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Delaware Solid Waste Authority

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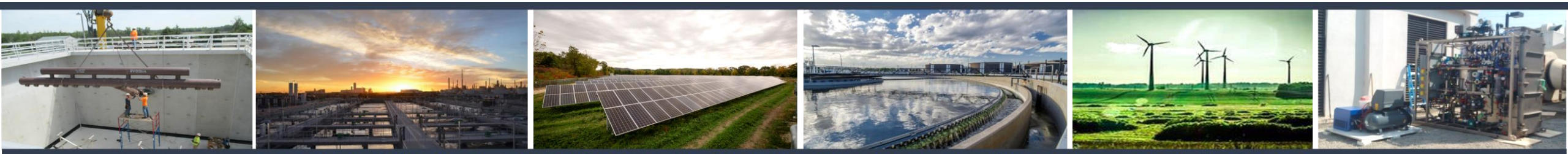
We will begin our presentation in a few minutes…



Drones and Their Role in Revolutionizing Landfill Operations Management

Alex Steuerwald, P.E.

Top 2 Priorities of Landfill Operations

Protecting the Environment

Complying with federal, state, and local regulations and permits

- Minimizing ecological impact, including odor control and proper waste covering

Maximizing Airspace

Getting the most waste in the least space

- Optimizing compaction, grading, and cell construction

Drones are an incredibly powerful tool to help fulfill both!

Further Details

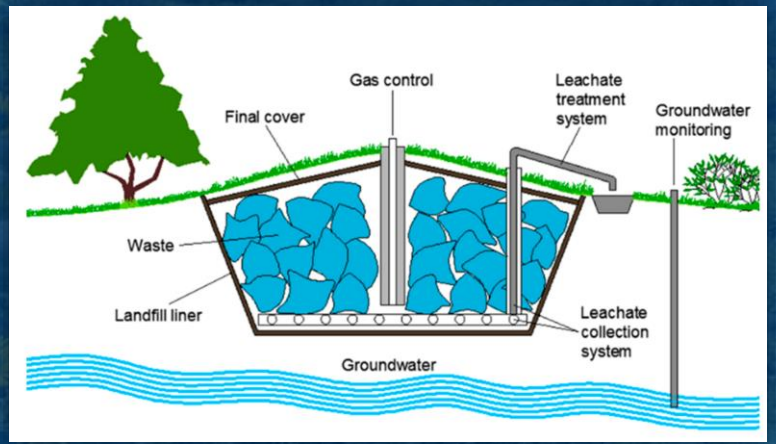
Protecting the Environment

Landfill Gas Collection

- Critical for capturing methane and minimizing odors

Leachate Collection

- Critical for conveying leachate to be properly treated and preventing it from entering surface waters and groundwater



Maximizing Airspace

Landfilling by Design

- Constructing waste cells in accordance with an engineered design

Optimized Compaction

- Ensuring that operators are covering enough ground and making enough passes

Traditional Methods

Protecting the Environment

Monitoring performance of the landfill gas collection system

- Gas well readings that check landfill gas composition
- Surface monitoring to ensure enough cover soil is in place

Ensuring all leachate is properly collected and conveyed

- Walking the landfill surface and inspecting for leachate seeps
- Monitoring pump station performance metrics

Traditional Methods

Maximizing Airspace

Frequently checking landfilling progress

- Utilizing a GNSS rover (i.e. Trimble) to verify finished grades follow design
- Staking out landfilling areas and recording elevations over time to calculate waste volumes

Generating topography maps on a regular basis to monitor life remaining

- Typically involves planes with high resolution cameras and/or LiDAR systems
- Data collected by surveyor then requires processing by a civil engineering firm for the final deliverable and to verify accuracy

Cost Case Study

Topographic Map and Remaining Capacity

Cost for Professional Surveying Services

** Assume organization has (3) operational landfills, each 350 acres in size, and has a survey performed every calendar quarter*

- Establishing ground controls - Providing report for those controls	- Performing the survey - Verifying with field measurements - Providing topographic map and mosaic image	- Calculating remaining volume - Providing capacity report	**TOTAL** *per*	**TOTAL** *annually organization-wide*
$4,500	**$17,500**	**$2,200**	**$24,200**	**$290,400!**

Drawbacks of These Methods

Costly

Labor and services necessary are expensive

Time-Consuming

Time lost to perform required tasks adds up

Safety Concerns

Frequent close exposure to the many dangers at a landfill

Solution?

Drones and Software Available

Drones

DJI Models

- Mavic 3 models
- Phantom 4 models
- Matrice 300 models

WISPR Models

- Ranger Pro
- SkyScout

Wingtra

- WingtraOne Gen II

Software

Propeller Aero

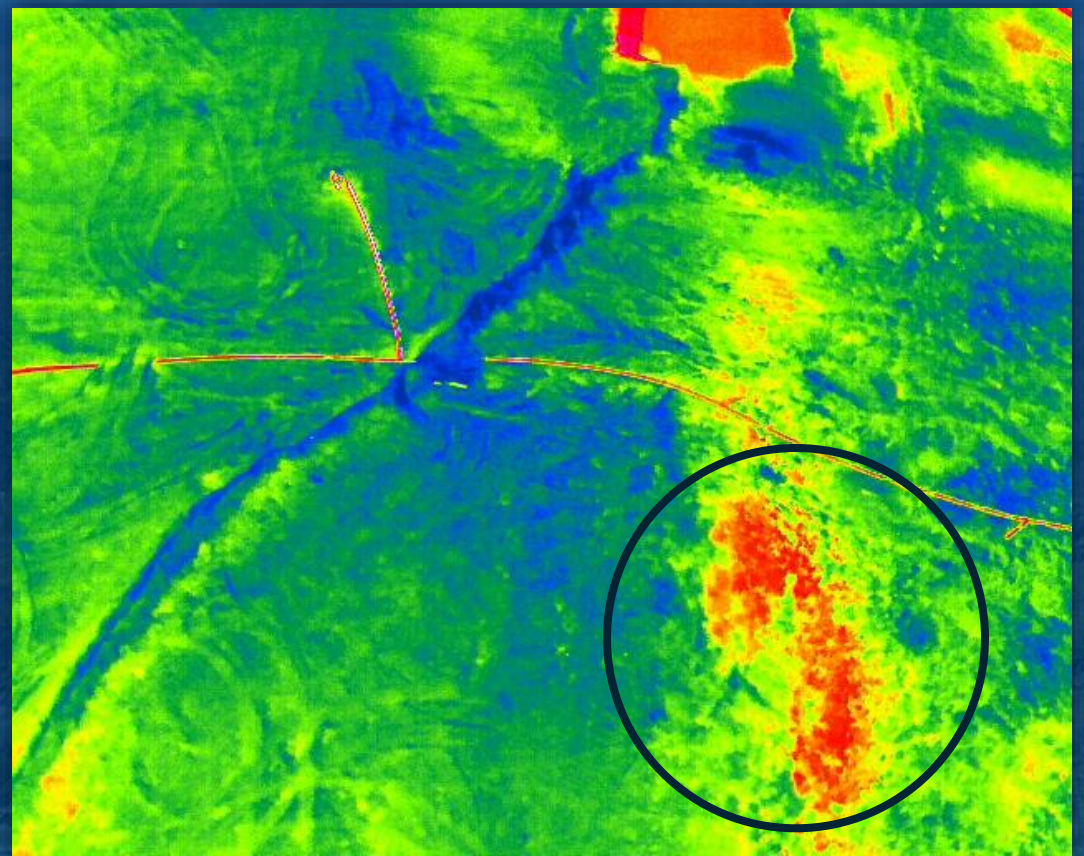
Kespry Cloud

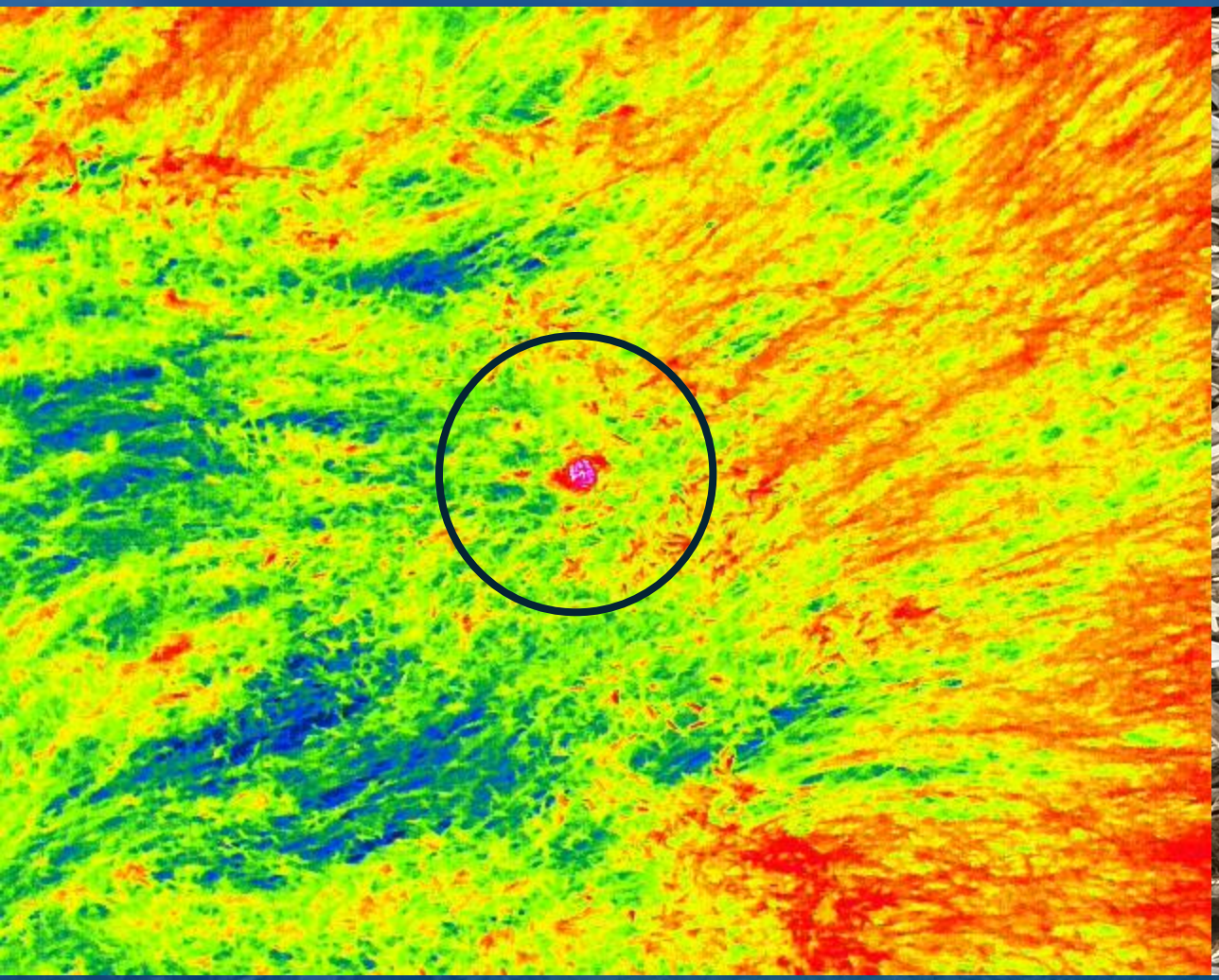
DroneDeploy

How Drones Can Help

Protecting the Environment

Monitoring performance of the landfill gas collection system



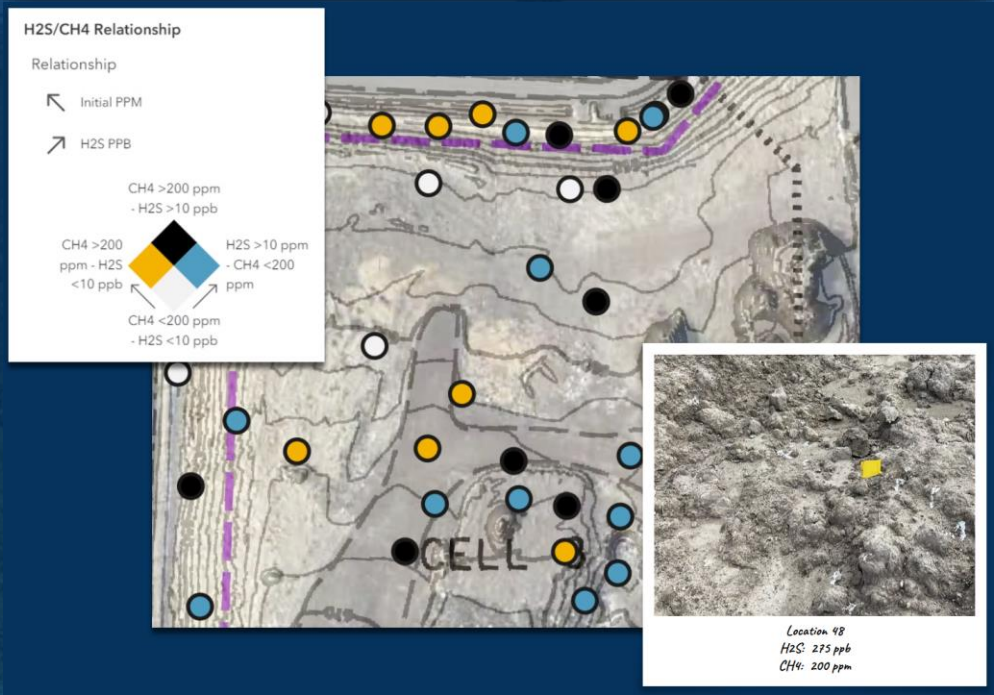


SnifferDRONE™

SnifferDRONE™ UAS consists of a package, designed and built by Sniffer Robotics, adapted to a commercially available unmanned aerial vehicle (UAV - drone). The integrated system includes the following:

- Gas detector specific to purpose (Methane or Hydrogen Sulfide)
- Flexible hose, weighted nozzle, and break-away coupling ("hozzle" system)
- Laser-guided system to enable terrain hugging capabilities
- Software for flight planning, flight control, in-flight reporting, algorithms for leak source detection and data management

Source: https://www.snifferrobotics.com/snifferdrone



How Drones Can Help

Protecting the Environment

Ensuring all leachate is properly collected and conveyed

How Drones Can Help

Protecting the Environment

Inspecting the stormwater conveyance system

Advantages

Cost Savings

Drone quickly pays for itself by eliminating provider contract costs and cost of the workforce required to perform the same tasks

Faster Execution

Job is completed substantially faster than a crew working on foot or in a vehicle

Minimized Risks

Pilot can be in a safe area with minimal risk of landfill dangers (traffic, equipment, landfill gas, etc.)

How Drones Can Help

Maximizing Airspace

Checking landfilling progress

Monitoring life remaining

Drones and Powerful Software → propeller

What You Need

To get started, you need the following:

Drone supported by Propeller

Ground controls (Fixed or AeroPoints)

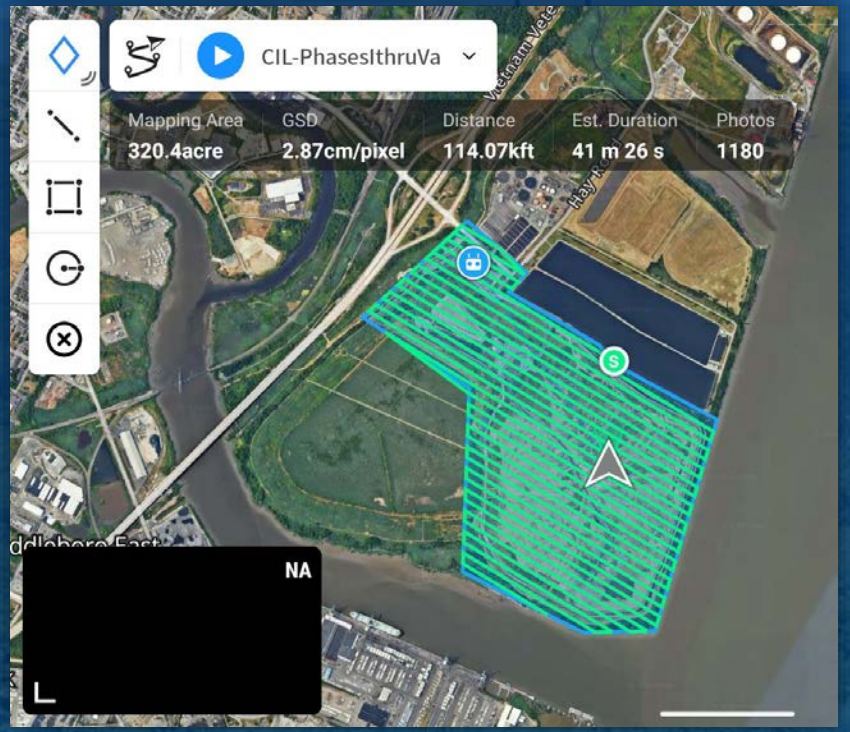
FAA Part 107 Certified Remote Pilot

What You Do

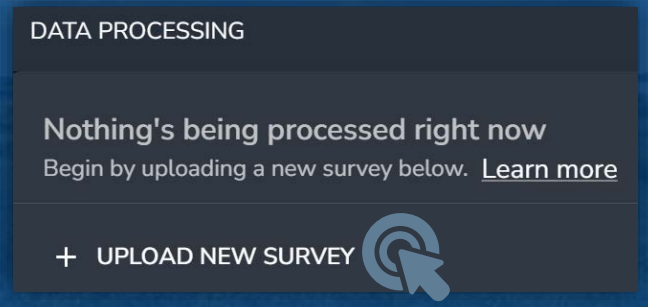
To get started, you need the following:

Establish ground controls

Perform the survey flight

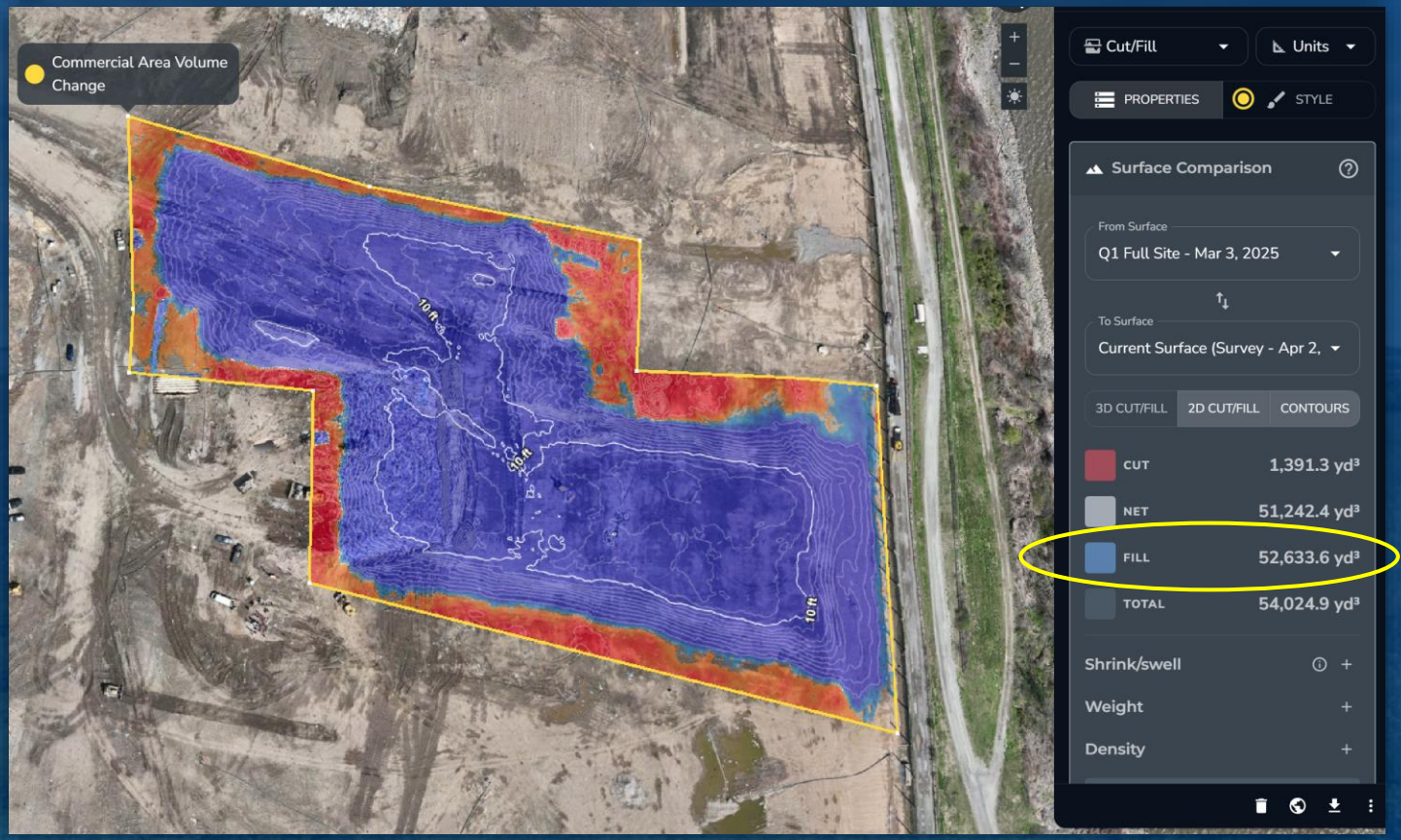


Upload to Propeller

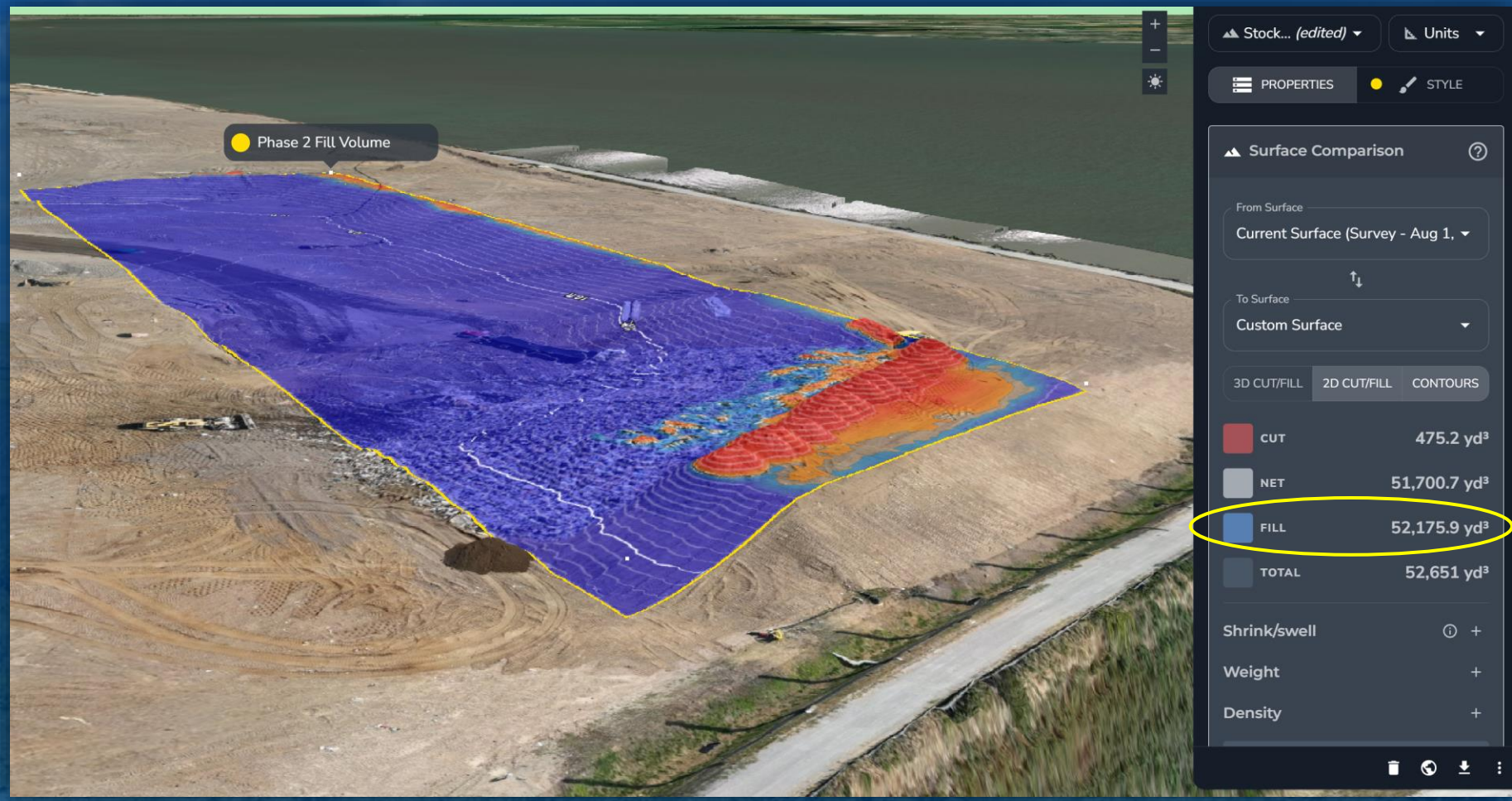


Now You Have a Model

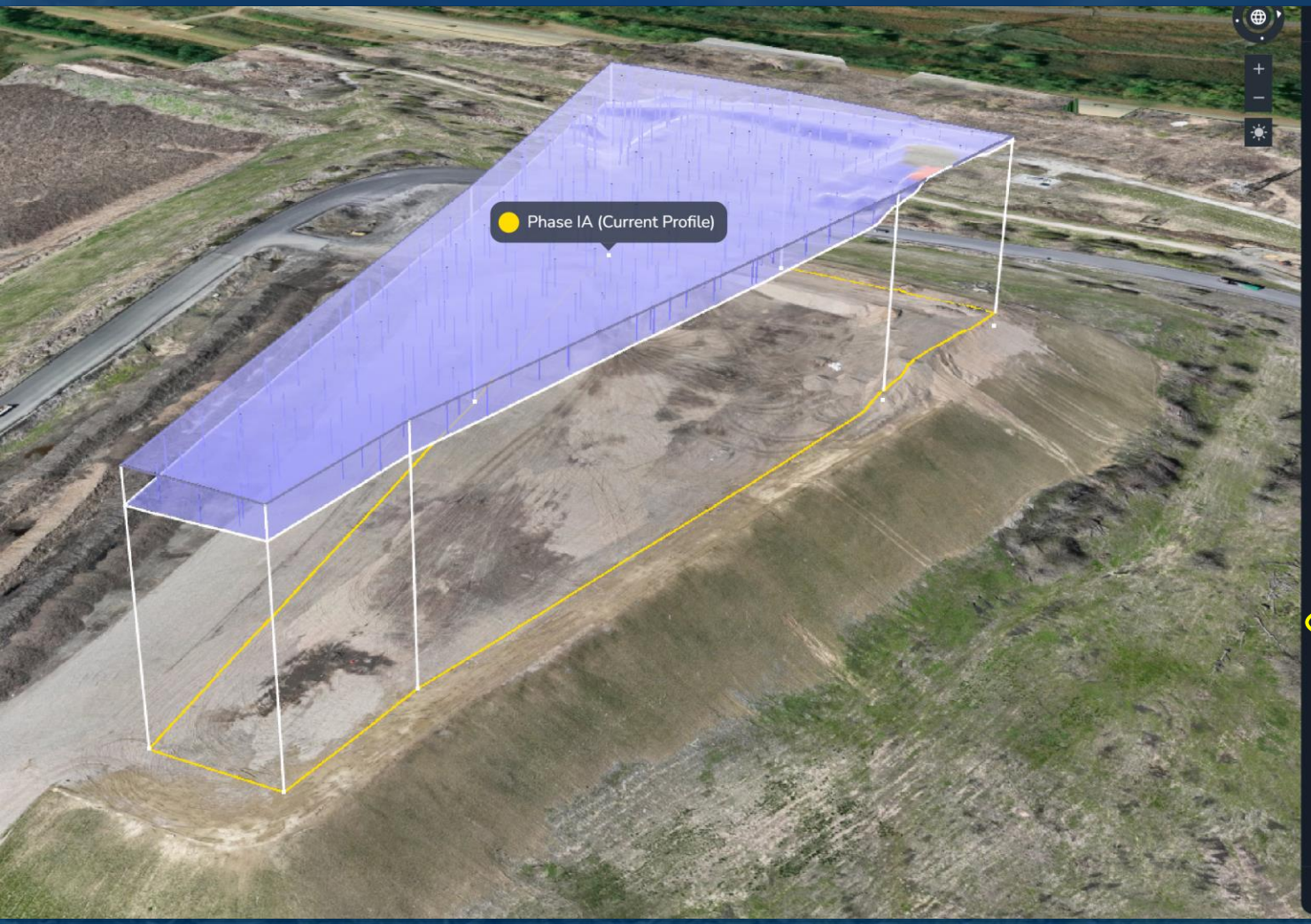
Checking Landfilling Progress

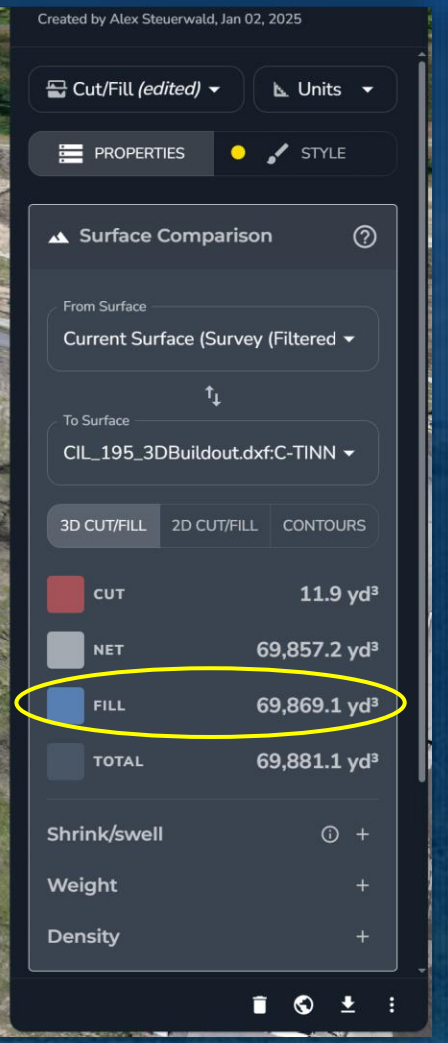


Effective Planning

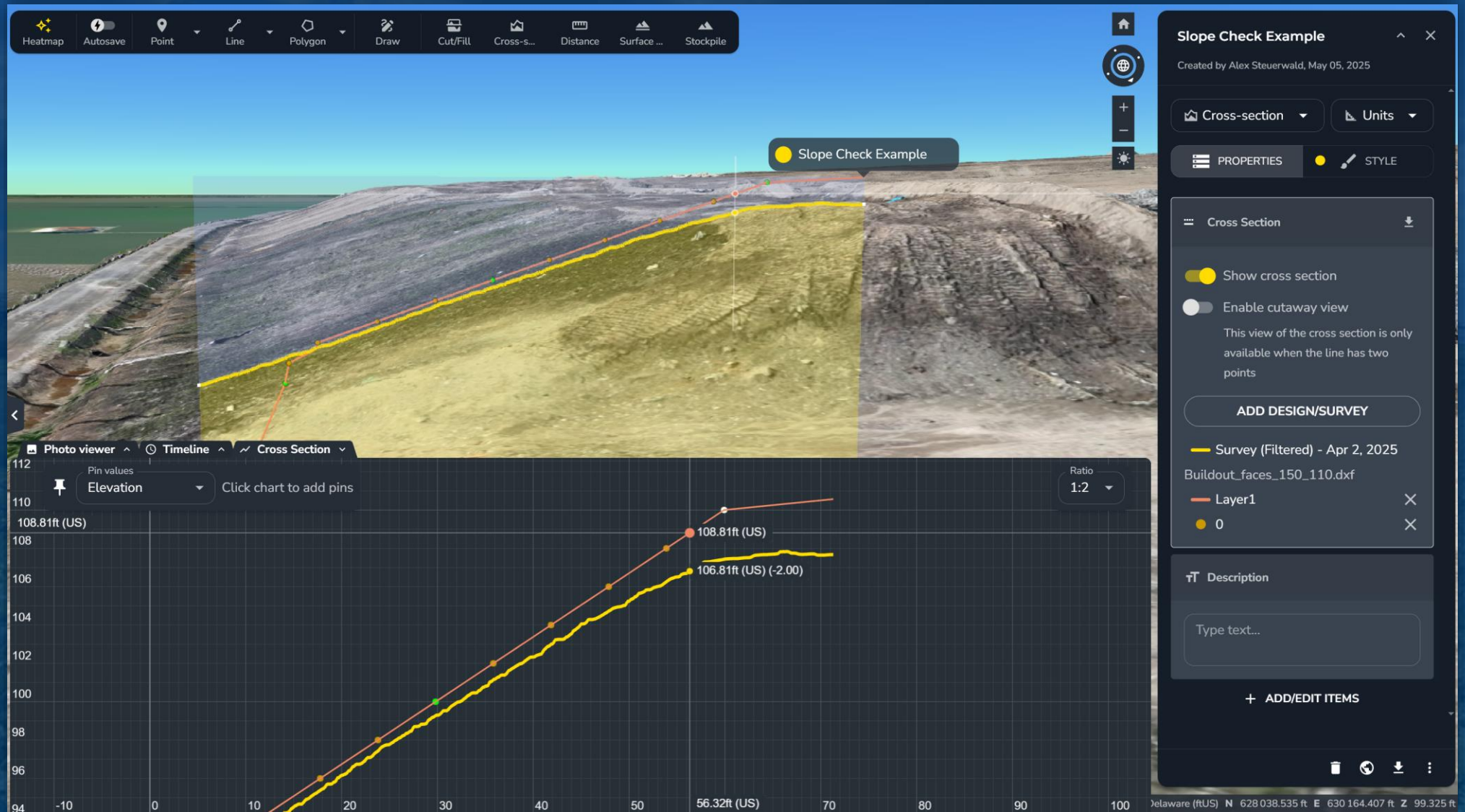


Calculating Life Remaining





Verifying Buildout Accuracy

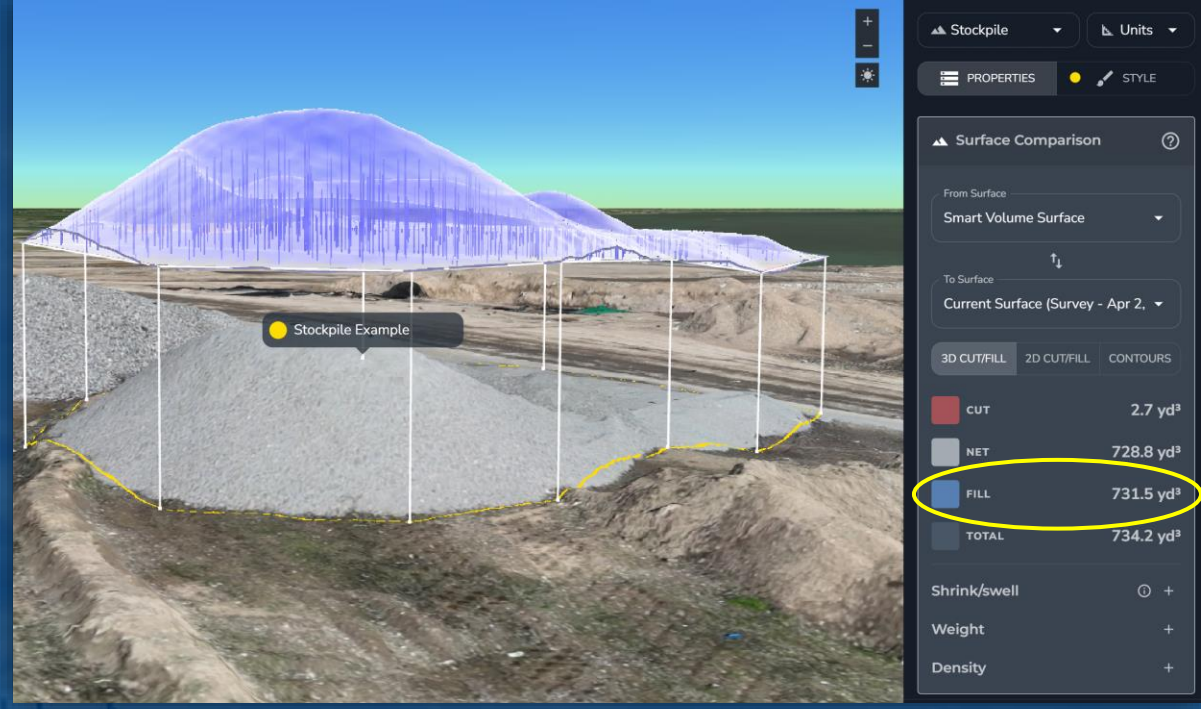


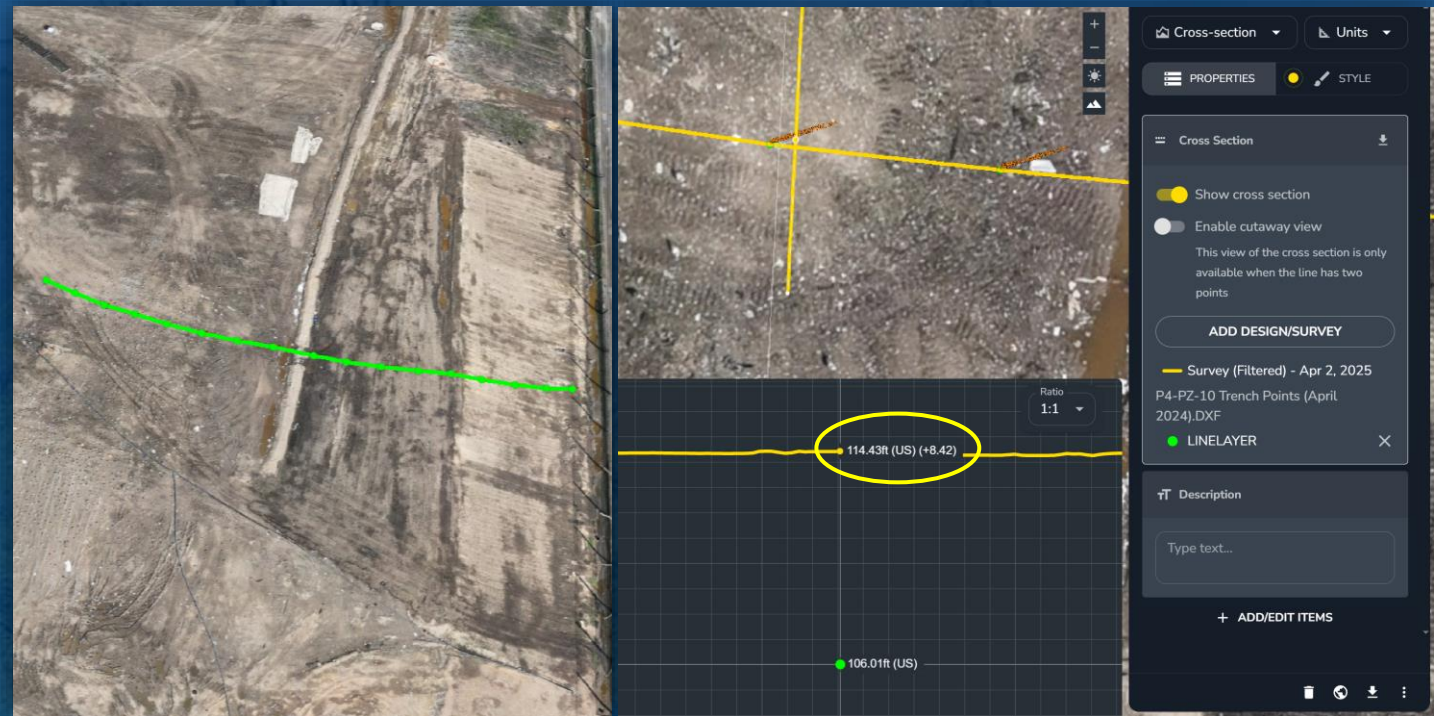
Monitoring Settlement

Beyond Airspace...

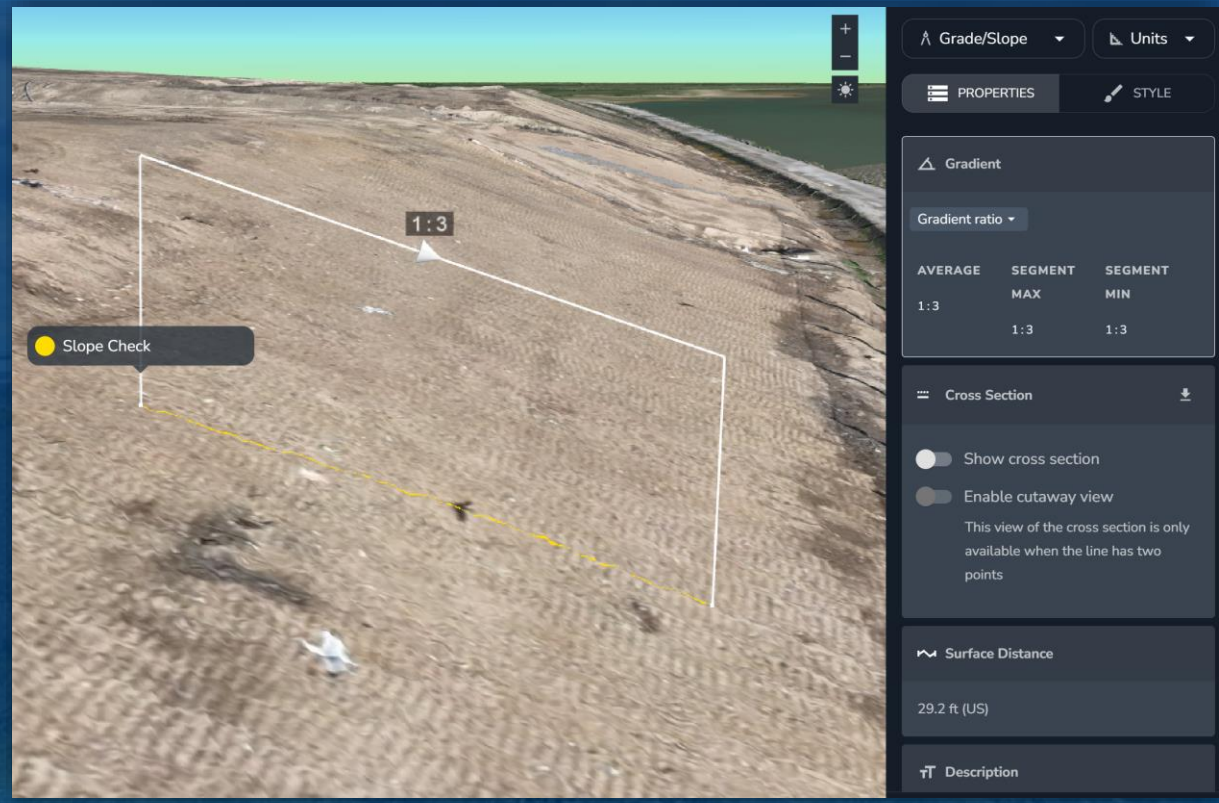
While Propeller is a powerful tool for volume and design calculations, it's also incredibly helpful for various other important operational tasks such as:

- Marking locations of facility utilities (underground electric lines, stormwater structures, landfill gas wells, etc.)
- Stockpile volume calculations
- Checking grading of hauls roads and side slopes
- Visualizing and storing as-builts
- Creating highly detailed 3D models of facilities
- Stormwater management modeling



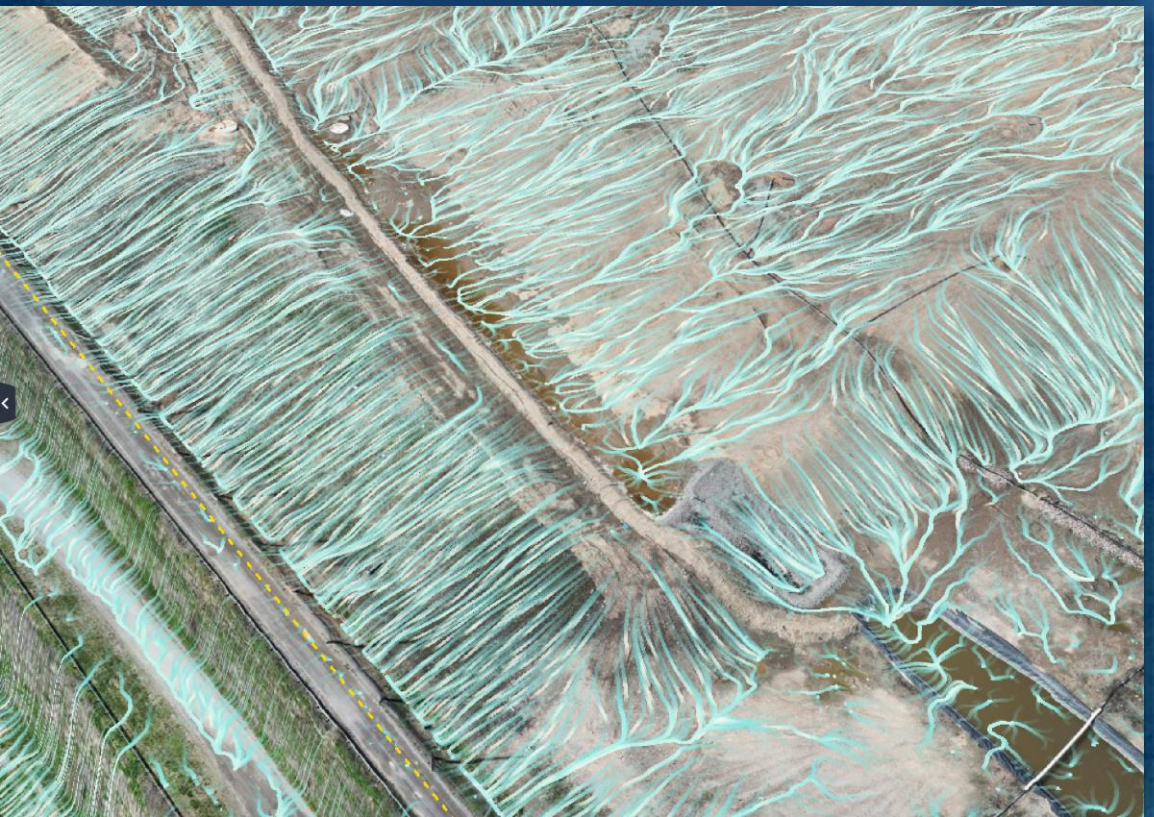


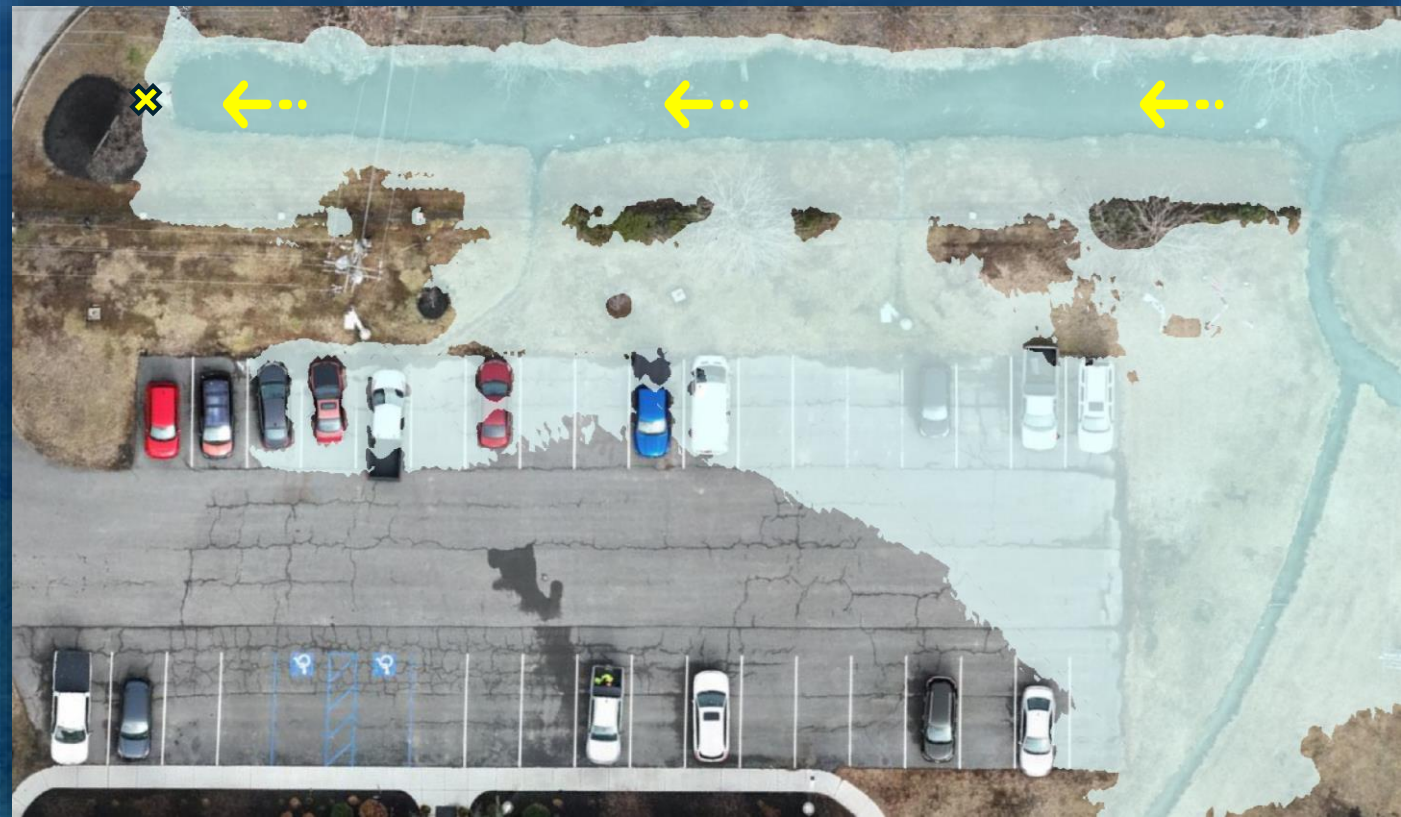
More Examples



Stormwater Modeling

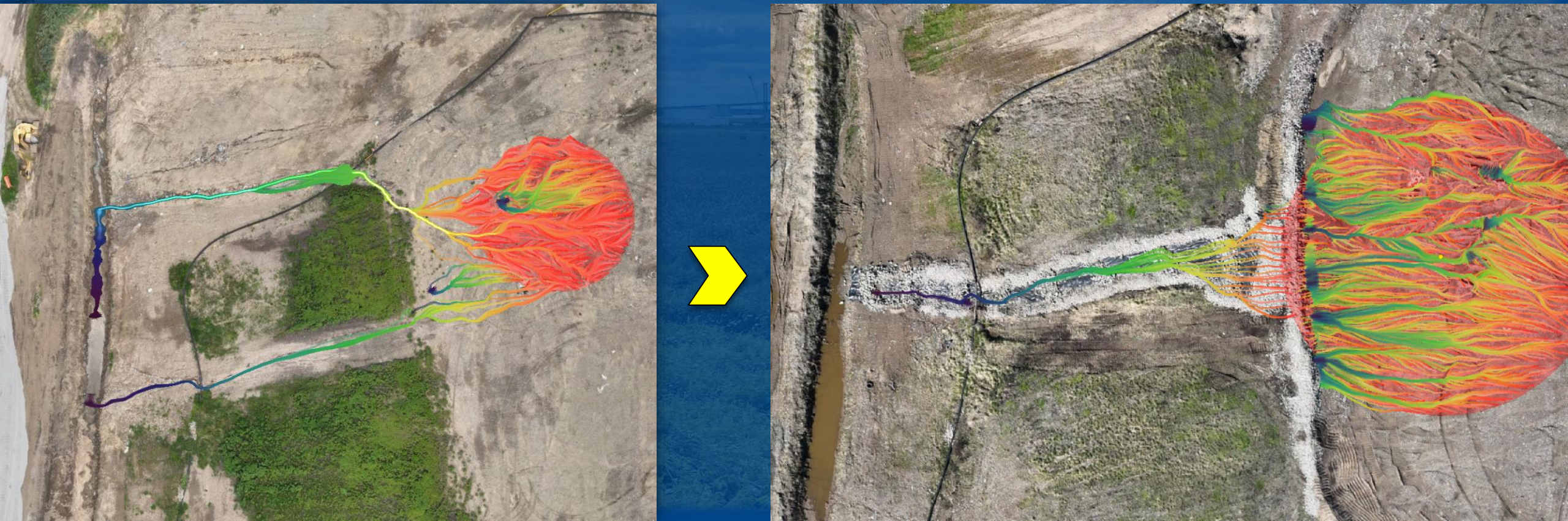
Stormwater modeling tools are highly beneficial for weather preparation and maintenance of the stormwater conveyance system.



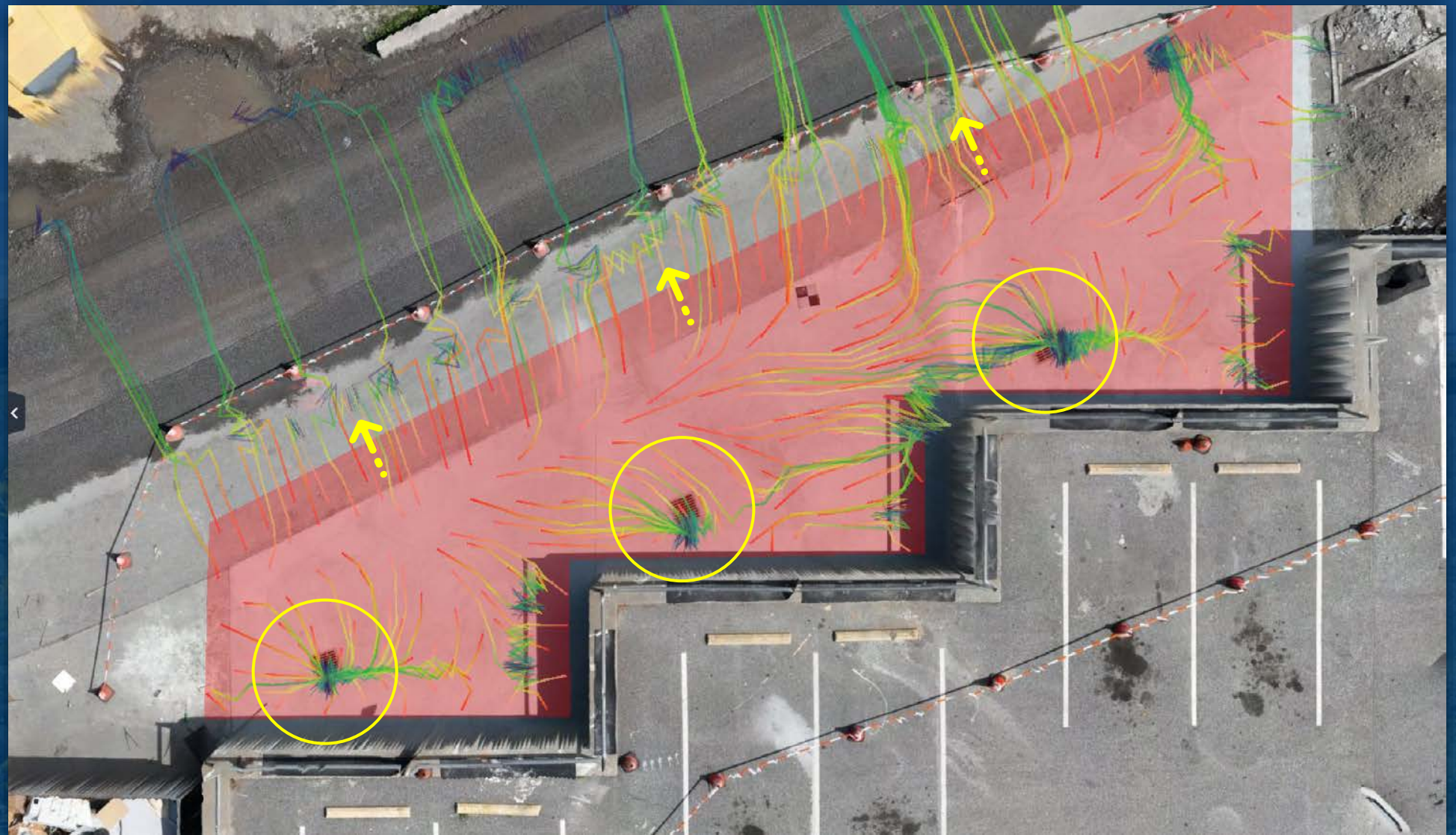


Stormwater Modeling

Using the model to identify areas where stormwater is collecting at a single point and causing significant erosion



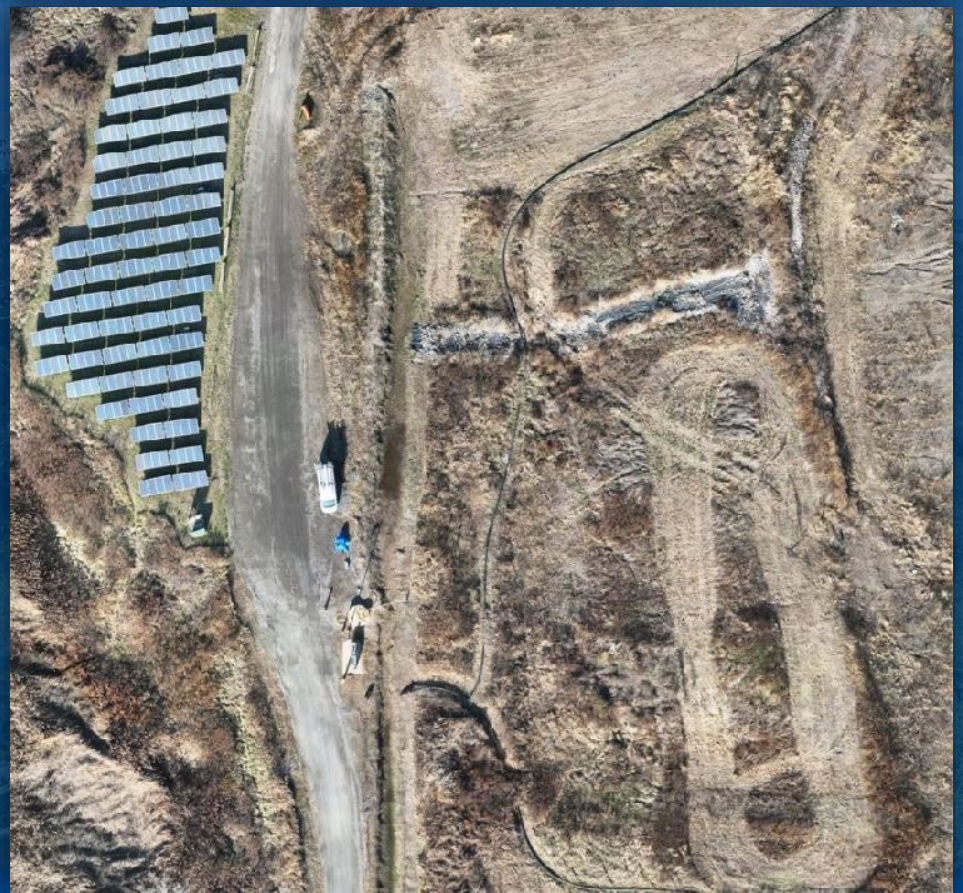
Another Example



Incorporating PDF's

Not all our designs are digital… but they're still useful!

You can incorporate as-built PDF's directly into your drone model!

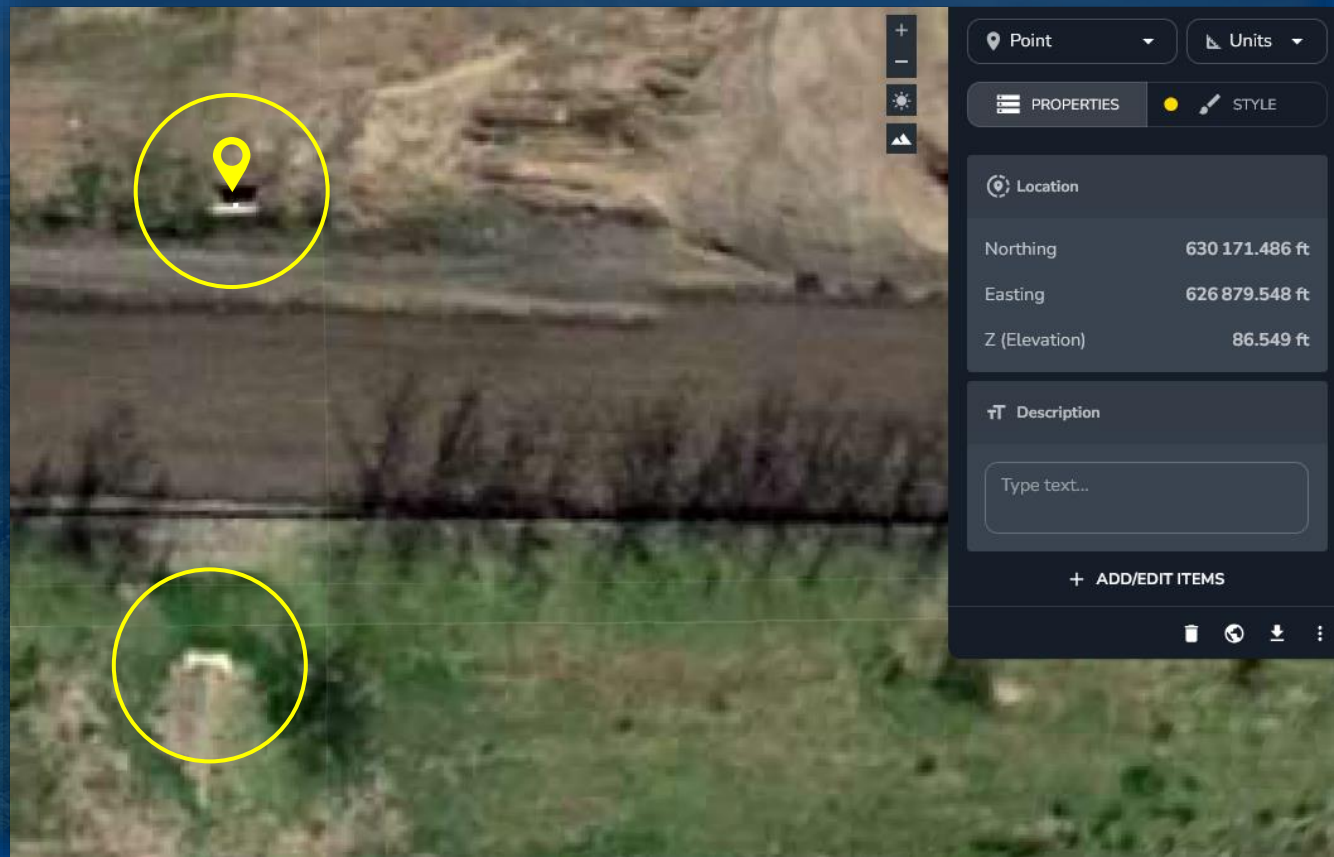


Incorporating PDF's

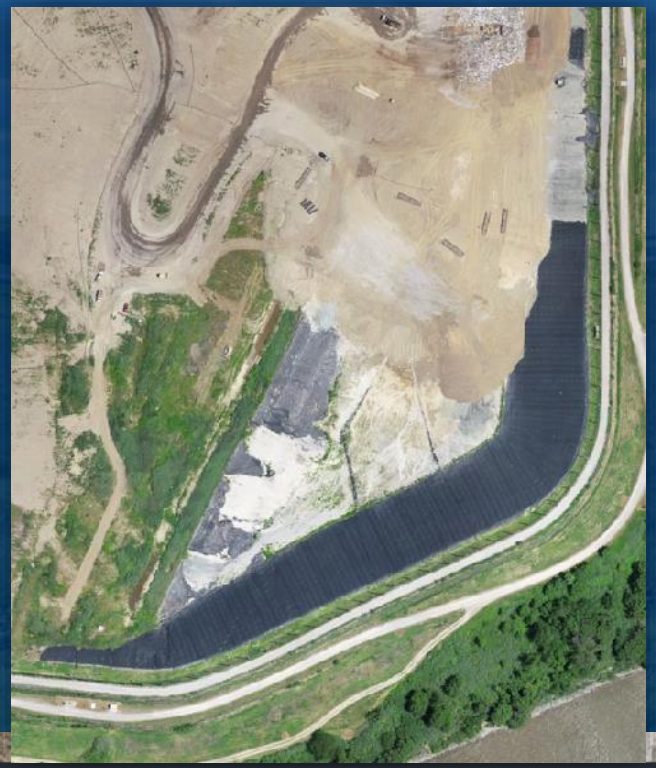
This concept is useful for pictures as well!

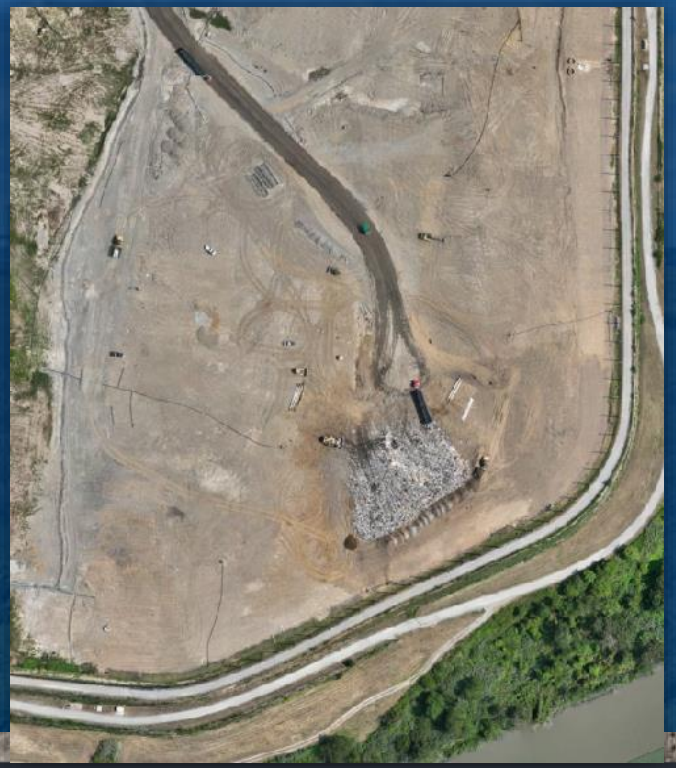
2025

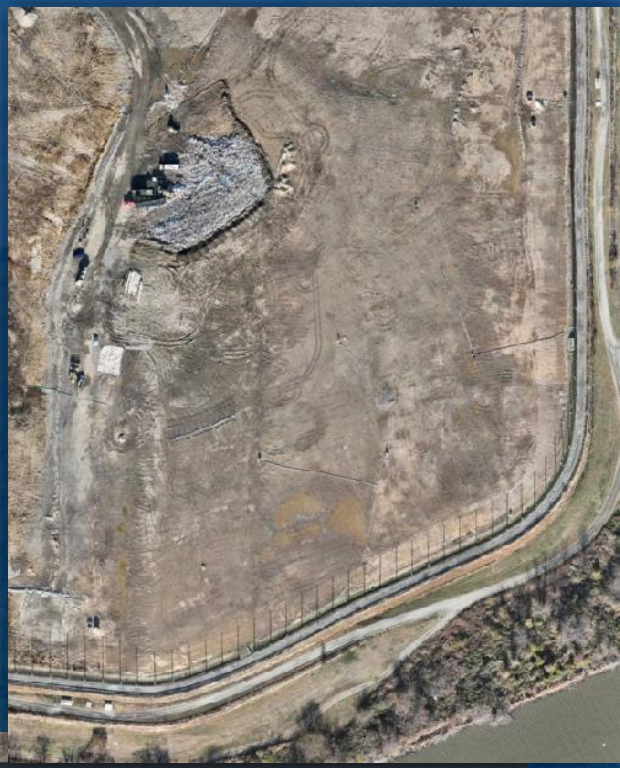
2002



Timeline Viewing







Jun 4, 2024 · Jul 2, 2024 · Jul 2, 2024 · Aug 1, 2024 · Aug 1, 2024 · Sep 3, 2024 · Sep 3, 2024 · Oct 2, 2024 · Oct 2, 2024 · Nov 4, 2024 · Nov 4, 2024 · **Dec 2, 2024**

Field Crew Sharing

Quickly get information out to field personnel without them needing to have a login or access to the organization's Propeller platform

Advantages

Cost Savings

Drone and accompanying software are now the middleman between operations staff and the results they seek, rather than a surveyor and/or engineering provider

Faster Execution

Staff can perform the surveys on their time, not someone else's. Software can generate models in a matter of hours, not days/weeks.

Dependable Results

Survey models have a horizontal and vertical error of < 1.5 cm

Cost Case Study

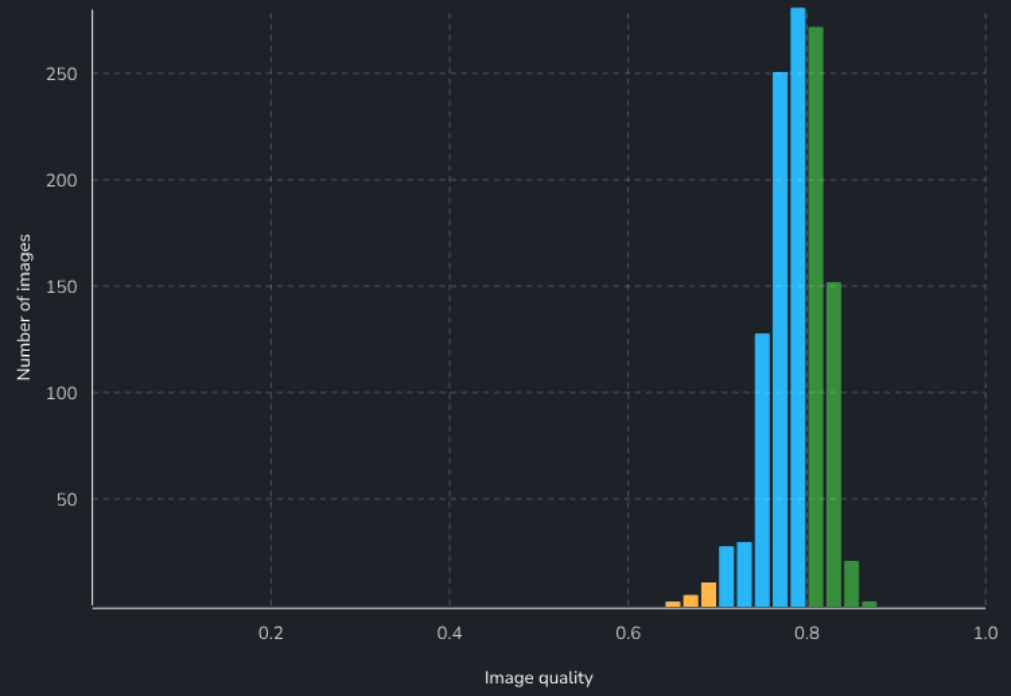
Topographic Map and Remaining Capacity

Cost for Drone Survey Services

** Assume organization has (3) operational landfills, each 350 acres in size, and has a survey performed every calendar quarter*

Cost of a DJI Mavic 3E	Cost of an AeroPoint Bundle (x5)	Subscription to Propeller	**TOTAL** *per*	**TOTAL** *annually organization-wide*	**Cost Savings** *compared to hiring professional services*
$6,500	$4,000	$10,000	$20,500	$20,500	$269,900 (~93%)

Processing Report Example



Total images	Good quality images	Fair quality images	Poor quality images	Unaligned Images
1171	443	713	15	0

X error (ft (US))	Y error (ft (US))	XY error (ft (US))	Z error (ft (US))	Total error (ft (US))
0.092	0.094	0.132	0.520	0.536

Expected Ground Control Accuracy

Control that was used to correct the model

Point name	X error (ft (US))	Y error (ft (US))	Z error (ft (US))	Total error (ft (US))
acb2e097d8	0.015	0.031	0.020	0.040
acb17a7c95	0.065	0.016	-0.019	0.070
ac6a2f7c6e	0.005	-0.028	0.017	0.033
acf08e3f94	-0.032	-0.034	-0.036	0.059
ac9a123106	-0.068	-0.008	-0.002	0.069
acf7ddfc7e	0.006	-0.035	0.031	0.047

Total error: 0.055ft (US)

***Image Error:* 0.536 ft (which is corrected)**
***Ground Control Error:* 0.055 ft**

In Summary...

Modernization of Landfill Management

Drones replace outdated methods with tools that integrate directly into GIS systems and other digital workflows, and positions operations staff to be tech-forward

Precision Tools for Smarter Operations

Real-time site monitoring and progress tracking, enhanced planning, compliance, and decision-making, with results that are accurate and dependable

Free Up Staff for Higher-Importance Tasks

Faster data collection with reduced turnaround time, allowing manpower and personnel costs to be allocated to the many other important operational tasks

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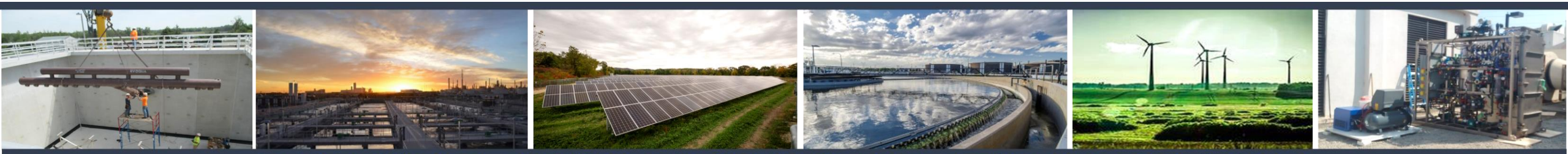
We have several webinars happening in the near future. Go to https://www.aaees.org/events to reserve your spot.

Would you like to watch this event again?
A recording of today's event will be available on our website in a few weeks.

Need a PDH Certificate?
Board Certified Individuals will be emailed a PDH Certificate for attending this event within the next week.

Questions?
Email Marisa Waterman at mwaterman@aaees.org with any questions you may have.



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