

# MEASURING LOG DECKS WITH SMALL UNMANNED AERIAL SYSTEM (sUAS)

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IDAHO FOREST GROUP

# USER EXPERIENCE AND LESSONS LEARNED SO FAR....

- Terminology
- Need for alternative measurement technique
- “Drone” selection
- Flight Planning
- Data Processing
- Data Deliverables
- Next Steps
- Other Beneficial Applications
- Limitations
- Regulations
- Q&A



# TERMINOLOGY – “DRONE”

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  2. one that lives on the labors of others : [PARASITE](#)
  3. an unmanned aircraft or ship guided by remote control or onboard computers



# TERMINOLOGY

Alternative synonyms for “DRONE”

- UAV – Unmanned Aerial Vehicle
- sUAS – Small Unmanned Aerial System (Under 55 pounds)
- “Micro” UAS – Unmanned Aerial System (4.4 pounds or less) June 2016? TBD



# LOG YARD INVENTORY – CHILCO, IDAHO

Country Log Yard  
in our Mills  
and in 2013





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Additional methods of  
inventory has been  
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# WHAT sUAS TO UTILIZE?

## Quadcopter vs. Fixed Wing

### Major Factors Considered:

- Safety
- Proven track record
- Flight Time per battery
- All inclusive SYSTEM
- Takeoff and Landing requirements

### Fixed Wing Advantages

- Longer flight times
- Safer
- Lighter weight

### Quadcopter Advantages

- Take off and land in small areas
- Ability to fly slow
- Gimbal and Video Capabilities



# OUR (sUAS) SMALL UNMANNED AERIAL SYSTEM EBEE BY SENSFLY

Weight = 1.52 pounds

Wingspan = 38 inches

Max flight time = 50 minutes

Cruise Speed = 25-56 MPH

Can fly in up to 28 mph wind

Horizontal Accuracy 1.2 inches

Vertical Accuracy 2.0 inches





# OUR (sUAS) SMALL UNMANNED AERIAL SYSTEM FLIGHT PLANNING & CONTROL

Software = eMotion

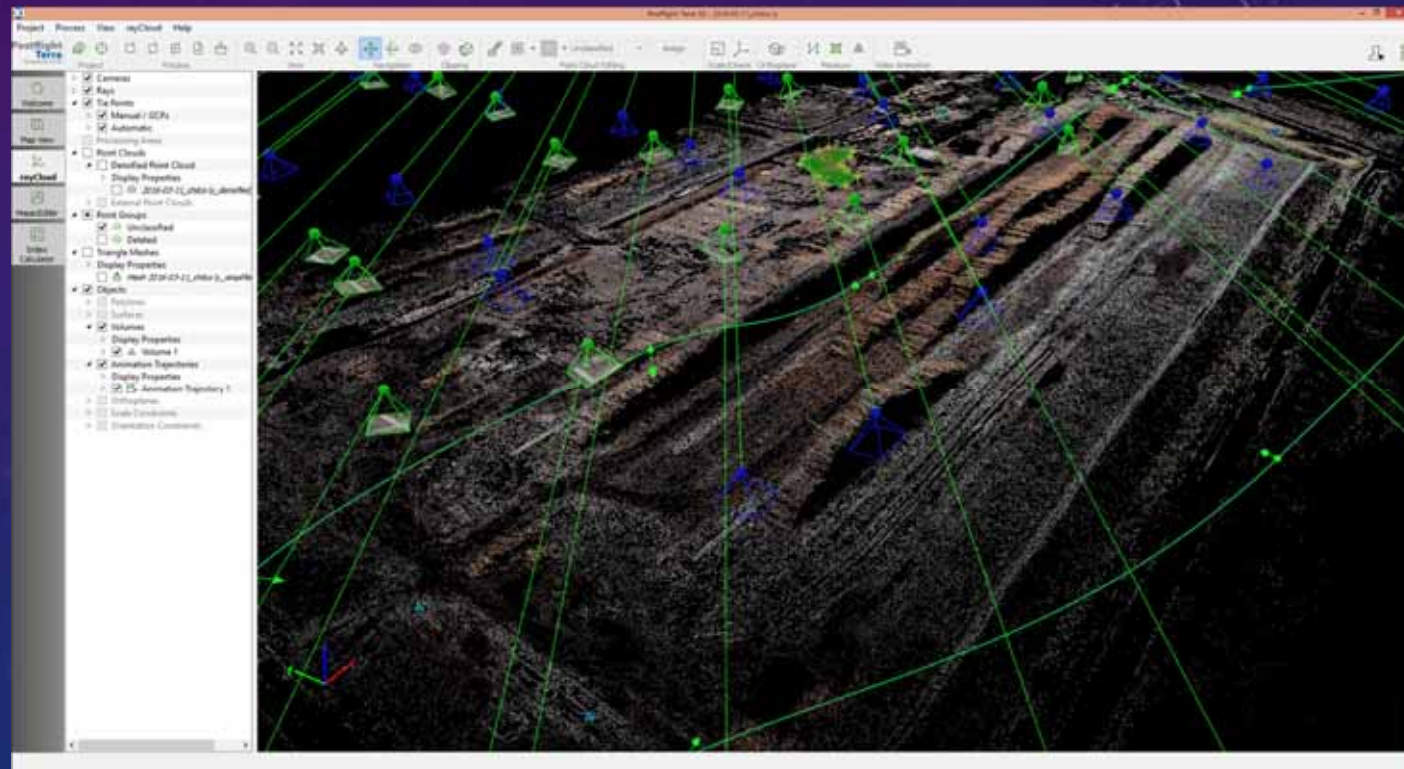
- Flight Planning
- Flight Monitoring
- Update Missions during flight
- Hazard avoidance
- Post processing of images



# OUR (sUAS) SMALL UNMANNED AERIAL SYSTEM POST FLIGHT DATA PROCESSING

Software = Post Flight Terra 3D

- Process Imagery
- Incorporate Ground Control Points (GCP)
- Create Point Cloud
- Create Orthomosaic
- Export data files
  - Image file
  - Point Cloud
  - Digital Surface Model (DSM)
  - Digital Terrain Model (DTM)
  - Google Earth File
  - Coordinate System



# FIRST THINGS FIRST

Establish ground control point (GCP) network

Traditional Survey GCP's and ground elevations in desired coordinate system



# LOG YARD INVENTORY – GROUND CONTROL POINTS

What are they?

- Known coordinates onsite; Northing, Easting, Elevation
- Need at least 4 per flight

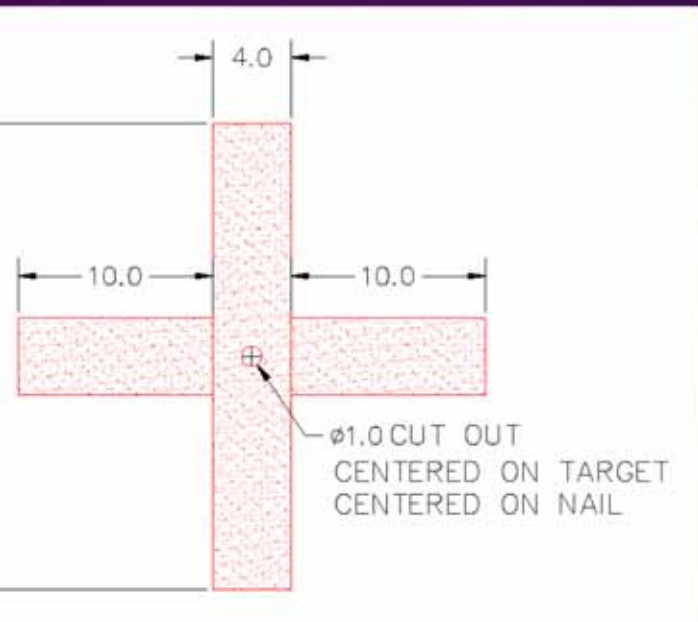
Why do we need them?

- Makes it so dataset models are in the same space every time
- Increases absolute accuracy

Where should you put them?

- Checker boarded across areas of future interest
- In areas that remain clear
- More is better

# LOG YARD INVENTORY – GROUND CONTROL POINTS



# LOG YARD INVENTORY – FLIGHT PLANNING

## Weather

- No precipitation
- Wind below 28 mph

## Lighting

- Overcast is the best light
- High noon best if no clouds are present

## Hazards

- Low flying aircraft
- Birds of Prey

## Preflight Checklist

- 25+/- items





WARNING
START MISSION
RESUME MISSION
GO TO START WPT
GO TO HOME WPT
GO LAND
HOLD POSITION
LAND NOW Click 3x
ABORT LANDING
FAST CLIMB

EB-01-008



116 x 517 m  
 14.8 acre / 0.02 sq mi  
 89°  
 47.8618477°N 116.7542335°W  
 Altitudes ATO

6.7533666°W 2290.03 ft / AMSL (2237.53 ft / WGS84)



Mapping and mission parameters

Difficult terrain  Easy   
 Mission area: Rectangular  
 Ground resolution: 1.1 in/p  
 Camera: DXUS/ELPH RGB  
 Desired altitude: 297.8 ft / ATO  
 Use elevation data to set absolute wa altitudes  
 Lateral overlap: 60%  
 Longitudinal overlap: 55%  
 Generate perpendicular flight lines  
 Reversed flight direction  
 Save parameters as default for DXUS

Advanced parameters

Starting waypoint: 1  
 Wind estimate: 0°  
 Use current wind es  
 Max flight time: 40

Resulting flight characteristics

Number of flights: 1  
 Flight time: 00:11:  
 Total flight distance: 4.7 mi  
 Total ground coverage: 14.8 ac  
 Number of flight lines: 4+12  
 Flight lines spacing: 169.0 f  
 Mean flight lines altitude above elevation data: 288.71  
 Max flight lines altitude above elevation data: 301.83  
 Min flight lines altitude above elevation data: 272.31  
 Distance between photos: 140.1 f  
 Single image coverage: 422.4x

Simulator

Wind: 0.4 kts





- WARNING
- START MISSION
- RESUME MISSION
- GO TO START WPT
- GO TO HOME WPT
- GO LAND
- HOLD POSITION
- LAND NOW Click 3x
- ABORT LANDING
- FAST CLIMB

EB-01-008



Battery voltage 90% (11.9 V)

Home distance 1048 ft (00:29)

Link quality 97 %

**Flight data**

Ground speed: 20.8 kts

Altitude: 2584.9 ft/AMSL

Ground sensor height: 278.9 ft

Position: N 47.8611675 W 116.75358

**Instruments**

AIRSPD kts 24 269 30

22 20.4 20 10 18 20.7

**Identification**

Name: Simulator (E)

Drone Flight Log: 1

**Camera information**

Camera type: IXUS/ELPH

Camera state: On

Number of photos: 4

**Advanced instruments**

Autopilot temperature 104.0 °F

Satellites: 8

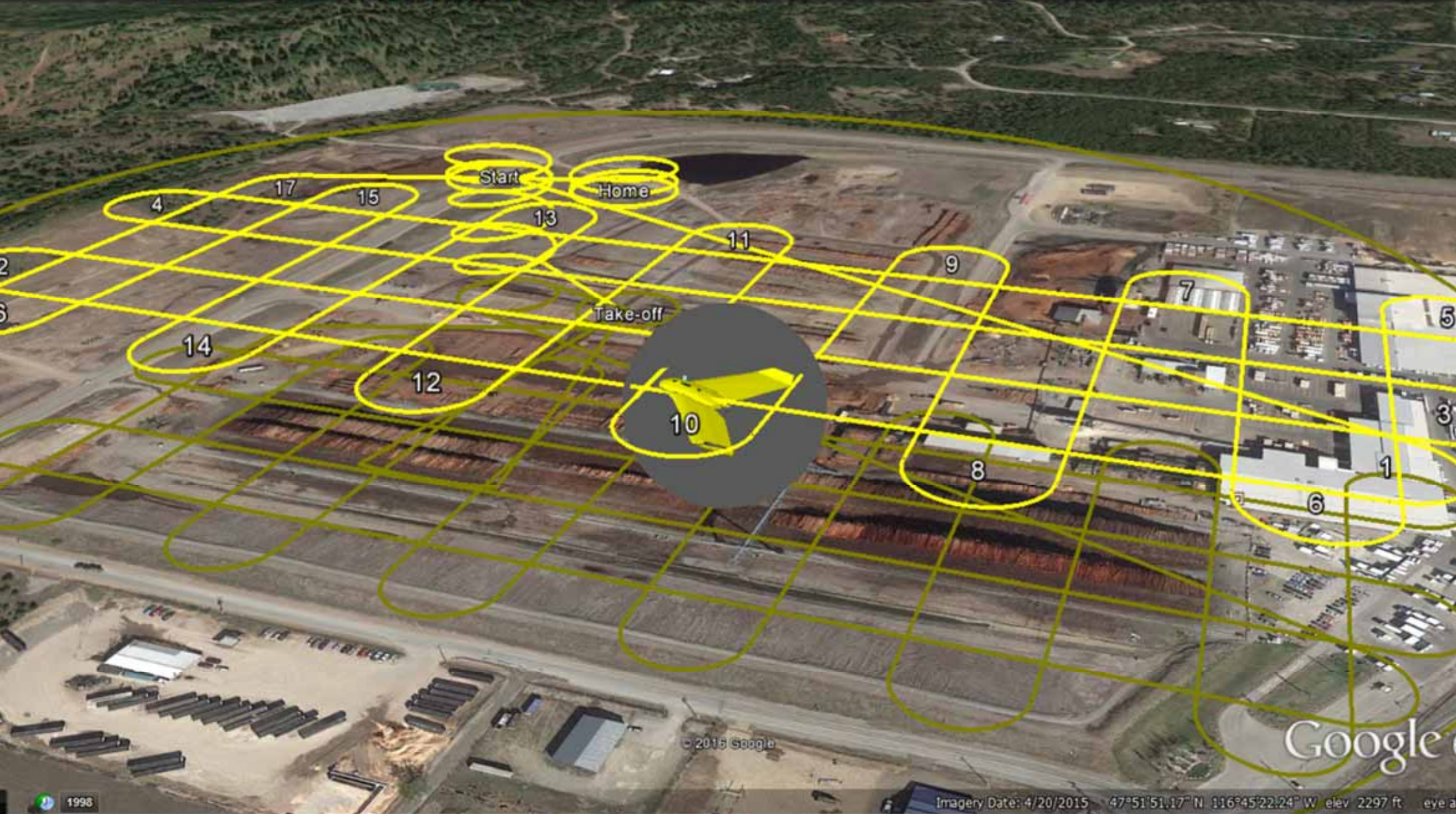
Accuracy: 1

Status: S

**Simulator**

Wind: 0.4 kts





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Google

Imagery Date: 4/20/2015 47°51'51.17" N 116°45'22.24" W elev 2297 ft eye a



# LOG YARD INVENTORY – POST PROCESSING

- Geotag images
- Initial rapid processing
- GCP allocation
- Full dataset processing
- Point Cloud Editing
- Orthomosaic Editing
- Export Data



- (120) DSC00665.JPG
- (121) DSC00666.JPG
- (122) DSC00667.JPG
- (123) DSC00668.JPG
- (124) DSC00669.JPG
- (125) DSC00670.JPG
- (126) DSC00671.JPG
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- (154) DSC00699.JPG
- (155) DSC00700.JPG
- (156) DSC00701.JPG
- (157) DSC00702.JPG
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- (165) DSC00710.JPG
- (166) DSC00711.JPG
- (167) DSC00712.JPG
- (168) DSC00713.JPG
- (169) DSC00714.JPG
- (170) DSC00715.JPG
- (171) DSC00716.JPG
- (172) DSC00717.JPG



Properties

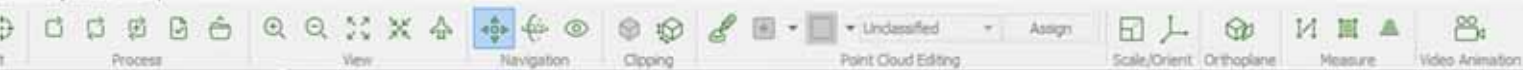
Selection

Images

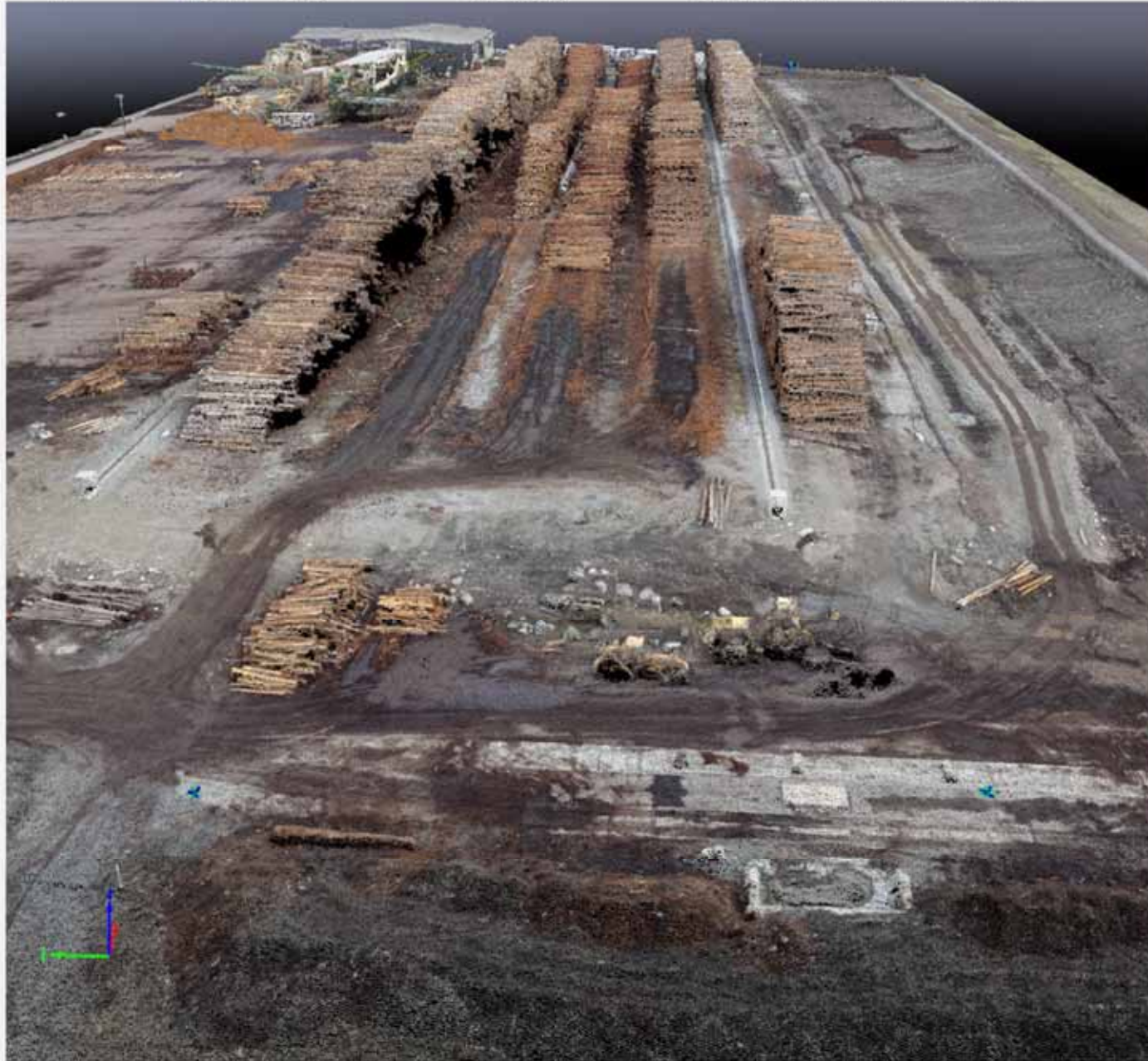
Image Size Zoom Level

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DSC00611.JPG	DSC00564.JPG
DSC00610.JPG	DSC00694.JPG
DSC00612.JPG	DSC00659.JPG





- (150) DSC00695.JPG
  - (151) DSC00696.JPG
  - (152) DSC00697.JPG
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  - (170) DSC00715.JPG
  - (171) DSC00716.JPG
  - (172) DSC00717.JPG
- Uncalibrated Cameras
- Layers
- Display Properties
  - Coordinate Points
  - Manual / GCPs
  - Automatic
  - Processing Areas
  - Point Clouds
  - Densified Point Cloud
  - Display Properties
  - 2016-03-11\_chilco ly\_d
  - External Point Clouds
  - Point Groups
  - Unclassified
  - Deleted
  - Triangle Meshes
  - Display Properties
  - Mesh 2016-03-11\_chilco ly\_smp
  - Objects
  - Polylines
  - Surfaces
  - Volumes
  - Display Properties
  - Volume 1
  - Animation Trajectories
  - Display Properties
  - Animation Trajectory 1
  - Orthoplanes
  - Scale Constraints
  - Orientation Constraints



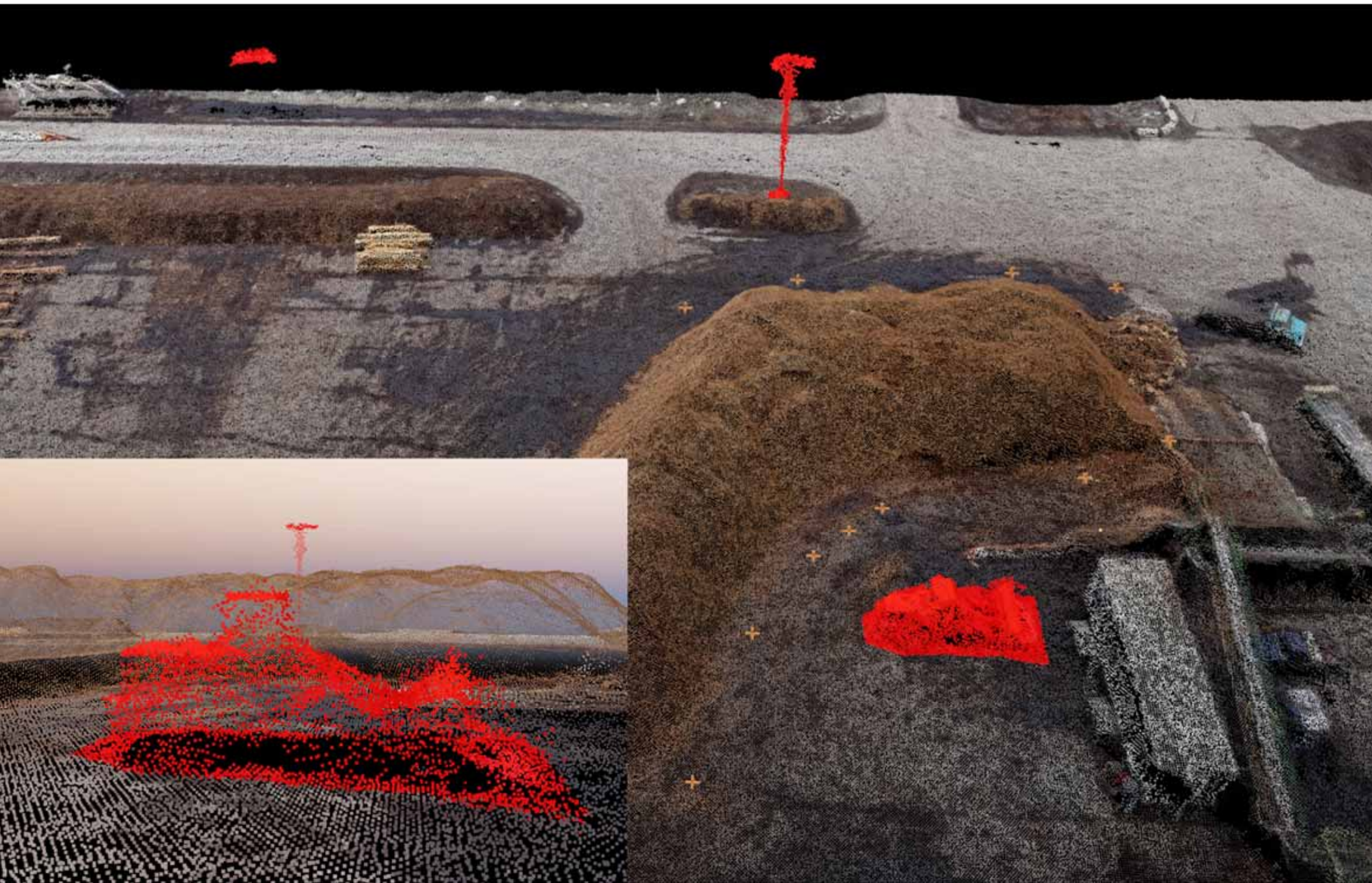
Properties

Selection

Images

Image Size:  Zoom Level:

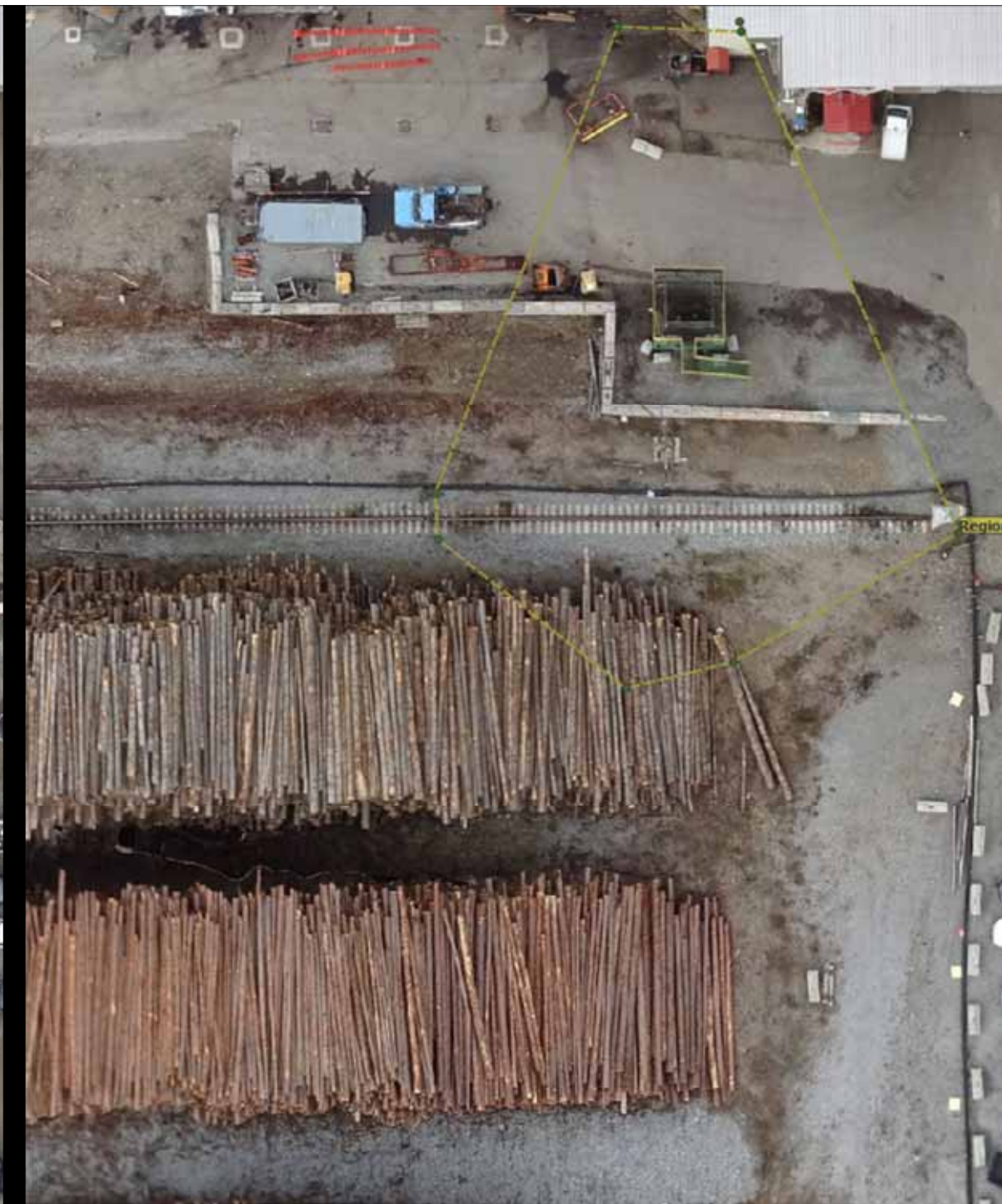
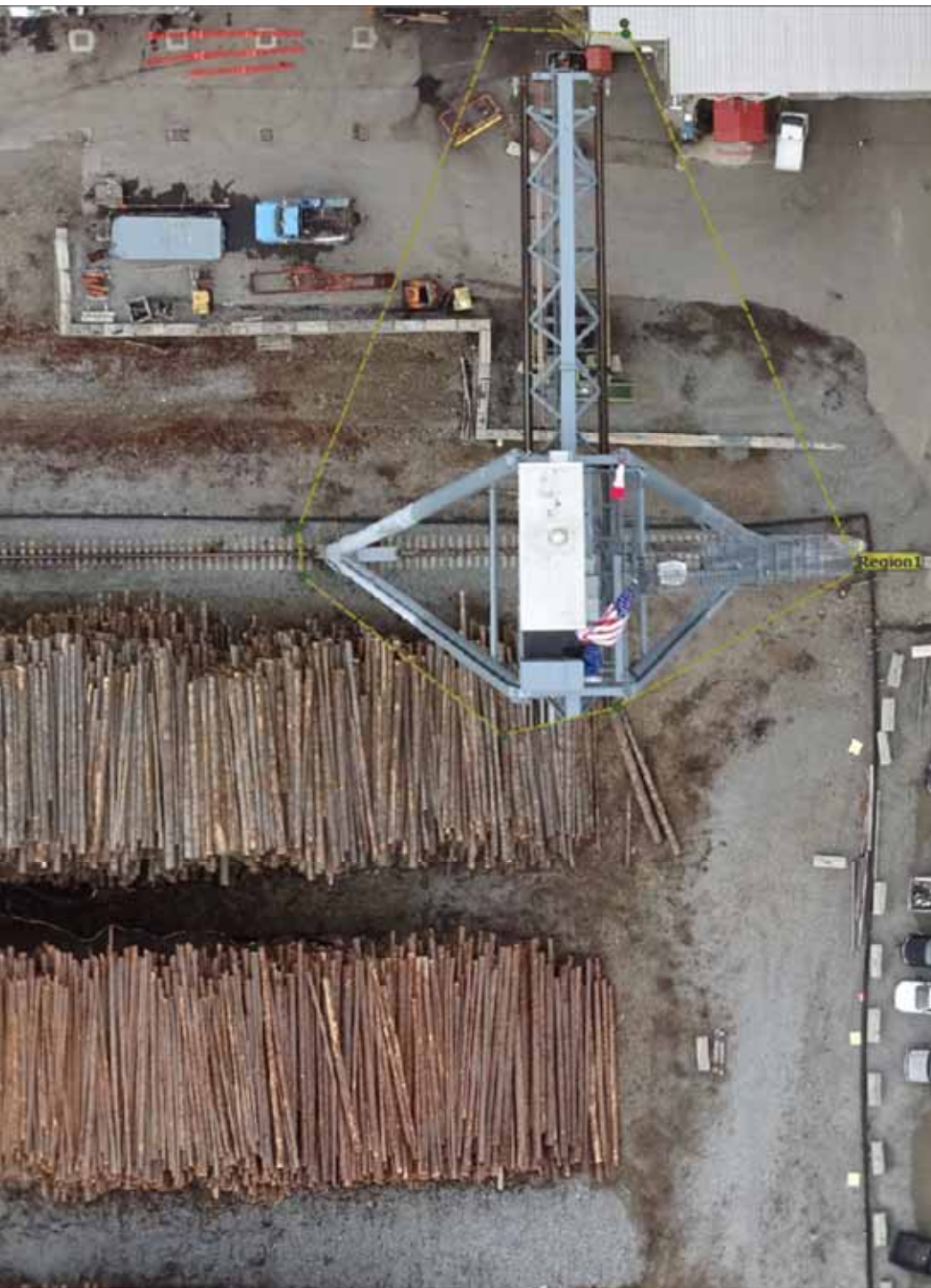














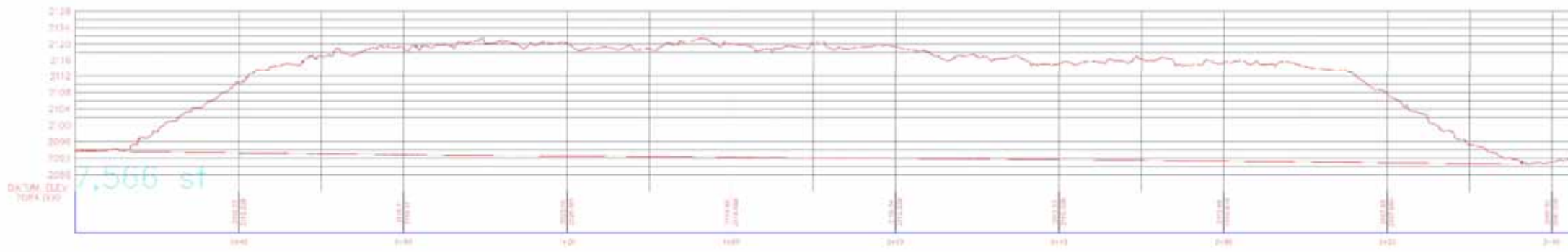
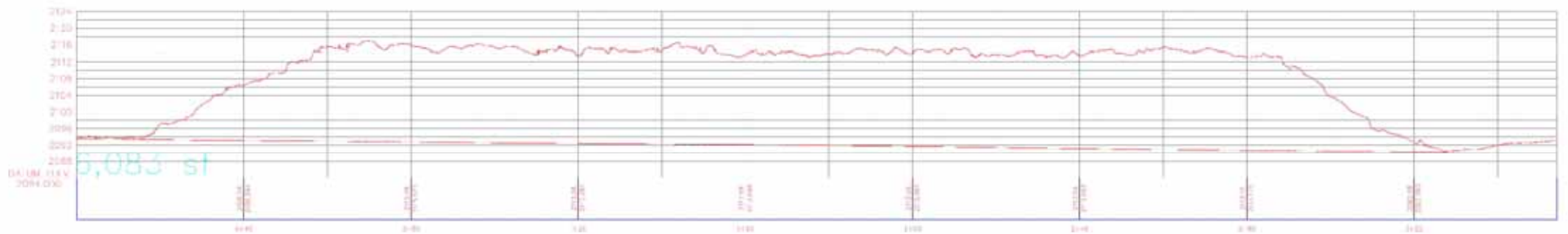
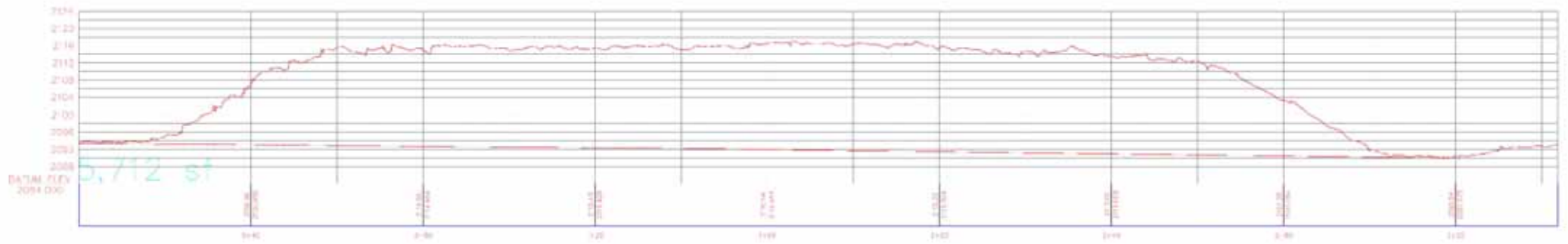






# LOG YARD INVENTORY – EXPORT

- Pick Coordinate System
- DSM geo tiff
- .las
- .dxf
- .kml





# LOG YARD INVENTORY – NEXT STEPS

Continue to validate data accuracy

Incorporate into our GIS system

Automate work flow

Run trials on different point cloud densities

Run trials on different image resolution / flight elevations

# OTHER BENEFICIAL APPLICATIONS

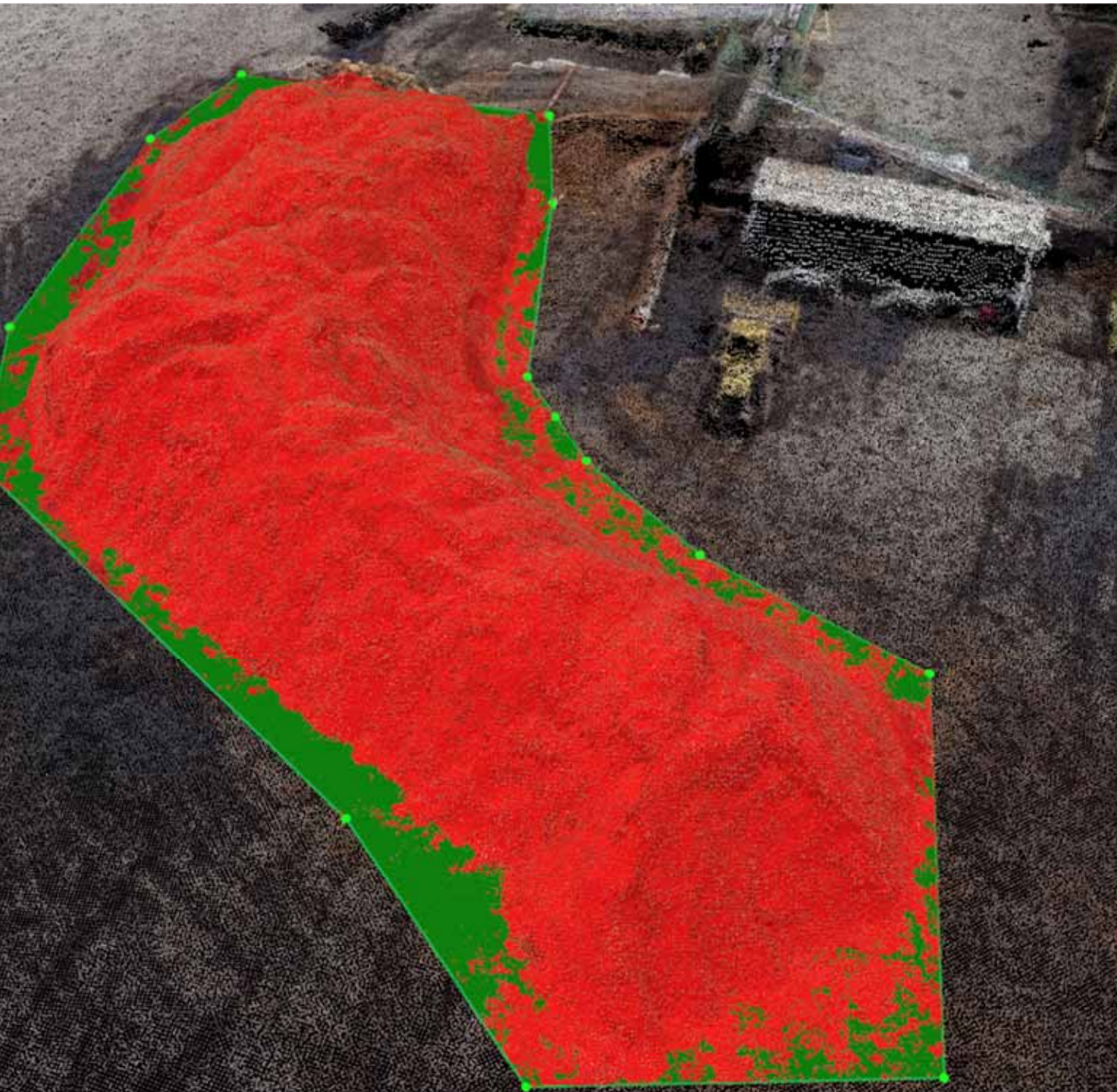
## Volume estimates

- Hog fuel
- Log yard debris
- Rock pit

## Irrigation Coverage

## Base mapping





▼ Selection

Volume 1 (Volume)

Number of Vertices: 15

Measurements

Terrain 3D Length [ft]:	522.04	error n/a	
Projected 2D Length [ft]:	520.97	error n/a	
Enclosed 3D Area [ft <sup>2</sup> ]:	13712.47		
Projected 2D area [ft <sup>2</sup> ]:	13677.43	error n/a	
Terrain 3D Area [ft <sup>2</sup> ]:	21182.95		
Cut Volume [ft <sup>3</sup> ]:	104319.17	± 6383.92	
Fill Volume [ft <sup>3</sup> ]:	-443.57	± 860.07	
<b>Total Volume [ft<sup>3</sup>]:</b>	<b>103875.60</b>	± 7243.99	

Update Measures Copy to Clipboard Apply Cancel

▼ Images

Image Size Zoom Level











# MAJOR LIMITATIONS

Surface uniformity = BAD Data

Tall Grass, Shrubs, Trees.... Limit accuracy

Weather

You can only measure what you can see



# REGULATIONS - KNOW BEFORE YOU GO

Federal Aviation Administration (FAA) 333 Exemption

Aircraft Registration

Certificate of Waiver or Authorization (COA)

Notice to Airman (NOTAM)

Check local jurisdictions as well

QUESTIONS?

