HAINES BEACH ROAD LANDSLIDE

WINTER SURVEY RECONNAISSANCE

Agreement No. 25213018 / IRIS Program No. SDRER00317 / Federal Project No. TBD

Prepared by:
AJ Griffin, PLS
R&M Consultants, Inc.
March 18, 2021

INTRODUCTION

The purpose of the winter reconnaissance effort was to recover and verify the existing survey control used for mapping and monitoring of the slide area and tie the survey control to the National Spatial Reference System (NSRS). R&M Consultants, Inc. (R&M) was also tasked with evaluating the existing monitor points/prisms currently used and working with Landslide Technology (LT) to develop recommendations for providing continued monitoring and possibly establishing an active monitoring solution with movement alerts. To accomplish this, R&M evaluated the site for the effectiveness of deploying a robotic total station and/or Global Navigation Satellite System (GNSS) equipment to facilitate the development of an automated monitoring system. While on site, R&M also assessed the area for future use of drone-based survey equipment for ongoing mapping and monitoring. Lastly, R&M preformed a comprehensive review and quality control examination of the existing 2020 LiDAR and drone-based imagery, and created one comprehensive base map. The survey was completed in accordance with Professional Services Agreement No. 25213018.

The field survey was performed by R&M February 22 through February 25, 2021. Field survey information can be found in R&M field book no. 2888.01, pages 1 through 5.

WINTER RECONNAISSANCE

SURVEY CONTROL

Horizontal Control

Methodology – Prior to mobilization, R&M reviewed control used by the Department of Natural Resources (DNR) for the 2020 LiDAR mapping and the temporary survey control used for the initial monitoring effort. R&M was able to locate and tie the necessary monuments from both surveys into one comprehensive static control network. In the process, R&M verified the control positions used by DNR. This effort will facilitate current and future work flows, as well as provide the ability to project mapped data in a useful coordinate system. The GNSS ties performed this survey allow R&M to establish future control that will be relative to the work previously done by others.

The positions for all the project control points were established by static GNSS network techniques using Trimble R10 and R10-2 receivers. All receivers were mounted on tripods and were centered over the point using tribrachs, which were pegged prior to use. The height reading was measured in feet and meters before and after each observation session. All data was collected at a maximum of five-second intervals with an elevation mask of 10. The receiver number, antenna height, start/stop times, and monument description were recorded in the field notes for each occupation. Digital photos were taken of all points tied. All control points were adjusted in a simultaneous least squares network adjustment within Trimble Business Center (TBC), version 5.20.

Coordinate System

This project is located entirely within Alaska State Plane Coordinate System of 1983 Zone 1, a rectangular plane coordinate system expressed in U.S. Survey Feet units developed by the National Geodetic Survey, National Ocean Service.

Basis of Coordinates – The Basis of Coordinates is the NAD83(2011) (EPOCH: 2010.0000) Geodetic value per OPUS Shared Solution dated 2020-12-15 of Primary Airport Control Station (PACS) "HNS D", PID A14905, a 3-1/2" brass cap set in top of a rock outcrop, having the following coordinates in U.S. Survey Feet:

NAD83(2011)(EPOCH: 2010.0000) Geodetic Coordinates
Latitude: 59°14'53.13952" North
Longitude: 135°32'03.04958" West
Ellipsoid Height: 55.210'

Alaska State Plane Zone 1 Coordinates
N= 2,713,021.99205'
E= 2,336,252.14042'

Basis of Bearings – Project bearings are based on Alaska State Plane Zone 1 grid bearings.

Vertical Control

Methodology – Elevations for the control used for this survey were derived by GNSS static techniques. No differential levels have been run between control points at this time.

Vertical Datum – The project vertical datum is NAVD88 utilizing Geoid12B. NAVD88 elevations were computed by holding the ellipsoid height of "HNS D" per the Shared Solution in TBC and having the software solve for the elevation. Elevations are based on Primary Airport Control Station "HNS D", point no. 1, having an elevation of 37.49 feet.

SLIDE PATH SURVEY

Temporary Monitoring

R&M, with the assistance of Dave Smith (Southeast Roadbuilders) and Erik Stevens (Haines Avalanche Center), was able to locate the survey control and monitor points currently being used for passive monitoring of the slide path. Unfortunately, recent snow fall obscured PT #102, a monitor point near the crack at the headscarp, preventing survey measurements at the time. Also, according to LT, PT #105, a monitor point on a large boulder in the temporary road has since been moved and is no longer usable as a monitor point. The amount of recent snowfall prevented LT and R&M from safely establishing any new monitor points within the slide area or outside the lateral boundaries of the slide.

AREA OF CONCERN (AOC) SURVEY

GNSS Evaluation

R&M traversed the entire slide area and AOC to the east with LT while on site. The terrain on both sides of the slide is very steep and heavily wooded with large coniferous trees. During the traverse, R&M was able to intermittently obtain GNSS Real Time Kinematic (RTK) initialization in the woods and used this information to verify topographic data derived from the 2020 LiDAR data. This effort also allowed R&M to analyze the effectiveness of utilizing GNSS in this challenging terrain.

CURRENT TOPOGRAPHY

Data Review & Quality Control

R&M has reviewed and compiled the current drone imagery and 2020 LiDAR data into one comprehensive base map referenced to the project coordinate system. While in the field, R&M performed quality control checks on the existing LiDAR data set in the area. The LiDAR-generated surface has a vertical accuracy of 0.97' at the 95% confidence level within the sampled area. The drone imagery acquired by others was captured autonomously and was found to be about 20'+/- off horizontally and 100' +/- vertically while in the field. R&M utilized the existing 2020 LiDAR data set to extract photo ID points to be used in controlling the drone imagery. After reprocessing the drone survey, R&M was able to get an orthoimage and associated photo point cloud to be within 1.6' horizontal and 1.3' vertical accuracy, as measured against the ground control check points. These numbers can all be improved upon greatly by implementing survey grade routines during the data capture process.

FUTURE MONITORING OPTIONS

OPTION #1

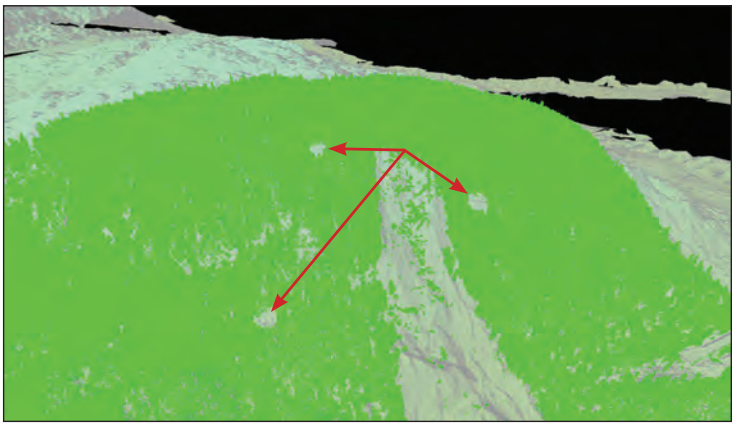
Long-Term Monitoring Slide Path

Potential robotic total station location

Long-term monitoring of the existing slide path and associated landslide features poses many challenges. Utilizing a robotic total station to monitor line of sight targets along the slide path will allow for active monitoring of the slide area. The instrument will need to be housed in a structure that provides protection from the elements, while providing an unobstructed 360° view. Backsight locations will have to be located away from the path and at a minimum, be built on a concrete pedestal, if not housed in their own structure. With the slide area having an open view of the sky, using solar panels to power the system and associated equipment seems reasonable. Battery back-up power would most likely be needed to get through the months of October through February. If possible, once power is restored to Beach Road, the ability to power the site from the grid would be ideal. We anticipate a good spot for the total station is on the outcrop about halfway up the slide area on the lookers left (see photo above). This spot should leave the instrument and structure safe from any future events. There are many different targets that can be placed on rocks, trees, poles, etc. Protecting them from the weather will be challenging. A hood constructed over the prism or monitoring point will help and is easily installed and commercially available. The potential for sideways snow sticking to targets may hamper monitoring operations. This option is also limited by weather conditions such as fog, mist, rain and snow. We cannot guarantee we will be able to obtain measurements all the time. It is possible to use more targets to enable better coverage of monitoring locations, even though some could be obscured from view. The area around the slide has good cellular service, so the ability to transfer data in real time exists.

OPTION #2

GNSS Monitoring



Example 50' radius clearing

To establish long term GNSS monitoring near the slide area, trees would have to be felled to open the sky. These cleared areas would then allow for accurate GNSS monitoring with an alert system. With the steep terrain and north facing aspect of the slide area, the AOCs could prove challenging for solar power as well. Access to these sites will require strenuous hiking and equipment will have to be slung by helicopter. Additionally, one base station would need to be established outside the slide area and constructed in town or at the airport. An opportunity would exist to develop this base as a Continuous Operating Reference Station (CORS) that could be incorporated into

the National Geodetic Surveys (NGS) CORS network. This would add value to the project, as well as benefit the community at large. Cellular service in the area seemed adequate and should be able to provide data transfers consistently if this approach is desired.

OPTION #3

Unmanned Aerial System (UAS) Monitoring

Utilizing LiDAR and photogrammetry sensors mounted on a UAS (Drone) to measure, map and monitor the area appears to be the most feasible option from a survey standpoint. Placing aerial targets in strategic locations areawide will allow for data points to be sited in potentially active areas, as well as control areas. This will allow for repeatability in the measurements, as well as keep expensive equipment and personnel out of potentially hazardous areas. By utilizing the same control points for base stations and executing the same flight plans each time, we will be able to accurately monitor the Beach Road slide and AOCs over time. Of course, weather plays a critical role in this monitoring as well. The UAS option would be afforded the luxury of being able to pick and choose fly days, as well as clear off targets prior to executing flights. Unfortunately, this option does not allow for real time active monitoring of the slide or provide an early warning system to residents of Beach Road.

SUMMARY

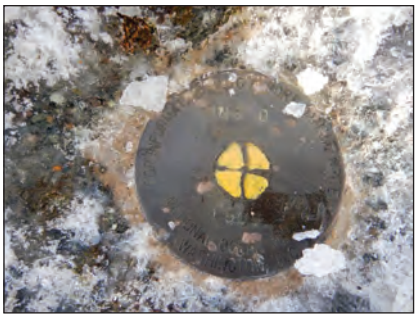
R&M believes that all three options are viable solutions to monitoring the Beach Road slide and surrounding areas. While all three pose certain challenges, if the need for real-time survey grade monitoring is desired, it can certainly be attained. R&M stands ready to provide whatever options DOT&PF and the Haines Borough decide is the best path forward.

SUPPORTING DATA

Project Control

PT #	NORTHING	EASTING	ELEV.	DESCRIPTION
1	2713021.9920	2336252.1404	37.49	FOUND BRASS CAP MONUMENT
10	2703157.2154	2358677.4008		TRIPOD
13	2703371.0662	2358538.6162	102.08	FOUND SPIKE
30	2707283.8623	2353377.1736	29.71	FOUND PK NAIL

PT#1



PT#10

PT#13

PT#30

Temporary Monitor Points

PT#101 & 102

PT#104

PT#105 (DESTROYED)

PT#106

PT#107

Temporary Monitor Spreadsheet

										R&M Survey
		12/12/20	12/22/20	12/29/20	01/07/21	01/12/21	01/20/21	01/27/21	02/12/21	02/23/21
POINT	**DESC**	**H. DIST.**	**H. DIST.**	**H. DIST.**	**H. DIST.**	**H. DIST.**	**H. DIST.**	**H. DIST.**	**H. DIST.**	**H. DIST.**
10	TRIPOD									
13	BS	254.9	254.9	254.9	254.9	254.9	254.9	255.0	255.0	254.9
101	TREE	1650.9	*	*	1650.9	1650.9	1650.8	1650.9	1650.8	1650.7
102	TREE	1679.2	1679.3	*	1679.3	1679.2	1679.2	1679.2	1679.2	*
104	ROCK	149.5	149.6	149.5	149.5	149.5	149.5	149.3	149.4	149.4
105	ROCK	229.0	229.0	229.0	229.0	229.1	229.1	***229.7	229.6	229.8
106	HOUSE	188.6	188.6	188.6	188.6	188.6	188.7	188.7	188.7	188.8
107	HOUSE						**168.7	168.7	168.7	168.7
NOTES										
*	Could not measure (snow covering reflector).									
**	New Monitoring point (initial measurement 1/20/21).									
***	Rock monitoring point moved during construction of temporary Access road on 1/24/21.									

Data Review & Quality Control

LiDAR TIN Checks

POINT	NORTHING	EASTING	ELEVATION		SURFACE ELEVATION	Δ ELEVATION	(Δ ELEVATION)^2	GROUND TYPE
6002	2703380.87	2358543.55	101.793		101.26	-0.54	0.286	GRASS
6005	2703157.97	2359295.79	110.226		109.79	-0.44	0.194	EXIST. ROAD
6006	2703055.86	2359339.52	120.719		120.18	-0.54	0.289	DRIVEWAY
6007	2702913.21	2359268.77	154.116		154.90	0.78	0.615	WOODS/MOUNTAIN
6008	2702848.34	2359225.9	208.808		208.60	-0.21	0.043	WOODS/MOUNTAIN
6009	2702668.18	2359387.11	269.081		268.93	-0.15	0.023	WOODS/MOUNTAIN
6010	2702448.94	2359335.03	310.552		309.78	-0.78	0.601	WOODS/MOUNTAIN
6011	2702328.89	2359090.48	370.733		370.30	-0.44	0.190	LANDSLIDE
6012	2702195.87	2359257.31	410.019		410.25	0.23	0.054	WOODS/MOUNTAIN
6017	2702701.55	2359828.61	164.661		164.05	-0.61	0.371	DRIVEWAY
6019	2702116.11	2359947.46	375.929		375.51	-0.42	0.177	WOODS/MOUNTAIN
6020	2701677.56	2359916.98	538.417		538.71	0.29	0.086	WOODS/MOUNTAIN
Total TIN Check Points								12
Root Mean Square Error (RMSE)								0.49
FGDC NSSDA Vertical Accuracy (95% Confidence Level)								**0.97**

Drone Photo Control Checks

Ground Control Points

GCP Name	Accuracy XY/Z [ft]	Error X [ft]	Error Y [ft]	Error Z [ft]	Projection Error [pixel]	Verified/Marked
1 (3D)	0.020/ 0.020	-0.014	0.012	-0.051	1.172	10 / 10
2 (3D)	0.020/ 0.020	-0.145	-0.048	-0.499	0.820	10 / 10
5 (3D)	0.020/ 0.020	0.035	-0.347	-0.137	0.858	10 / 10
6 (3D)	0.020/ 0.020	0.365	0.523	0.731	1.816	11 / 11
7 (3D)	0.020/ 0.020	-0.204	-0.167	-0.376	0.712	11 / 11
8 (3D)	0.020/ 0.020	-0.015	-0.002	0.257	1.187	10 / 10
9 (3D)	0.020/ 0.020	0.129	0.045	0.331	0.629	10 / 10
Mean [ft]		0.021662	0.002304	0.036650		
Sigma [ft]		0.173497	0.246667	0.398591		
RMS Error [ft]		0.174844	0.246677	0.400272		

0 out of 3 check points have been labeled as inaccurate.

Check Point Name	Accuracy XY/Z [ft]	Error X [ft]	Error Y [ft]	Error Z [ft]	Projection Error [pixel]	Verified/Marked
3		0.6289	-1.5430	1.7247	1.6818	10 / 10
4		-0.5108	-2.0439	1.2662	0.9819	10 / 10
10		-0.3031	0.8847	-0.4382	1.1334	10 / 10
Mean [ft]		-0.061655	-0.900759	0.850864		
Sigma [ft]		0.495573	1.278935	0.930545		
RMS Error [ft]		0.499393	1.564302	1.260906		

FIELD PERSONNEL

AJ Griffin, PLS

FIELD EQUIPMENT

Trimble R10 & R10-2 multi-frequency GNSS Receivers

Trimble S7 Total Station

Trimble TSC3 Data Collector

DRAFTING

Autodesk Civil 3D 2018

CERTIFICATION

PREPARED BY:

R&M Consultants, Inc.

9101 Vanguard Drive

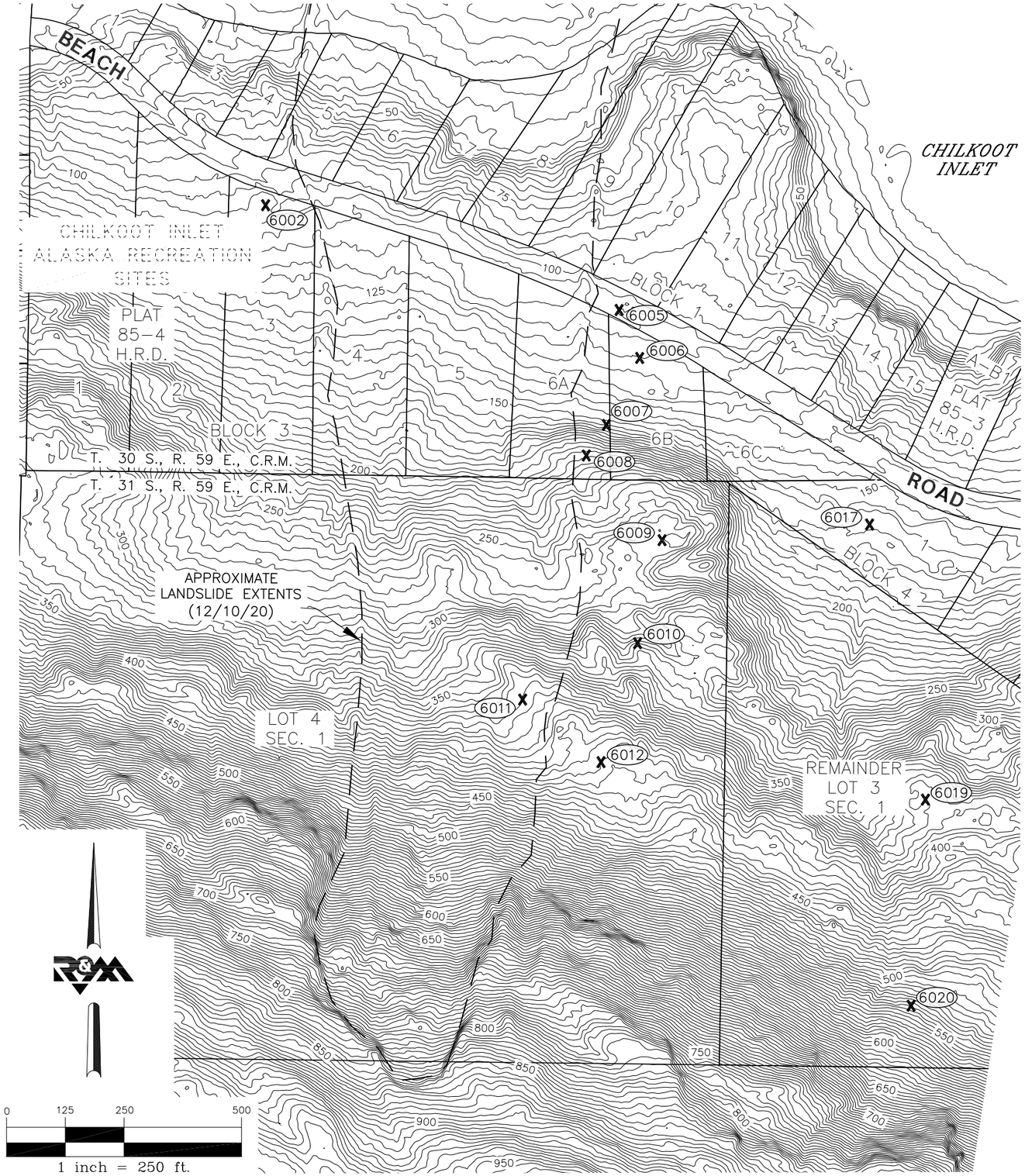
Anchorage, Alaska 99507

Certificate of Authorization

No. AECC111

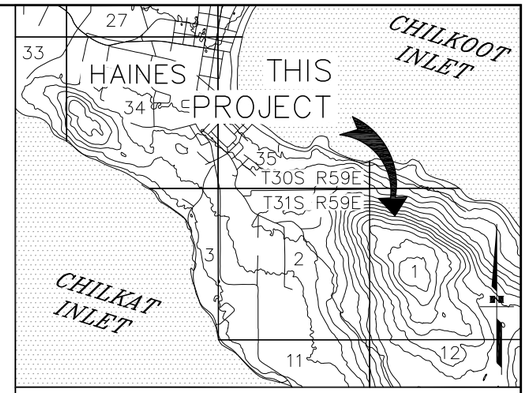
ATTACHMENTS

1. MAP EXHIBIT
2. FIELD NOTES
3. GNSS NETWORK ADJUSTMENT REPORT
4. OPUS SHARED SOLUTION
5. ORTHOIMAGERY PROCESSING REPORT



Legend:

- Survey Control Point (SCP)
- Temporary Monitor Point
- TIN Check (GNSS Location)
- 250 — Major Contour
- H.R.D. — Haines Recording District
- (123) — Point Number



VICINITY MAP

Scale: 1" = 1 Mile

USGS Skagway (A-2 NE)

Notes:

1. The information shown hereon is based on a field survey performed by R & M Consultants, Inc. (R&M) February 22 thru February 25, 2021. Field survey information can be found in R&M field book no. 2888.01, pages 1 thru 5.
2. The positions of horizontal control points shown hereon were determined by a constrained least-squares adjusted static GNSS network, utilizing Trimble R10 multi-frequency receivers in Trimble Business Center ver. 5.20.
3. All dimensions, coordinates, and elevations shown hereon are expressed in U.S. Survey Feet, unless otherwise noted.
4. Property lines shown hereon were provided by Haines Borough GIS and are for reference only.
5. Contours shown hereon were created from the 2020 Digital Terrain Model developed by State of Alaska Geological & Geophysical Surveys. Airborne data was collected on December 8-12, 2020. Minor contour interval is 5'.
6. Background imagery shown hereon was captured via Unmanned Aerial System (UAS) by Elevate UAS on December 10, 2020.

STATE OF ALASKA
49TH
Alan J. Griffin
LS-13020
3/17/21
REGISTERED PROFESSIONAL LAND SURVEYOR

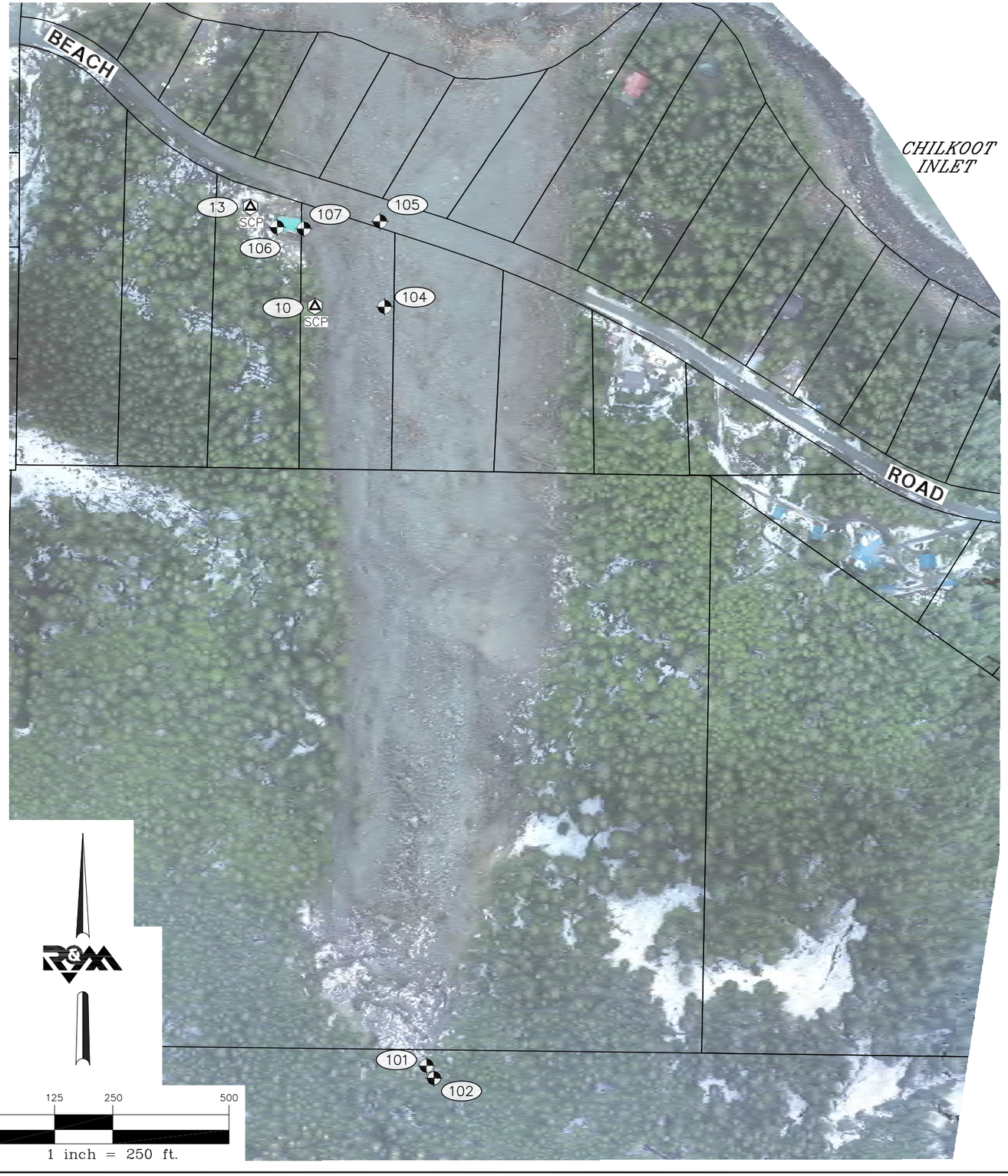
CERTIFICATE OF AUTHORIZATION
No. AECC111

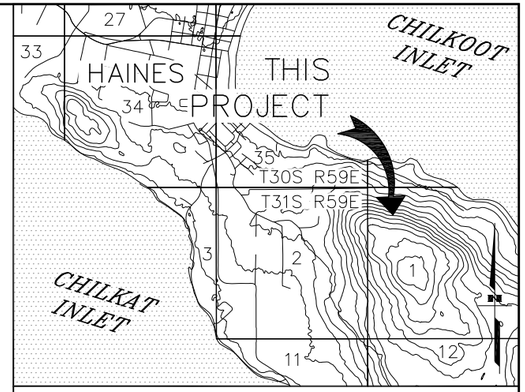
EXHIBIT

BEACH ROAD LANDSLIDE WINTER SURVEY RECONNAISSANCE

9101 Vanguard Drive
Anchorage, Alaska, 99507
PH (907) 522-1707
www.rmconsult.com

DRAWN:	AJG	PROJECT:	2888.01	DATE:	03/17/21
CHECKED:	WP	SCALE:	1"=250'	SHEET:	1 OF 3





VICINITY MAP

Scale: 1" = 1 Mile

USGS Skagway (A–2 NE)

Legend:

SCP	Survey Control Point
	Temporary Monitor Point
X	TIN Check (GNSS Location)
250	Major Contour
H.R.D.	Haines Recording District
123	Point Number

STATE OF ALASKA
49 TH
Alan J. Griffin
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3/17/21
REGISTERED PROFESSIONAL LAND SURVEYOR

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DRAWN:	AJG	PROJECT:	2888.01	DATE:	03/17/21
CHECKED:	WP	SCALE:	1"=250'	SHEET:	2 OF 3

PRIMARY CONTROL				
POINT	NORTHING	EASTING	ELEVATION	DESCRIPTION
1	2713021.9920	2336252.1404	37.49	Found Brass Cap Monument
10	2703157.2154	2358677.4008	–	TRIPOD
13	2703371.0662	2358538.6162	102.08	Found Spike / Nail
30	2707283.8623	2353377.1736	29.71	Found PK / Magnail

TEMPORARY MONITOR POINTS			
POINT	NORTHING	EASTING	DESCRIPTION
101	2701523.87	2358917.39	TREE
102	2701497.60	2358933.27	TREE
104	2703156.07	2358826.93	ROCK
*105	2703339.03	2358816.68	ROCK
106	2703327.23	2358595.87	HOUSE
107	2703324.20	2358653.30	HOUSE

* Monitor point destroyed 2/27/2021

Note:
Temporary monitor coordinates shown here are based upon control file received 2/8/2021 provided by Dave Smith, PLS (Local Surveyor) and have been translated and rotated to the recovered survey control positions. These are the initial baseline monitor point locations.

TIN SURFACE CHECKS				
POINT	ELEVATION	SURFACE ELEVATION	Δ ELEVATION	GROUND TYPE
6002	101.79	101.26	−0.54	GRASS
6005	110.23	109.79	−0.44	EXIST. ROAD
6006	120.72	120.18	−0.54	DRIVEWAY
6007	154.12	154.90	0.78	WOODS/MOUNTAIN
6008	208.81	208.60	−0.21	WOODS/MOUNTAIN
6009	269.08	268.93	−0.15	WOODS/MOUNTAIN
6010	310.55	309.78	−0.78	WOODS/MOUNTAIN
6011	370.73	370.30	−0.44	LANDSLIDE
6012	410.02	410.25	0.23	WOODS/MOUNTAIN
6017	164.66	164.05	−0.61	DRIVEWAY
6019	375.93	375.51	−0.42	WOODS/MOUNTAIN
6020	538.42	538.71	0.29	WOODS/MOUNTAIN
TOTAL TIN CHECK POINTS				12
ROOT MEAN SQUARE ERROR (RMSE)				0.49
FGDC NSSDA VERTICAL ACCURACY (95% CONFIDENCE LEVEL)				0.97

Vertical Control Statement:
Vertical Datum:
The project vertical datum is NAVD88 utilizing Geoid12B. NAVD88 elevations were computed by seeding the ellipsoid value of "HNS D" per said Shared Solution in Trimble Business Center and having the software solve for the elevation. Elevations are based on Primary Airport Control Station "HNS D", point no. 1, having an elevation of 37.49 feet.

Horizontal Control Statement:
Coordinate System:
This project is located entirely within Alaska State Plane Coordinate System of 1983 Zone 1, a rectangular plane coordinate system expressed in U.S. Survey Feet units, developed by the National Geodetic Survey, National Ocean Service.

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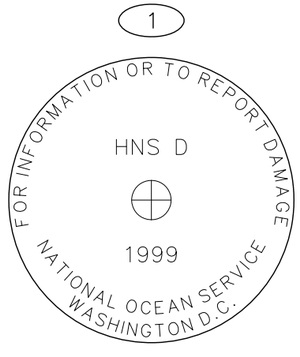

FOUND 3−1/2" BRASS CAP,
FLUSH WITH TOP OF ROCK OUTCROP.

CERTIFICATE OF AUTHORIZATION
No. AECC111

EXHIBIT

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9101 Vanguard Drive
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CHECKED:	WP	SCALE:	N.T.S.	SHEET:	3 OF 3

Z888.01

Rite in the Rain®
ALL-WEATHER
CROSS SECTION FIELD BOOK
№ 370-6F

HAINES BEACH ROAD LANDSLIDE

Z888.01 HNS BEACH RD. LANDSLIDE

No. 370-6F - Cross Section - 6.75"x8.75"
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ISBN 978-1-932149-49-4

CONTENTS

PAGE	REFERENCE	DATE

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— SINCE 1916 —
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ALL-WEATHER
CROSS SECTION FIELD BOOK

Name R & M CONSULTANTS, INC

Address 9101 VANGUARD DR.
ANCHORAGE AK, 99507

Phone

Project 2888.01 DOT_SC HAINES
BEACH ROAD LANDSLIDE

MADE USA · RITE GREEN · Archival paper

RiteintheRain.com

JL DARLING LLC
Tacoma, WA 98424-1017 USA
US Pat No. 6,863,940
10-19

INDEX

(i)

DALY JOURNAL

FEB. 21, 2021

TRAVEL ANC TO JNU

ACQUIRE BEAR SPRAY

LODGING @ GRANDMA'S BEST WESTERN

FEB. 22, 2021

5:00 AM TRAVEL TO HNS VIA FERRY

11:30 AM ARRIVE IN HNS, LODGING @ ASPEN SUITES

12:00 - 2:00 RENTAL CARS, DRIVE BY SITE ASSESS ACCESS BY FOOT

2:00 - 3:00 MEET W/ EOC DISCUSS SAFETY & ACCESS TO SITE

3:00 - 5:00 SEARCH FOR PREVIOUS SURVEY CONTROL

5:00 - 7:00 UNPACK GEAR, CHARGE EQUIP ORGANIZE ~~FOR~~ DATA FOR FIELD

FEB 23, 2021

7:00AM - 10:00 SETUP RTK BASE @ PT DNR USED FOR TOPO, RECOVER HNS D @ AIRPORT SETUP STATIC BASE, MEET W/ APT MGR AND FIND HNS A

10:15AM MEET ERIC STEVENS @ BEACH RD TO RECOVER MONITOR CONTROL

10:30 - 3:30 RECOVER DAVE SMITH CONTROL & TRIPOD STATIC SVY OF CONTROL, SHOOT MONITOR POINTS.

3:30 - 4:00 BREAK DOWN GEAR

4:00+ FIELD NOTES, PROCESS DATA

Z 388.01

A. GRIFFIN

FEB 24, 2021

6:30 - 8:00 FIELD NOTES, UPDATE MONITOR SPREADSHEET PACK UP GEAR SETUP RTK BASE

8:30 - 3:30 MEET LT, ACCESS SLIDE VIA BEACH RD HIKE E. FLANK OF SLIDE. TOOK TINCLITS ALONG THE WAY. GOOD RTK RADIO ALL DAY TOOK A WHILE TO GET LOCK IN WOODS BUT WAS MOSTLY POSSIBLE. RTK WORKED GOOD ~~RTK~~ ON LATERAL SLOPE OF SLIDE WAS TRACKING 15-20 SATS ALL DAY ON ROVER. ~~DIFF~~ YESTERDAYS STATIC ON PT #10 PROCESSED WELL. PT 10 IS ON WLY FLANK OF THE LATERAL SLOPE. TERRAIN WAS DIFFICULT HIKING W/ UP TO A COUPLE FEET OF SNOW UP HIGH. LARGE TALL TREES AND LOTS OF LOW UNDERBRUSH STEEP SLOPES! STATIC IN THE WOODS W/ FAIRLY OPEN SKY SHOULD BE POSSIBLE

3:30 - 4:00 BREAK DOWN GEAR, CHECK W/ ACASICA SEAPLANE ABOUT CARGO

4:30 - 6:30 DOWNLOAD DATA, FIELD NOTES, ORGANIZ GEAR FOR SHIPPING

FEB 25, 2021

7:30 - 2:00 SETUP BASE MEET LT AND ACCESS ECY AOC. SIMILAR RESULTS W/ RTK. THINNER TREES BUT STEEP N. FACING TERRAIN MADE INITIALIZATION CHALLENGING. GOOD CELL COVERAGE ALL DAY. TRAVERSED SLIDE + HEADSCARP. CAME DOWN W. SIDE TO MT RICE ROAD.

2:30 - 4:00 PACK UP GEAR AND SHIP TO JNU — ANC. NOTES AND DATA

DAILY

JOURNAL

MONITOR SHA ON MOUND E. SIDE?
ACCESS TO UPPER AOIS DIFFICULT
POWER MAJOR ISSUE
~~IS GS NECESSARY~~
~~ASSUMED CTRL IN WOODS? JUST S + DIST?~~
CELL COVERAGE FOR DATA TRASNFER
STEEP N. FACING TERRAIN
TALL TREES
ANCHOR GPS W/ LT EQUIP
SOLAR PANELS + LOTS OF BATTERIES
NO POWER TO SLIDE AREA CURRENTLY
HELICOPTER TO SLING EQUIP TO POT. MONITOR AREAS
TOTAL STATION MONITOR IN SLIDE AREA SHOULD BE EASY.
RTK / GPS ALONG LATERAL SLOPES & HEADSCARP DOABLE
SOME SORT OF HEATING ELEMANT (SNOW MACHINE HAND WARMER) TO KEEP TARGETS CLEAR OF SNOW
DEBRIS APPEARS TO BE GONE BELOW TIDE LINE NO BATHY NECESSARY
DRONE TARGETS COULD BE BUCKET LID ON REBAR SET @ TO REFUSAL
PHASED APPROACH TO TEST PRACICALITY
AMOUNT OF SNOW ON SITE HAMPERED RECON

2389.01

A. GRIFFIN

FEB 26, 2021

7:00 – 8:00 PACK-UP AND HEAD TO AIRPORT

8:00 – 11:00 TRAVEL HNS TO JNU

11:00 – 3:00 NOTES / DATA, WAIT FOR ALASKA FLT TO ANC, CHECK ON CARGO & SHOULD BE ON FLT TO ANC TONIGHT

3:00 – 5:00 TRAVEL TO ANC.

Z993.01

A. GRIFFIN

Z-23-21

30°F

PTLY CLOUDY

TRIMBLE

R-10

(1)

NEW SURVEY

HNS

BEACH ROAD

LANDSLIDE

HORIZ CONTROL

(80) <BASE>

START : 09:27 AM

STOP : 3:15 PM

FPKV

RECVR # 0369

ANT TYPE R-10

FILE 0369 0541.T02

HI 4.871 FT LEVER R-10

1.484 M EXT

ARP 1.679 M

FOUND SMALL PK NAIL IN EXPANSION JOINT OF CONC. SIDEWALK

(1) <BASE>

START 9:48 AM

STOP 2:59 PM (11.484 M)

FBCMONV

RECVR # 6933

ANT TYPE R-10

FILE 6933 0540.T02

4.871 FT LEVER R-10

HI 1.485 M EXT

ARP 1.680 M

FOUND 3½" BRASS CAP IN ~~BED~~ CONCRETE. TOP OF LARGE OUTCROP BEDROCK NW COR AIRPORT 7.5' SLY OF ORANGE CARSONITE. SET FLUSH GOOD COND

FOR INFORMATION OR TO REPORT DAMAGE WRITE TO

HNS D

1999

NATIONAL OCEAN SERVICE WASHINGTON D.C.

COPY

HNS
BEACH ROAD
LANDSLIDE
HORIZ CONTROL

(2) LOT

(13) <BASE>
FSPKV

START 10:58 AM

STOP 11:38 AM
(1.416M)

RECV'R # 0269

ANT TYPE R-10

FILE 02690540.T04

4.647 ✓ FT LEVER

ARP 1.609 M

HI 1.416 M R-10 EXT

(10) <BASE>

START 12:32 PM

TRIPOD

STOP 1:13 PM
(1.586M)

RECV'R # 0269

ANT TYPE R-10

FILE 02690541.T04

5.205 ✓ FT LEVER

ARP 1.785

HI 1.586 M R-10 EXT

Z333.01

A. GRIFFIN

Z-23-21

30°F

PTLY CLOUDY

(2)

TRIMBLE

R-10

FOUND SPIKE SET BY DAVE SMITH, NEAR NE COR OF STEEL FRAME STRUCTURE W/ NO SIDING W/LY OF HOUSE AND SMALL CREEK

FOUND TRIPOD SET SOLID IN SLIDE DEBRIS, UPHILL FROM HOUSE ON W/LY EDGE OF SLIDE

(5) K
CONT'D

HNS
BEACH ROAD
LANDSLIDE
MONITOR

X @ (10) TRIPOD			BS @ (13) FSPKV	-30 MM
HI = 5.74 ✓			HT = 4.90 ✓	

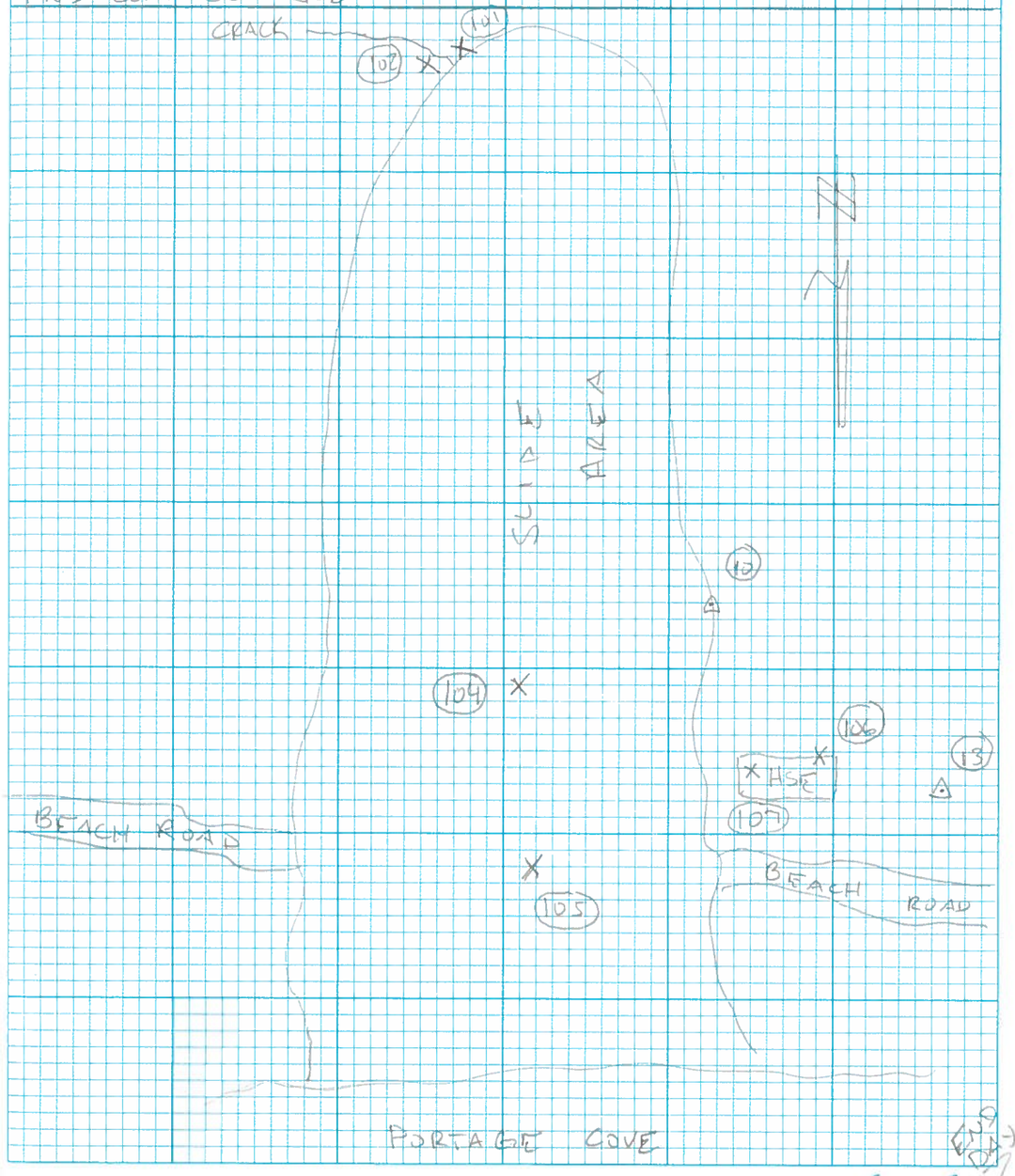
STAKE	STORE	HT	CODE	DESCRIPTION
13	5001	4.90 ✓	HORCHK13	HD = + 0.083
106	5002	ϕ D.R. ✓	HORCHK106	BOTT. LEFT COR OF SECOND STY WINDOW. WLY MOST WINDOW
107	5003		HORCHK107	CTR CHIMNEY ELY SIDE OF HOUSE @ WELD
105	5004		HORCHK105	ROCK FACE
104	5005		HORCHK104	ROCK FACE
102	—		—	REFLECTOR ON TREE OBSCURED BY SNOW
101	5006		HORCHK101	REFLECTOR ON TREE
13	5007	4.90 ✓	HORCHK13	HD = + 0.086

7999.01

A. GRIFFIN
PRESSURE: 30.24 in Hg
PPM: -22
HNS-CONV-0041.JOB

2-23-21
34°F
PTLY CLOUDY

(3)
TRIMBLE
S7



(4)
NEW DAY

HNS
BEACH ROAD
LANDSLIDE
RTK CHECK

BASE @ (30) <BASE RTK>
FPKV

START 7:59 AM
STOP 3:30 PM

RECVR # 0369

ANT TYPE: R-10

FILE: 03690551.T02

4.579 ✓ FT LEVER R-10 EXTENSION

ARP 1.5898 M HI 1.395 M

STORE	ROD	CODE	DESCRIPTION
6001	6.68	VERCHK13	H=0.047 V=0.050
6002-6014	"	TINCHK	
6015	"	VERCHK13	H=0.039 V=-0.002

6384.01

A. GRIFFIN
2-24-21
34°F
SNOW

(4)
TRIMBLE
R-10

HNS_RTK_0041.JOB

NOTE: HAD TO RESTART BASE AFTER CHECKING RADIO CHANNEL. FORGOT TO ENTER HI. NEED TO ENTER BASE HI IN TBC.
AND RECOMPUTE PROJECT. ADDED PT 13 TO JOB FILE FOR INU IN FIELD CHECK. JOB FILE HAS PRELIM CONTROL VALUES NEED TO UPDATE VALUES FOR PT #30 TO CURRENT COORD PER STATIC SVY
2/23/21

(5) NEW DAT

HWS
BEACH ROAD
LANDSLIDE

BASE # (30) <BASE RTK>
FPKU

RECVR# 0369

ANT TYPE: R-10

FILE 03690560.T02

ARP 1.6031 M

START 7:54 AM
STOP 2:16 PM

4.317 FT LEVER R-10 EXTENSION

HI 1.468 M

STORE	ROD	CODE	DESCRIPTION
6016	6.68	VERCHK13	H=0.103 V=0.004
6017-6022	"	TINCHK	
6023	"	VERCHK13	H=0.025 V=0.021

C989.1

A. GRIFFIN

2-25-21
32°
SNOW

(5)
TRIMBLE
R-10

HWS-RTK-0041

END DAT

Haines Beach Road Landslide

R&M CONSULTANTS, INC.
9101 Vanguard Drive
Anchorage, Alaska 99507

Phone: 907.646.9639
agriffin@rmconsult.com

Project File Data		**Coordinate System**	
Name:	C:\Work\!!R&M_Projects\TBC Projects\HNS Static Control_02-23-21.vce	Name:	United States/State Plane 1983
Size:	74 KB	Datum:	NAD 1983 (Alaska)
Modified:	3/3/2021 11:14:43 AM (UTC:-9)	Zone:	Alaska Zone 1 5001
Time zone:	Alaskan Standard Time	Geoid:	GEOID12B (Alaska)
Reference number:	2888.01	Vertical datum:	NAVD88
Description:	Haines Beach Road Landslide	Calibrated site:	
Comment 1:			
Comment 2:			
Comment 3:			

Network Adjustment Report

Adjustment Settings

Set-Up Errors

GNSS

Error in Height of Antenna: 0.007 ft

Centering Error: 0.010 ft

Covariance Display

Horizontal:

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 ft

Scale on Linear Error [S]: 1.960

Three-Dimensional

Propagated Linear Error [E]: U.S.

Constant Term [C]: 0.000 ft

Scale on Linear Error [S]: 1.960

Adjustment Statistics

Number of Iterations for Successful Adjustment:	2
Network Reference Factor:	0.84
Chi Square Test (95%):	Passed
Precision Confidence Level:	95%
Degrees of Freedom:	6

Post Processed Vector Statistics

Reference Factor:	0.84
Redundancy Number:	6.00
A Priori Scalar:	1.00

Control Coordinate Comparisons

Values shown are control coordinates minus adjusted coordinates.

Point ID	ΔNorthing (US survey foot)	ΔEasting (US survey foot)	ΔElevation (US survey foot)	ΔHeight (US survey foot)
30	-0.077	-0.045	0.045	?

Control Point Constraints

Point ID	Type	North σ (US survey foot)	East σ (US survey foot)	Height σ (US survey foot)	Elevation σ (US survey foot)
1	Local	Fixed	Fixed	Fixed	
Fixed = 0.000003(US survey foot)					

Adjusted Grid Coordinates

Point ID	Northing (US survey foot)	Northing Error (US survey foot)	Easting (US survey foot)	Easting Error (US survey foot)	Elevation (US survey foot)	Elevation Error (US survey foot)	Constraint
1	2713021.9920	?	2336252.1404	?	37.490	?	LLh
10	2703157.2154	0.030	2358677.4008	0.026	138.293	0.085	

13	2703371.0662	0.024	2358538.6162	0.022	102.084	0.037	
30	2707283.8623	0.019	2353377.1736	0.018	29.714	0.033	

Adjusted Geodetic Coordinates

Point ID	Latitude	Longitude	Height (US survey foot)	Height Error (US survey foot)	Constraint
1	N59°14'53.13952"	W135°32'03.04958"	55.210	?	LLh
10	N59°13'21.86955"	W135°24'47.06991"	154.933	0.085	
13	N59°13'23.94029"	W135°24'49.84148"	118.734	0.037	
30	N59°14'01.15412"	W135°26'30.95578"	46.645	0.033	

Adjusted ECEF Coordinates

Point ID	X (US survey foot)	X Error (US survey foot)	Y (US survey foot)	Y Error (US survey foot)	Z (US survey foot)	Z Error (US survey foot)	3D Error (US survey foot)	Constraint
1	-7655016.3836	?	-7513592.2012	?	17907226.177	?	?	LLh
10	-7644824.7110	0.049	-7535380.8440	0.042	17902572.182	0.067	0.093	
13	-7644784.1333	0.024	-7535138.3252	0.024	17902648.654	0.036	0.049	
30	-7646137.7568	0.021	-7529086.3330	0.021	17904519.631	0.030	0.042	

Error Ellipse Components

Point ID	Semi-major axis (US survey foot)	Semi-minor axis (US survey foot)	Azimuth

10	0.040	0.029	N27°E
13	0.029	0.027	S6°E
30	0.024	0.023	N15°E

Adjusted GNSS Observations

Observation ID		Observation	A-posteriori Error	Residual	Standardized Residual
1 --> 30 (PV101)	**Az.**	S73°02'58"E	0.221 sec	-0.099 sec	-1.158
	ΔHt.	-8.565 ft	0.033 ft	-0.016 ft	-1.464
	Ellip Dist.	18061.614 ft	0.018 ft	0.009 ft	1.238
10 --> 30 (PV99)	**Az.**	N53°34'01"W	0.942 sec	-0.514 sec	-1.446
	ΔHt.	-108.289 ft	0.083 ft	0.026 ft	0.800
	Ellip Dist.	6717.541 ft	0.024 ft	0.007 ft	0.685
1 --> 10 (PV102)	**Az.**	S67°49'47"E	0.269 sec	0.206 sec	1.368
	ΔHt.	99.724 ft	0.085 ft	0.046 ft	0.873
	Ellip Dist.	24500.182 ft	0.024 ft	-0.013 ft	-1.188
1 --> 13 (PV103)	**Az.**	S68°09'35"E	0.197 sec	0.039 sec	0.404
	ΔHt.	63.524 ft	0.037 ft	0.026 ft	1.187
	Ellip Dist.	24287.430 ft	0.022 ft	-0.003 ft	-0.302
30 --> 13 (PV100)	**Az.**	S54°19'48"E	0.675 sec	-0.149 sec	-0.645
	ΔHt.	72.089 ft	0.029 ft	-0.008 ft	-1.185
	Ellip Dist.	6477.186 ft	0.021 ft	0.001 ft	0.136

Covariance Terms

From Point	To Point		Components	A-posteriori Error	Horiz. Precision (Ratio)	3D Precision (Ratio)
10	1	**Az.**	N67°43'33"W	0.268 sec	1 : 1037117	1 : 1034040
		ΔHt.	-99.724 ft	0.085 ft		
		ΔElev.	-100.803 ft	0.085 ft		
		Ellip Dist.	24500.182 ft	0.024 ft		
10	30	**Az.**	N53°34'01"W	0.938 sec	1 : 283995	1 : 281068

		ΔHt.	-108.289 ft	0.083 ft		
		ΔElev.	-108.579 ft	0.083 ft		
		Ellip Dist.	6717.541 ft	0.024 ft		
13	1	**Az.**	N68°03'23"W	0.196 sec	1 : 1103081	1 : 1105573
		ΔHt.	-63.524 ft	0.037 ft		
		ΔElev.	-64.594 ft	0.037 ft		
		Ellip Dist.	24287.430 ft	0.022 ft		
13	30	**Az.**	N54°18'21"W	0.672 sec	1 : 305879	1 : 306781
		ΔHt.	-72.089 ft	0.029 ft		
		ΔElev.	-72.370 ft	0.029 ft		
		Ellip Dist.	6477.186 ft	0.021 ft		
30	1	**Az.**	N72°58'13"W	0.221 sec	1 : 989968	1 : 990113
		ΔHt.	8.565 ft	0.033 ft		
		ΔElev.	7.776 ft	0.033 ft		
		Ellip Dist.	18061.614 ft	0.018 ft		

Date: 3/3/2021 11:15:38 AM	Project: C:\Work\!!R&M_Projects\TBC Projects\HNS Static Control_02-23-21.vce	Trimble Business Center

Shared Solution

PID: AI4905
Designation: HNS D
Stamping: HNS D 1999
Stability: Most reliable; expected to hold position well
Setting: In rock outcrop or ledge
Mark Condition: G
Description:
Observed: 2020-12-15T21:44:00Z more obs 2016-01-20
Source: OPUS - page5 2008.25

Close-up View

REF_FRAME:	EPOCH:	SOURCE:	UNITS:	SET PROFILE	DETAILS
NAD_83(2011)	2010.0000	NAVD88 (Computed using GEOID12B)	m		

LAT:	59° 14' 53.13952"	± 0.019	m
LON:	-135° 32' 3.04958"	± 0.013	m
ELL HT:	16.828	± 0.012	m
X:	-2333253.660	± 0.010	m
Y:	-2290147.483	± 0.019	m
Z:	5458133.455	± 0.013	m
ORTHO HT:	11.428	± 0.297	m

	UTM 8	**SPC** 5001(AK 1)
NORTHING:	6567800.055m	826930.757m
EASTING:	469531.371m	712091.077m
CONVERGENCE:	-0.45907222°	-1.57395278°
POINT SCALE:	0.99961138	0.99995300
COMBINED FACTOR:	0.99960875	0.99995037

CONTRIBUTED BY

gwen.gervelis
DNR Division of Mining, Land and Water

Horizon View

The numerical values for this position solution have satisfied the quality control criteria of the National Geodetic Survey. The contributor has verified that the information submitted is accurate and complete.

Quality Report

Generated with Pix4Dmapper version 4.5.2 Preview

Important: Click on the different icons for:

Help to analyze the results in the Quality Report

Additional information about the sections

Click here for additional tips to analyze the Quality Report

Summary

Project	Haines DGGS Data
Processed	2021-03-04 11:33:23
Camera Model Name(s)	FC6510_8.8_4864x3648 (RGB)(1), FC6510_8.8_4864x3648 (RGB)(2), FC6510_8.8_4864x3648 (RGB)(3)
Average Ground Sampling Distance (GSD)	6.19 cm / 2.44 in
Area Covered	0.905 km^2 / 90.4747 ha / 0.35 sq. mi. / 223.6835 acres

Quality Check

Images	median of 67054 keypoints per image	✓
Dataset	971 out of 971 images calibrated (100%), all images enabled	✓
Camera Optimization	0.38% relative difference between initial and optimized internal camera parameters	✓
Matching	median of 8363.65 matches per calibrated image	✓
Georeferencing	yes, 7 GCPs (7 3D), mean RMS error = 0.272 ft	✓

Preview

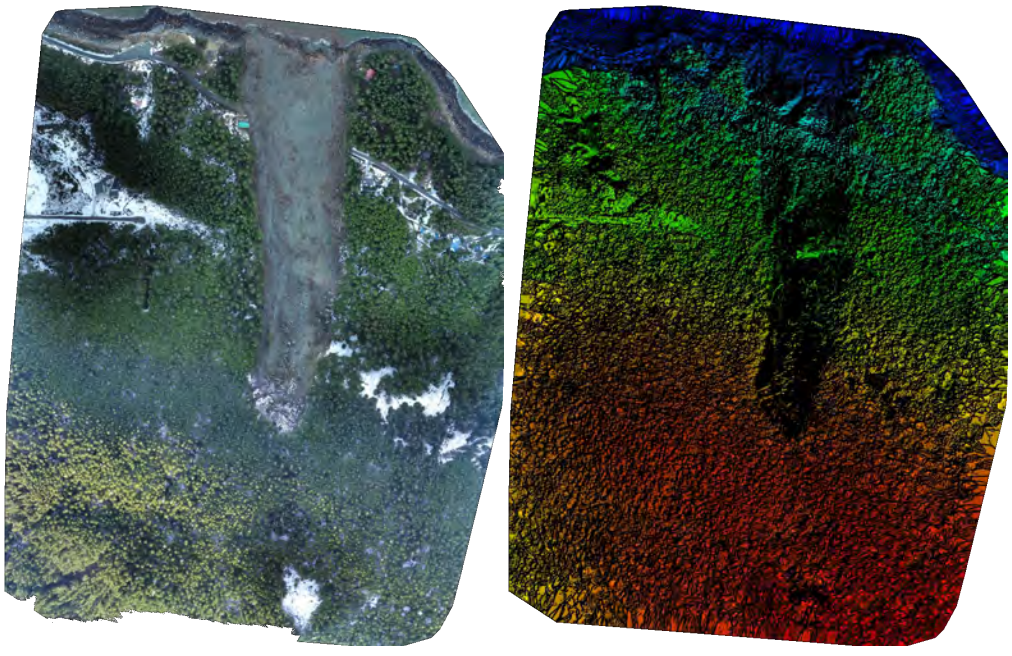


Figure 1: Orthomosaic and the corresponding sparse Digital Surface Model (DSM) before densification.

Calibration Details

Number of Calibrated Images	971 out of 971
Number of Geolocated Images	971 out of 971

Initial Image Positions

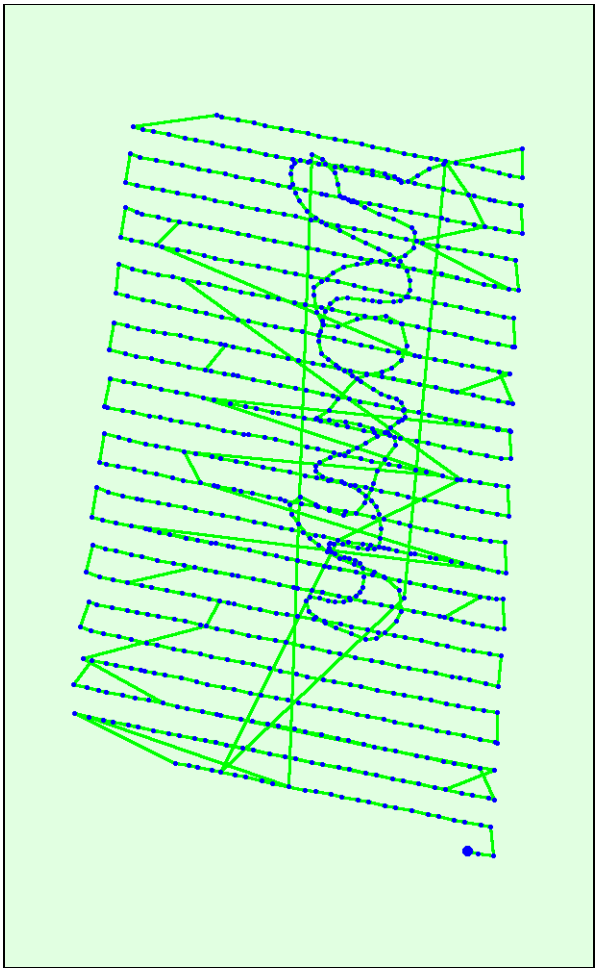
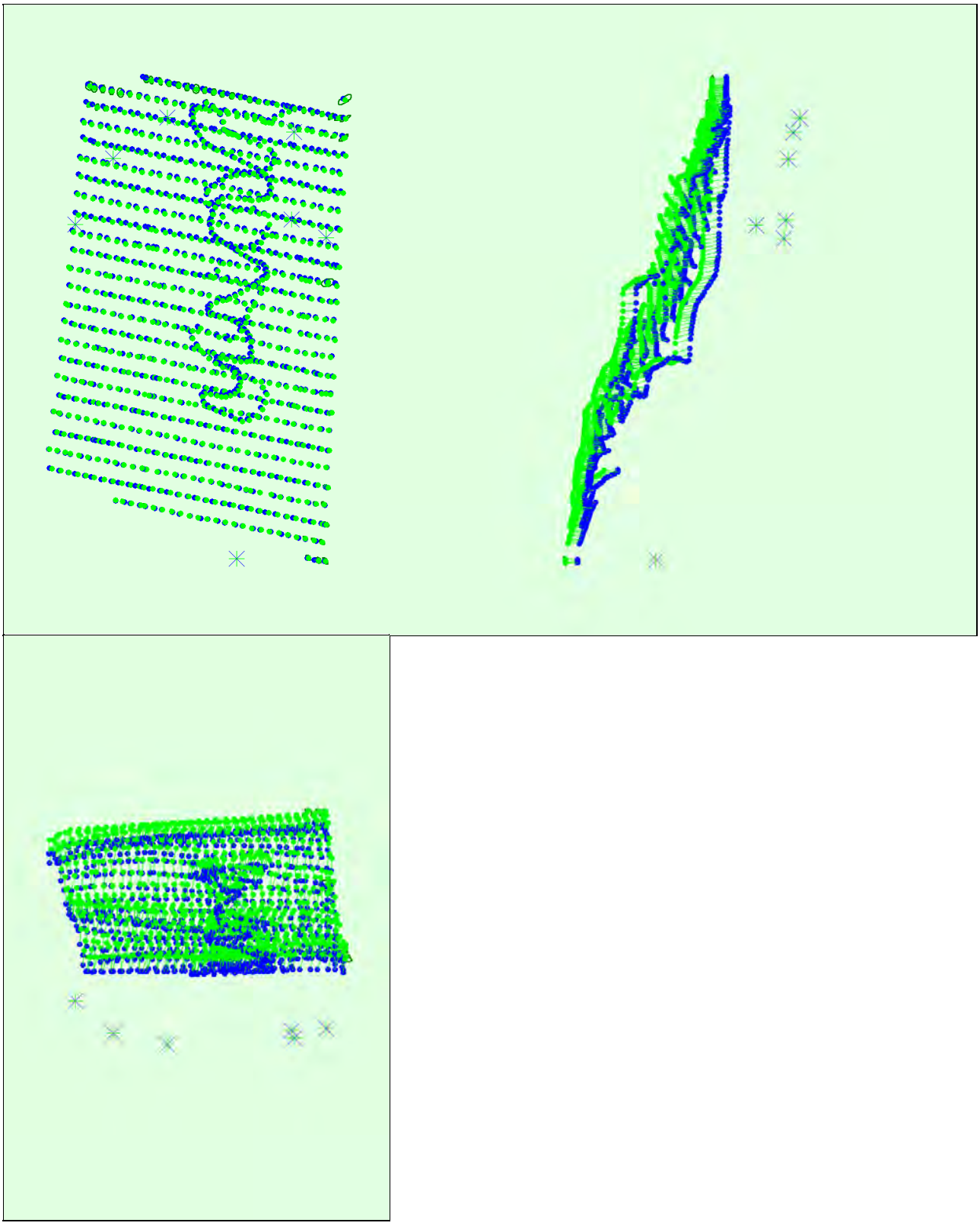


Figure 2: Top view of the initial image position. The green line follows the position of the images in time starting from the large blue dot.

Computed Image/GCPs/Manual Tie Points Positions



Uncertainty ellipses 100x magnified

Figure 3: Offset between initial (blue dots) and computed (green dots) image positions as well as the offset between the GCPs initial positions (blue crosses) and their computed positions (green crosses) in the top-view (XY plane), front-view (XZ plane), and side-view (YZ plane). Dark green ellipses indicate the absolute position uncertainty of the bundle block adjustment result.

Absolute camera position and orientation uncertainties

	X [ft]	Y [ft]	Z [ft]	Omega [degree]	Phi [degree]	Kappa [degree]
Mean	0.110	0.113	0.099	0.008	0.008	0.003
Sigma	0.035	0.039	0.021	0.004	0.003	0.002

Overlap

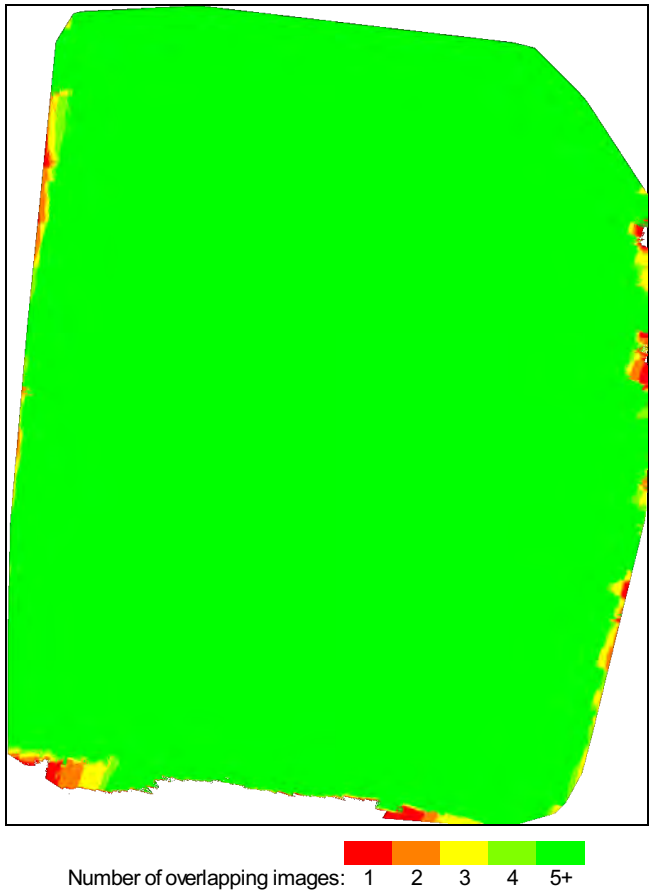


Figure 4: Number of overlapping images computed for each pixel of the orthomosaic.
Red and yellow areas indicate low overlap for which poor results may be generated. Green areas indicate an overlap of over 5 images for every pixel. Good quality results will be generated as long as the number of keypoint matches is also sufficient for these areas (see Figure 5 for keypoint matches).

Bundle Block Adjustment Details

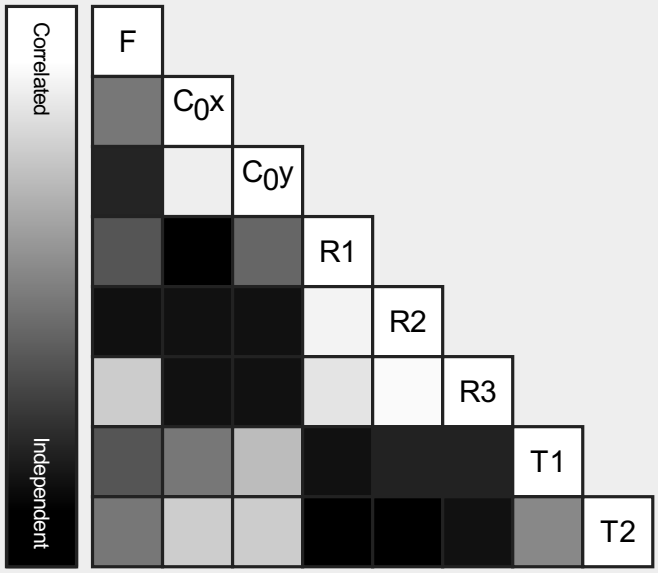
Number of 2D Keypoint Observations for Bundle Block Adjustment	8078126
Number of 3D Points for Bundle Block Adjustment	2624660
Mean Reprojection Error [pixels]	0.126

Internal Camera Parameters

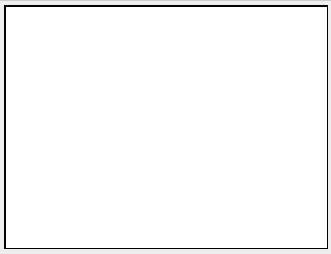
FC6510_8.8_4864x3648 (RGB)(1). Sensor Dimensions: 11.407 [mm] x 8.556 [mm]

EXIF ID: FC6510_8.8_4864x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3689.447 [pixel] 8.653 [mm]	2427.473 [pixel] 5.693 [mm]	1829.687 [pixel] 4.291 [mm]	0.003	-0.011	0.011	0.001	0.001
Optimized Values	3675.200 [pixel] 8.619 [mm]	2407.366 [pixel] 5.646 [mm]	1804.905 [pixel] 4.233 [mm]	0.008	-0.020	0.022	-0.002	-0.000
Uncertainties (Sigma)	0.362 [pixel] 0.001 [mm]	0.065 [pixel] 0.000 [mm]	0.059 [pixel] 0.000 [mm]	0.000	0.000	0.000	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



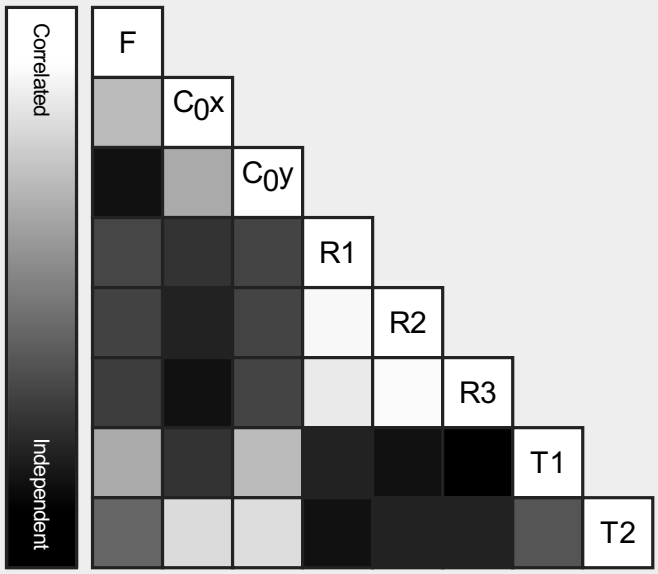
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

Internal Camera Parameters

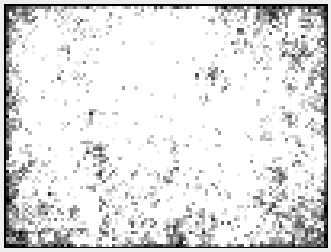
FC6510_8.8_4864x3648 (RGB)(2). Sensor Dimensions: 11.407 [mm] x 8.556 [mm]

EXIF ID: FC6510_8.8_4864x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3689.447 [pixel] 8.653 [mm]	2427.473 [pixel] 5.693 [mm]	1829.687 [pixel] 4.291 [mm]	0.003	-0.011	0.011	0.001	0.001
Optimized Values	3675.049 [pixel] 8.619 [mm]	2407.284 [pixel] 5.646 [mm]	1804.586 [pixel] 4.232 [mm]	0.007	-0.018	0.018	-0.002	-0.000
Uncertainties (Sigma)	0.461 [pixel] 0.001 [mm]	0.281 [pixel] 0.001 [mm]	0.245 [pixel] 0.001 [mm]	0.000	0.002	0.002	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



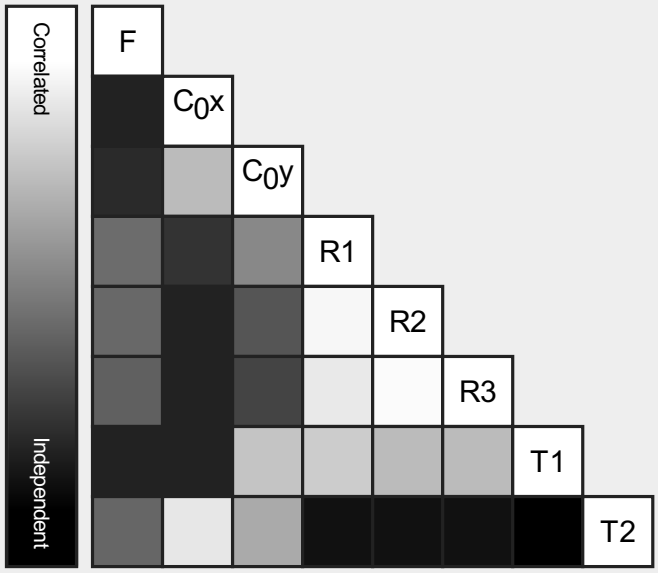
The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

Internal Camera Parameters

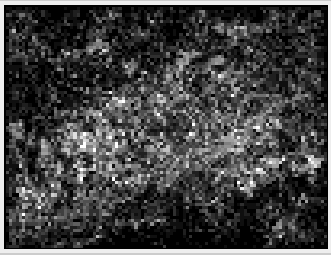
FC6510_8.8_4864x3648 (RGB)(3). Sensor Dimensions: 11.407 [mm] x 8.556 [mm]

EXIF ID: FC6510_8.8_4864x3648

	Focal Length	Principal Point x	Principal Point y	R1	R2	R3	T1	T2
Initial Values	3689.447 [pixel] 8.653 [mm]	2427.473 [pixel] 5.693 [mm]	1829.687 [pixel] 4.291 [mm]	0.003	-0.011	0.011	0.001	0.001
Optimized Values	3675.797 [pixel] 8.621 [mm]	2405.684 [pixel] 5.642 [mm]	1803.234 [pixel] 4.229 [mm]	0.006	-0.011	0.011	-0.002	-0.000
Uncertainties (Sigma)	0.716 [pixel] 0.002 [mm]	0.723 [pixel] 0.002 [mm]	0.565 [pixel] 0.001 [mm]	0.001	0.004	0.004	0.000	0.000



The correlation between camera internal parameters determined by the bundle adjustment. White indicates a full correlation between the parameters, ie. any change in one can be fully compensated by the other. Black indicates that the parameter is completely independent, and is not affected by other parameters.



The number of Automatic Tie Points (ATPs) per pixel, averaged over all images of the camera model, is color coded between black and white. White indicates that, on average, more than 16 ATPs have been extracted at the pixel location. Black indicates that, on average, 0 ATPs have been extracted at the pixel location. Click on the image to the see the average direction and magnitude of the re-projection error for each pixel. Note that the vectors are scaled for better visualization. The scale bar indicates the magnitude of 1 pixel error.

2D Keypoints Table

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	67054	8364
Min	31525	1455
Max	79812	17819
Mean	64669	8319

2D Keypoints Table for Camera FC6510_8.8_4864x3648 (RGB)(1)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image

Median	67052	8415
Min	31525	1455
Max	79812	17819
Mean	64517	8359

2D Keypoints Table for Camera FC6510_8.8_4864x3648 (RGB)(2)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	67743	7211
Min	39218	2384
Max	79112	13539
Mean	67512	7221

2D Keypoints Table for Camera FC6510_8.8_4864x3648 (RGB)(3)

	Number of 2D Keypoints per Image	Number of Matched 2D Keypoints per Image
Median	69977	8619
Min	61586	6297
Max	73129	14785
Mean	68856	10175

Median / 75% / Maximal Number of Matches Between Camera Models

	FC6510_8.8_4...(RGB)(1)	FC6510_8.8_4...(RGB)(2)	FC6510_8.8_4...(RGB)(3)
FC6510_8.8_4864x3648 (RGB)(1)	23 / 108 / 11639	21 / 94 / 9306	26 / 143 / 10791
FC6510_8.8_4864x3648 (RGB)(2)		25 / 126 / 4296	17 / 101 / 1076
FC6510_8.8_4864x3648 (RGB)(3)			17 / (n/a) / 1467

3D Points from 2D Keypoint Matches

	Number of 3D Points Observed
In 2 Images	1656912
In 3 Images	459640
In 4 Images	197984
In 5 Images	103461
In 6 Images	60142
In 7 Images	37777
In 8 Images	25575
In 9 Images	17470
In 10 Images	12570
In 11 Images	9503
In 12 Images	7230
In 13 Images	5600
In 14 Images	4429
In 15 Images	3682
In 16 Images	2936
In 17 Images	2405
In 18 Images	2118
In 19 Images	1707
In 20 Images	1390
In 21 Images	1247
In 22 Images	1018
In 23 Images	918
In 24 Images	854
In 25 Images	747
In 26 Images	666
In 27 Images	600
In 28 Images	513
In 29 Images	467

In 30 Images	410
In 31 Images	374
In 32 Images	335
In 33 Images	288
In 34 Images	276
In 35 Images	223
In 36 Images	246
In 37 Images	192
In 38 Images	201
In 39 Images	172
In 40 Images	161
In 41 Images	149
In 42 Images	140
In 43 Images	110
In 44 Images	121
In 45 Images	108
In 46 Images	101
In 47 Images	84
In 48 Images	87
In 49 Images	89
In 50 Images	76
In 51 Images	64
In 52 Images	66
In 53 Images	59
In 54 Images	52
In 55 Images	39
In 56 Images	63
In 57 Images	46
In 58 Images	36
In 59 Images	39
In 60 Images	44
In 61 Images	41
In 62 Images	30
In 63 Images	21
In 64 Images	33
In 65 Images	26
In 66 Images	20
In 67 Images	19
In 68 Images	14
In 69 Images	26
In 70 Images	19
In 71 Images	22
In 72 Images	15
In 73 Images	19
In 74 Images	21
In 75 Images	19
In 76 Images	9
In 77 Images	18
In 78 Images	9
In 79 Images	13
In 80 Images	8
In 81 Images	11
In 82 Images	15
In 83 Images	8
In 84 Images	14
In 85 Images	8
In 86 Images	14
In 87 Images	12
In 88 Images	8

In 89 Images	8
In 90 Images	7
In 91 Images	8
In 92 Images	12
In 93 Images	8
In 94 Images	7
In 95 Images	9
In 96 Images	7
In 98 Images	4
In 99 Images	4
In 100 Images	5
In 101 Images	4
In 102 Images	7
In 103 Images	4
In 104 Images	3
In 105 Images	1
In 106 Images	2
In 107 Images	4
In 108 Images	3
In 109 Images	1
In 110 Images	1
In 112 Images	5
In 113 Images	1
In 114 Images	2
In 115 Images	1
In 116 Images	4
In 117 Images	1
In 118 Images	1
In 119 Images	3
In 120 Images	2
In 121 Images	3
In 122 Images	2
In 123 Images	1
In 125 Images	2
In 126 Images	1
In 128 Images	1
In 131 Images	2
In 132 Images	1
In 133 Images	2
In 134 Images	2
In 135 Images	1
In 136 Images	1
In 137 Images	1
In 140 Images	1
In 141 Images	1
In 142 Images	1
In 145 Images	1
In 155 Images	1
In 159 Images	1
In 160 Images	1

2D Keypoint Matches

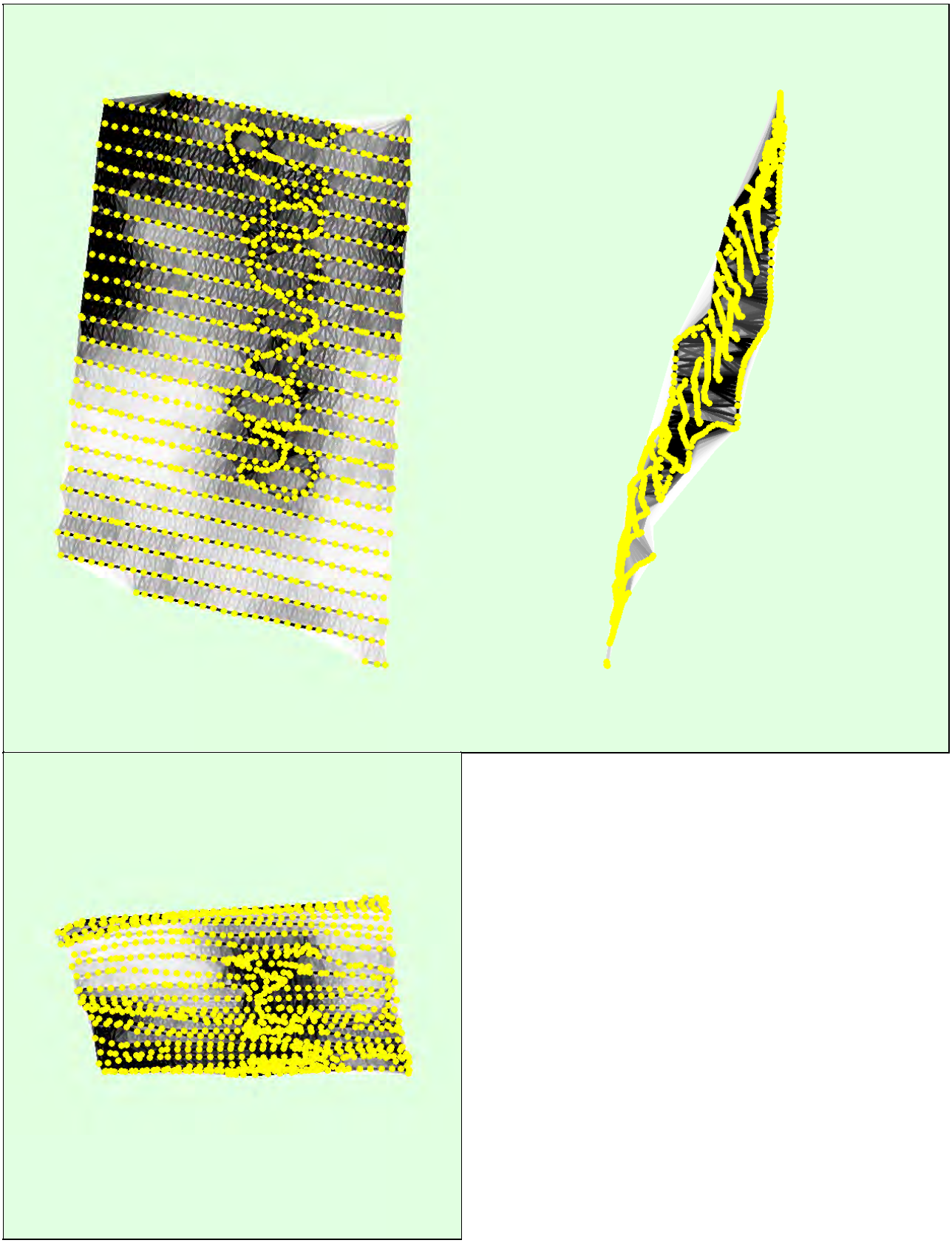


Figure 5: Computed image positions with links between matched images. The darkness of the links indicates the number of matched 2D keypoints between the images. Bright links indicate weak links and require manual tie points or more images.

Geolocation Details

Ground Control Points

GCP Name	Accuracy XY/Z [ft]	Error X [ft]	Error Y [ft]	Error Z [ft]	Projection Error [pixel]	Verified/Marked
1 (3D)	0.020/ 0.020	-0.014	0.012	-0.051	1.172	10 / 10
2 (3D)	0.020/ 0.020	-0.145	-0.048	-0.499	0.820	10 / 10
5 (3D)	0.020/ 0.020	0.035	-0.347	-0.137	0.858	10 / 10
6 (3D)	0.020/ 0.020	0.365	0.523	0.731	1.816	11 / 11
7 (3D)	0.020/ 0.020	-0.204	-0.167	-0.376	0.712	11 / 11
8 (3D)	0.020/ 0.020	-0.015	-0.002	0.257	1.187	10 / 10
9 (3D)	0.020/ 0.020	0.129	0.045	0.331	0.629	10 / 10
Mean [ft]		0.021662	0.002304	0.036650		
Sigma [ft]		0.173497	0.246667	0.398591		
RMS Error [ft]		0.174844	0.246677	0.400272		

0 out of 3 check points have been labeled as inaccurate.

Check Point Name	Accuracy XY/Z [ft]	Error X [ft]	Error Y [ft]	Error Z [ft]	Projection Error [pixel]	Verified/Marked
3		0.6289	-1.5430	1.7247	1.6818	10 / 10
4		-0.5108	-2.0439	1.2662	0.9819	10 / 10
10		-0.3031	0.8847	-0.4382	1.1334	10 / 10
Mean [ft]		-0.061655	-0.900759	0.850864		
Sigma [ft]		0.495573	1.278935	0.930545		
RMS Error [ft]		0.499393	1.564302	1.260906		

Localisation accuracy per GCP and mean errors in the three coordinate directions. The last column counts the number of calibrated images where the GCP has been automatically verified vs. manually marked.

Absolute Geolocation Variance

Min Error [ft]	Max Error [ft]	Geolocation Error X [%]	Geolocation Error Y [%]	Geolocation Error Z [%]
-	-49.21	0.00	0.00	0.00
-49.21	-39.37	0.00	0.00	0.00
-39.37	-29.53	0.93	0.10	0.00
-29.53	-19.68	7.31	0.21	0.00
-19.68	-9.84	15.24	11.74	10.61
-9.84	0.00	27.19	37.08	45.31
0.00	9.84	23.89	40.16	25.75
9.84	19.69	17.10	10.40	16.07
19.69	29.53	7.93	0.31	2.16
29.53	39.37	0.41	0.00	0.10
39.37	49.21	0.00	0.00	0.00
49.21	-	0.00	0.00	0.00
Mean [ft]		-9.364183	8.767763	-105.798515
Sigma [ft]		13.391775	7.890042	9.275657
RMS Error [ft]		16.340978	11.795187	106.204349

Min Error and Max Error represent geolocation error intervals between -1.5 and 1.5 times the maximum accuracy of all the images. Columns X, Y, Z show the percentage of images with geolocation errors within the predefined error intervals. The geolocation error is the difference between the initial and computed image positions. Note that the image geolocation errors do not correspond to the accuracy of the observed 3D points.

Geolocation Bias	X	Y	Z
Translation [ft]	-9.364183	8.767763	-105.798515

Bias between image initial and computed geolocation given in output coordinate system.

Relative Geolocation Variance

Relative Geolocation Error	Images X [%]	Images Y [%]	Images Z [%]
[-1.00, 1.00]	73.84	98.56	100.00

[-2.00, 2.00]	100.00	100.00	100.00
[-3.00, 3.00]	100.00	100.00	100.00
Mean of Geolocation Accuracy [ft]	16.404167	16.404167	32.808333
Sigma of Geolocation Accuracy [ft]	0.000001	0.000001	0.000001

Images X, Y, Z represent the percentage of images with a relative geolocation error in X, Y, Z.

Geolocation Orientational Variance	RMS [degree]
Omega	1.318
Phi	1.482
Kappa	3.220

Geolocation RMS error of the orientation angles given by the difference between the initial and computed image orientation angles.

Initial Processing Details

System Information

Hardware	CPU: Intel(R) Core(TM) i7-9800X CPU @ 3.80GHz RAM: 128GB GPU: NVIDIA Quadro RTX 4000 (Driver: 26.21.14.3086)
Operating System	Windows 10 Enterprise, 64-bit

Coordinate Systems

Image Coordinate System	WGS 84 (EGM96 Geoid)
Ground Control Point (GCP) Coordinate System	NAD_1983_StatePlane_Alaska_1_FIPS_5001_Feet (EGM96 Geoid)
Output Coordinate System	NAD_1983_StatePlane_Alaska_1_FIPS_5001_Feet (EGM96 Geoid)

Processing Options

Detected Template	No Template Available
Keypoints Image Scale	Full, Image Scale: 1
Advanced: Matching Image Pairs	Aerial Grid or Corridor
Advanced: Matching Strategy	Use Geometrically Verified Matching: no
Advanced: Keypoint Extraction	Targeted Number of Keypoints: Automatic
Advanced: Calibration	Calibration Method: Standard Internal Parameters Optimization: All External Parameters Optimization: All Rematch: Auto, no

Point Cloud Densification details

Processing Options

Image Scale	multiscale, 1/2 (Half image size, Default)
Point Density	Optimal
Minimum Number of Matches	3
3D Textured Mesh Generation	yes
3D Textured Mesh Settings:	Resolution: Medium Resolution (default) Color Balancing: no
LOD	Generated: no
Advanced: 3D Textured Mesh Settings	Sample Density Divider: 1
Advanced: Image Groups	group1
Advanced: Use Processing Area	yes

Advanced: Use Annotations	yes
Time for Point Cloud Densification	03h:28m:19s
Time for Point Cloud Classification	10m:58s
Time for 3D Textured Mesh Generation	34m:55s

Results

Number of Generated Tiles	4
Number of 3D Densified Points	66520740
Average Density (per ft^3)	0.34

DSM, Orthomosaic and Index Details

Processing Options

DSM and Orthomosaic Resolution	1 x GSD (6.19 [cm/pixel])
DSM Filters	Noise Filtering: yes Surface Smoothing: yes, Type: Medium
Orthomosaic	Generated: yes Merge Tiles: yes GeoTIFF Without Transparency: no Google Maps Tiles and KML: no
Time for DSM Generation	00s
Time for Orthomosaic Generation	56m:19s
Time for DTM Generation	00s
Time for Contour Lines Generation	00s
Time for Reflectance Map Generation	00s
Time for Index Map Generation	00s