Drone-Based Phytoremediation Reconnaissance Using NDVI/NIR Multispectral Imagery at a Historical Waste Storage Lagoon

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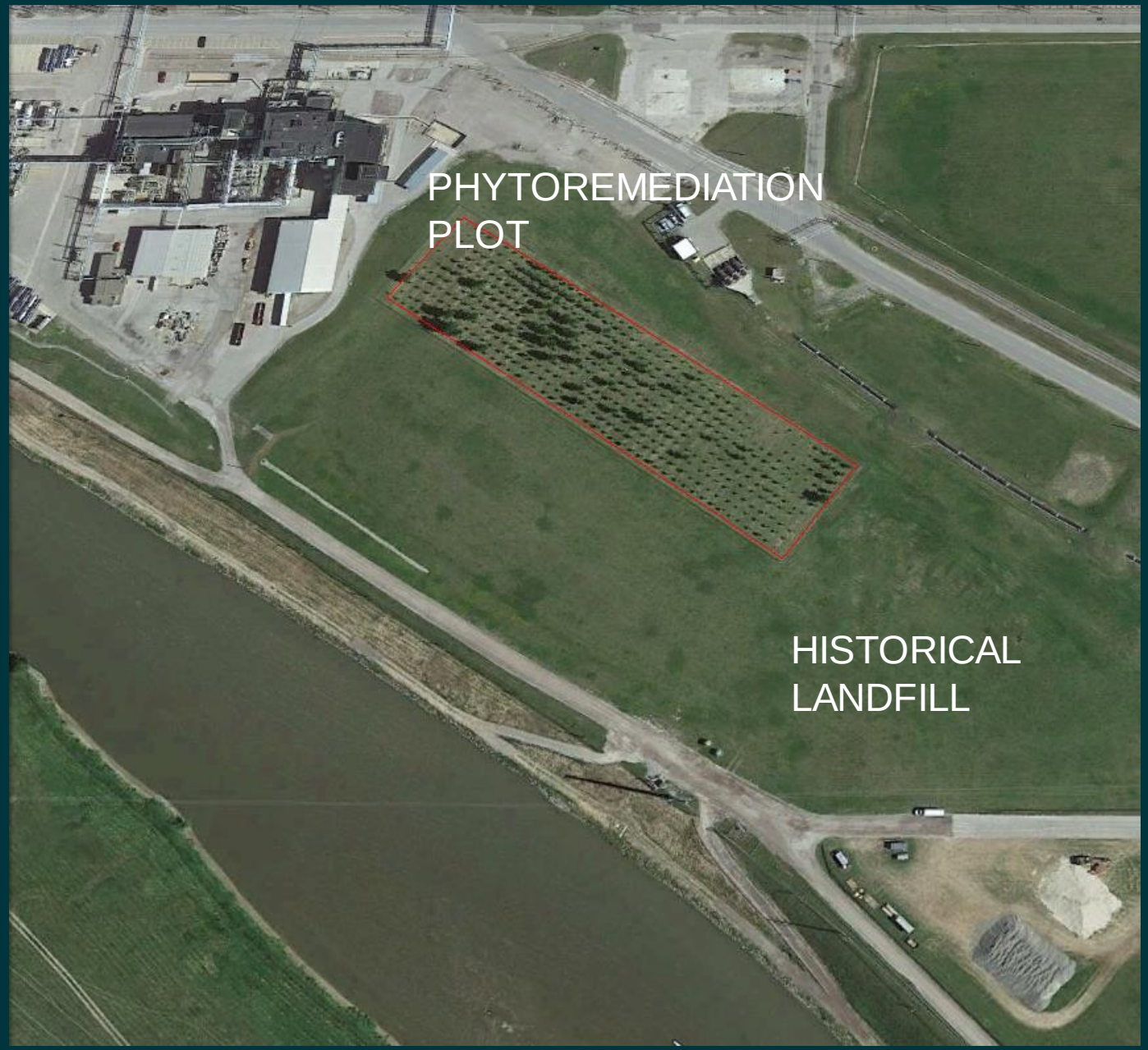
AECOM Remediation West

Name



Background

- Existing landfill is approximately 11.5 acres
- Historically received wastewater solids and mixed waste streams
- Periodic groundwater and leachate seeps
- 500 hybrid poplars planted for groundwater control and leachate mitigation

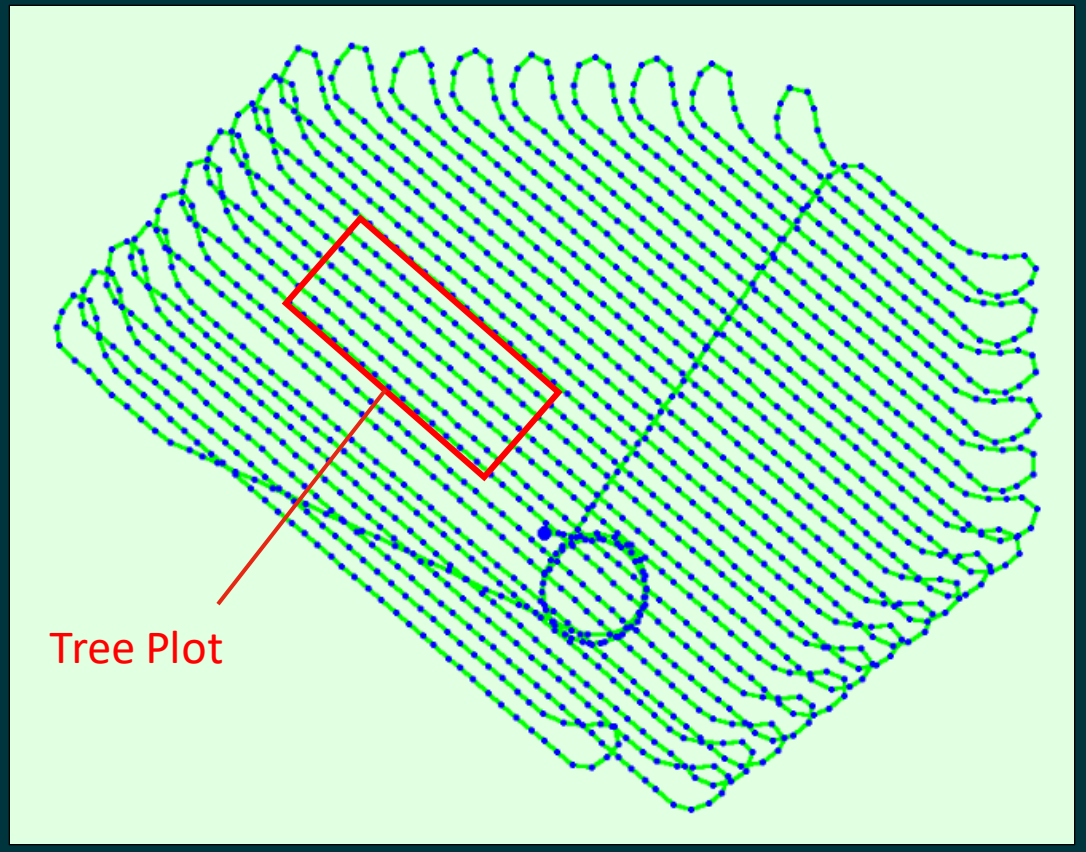
Project Objectives

- Cost-effectively develop and implement an approach to map and classify the landfill tree plot
- Classify health of trees and determine reasons for tree-dieback and morbidity
- Identify area of groundwater seeps and leachate surfacing

Diseased poplar tree with canker possibly induced by hypoxylon infection

Drone Technology

- WingtraOne GEN II, VTOL craft
- 8020 Images Collected
- Flight Time 1Hr 55min 04 Sec

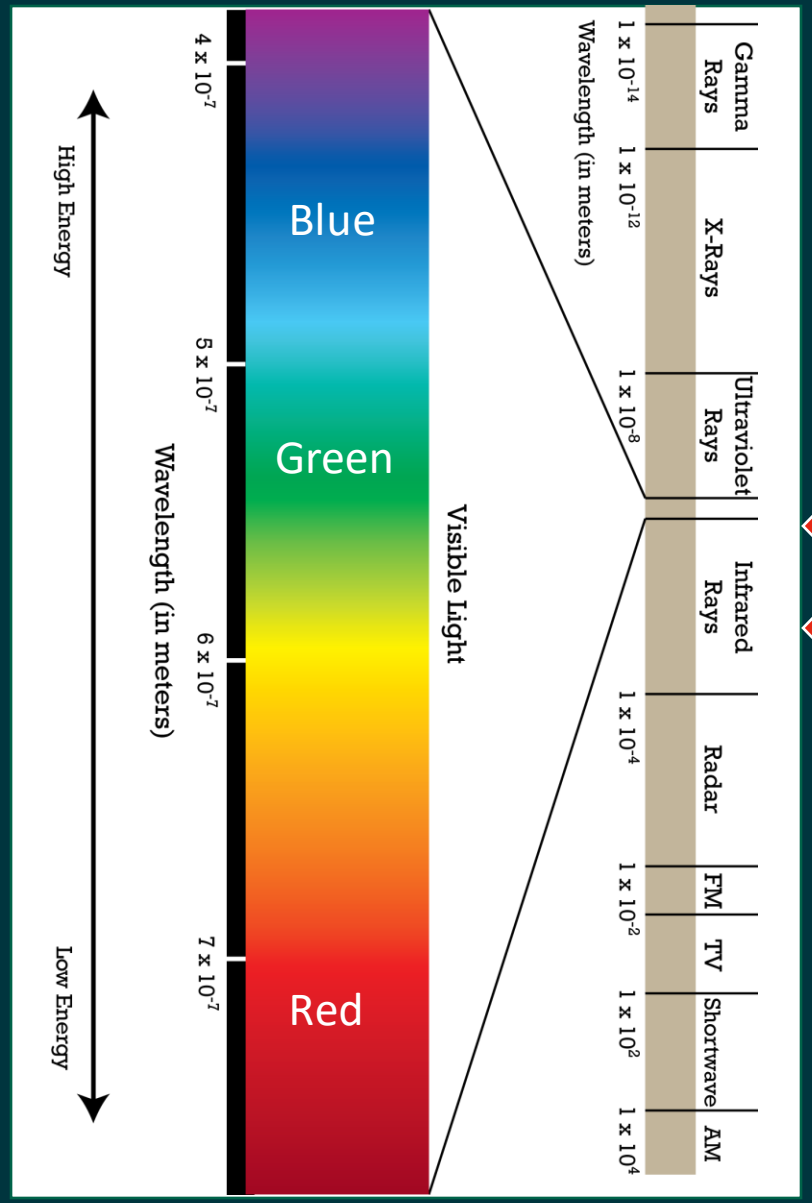


Payload

MicaSense RedEdge-P Multispectral and Panchromatic Sensor. Five bands: Blue, green, red, red-edge, and near-infrared (NIR)

EM Spectrum

- Red, Green, Blue is visible light
- Red-Edge: Between red and IR where reflectance from green vegetation is very low
- Near-IR: Chlorophyll reflectance is very high, giving contrast to Red-Edge
- NDVI: Ratio of wavelengths

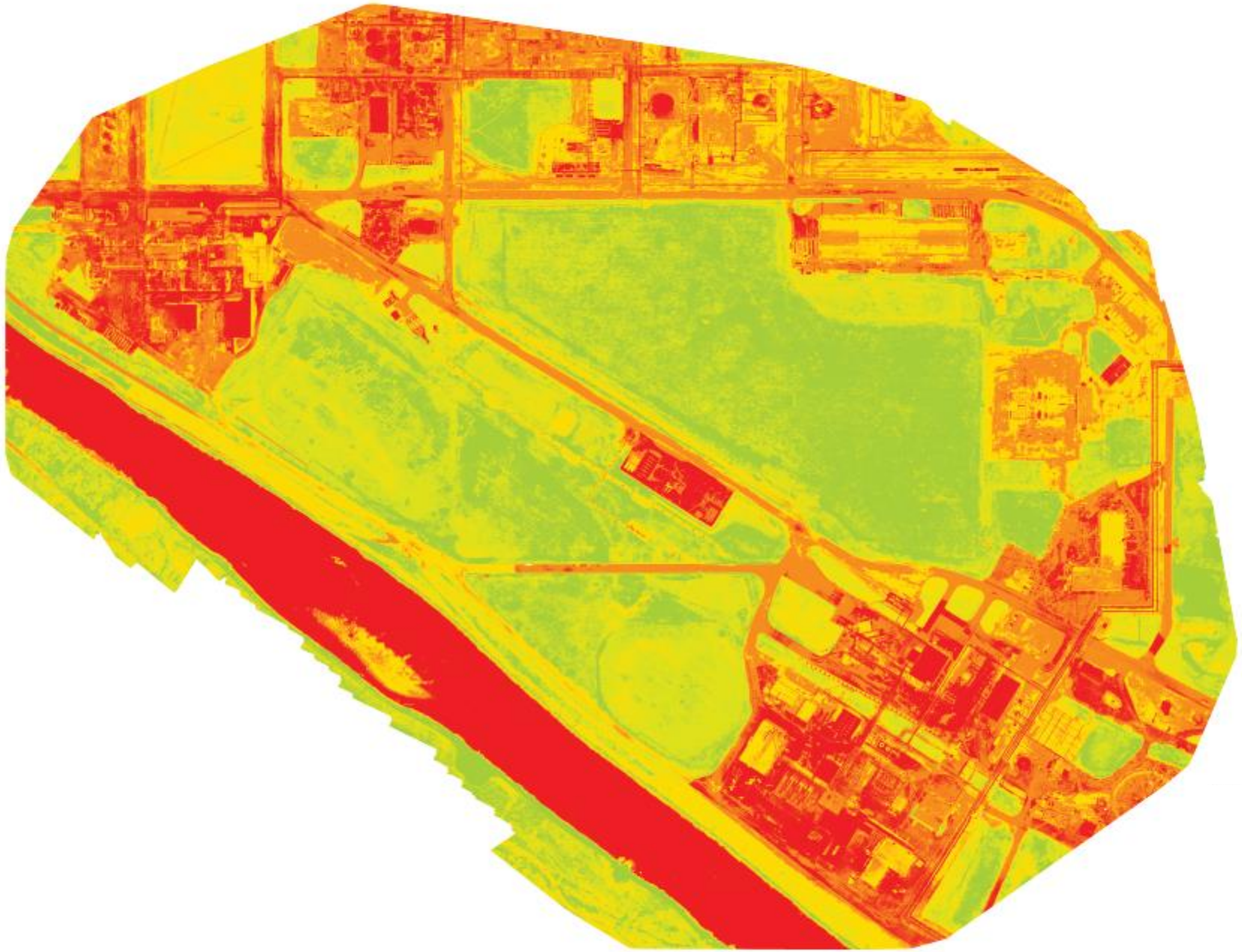


$$NDVI = \frac{NearInfrared - RedVisibleWavelength}{NearInfrared + RedVisibleWavelength}$$

Normalized Difference Vegetation Index

Imagery (RGB – Visible)

Normalized Difference Vegetative Index (NDVI)



Normalized Difference Vegetation Index (NDVI)

0.96
0.64
0.49
0.12
0.02
-0.66

Sparse vegetation or senescing crops

2021 Drone Flight Imagery, NDVI Image Processing

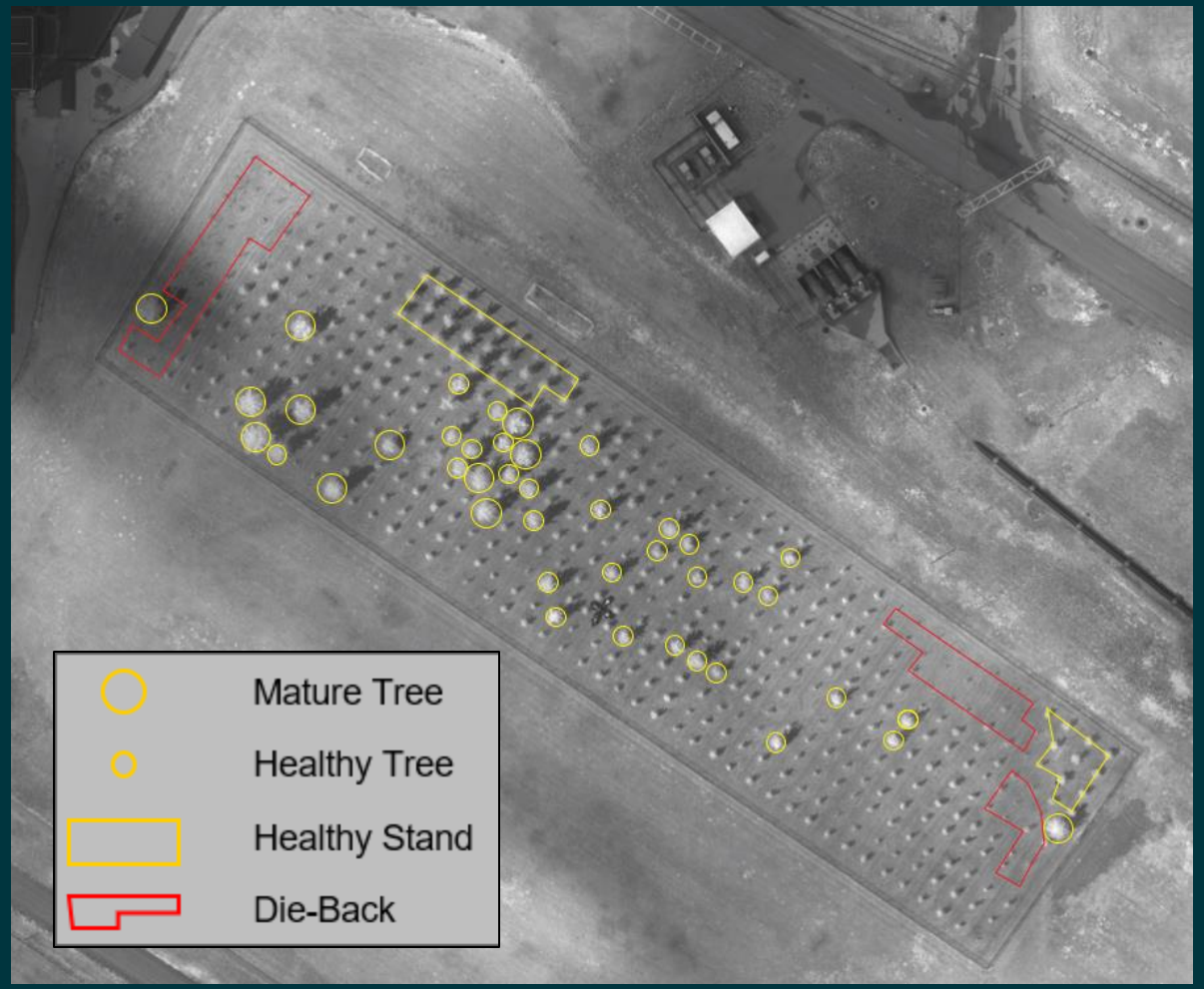
Imagery (Red-Edge)

- Red-edge spectral band selected to resolve the sharp change in leaf reflectance at 680-750 nm
- Key wavelength for assessing leaf canopy health
- Also sensitive to water adsorption

Surficial groundwater seeps show as dark areas (demarcated in red). Trees show in dark gray.

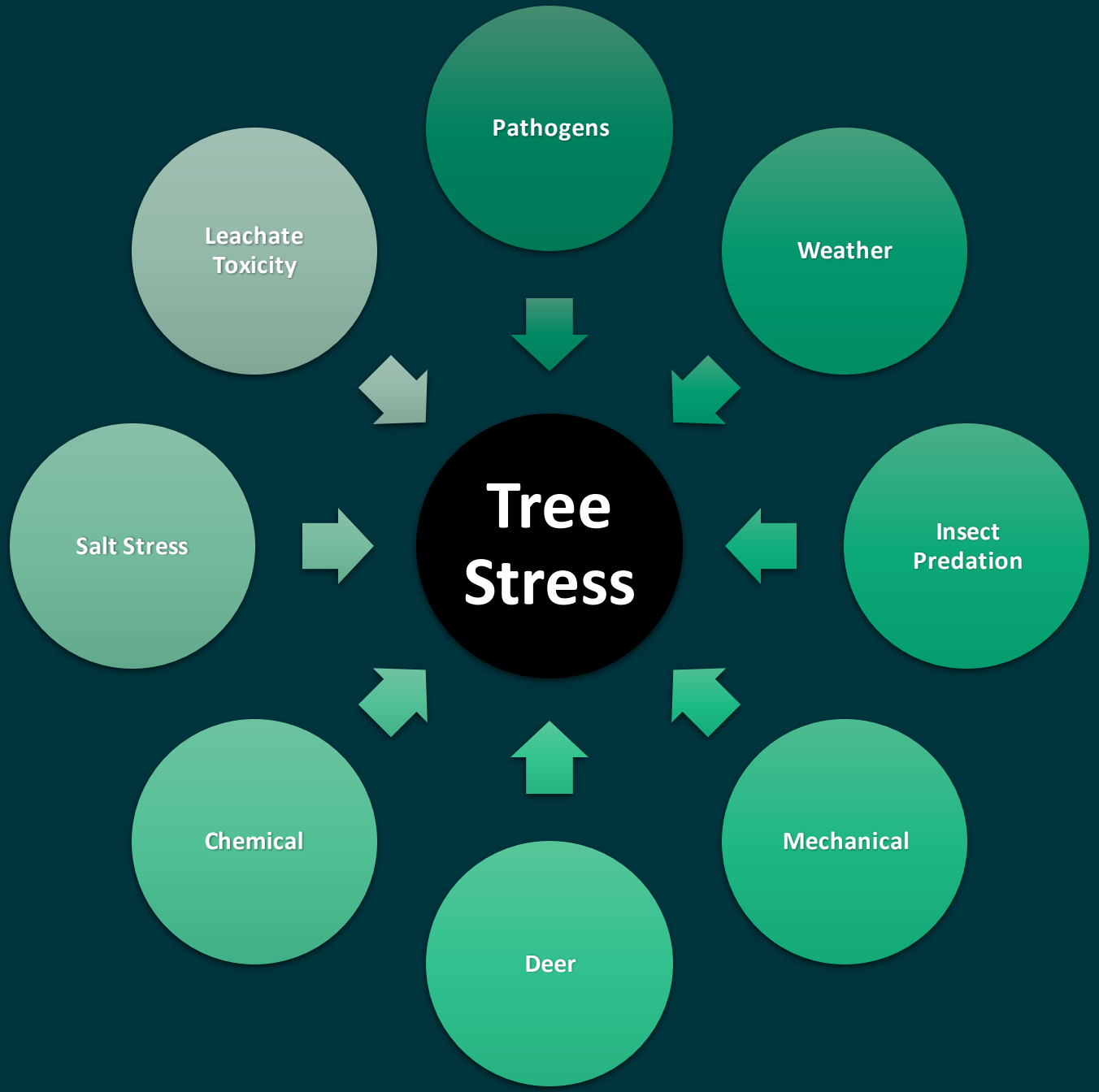
Imagery (Near-IR)

- Chlorophyll (healthy tree) signature shows as bright white response in near-IR



Tree-health assessment and classification using near-IR spectroscopy and drone deployment

Tree Stress


Pathogens
Weather
Insect Predation
Mechanical
Deer
Chemical
Salt Stress
Leachate Toxicity
Tree Stress

Ground-Based Field Validation

Stunted leaf with bacterial or fungal blight

Stunted leaf with chlorosis and leaf margin burning (salt or leachate stress)

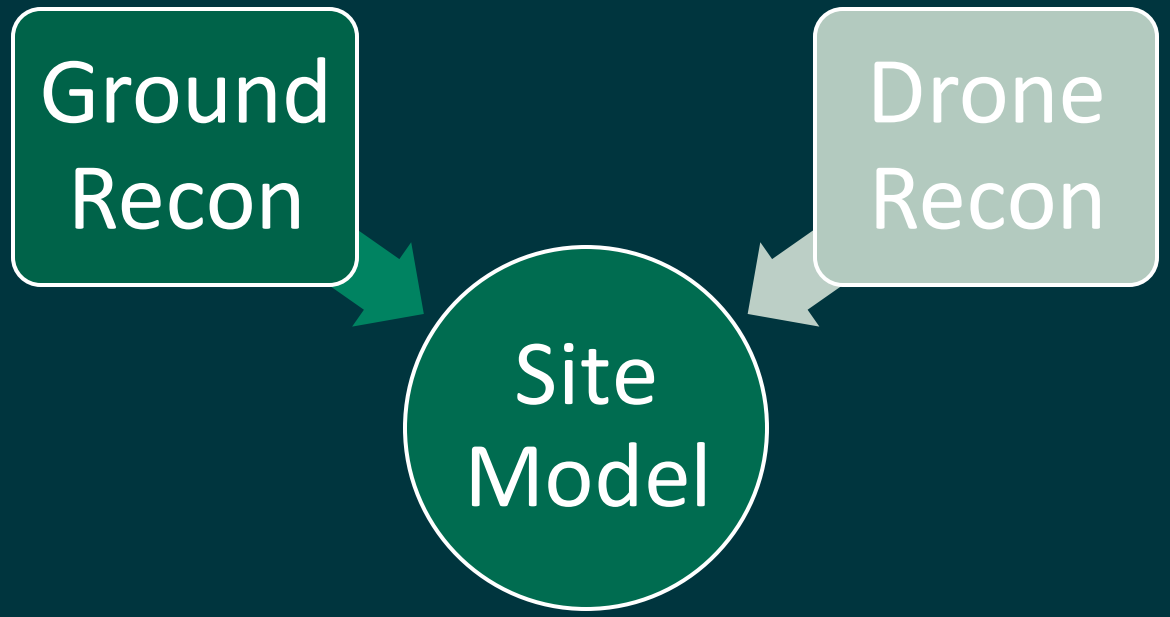
- Identified Field Stresses
  - Mechanical (mowing and deer predation)
  - Pathogens
    - Fungal
    - Bacterial
  - Insect Predation
  - Salt-stresses (leachate-induced phytotoxicity)

Ground-Based Field Validation

- Stressed vegetation indicators:
- Bagworm and carpenter ants
- Bark sloughing along the base of the tree from mechanical mowing

Lessons Learned

- Near-IR, red-edge and NDVI quickly identifies healthy trees, density and canopy-chlorophyll signatures at sub-meter resolution
- Ground-based reconnaissance is essential to confirm observations made from the aerial data acquisition
- Drone-based aerial reconnaissance is a cost-effective alternative approach for quickly delineating and mapping stressed and damaged phytoremediation plots.



Team Recognition

AECOM Team:

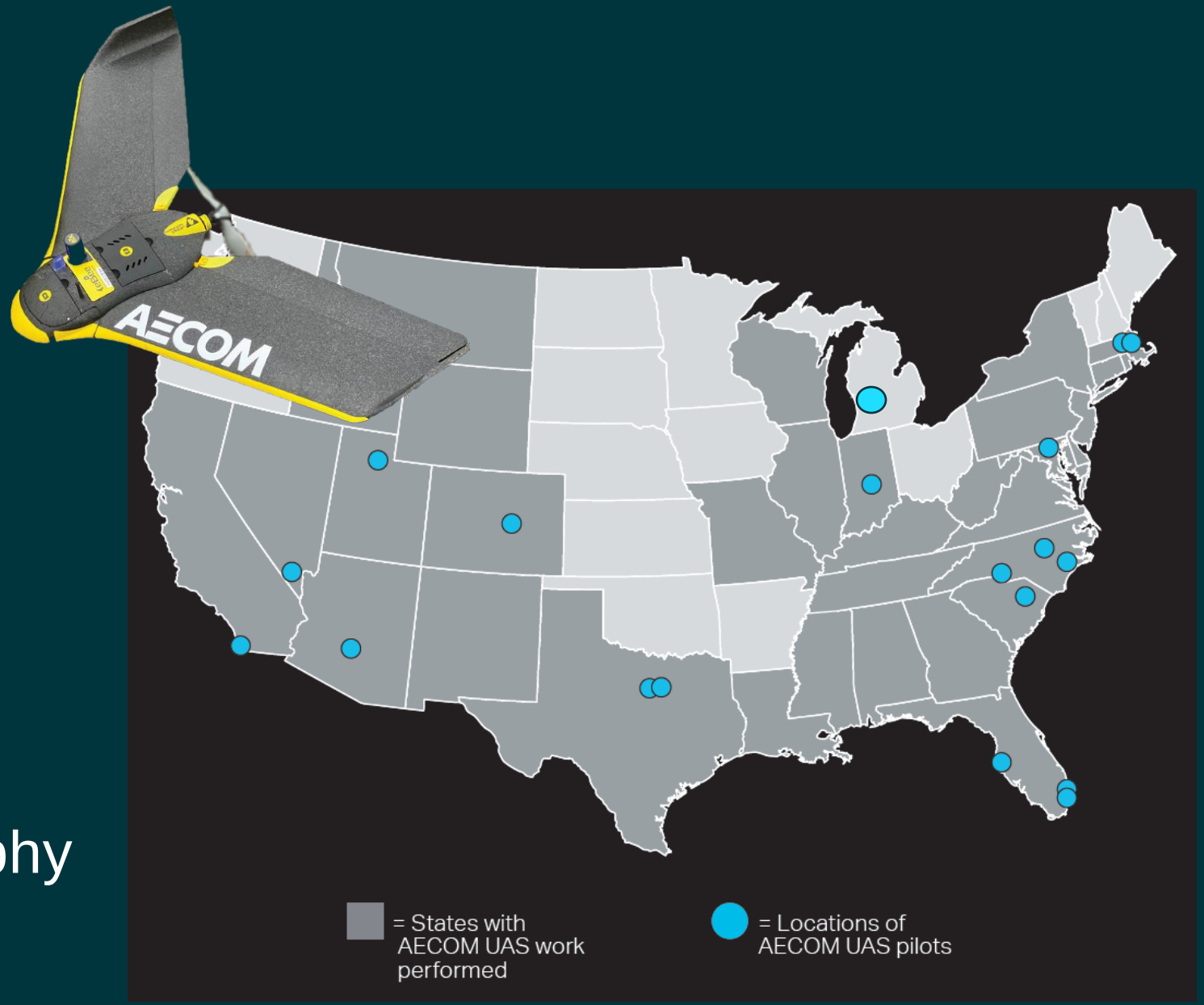
- Aaron Martin, Project Manager
- Doug Gray, Innovative Remedial Technologies
- Barry Harding, Director / Nature Based Solutions
- Clara Austin, Ecologist / Task Manager

Client Team:

- Jim Sprague, Remediation Leader
- Corporate Aviation team
- Claudia Walecka-Hutchison, Remediation Technology

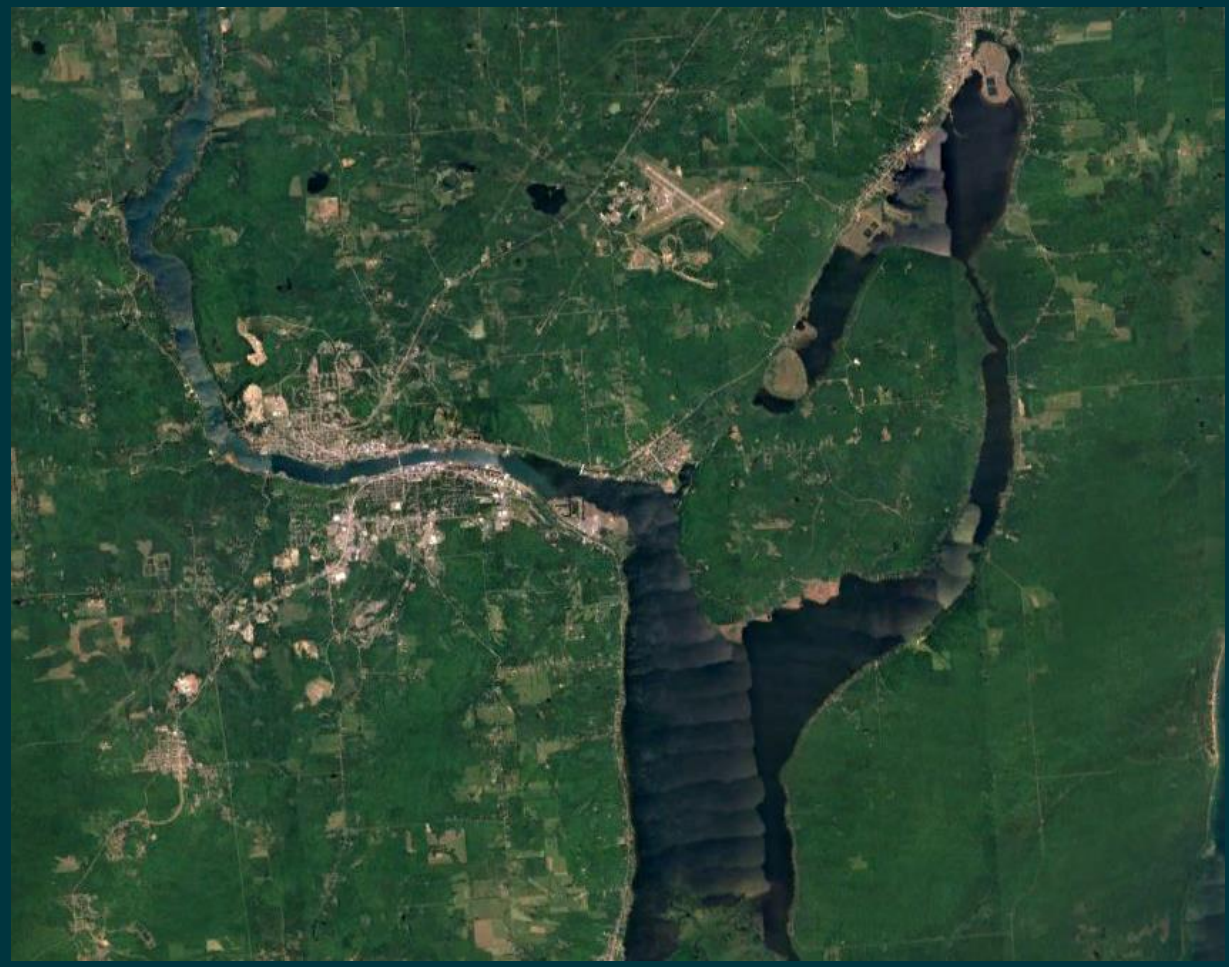
AECOM Drone Services

- 60+ Drone pilots
- 55+ Drones
- Work performed in 30+ states
- Aerial mapping, photogrammetry, LiDAR, inspections, data analysis and integration, photography and videography



Upcoming work!

- 14 superfund sites
- Use multispectral data collected by drone to quickly assess soil and vegetative cover performance
- Identify areas where maintenance activities are necessary
- Confirmation via ground truthing
- Reduce O&M cost



14 capped landfills (over 1,000 acres)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