

Estimating Stockpile Volumes Using Drone Surveying Technology



Presenter & Co-Author



PRESENTER

JAY RECLA,
FAA Part 107, USDOT, Caltrans
jrecla@ninyoandmoore.com
Ninyo & Moore, Irvine, CA, USA



CO-AUTHOR

ANTHONY J. LIZZI, PG, CHG
alizzi@ninyoandmoore.com
Ninyo & Moore, Irvine, CA, USA



Presentation Outline & Objectives

Outline:

1. Equipment - DJI Phantom 4 Pro Obsidian
2. Temporary Entry Use Permit from Local Agency
3. Photogrammetry – What is it?
4. Airspace Monitoring – Class G
5. Programming Flight Path in  DroneDeploy
6. Ground Control Points (GCPs)
7. Federal Aviation Administration (FAA) Low Altitude Avoidance and Notification Capability (LAANC)
8. Drone Flight
9. Stockpile Volume

Objectives:

10. Post Processing Data – Producing 2-dimensional (2D) and 3D Models of the Site
11. Output of Final Figures



Aerial Survey Case Study

Ground Based Survey – Measures square meters per point
Aerial Survey – Measures hundreds of points per square meter

Study measured 19 stockpiles in 4 hours. A task which would take 10-12 hours with two ground based surveyors

Results of the study

Ground Based – Point Density 3.25 Square Meters per Point
Volume = 3,394.9 Cubic Meters

Aerial Survey – Point Density 400 Points per Square Meter
Volume = 3,375.0 Cubic Meters

Result = Variation of only 0.6%

Benefits of Aerial Survey:

1. **Cost Savings – Ability to cover larger areas in a fraction of the time**
2. **More Information - Including High Resolution 2D and 3D models**
3. **Safety – Removing workers from steep slopes and active piles**

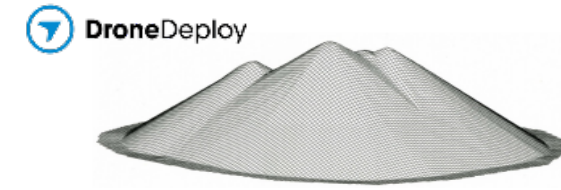


Fig 3. GPS Surveyed Stockpile



Fig 4. Same Stockpile – Surveyed with UAV

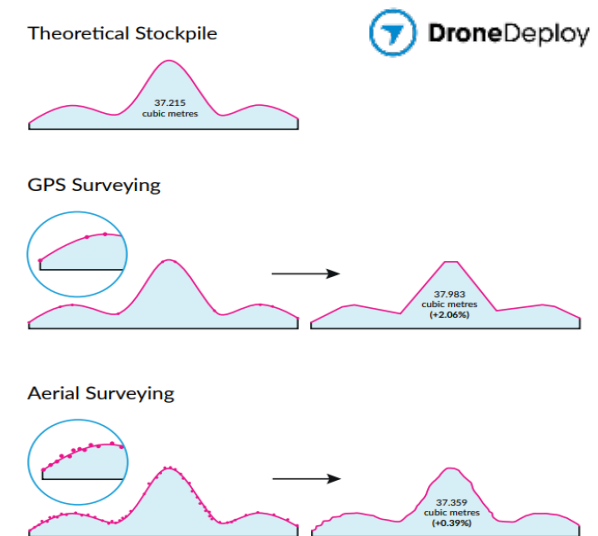


Fig 2. Stockpile Survey Output

dji Phantom 4 Pro V 2.0

- Best Overall Consumer Drone Around
- Maximum Flight Time: 30 Minutes per Battery
- Operating Temps: 32°F – 104°F
- Maximum Ceiling: 400 ft Above Ground Level per FAA
- Capable of 4K/60fps Videos & 20MP Photos
- Five Direction Obstacle Avoidance
- Maximum 31mph (50kph) at 6.6 ft (2m) Above Ground
- Easy to Fly Which Includes Automatic Return to Home Function



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Permit

This form is to reserve ~~Port Property~~ for temporary or long-term use by internal ~~Port Division~~ only. External entities need to submit Form #413, *Application for Temporary Entry and Use of Port Property*

Division Requesting Use: Contact Person:
Contact Phone Number: E-mail:

Property or Requested Area: (Attach map outlining requested area)

Description of Use: (Include project name, if applicable)

The scope of work is to assess existing stockpiles onsite by utilizing a drone to collect aerial photos and map out the stockpiles. Drone model is Phantom 4 Pro Obsidian Serial No. ~~XXXXXXXXXX~~ FAA Registration #A3638718. This is part of the site assessment for the ~~Joint Ports Goods Movement Training Center~~

Construction: (Describe any construction or modification proposed for the property or requested area, if applicable)

Requested Date(s) and Hour(s) of Use: (Include Event/Construction, Set Up, and Tear Down Date(s) and Hour(s))

Event/Construction: Thursday 9/22/2022; 2 hours
Set Up (if applicable): N/A
Tear Down (if applicable): N/A

If a joint event or use with another entity or company, include:

Entity/Company: Ninyo & Moore Contact Person: Anthony Lizzi
Contact Phone Number: (949) 753-7070 x 12214 E-mail: alizzi@ninyoandmoore.com

Requesting Division is responsible for coordinating support services with internal divisions if necessary (i.e. Port Police, Construction and Maintenance, Wharfinger, Construction, Engineering, Risk Management, etc.)

Approved by (Requesting Division Director):



Date: 08/18/22

1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

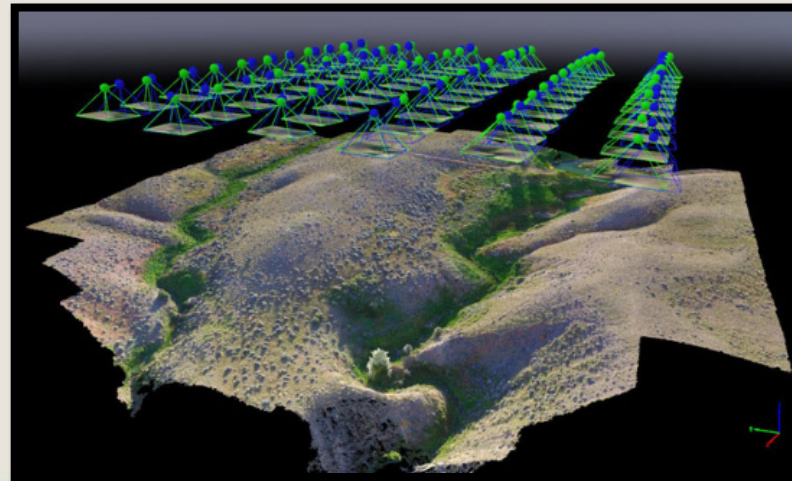
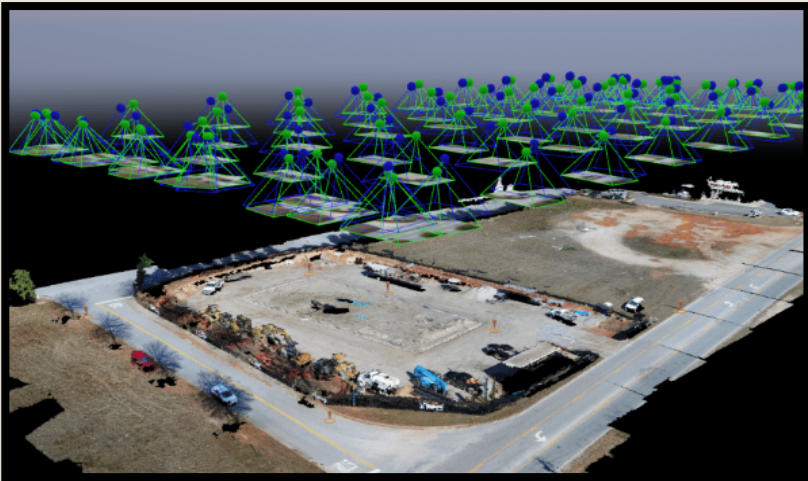
9. Stockpile Volume

10. Post Processing

11. Final Figures

Drone Deploy Photogrammetry Software

- Drone deploy is used to fly the drone, capture and organize photos, generate maps and inspection reports, and easily share them with the entire project team.
- Photogrammetry is the method used to stitch thousands of high-resolution photographs (providing more data points) into complex 3D models to calculate volumes of materials.
- 5 Step Process: Capture, Process, Measure, Report, and Share



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

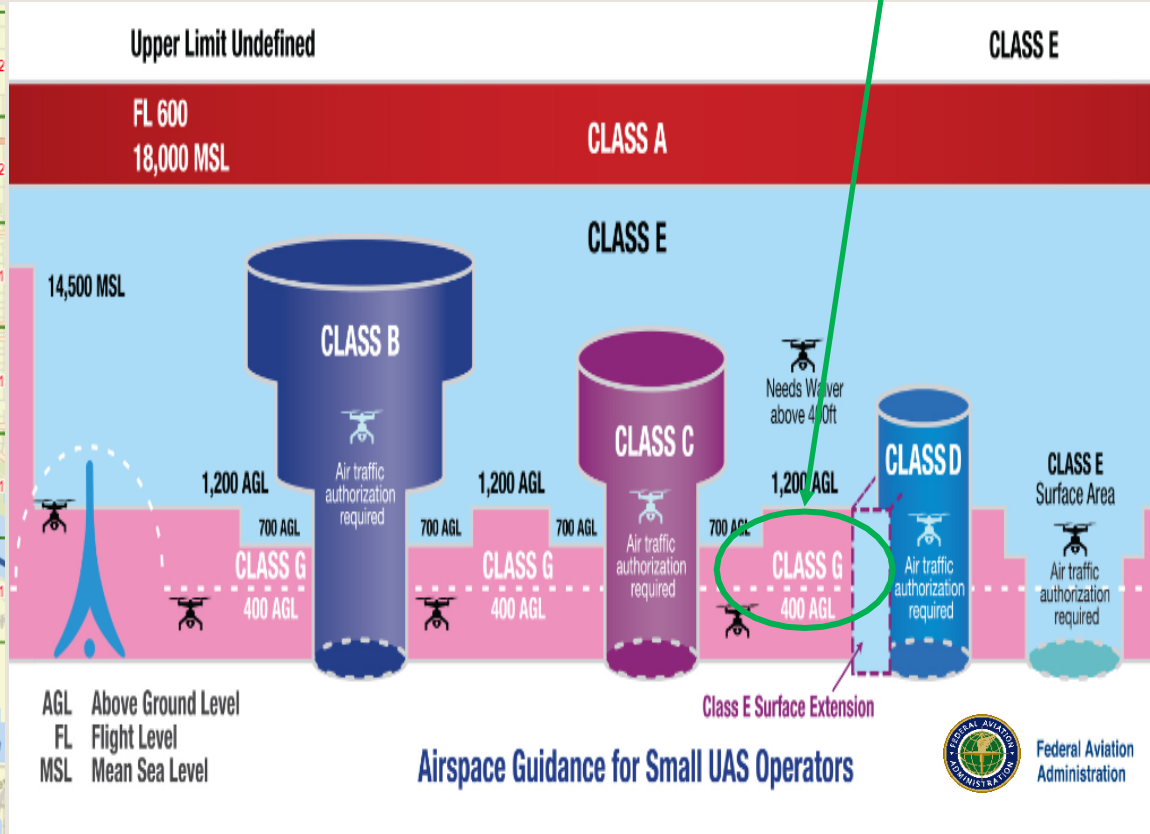
8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

FAA Airspace Utilization – Visualize It – Class G Airspace



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Programming Flight Path in Drone Deploy

The screenshot displays the Drone Deploy software interface. On the left is a sidebar with various settings and controls. The main area shows an aerial map of a coastal area with a programmed flight path overlaid. The flight path is a series of green lines forming a rectangular grid, starting from a green dot labeled 'Start' and ending at a white dot. The path is located near a body of water and a road labeled 'Shore Rd'. Other roads visible include 'Anchorage Rd' and 'Peninsula Rd'. The sidebar includes the following controls:

- Capture Plan: Map Plan (with a plus icon)
- 8:43 Minutes, 10 Acres, 142 Images, 1 Battery
- Flight Altitude: 200ft (Resolution: 0.5 in / px)
- Enhanced 3D (toggle off)
- Live Map HD (toggle off)
- Advanced (dropdown arrow)
- Airspace & LAANC (toggle on)
- RTK Coverage (toggle off)
- Data On Demand (Request button)
- Import KML or SHP (dropdown arrow)

1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Ground Control Point Locating with GNSS Equipment



Ground Control Point



GNSS Base

Rover

1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

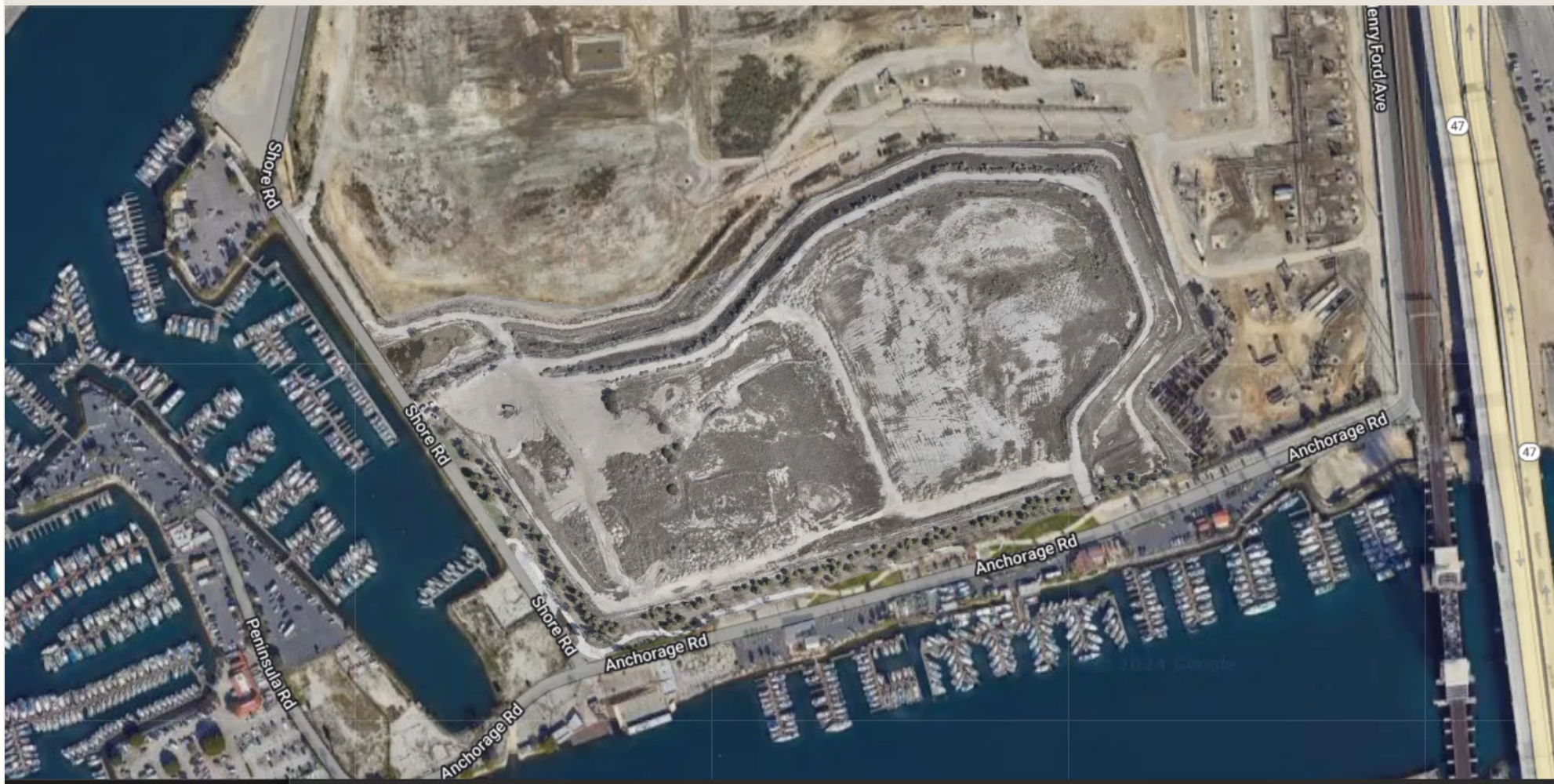
8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Ground Control Point Locations – Why are They Important?



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

LAANC – Low Altitude Avoidance and Notification Capability

The FAA UAS Data Exchange is an innovative, Collaborative approach between government and private industry facilitating the sharing of airspace data between the two parties.

LAANC provides:

1. Drone Pilots with access to controlled airspace at or below 400 feet.
2. Awareness of where pilots can and cannot fly
3. Air traffic professionals with visibility into where and when drones will operate.



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Video of Drone Survey Take Off



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

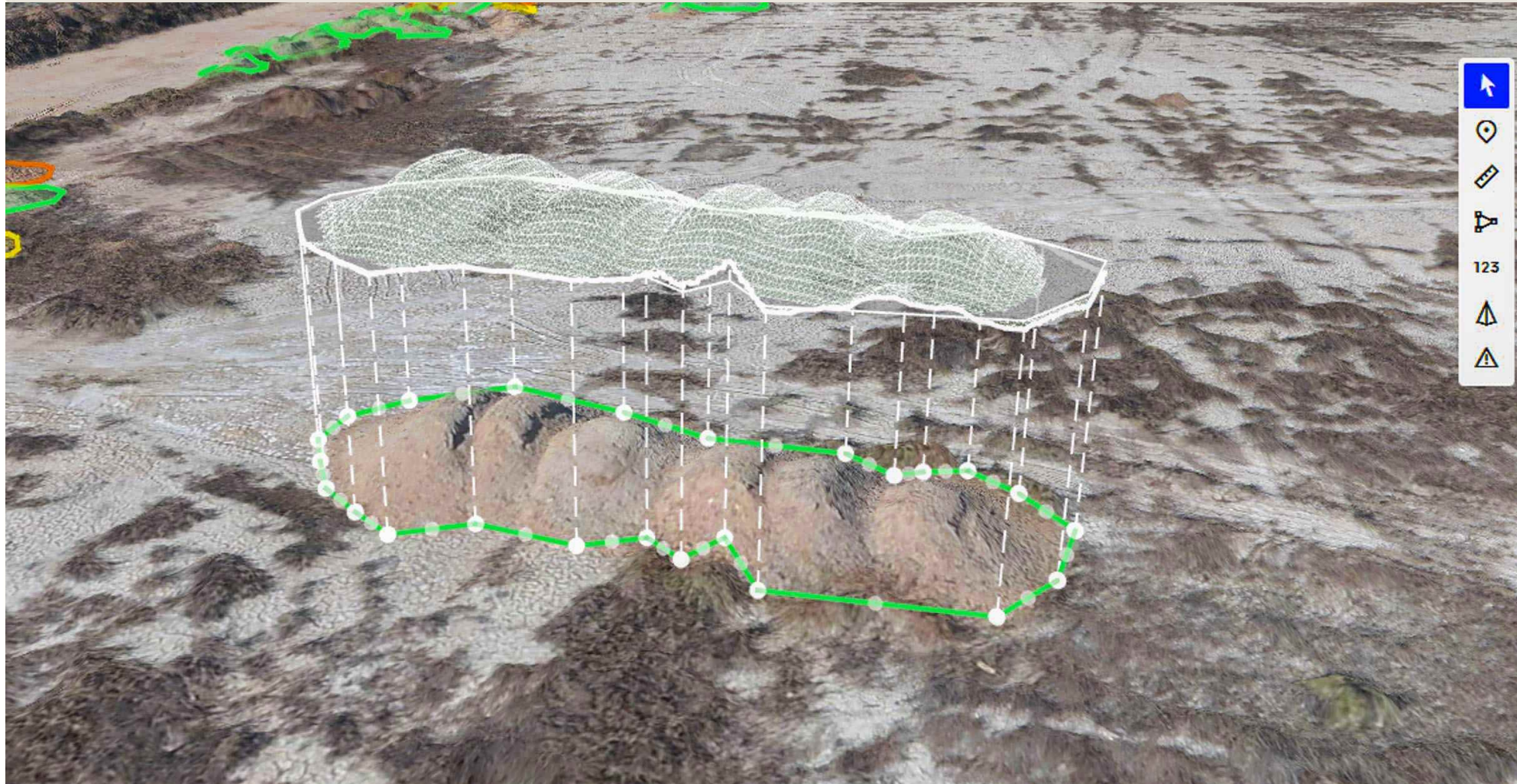
8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Stockpile Volume Calculations



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

3D Video of Stockpile Calculation from Drone Deploy



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Stockpile Soil Viewed using Drone

Overview0 >

Locations0 >

Map Analysis

Map>

Plant Health>

Elevation>

Ground Control Points0/5 >

Media

Photos0/3 >

Photos0/1 >

Map Photos0/357 >

Markup

Annotations0/101 >

Issues0 >

Apps & Integrations

Export

Help

All time

Exterior

Interior

2D

3D

Map

Measure

Annotations

Issues

125

4

MATERIAL LEGEND

Concrete/Asphalt

Construction Debris

Gravel/Boulders/Cobbles

Soil/Dredge Materials

1. Equipment
2. Temporary Use Permit
3. Photogrammetry
4. Airspace Monitoring
5. Programming Flight Path
6. Ground Control Points
7. FAA/LAANC
8. Drone Flight
9. Stockpile Volume
10. Post Processing
11. Final Figures

Panoramic Photography from Drone Deploy



MATERIAL LEGEND



Concrete/Asphalt



Construction Debris



Gravel/Boulders/Cobbles



Soil/Dredge Materials

1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

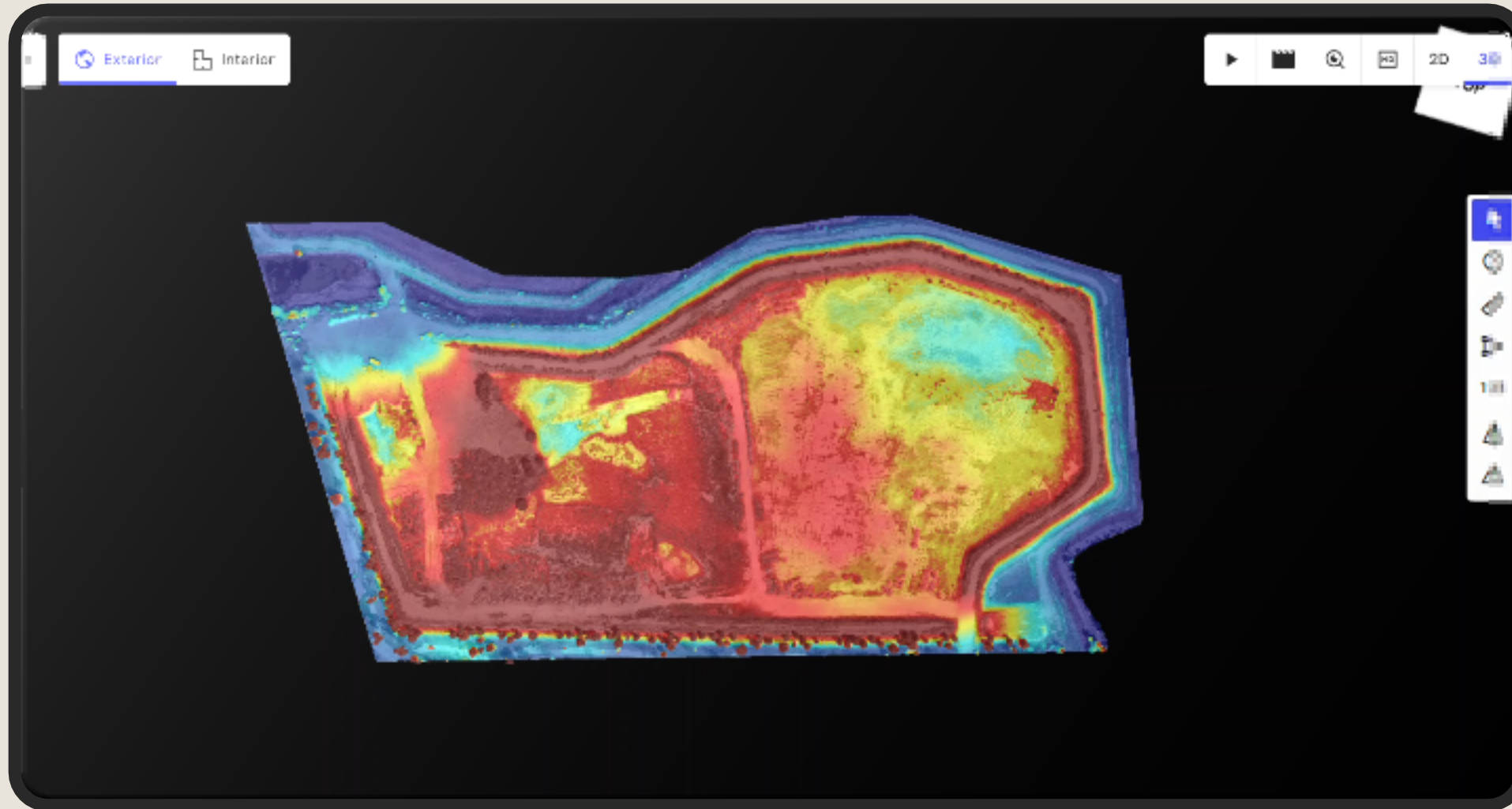
8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Geospatially Located Photography



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Drone Deploy 3D Manipulation & Measurements

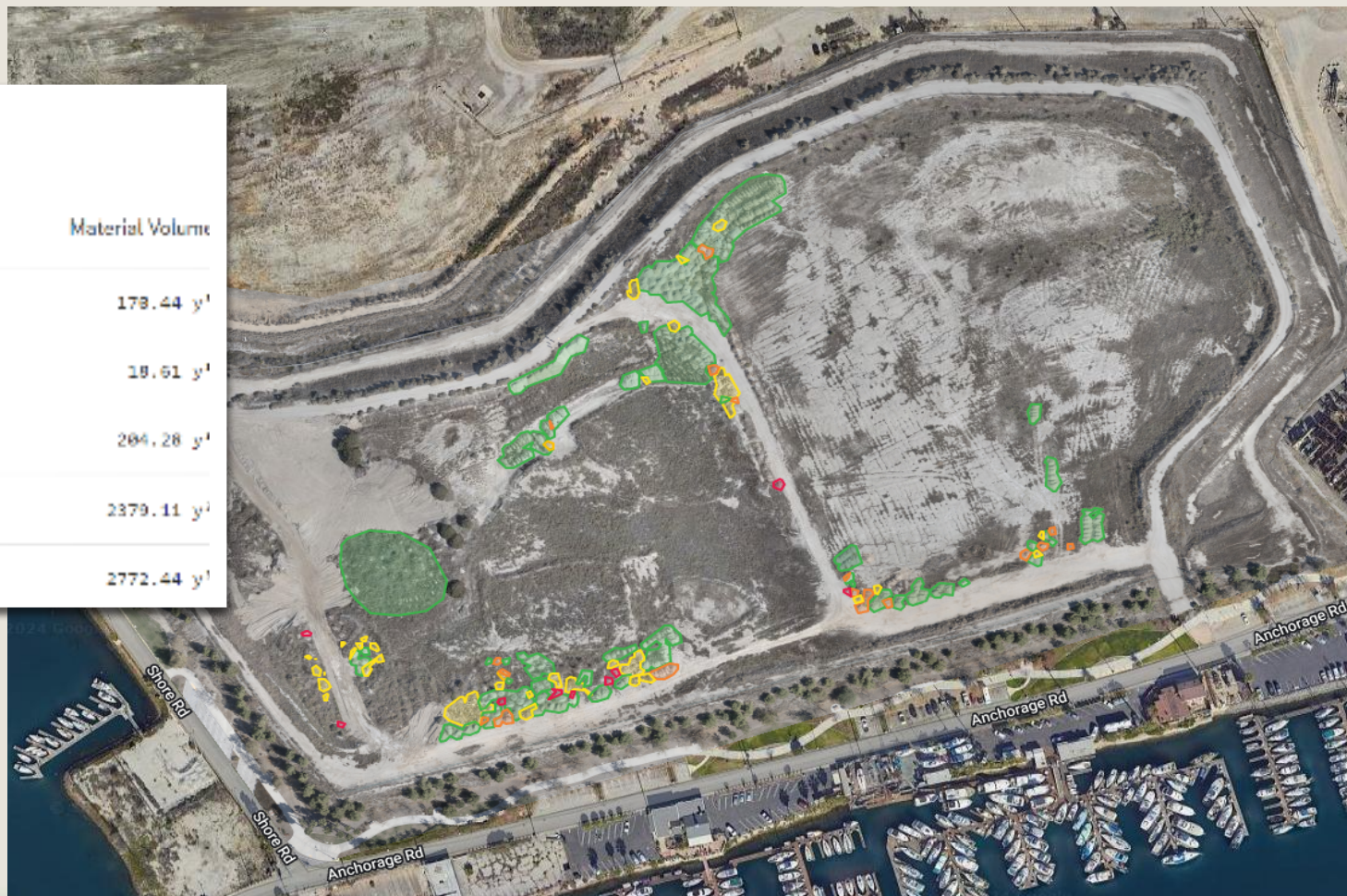


Objectives: Post Processing of Data & Findings

Stockpile Volume Calculation - Annotation

Material 📍

Label	Title	#	Material Volume
●	Concrete/Asphalt	32	178.44 y ³
●	Construction Debris	5	18.61 y ³
●	Gravel/Boulders/Cobbles	18	284.28 y ³
●	Soils/Dredge Materials	39	2379.11 y ³
Total:		94	2772.44 y ³



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

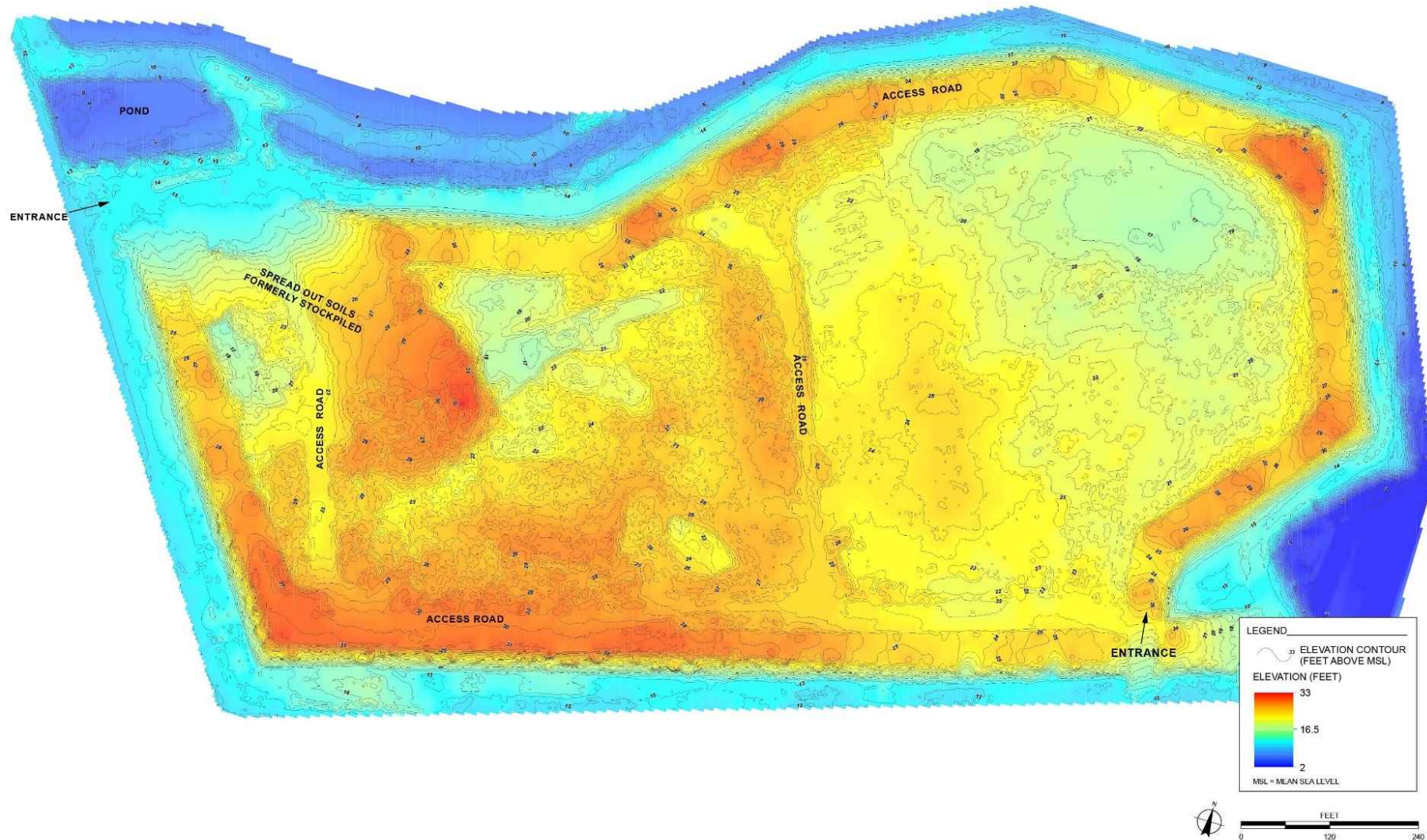
8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Orthomosaic Topographical Elevation Map



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

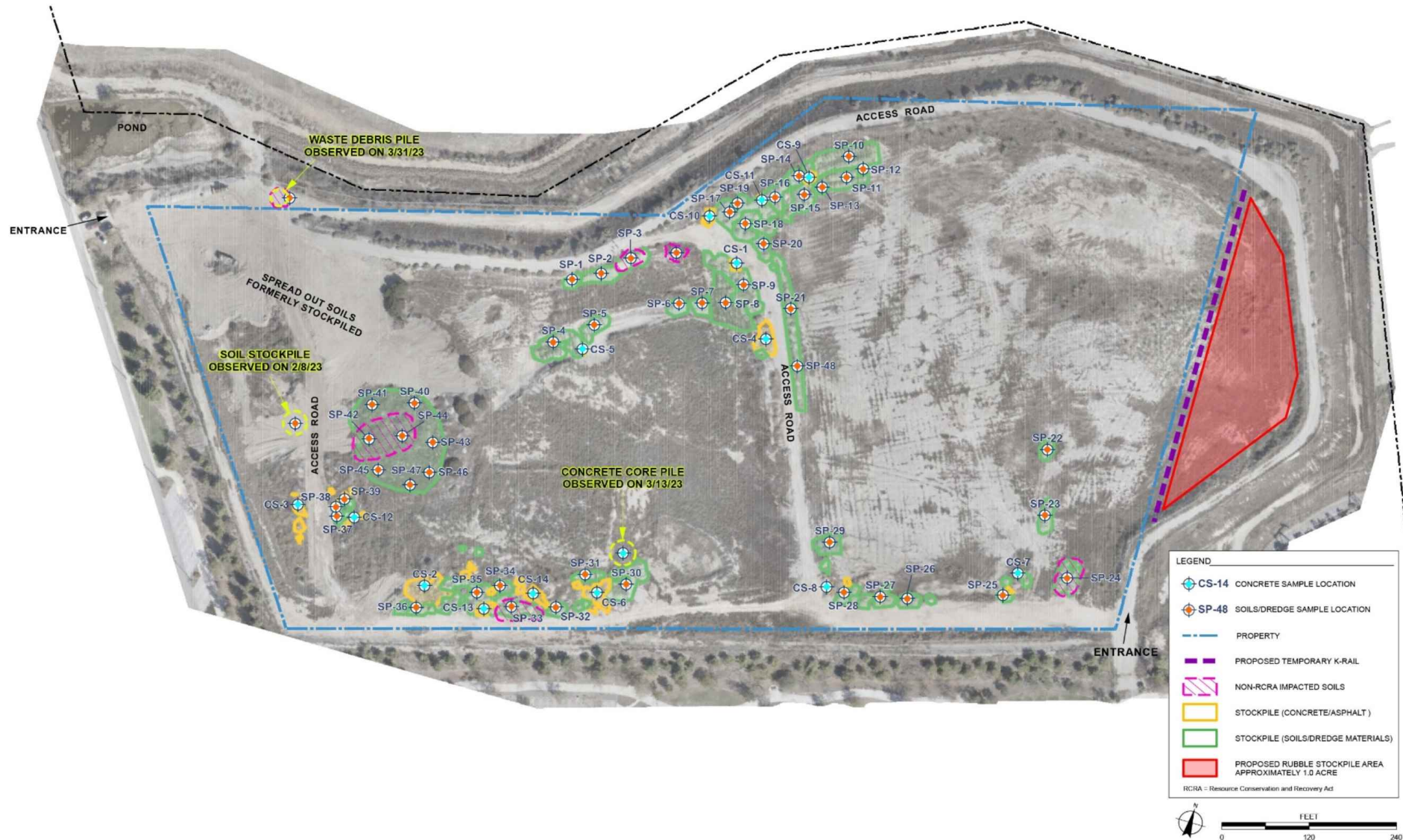
8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Stockpile Soil & Concrete Debris Sample Locations



1. Equipment

2. Temporary Use Permit

3. Photogrammetry

4. Airspace Monitoring

5. Programming Flight Path

6. Ground Control Points

7. FAA/LAANC

8. Drone Flight

9. Stockpile Volume

10. Post Processing

11. Final Figures

Photos of Stockpile Sample Locations



Questions?

