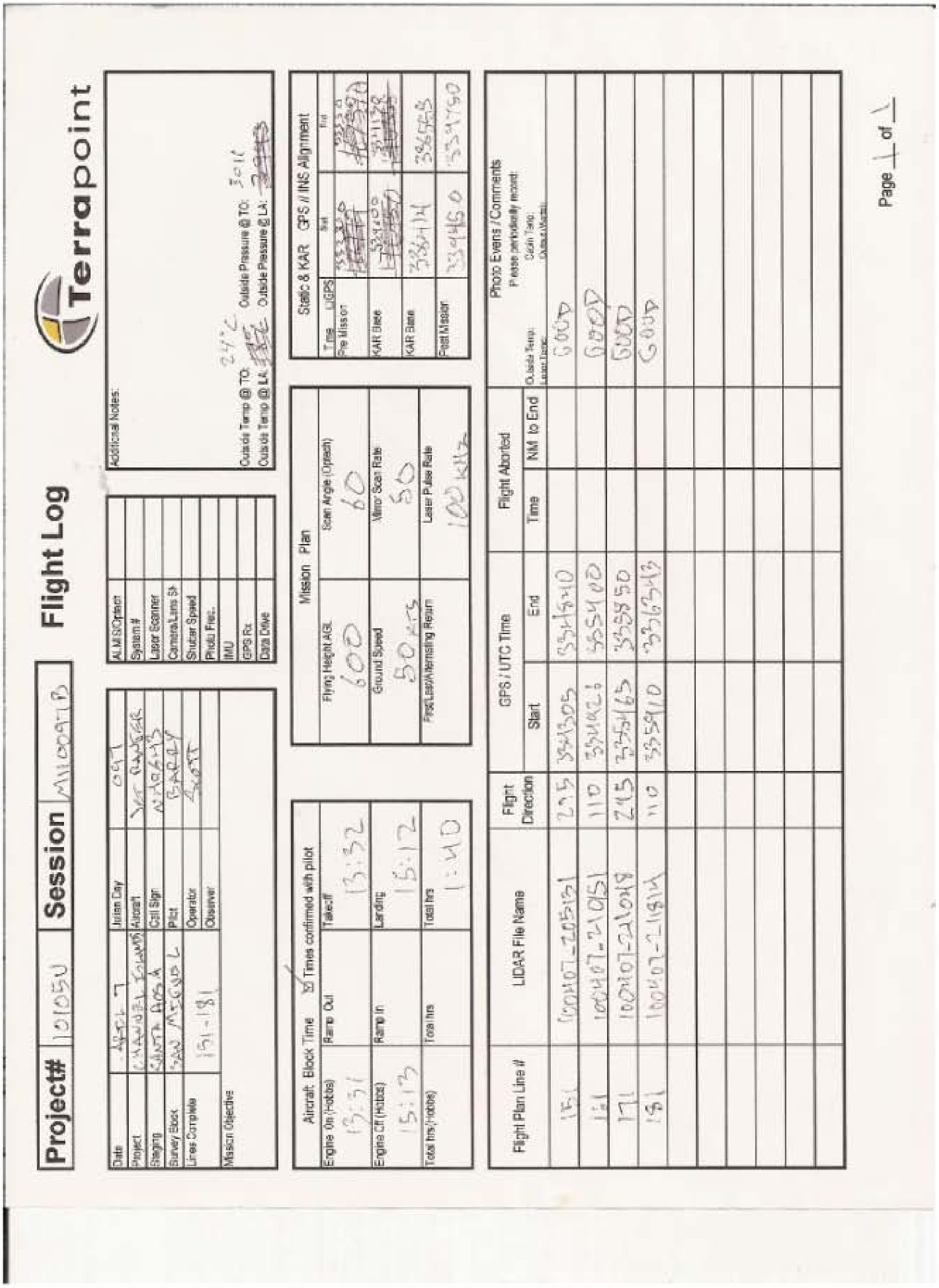

Flight Log

Terrapoint

Project#	10105U	Session	M110097B

Date	APRIL 7	Julian Day	097
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	SANTA ROSA	Call Sign	N1064S
Survey Block	SAN MIGUEL	Pilot	BARRY
Lines Complete	151-181	Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens S#	
Shutter Speed	
Photo Freq.	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 24°C Outside Pressure @ TO: 3011
Outside Temp @ LA: Outside Pressure @ LA:

Aircraft Block Time ☑ Times confirmed with pilot

Engine On (Hobbs) 13:31	Ramp Out	Takeoff 13:32
Engine Off (Hobbs) 15:13	Ramp In	Landing 15:12
Total hrs (Hobbs)	Total hrs	Total hrs 1:40

Mission Plan

Flying Height AGL 600	Scan Angle (Optech) 60
Ground Speed 50 KTS	Mirror Scan Rate 50
First/Last/Alternating Return	Laser Pulse Rate 100 KHz

Static & KAR GPS // INS Alignment

Time LIGPS	Start	End
Pre Mission	333300	333370
KAR Base	334100	334138
KAR Base	336414	336555
Post Mission	339450	339750

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Evens / Comments
151	100407_205131	295	334305	334840			GOOD
161	100407_210151	110	334926	335400			GOOD
171	100407_221048	295	335463	335850			GOOD
181	100407_211814	110	335910	336343			GOOD

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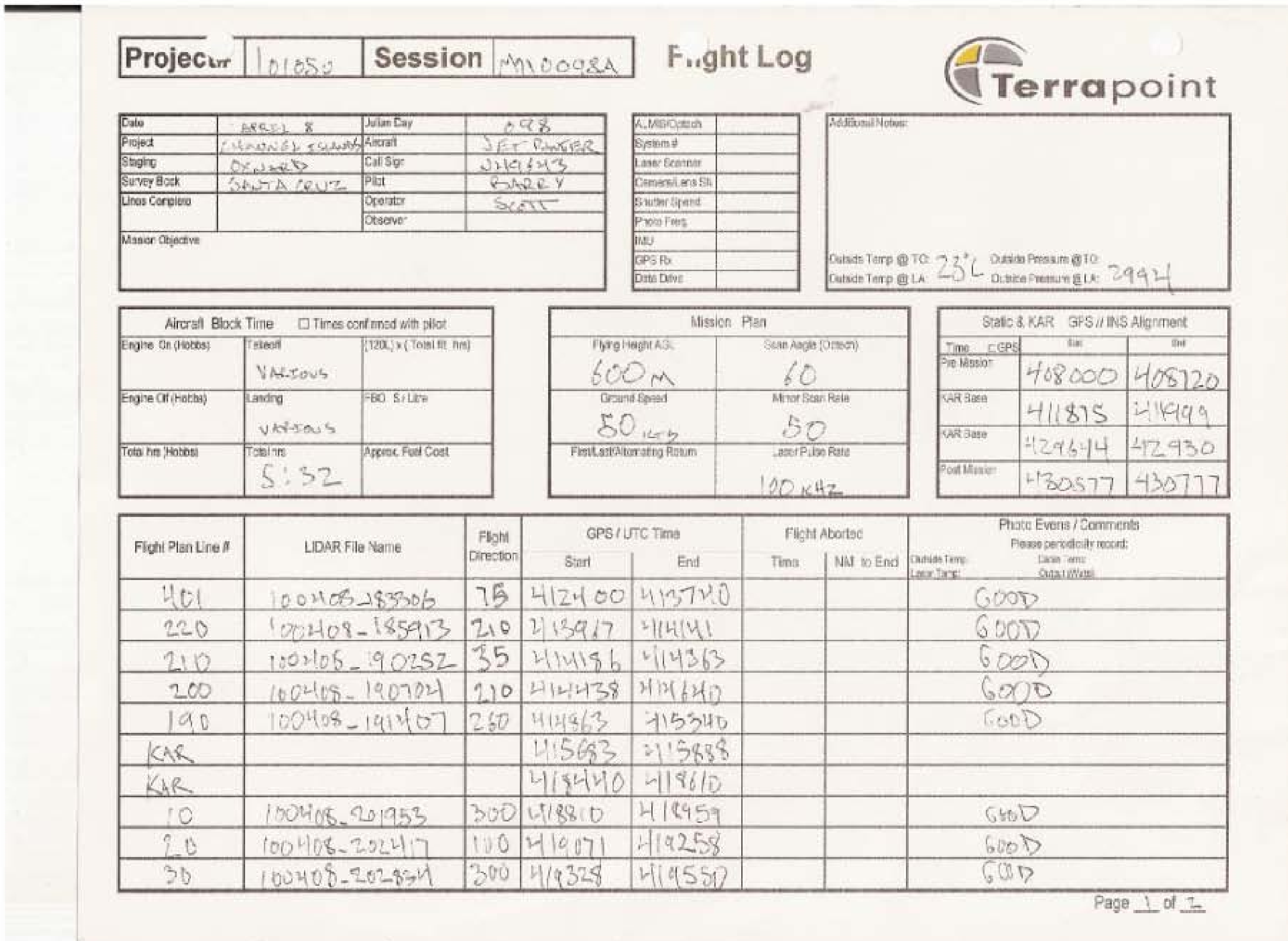

Project 101050 **Session** MN0098A **Flight Log** Terrapoint

Date	APRIL 8	Julian Day	098
Project	CHANNEL ISLANDS	Aircraft	JET RANGER
Staging	OXNARD	Call Sign	N14643
Survey Block	SANTA CRUZ	Pilot	BARRY
Lines Complete		Operator	SCOTT
		Observer	
Mission Objective			

ALMS/Optech	
System #	
Laser Scanner	
Camera/Lens SN	
Shutter Speed	
Photo Freq	
IMU	
GPS Rx	
Data Drive	

Additional Notes:

Outside Temp @ TO: 23°C Outside Pressure @ TO:
Outside Temp @ LA: 25C Outside Pressure @ LA: 2992

Aircraft Block Time ☐ Times confirmed with pilot

Engine On (Hobbs)	Takeoff: VARIOUS	(120L) x (Total flt. hrs)	
Engine Off (Hobbs)	Landing: VARIOUS	FBO $ / Litre	
Total hrs (Hobbs)	Total hrs: 5:32	Approx. Fuel Cost	

Mission Plan

Flying Height AGL: 600 m	Scan Angle (Optech): 60
Ground Speed: 50 kts	Mirror Scan Rate: 50
First/Last/Alternating Return	Laser Pulse Rate: 100 kHz

Static & KAR GPS / INS Alignment

Time ☐ GPS	Start	End
Pre Mission	408000	408120
KAR Base	411815	411999
KAR Base	429644	429930
Post Mission	430577	430777

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time Start	GPS / UTC Time End	Flight Aborted Time	Flight Aborted NM to End	Photo Events / Comments
401	100408_183306	75	412400	413740			GOOD
220	100408-185913	210	413917	414141			GOOD
210	100408_190252	35	414186	414363			GOOD
200	100408_190704	210	414438	414640			GOOD
190	100408_191407	260	414863	415340			GOOD
KAR			415683	415888			
KAR			418440	418610			
10	100408_201953	300	418810	418959			GOOD
20	100408_202417	100	419071	419258			GOOD
30	100408_202854	300	419328	419550			GOOD

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Project: 101050 Session: A100098A

Flight Log

Terrapoint

Flight Plan Line #	LIDAR File Name	Flight Direction	GPS / UTC Time		Flight Aborted		Photo Evens, Comments Please periodically record: Outside Temp: Cabin Temp: Laser Temp: Output (Watts):
			Start	End	Time	NM to End	
40	100408_203506		419720	419918			GOOD
50	100408_203930		419984	420202			GOOD
60	100408_204412		420267	420465			GOOD
70	100408_205320		420825	420940			GOOD
80	100408_205630		421005	421130			GOOD
90	100408_210116		421290	421717			GOOD
100	100408_210417		421772	422232			GOOD
110	100408_211800		422294	422710			GOOD
120	100408_212602		422776	423190			GOOD
130	100408_215532		423350	423762			GOOD
KAR			424100	425570			DID ONE LINE KAR THROUGH [illegible]
140	100408_221841		425940	426310			GOOD
150	100408_222550		426366	426755			GOOD
160	100408_223529		426943	427359			GOOD
170	100408_224321		427416	427890			GOOD
180	100408_230356		428651	429056			GOOD

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Appendix D Terrapoint Waveform File Structure

[redacted]