

# Kentucky Division of Water

## Drone Program

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Watershed Management Branch

Kentucky Division of Water

Department for Environmental Protection

Energy and Environment Cabinet

# **DIVISION OF WATER**

## **General Responsibilities:**

### **MISSION:**

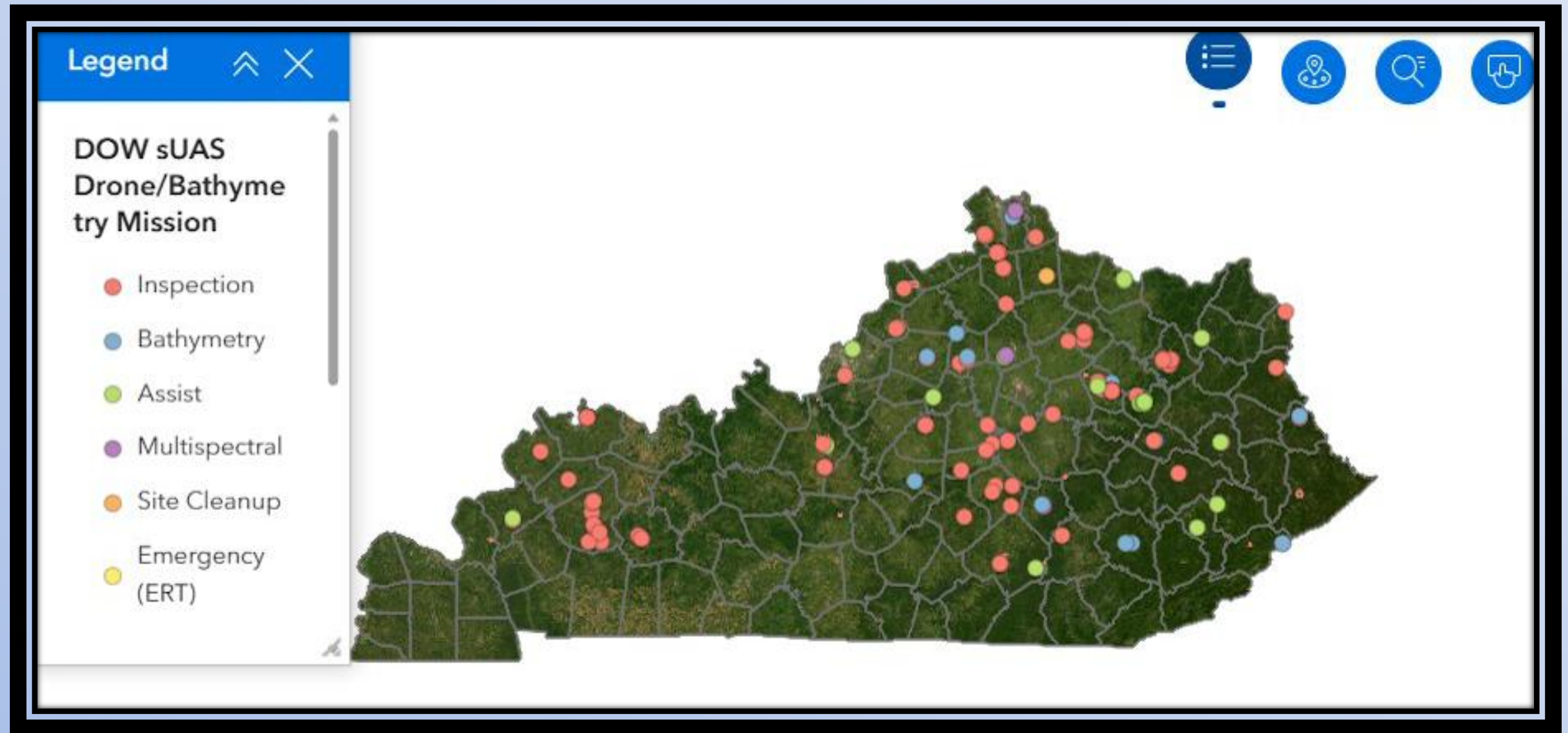
*“To manage, protect, and enhance the quality and quantity of the Commonwealth’s water resources for present and future generations through voluntary, regulatory, and educational programs”*

- Protect human health and the environment
- Manage and administer over 50 state and federal programs with ~240 employees at 11+ offices across the commonwealth

# Kentucky Division of Water- Remote Data Collection Program

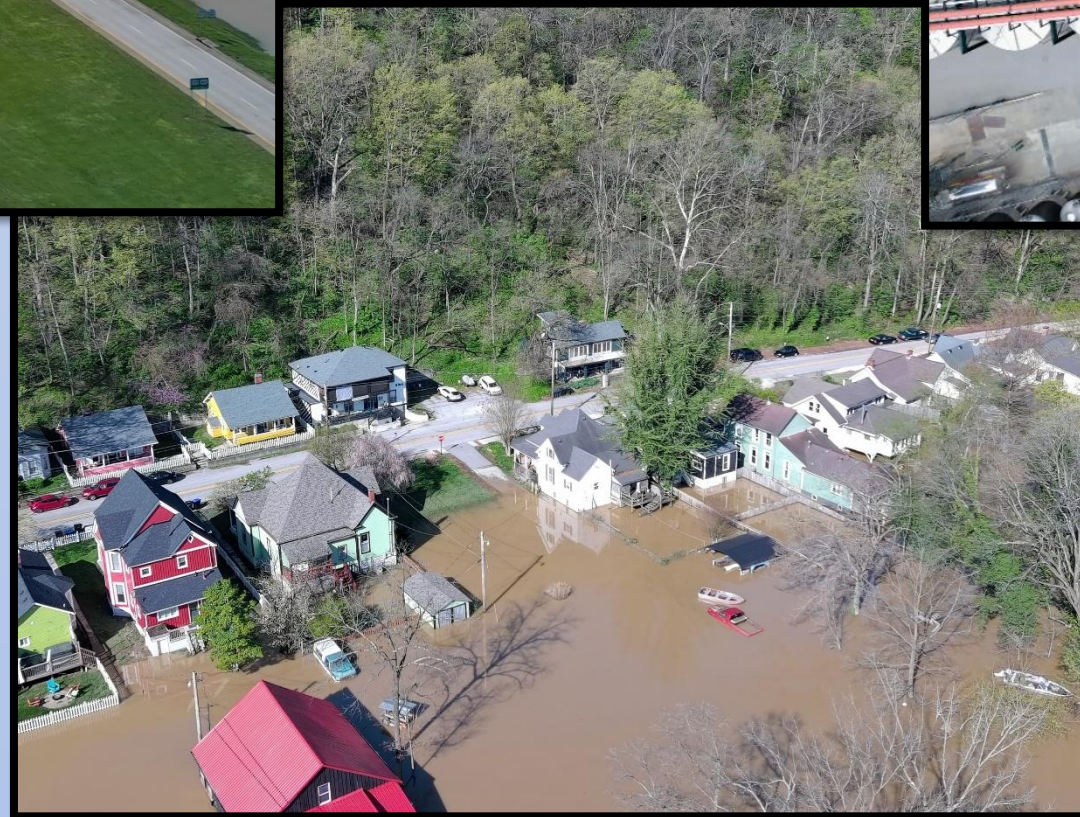
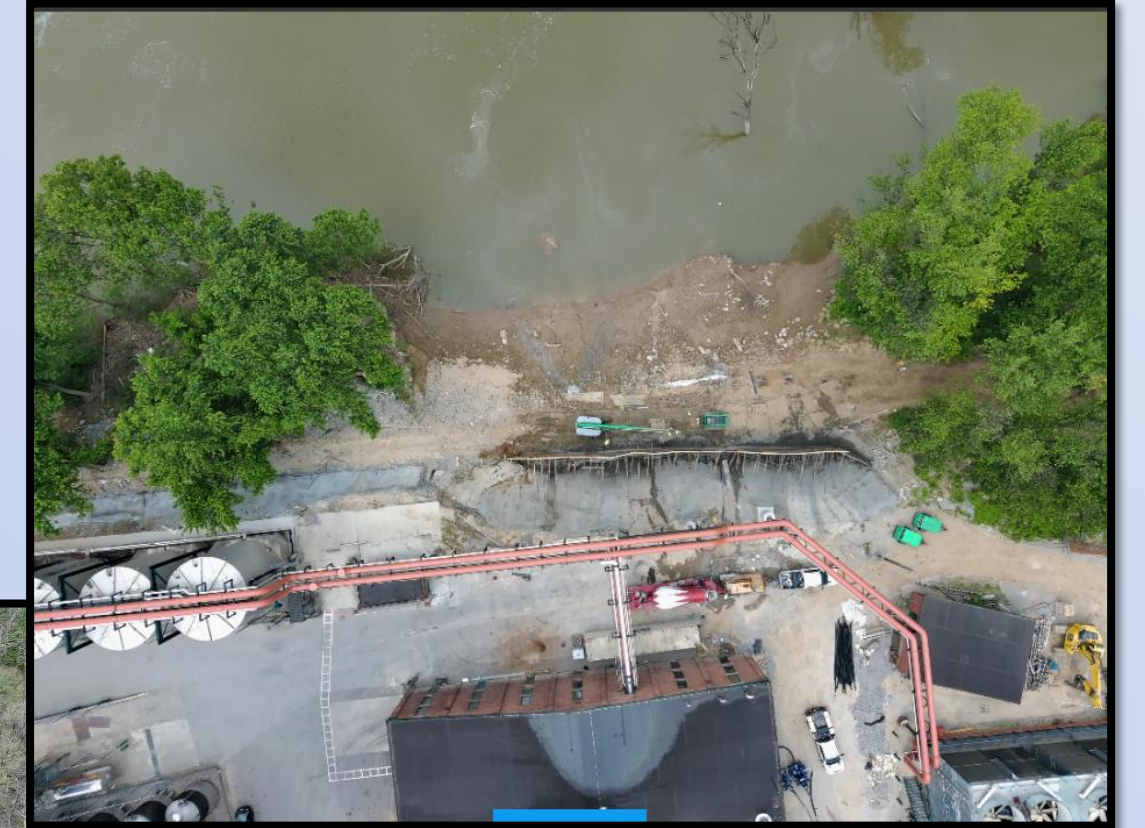
- Dam Inspection- Aerial Imagery
- Thermal Aerial Imagery
  - Water Line Leaks
  - Dam Failure or Issues
  - Springs and Groundwater
  - Drought Conditions in Soil
  - Wetland Delineation
- Bathymetry
- HAB/ Water Quality Monitoring

# Flights and Floats



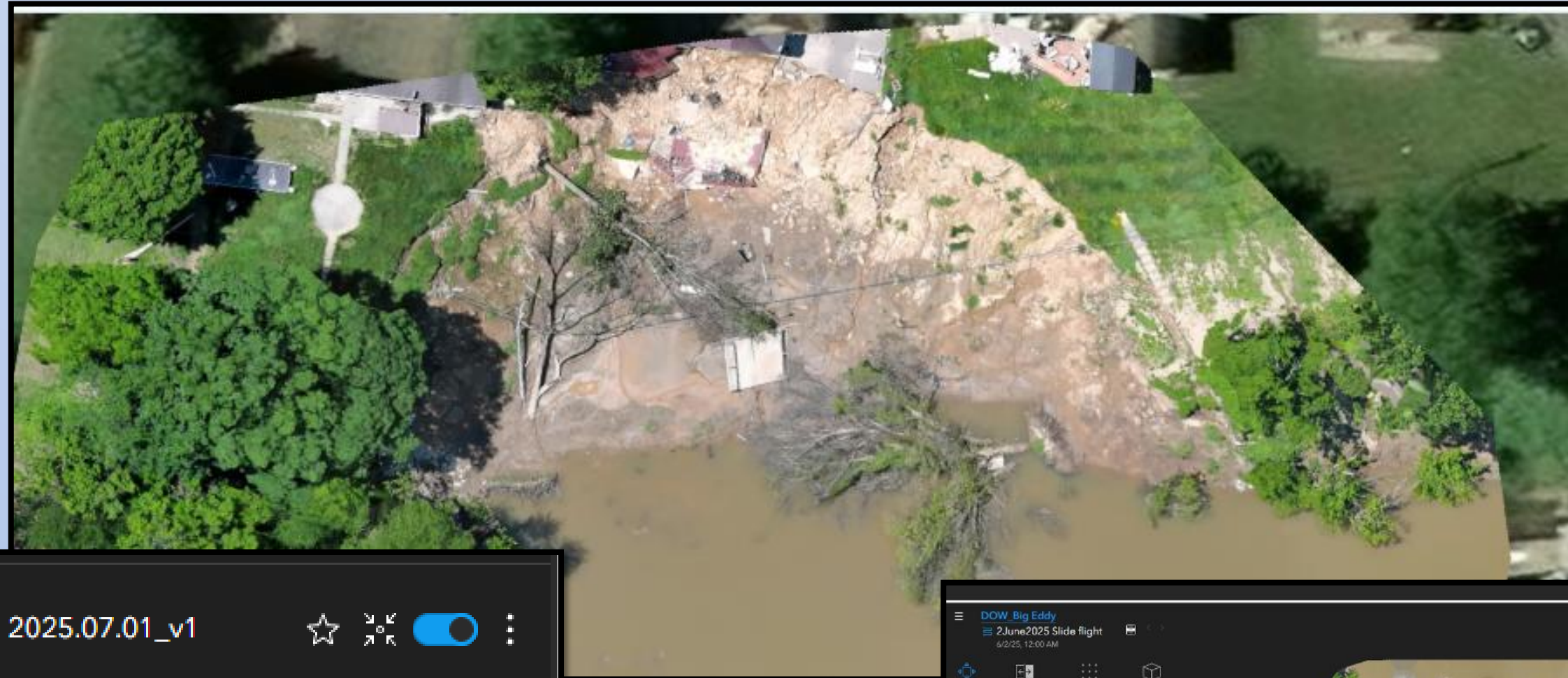
- 2024 conducted 62 flights/ 18 floats (bathymetric studies)
- 2025 conducted 25 flights/3 floats (as of 30 May 2025)

# Flood Monitoring and Inspection

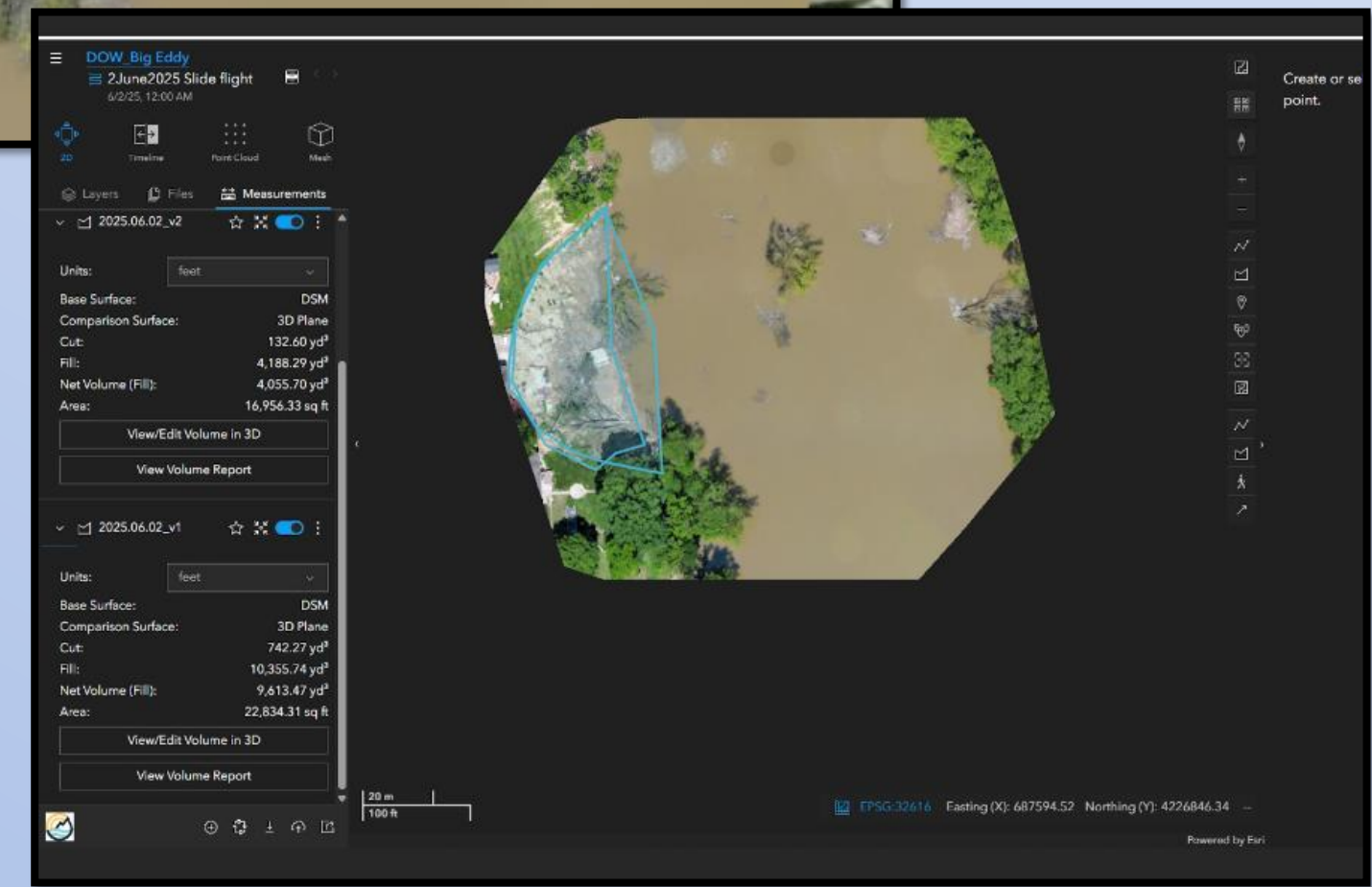


Frankfort Kentucky May 2025 Flood

# Landslide Estimates from May 2025 Flood



|                     |                       |   |   |   |
|---------------------|-----------------------|---|---|---|
| 2025.07.01_v1       | ☆                     | ✕ | ☑ | ⋮ |
| Units:              | feet                  |   |   |   |
| Base Surface:       | DSM                   |   |   |   |
| Comparison Surface: | 3D Plane              |   |   |   |
| Cut:                | 3.60 yd <sup>3</sup>  |   |   |   |
| Fill:               | 18.02 yd <sup>3</sup> |   |   |   |
| Net Volume (Fill):  | 14.42 yd <sup>3</sup> |   |   |   |
| Area:               | 1,369.93 sq ft        |   |   |   |

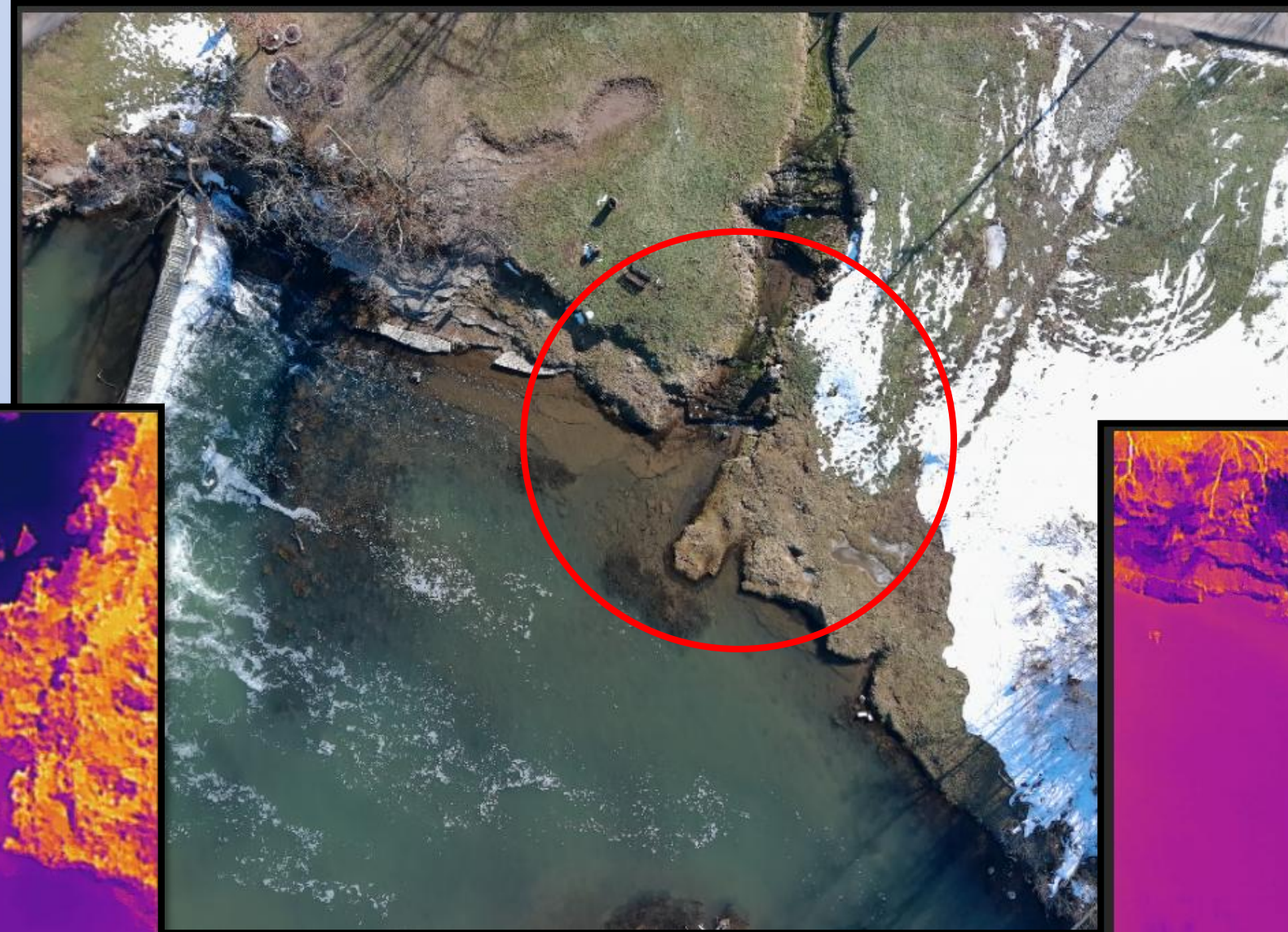


# Aerial Imagery- Dam Inspections

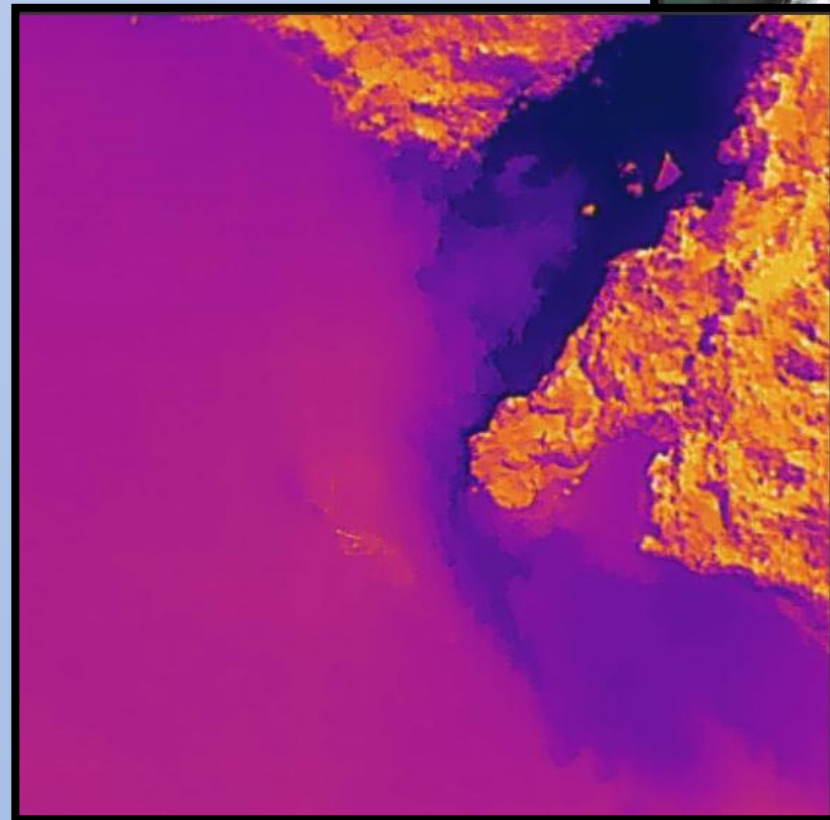


## Bullock Pen Dam Construction

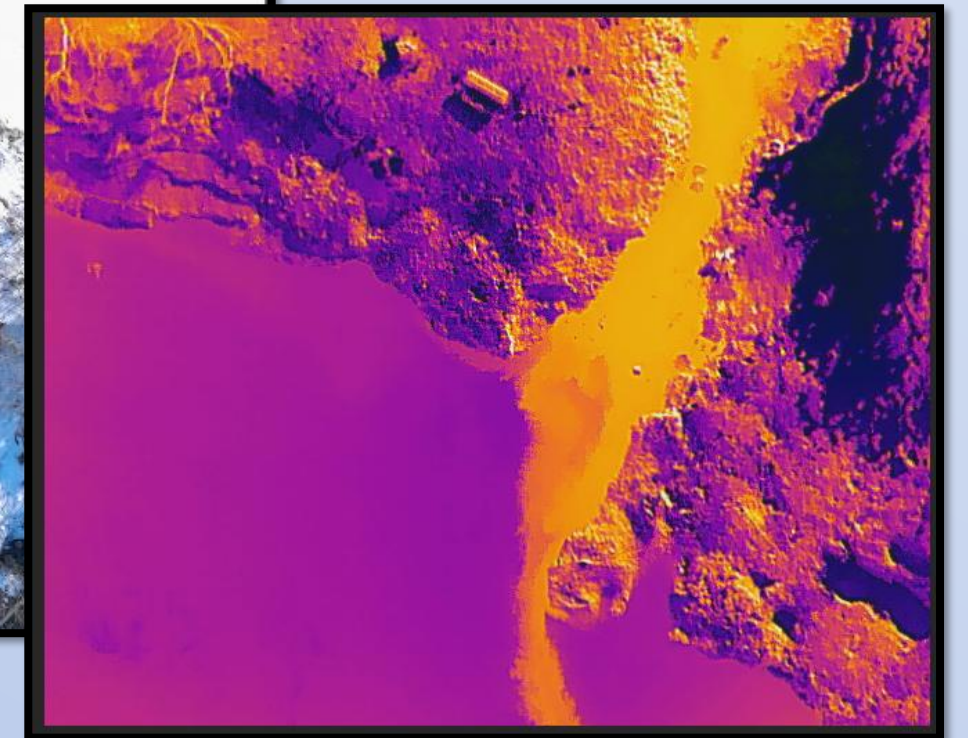
# Aerial Imagery- Thermal Imagery



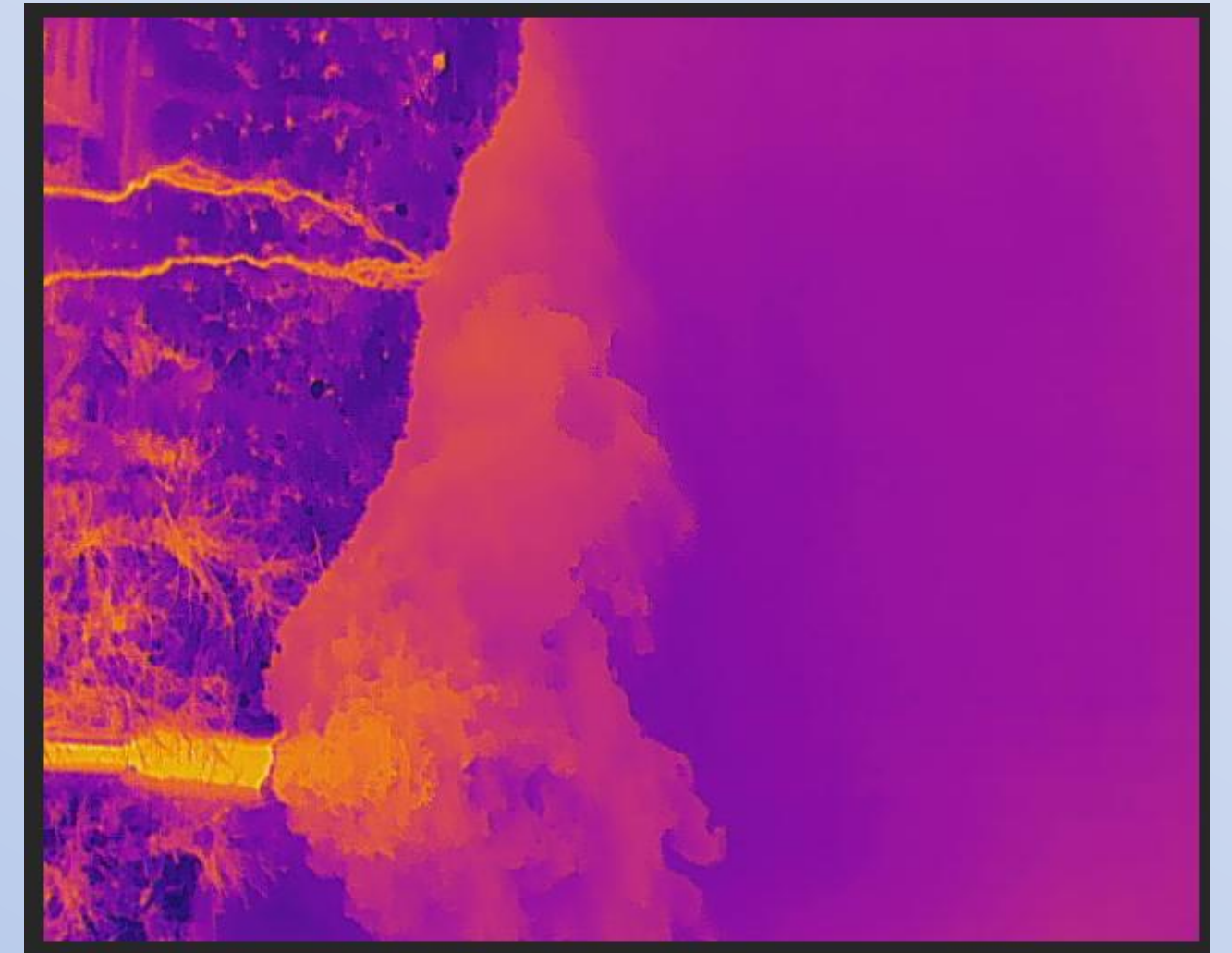
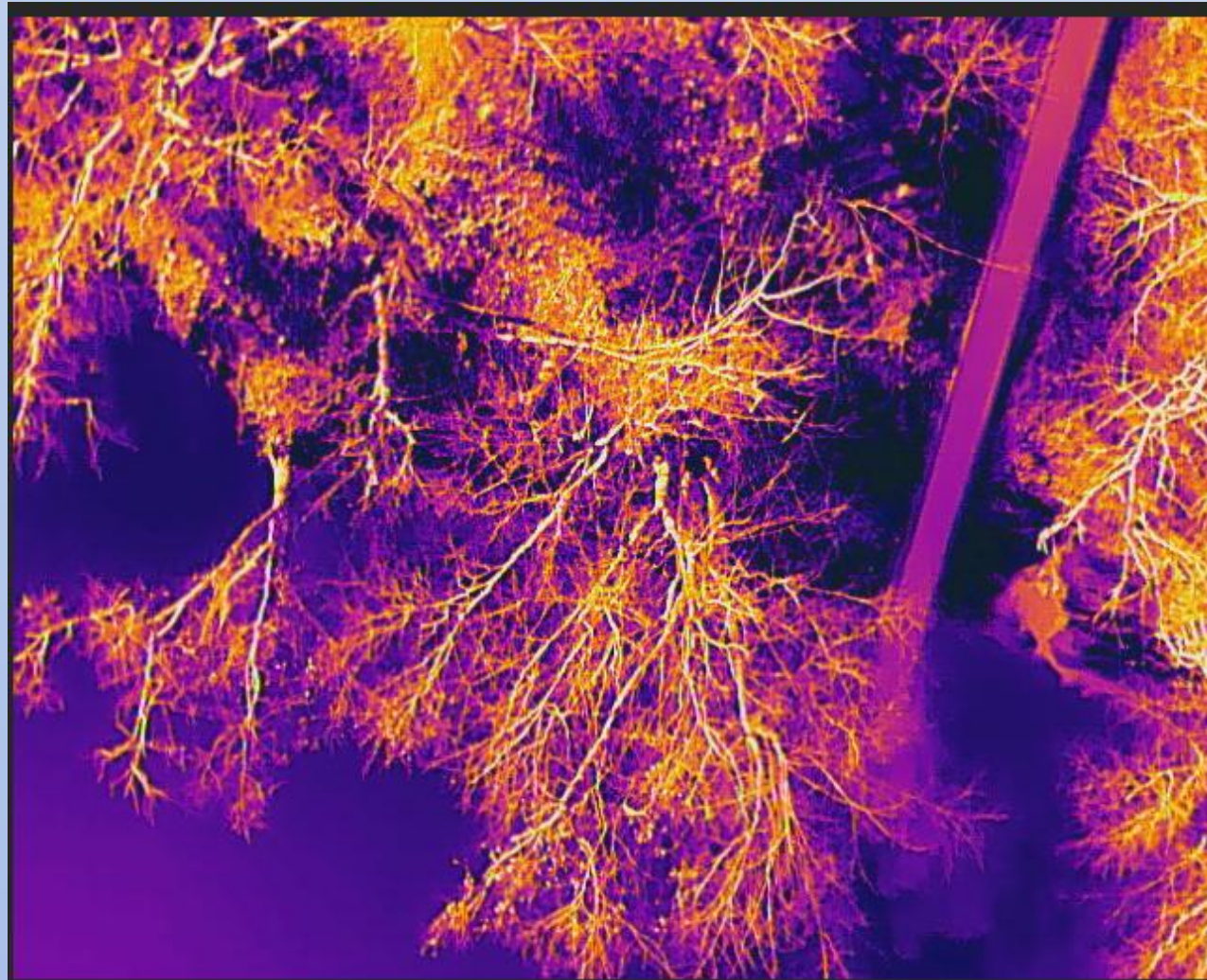
January 2025



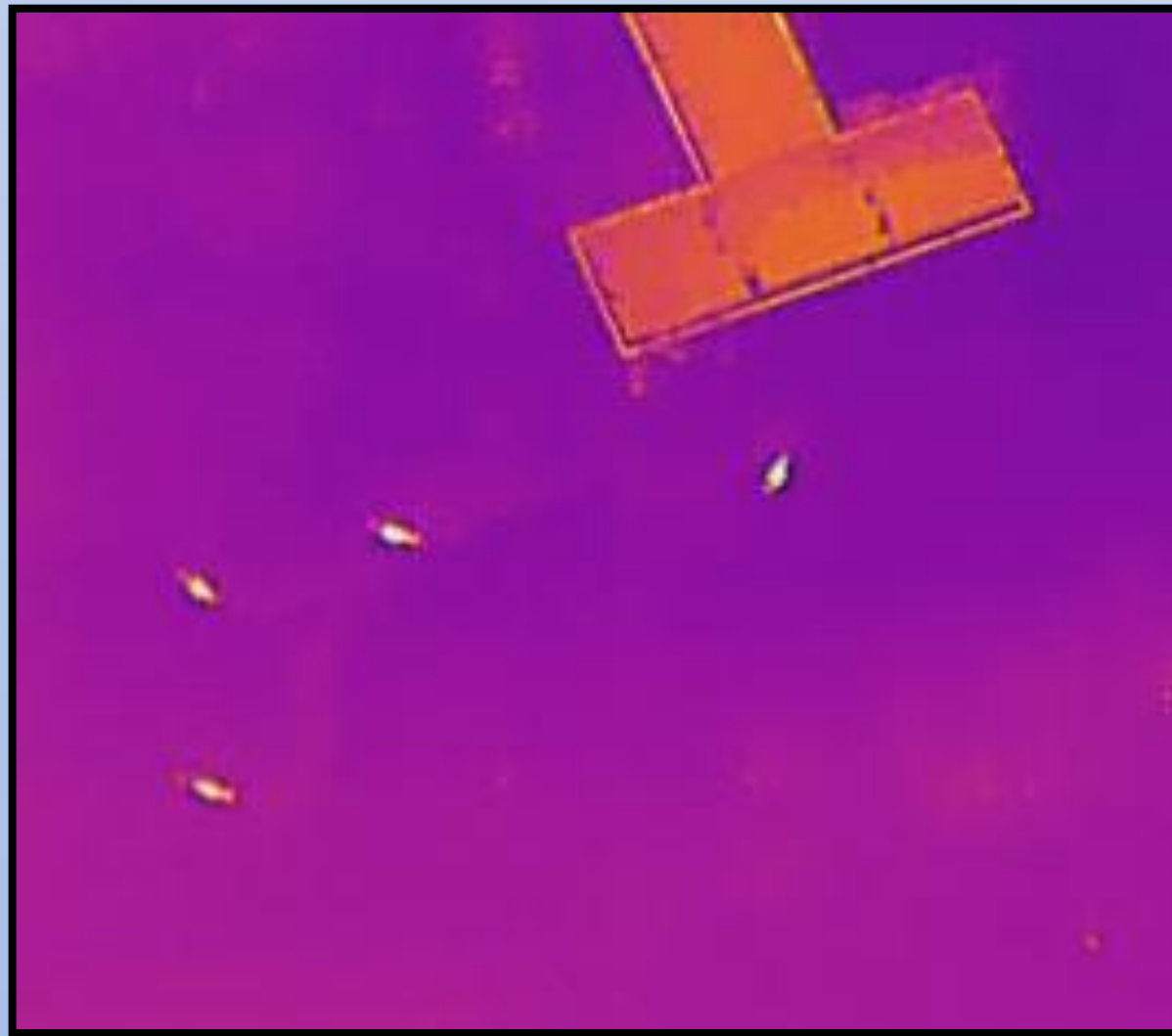
July 2025



# Outfalls



# Geese



# Aerial Imagery- Multispectral

## Typical spectral bands

- The wavelengths are approximate; exact values depend on the instruments (e.g. characteristics of satellite's sensors for Earth observation, characteristics of illumination and sensors for document analysis):
- **Blue**, 450–515/520 nm, is used for atmosphere and deep-water imaging, and can reach depths up to 150 feet (50 m) in clear water.
- **Green**, 515/520–590/600 nm, is used for imaging vegetation and deep- water structures, up to 90 feet (30 m) in clear water.
- **Red**, 600/630–680/690 nm, is used for imaging man-made objects, in water up to 30 feet (9 m) deep, soil, and vegetation.
- **Near infrared (NIR)**, 750–900 nm, is used primarily for imaging vegetation.
- **Thermal Infrared**, 10,400–12,500 nm, uses emitted instead of reflected radiation to image geological structures, thermal differences in water currents, fires, and for night studies.

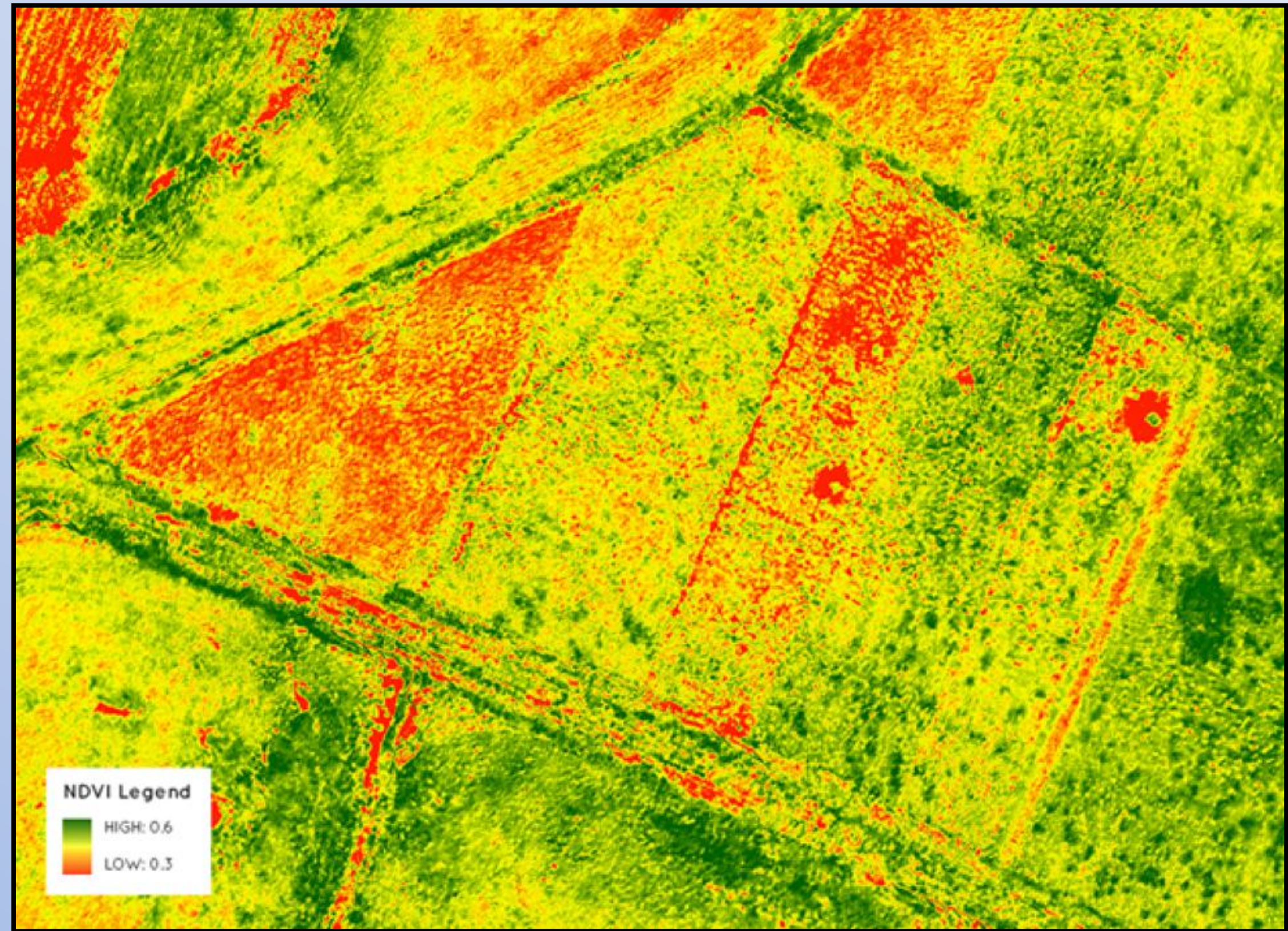
# Multispectral Indices

## NDVI- Normalized Difference Vegetation Index

- NDVI- uses two bands of electromagnetic energy to detect plant health. Vegetation absorbs very little energy in the near infrared bands but absorbs red light very effectively.
- NDVI values closer to 1 shows higher vegetative occurrence while near or below 0 indicates no vegetation.
- Plant health can be estimated by the amount of energy reflected

$$NDVI = \frac{\text{near infrared} - \text{red}}{\text{near infrared} + \text{red}}$$

# Normalized Difference Vegetative Index



High= healthy growth    Low= poor or stressed growth

# Multispectral Indices

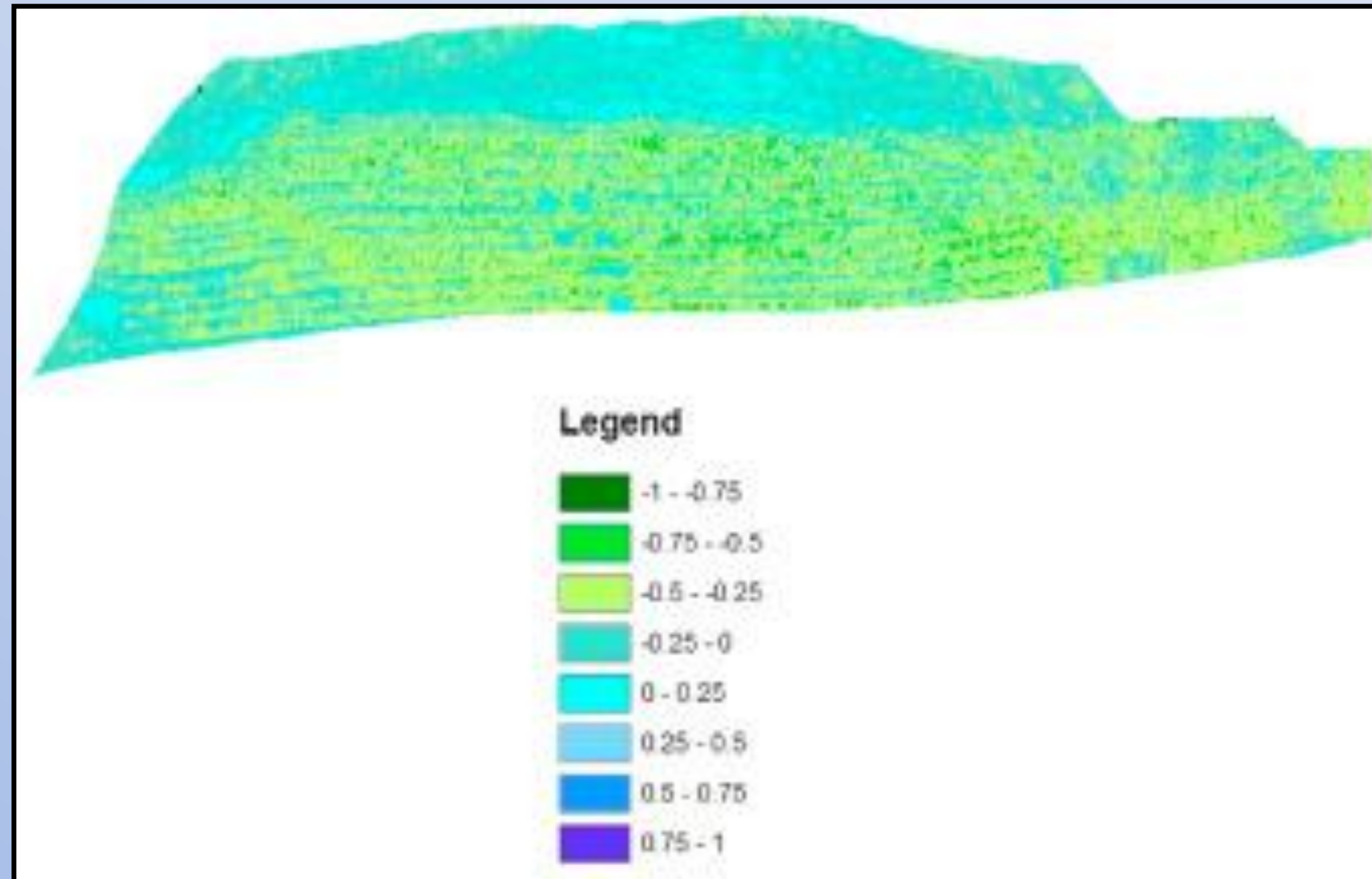
## NDWI- Normalized Difference Water Index

This variant of the NDWI avoids creating false alarms in urban areas:

- $< 0.3$  - Non-water
- $\geq 0.3$  – Water
- May be used to detect drought conditions and possibly line leaks

$$\text{NDWI} = \frac{(X_{\text{green}} - X_{\text{nir}})}{(X_{\text{green}} + X_{\text{nir}})}$$

## NDWI- Normalized Difference Water Index



< 0.3 - Non-water

>= 0.3 – Water

# Multispectral Indices

## NDRE-Normalized Difference Red Edge

- The Index will give a value between -1.0 to +1.0, with a higher value showing a healthy plant environment
- Measures the amount of chlorophyll in a plant
- Some studies have shown links to phycocyanin production in HABs

$$\text{NDRE} = \frac{(\text{NIR} - \text{RE})}{(\text{NIR} + \text{RE})}$$

# Normalized Difference Red Edge

- -1 to 0.2 indicate bare soil or a developing crop;
- 0.2 to 0.6 can be interpreted as either an unhealthy plant or a crop that is not mature yet;
- 0.6 to 1 are good values indicating healthy, mature, ripening crops.



How NDRE map looks on EOSDA Crop Monitoring.

# HAB Monitoring

- Multi- platform devices used
- rQPOD equipped with EXO-sonde and probes
  - pH
  - Conductivity
  - Total Algae
  - Temperature
  - Dissolved Oxygen
  - Nitrate UV
- P4 Multispectral Drone
- Autel EVO II 640Tv3-Thermal/RGB



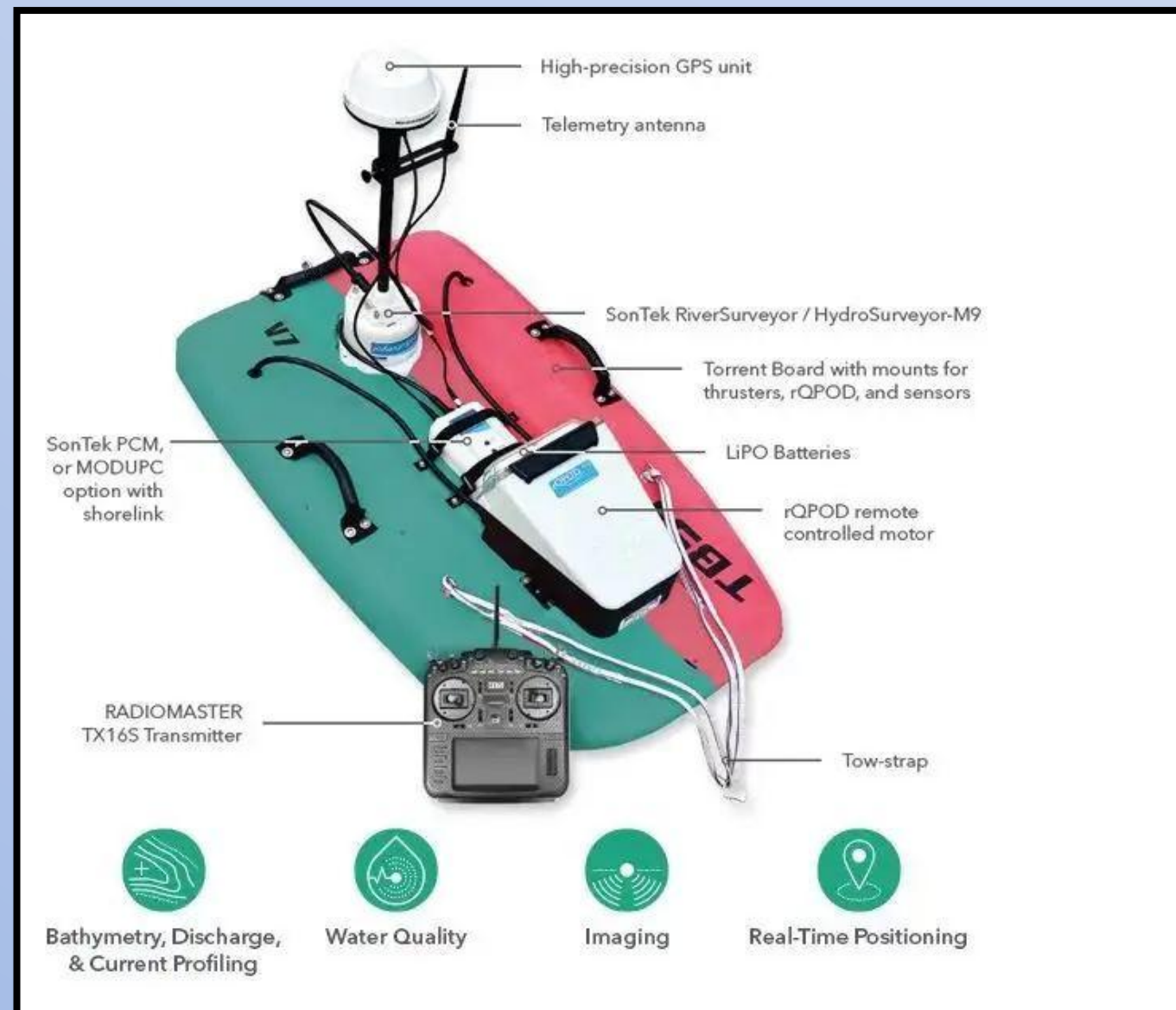
# The Tools of the Trade

# Bathymetry



# Equipment

- rQPOD Drone Boat

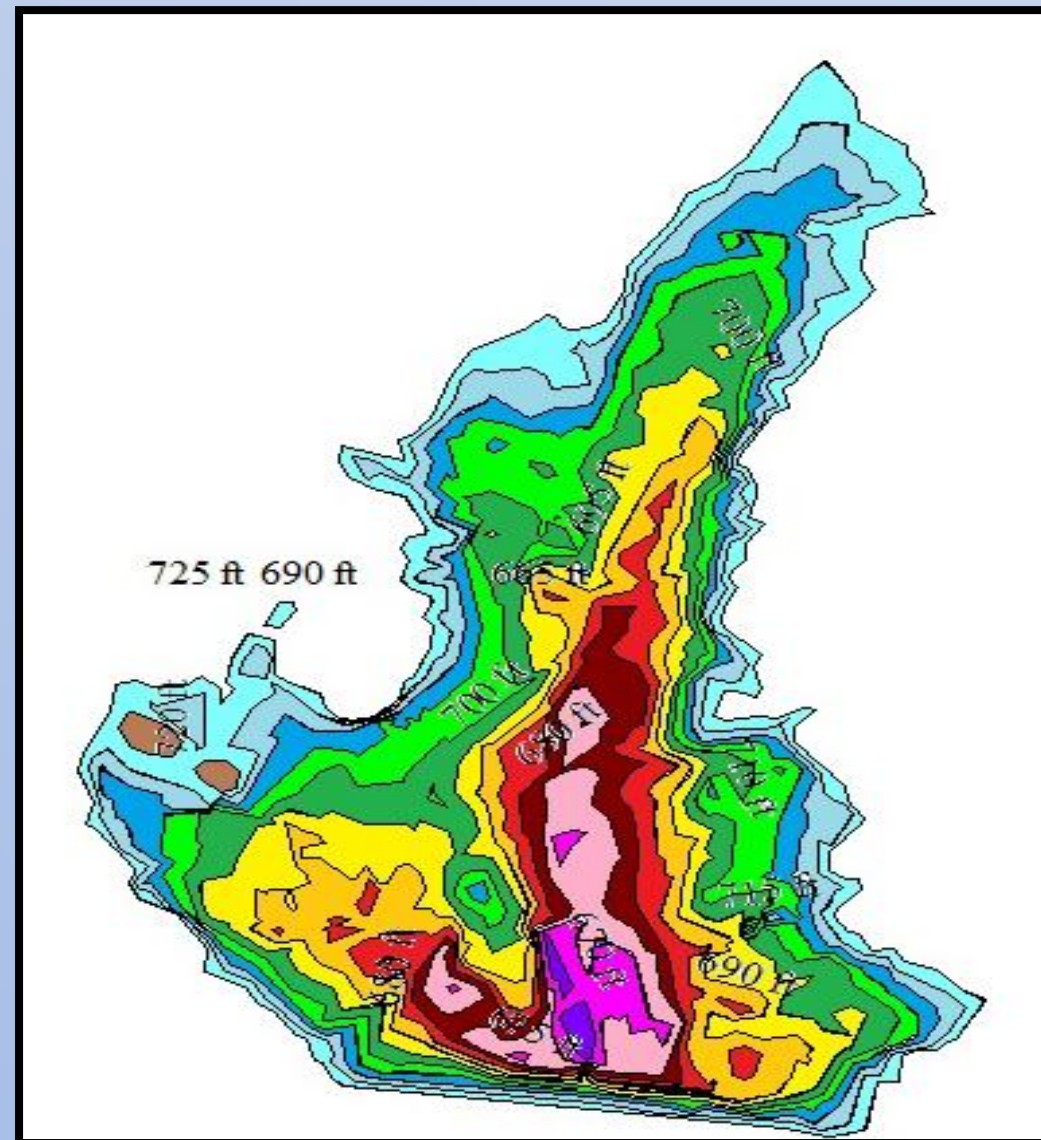


- Son-Tek M9

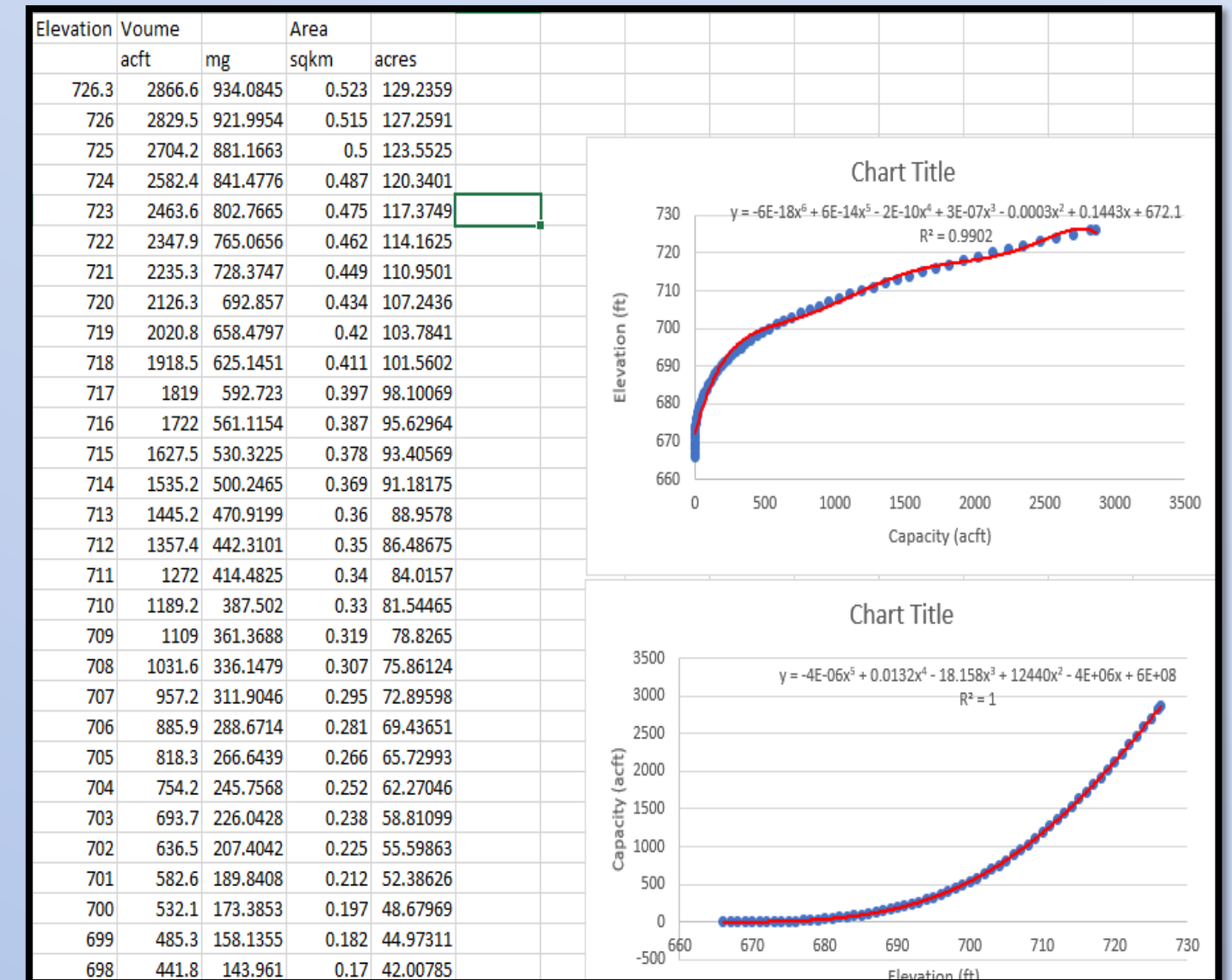


# Sample of Products Generated

## Filled Contours

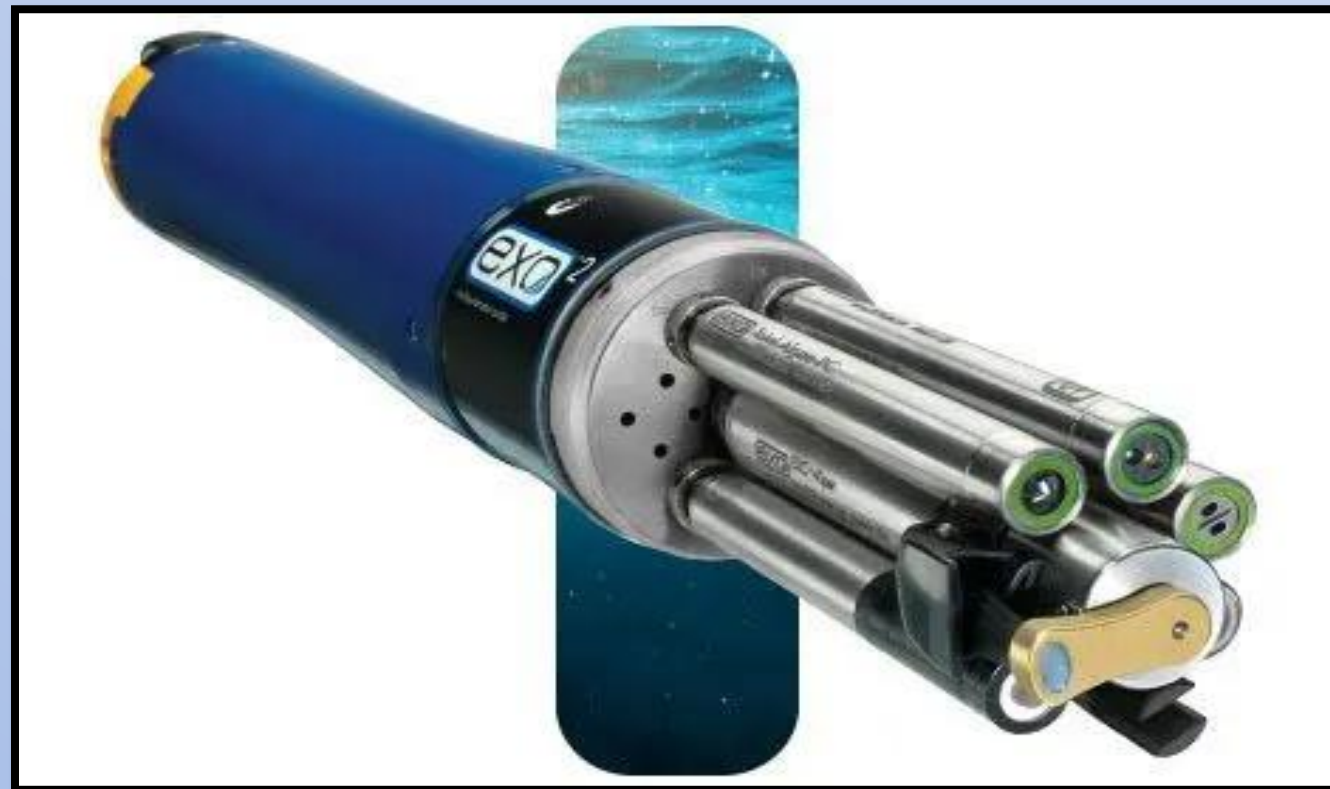


## Capacity Curves



# Water Quality – Next Phase of the Program

- Exo-Sonde

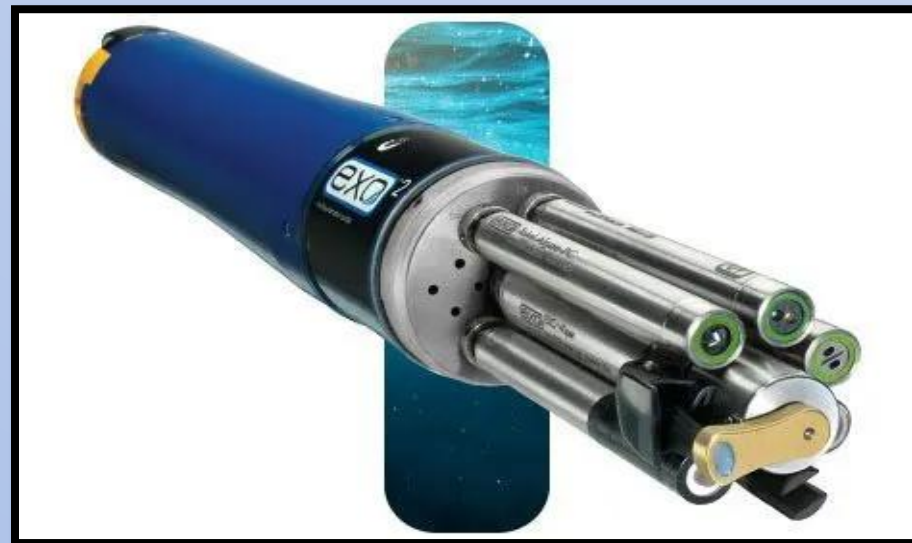


- rQPOD –Drone Boat



# Water Quality – Next Phase of the Program

- Exo-Sonde

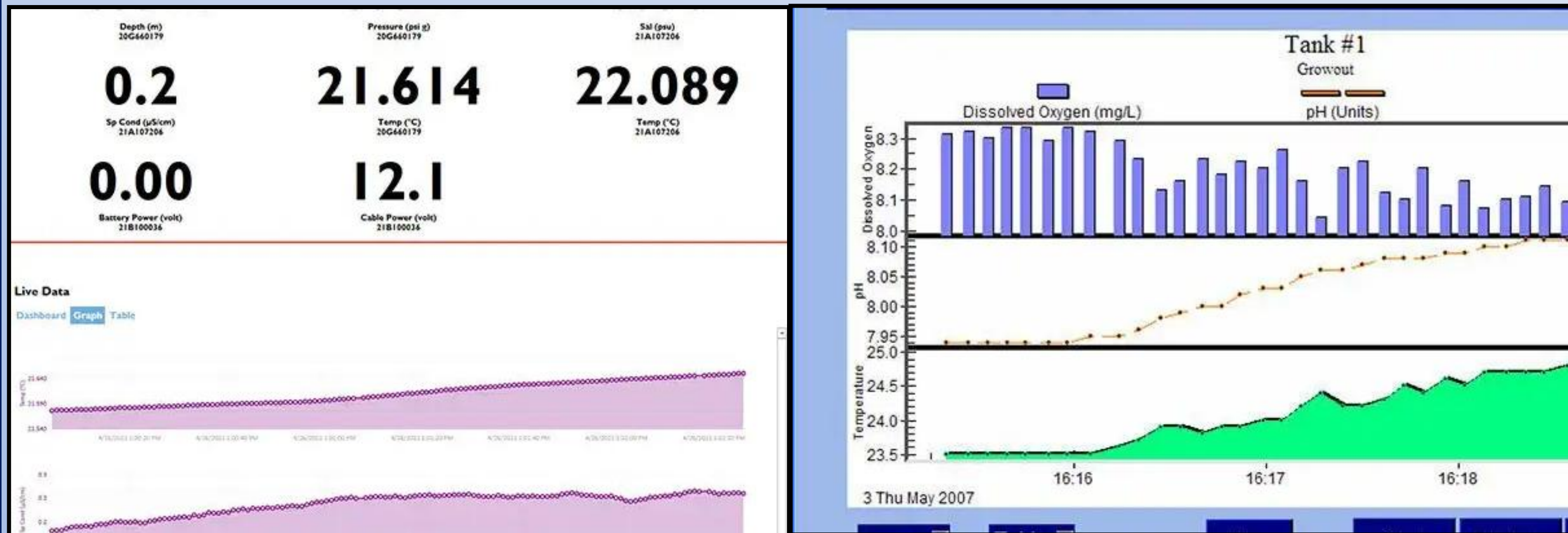


- rQPOD –Drone Boat

- ▶ pH
- ▶ Temperature
- ▶ NitaLED-UV  
Nitrate
- ▶ Dissolve Oxygen
- ▶ Blue-Green  
Algae
- ▶ Turbidity
- ▶ Chlorophyll



# Products



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