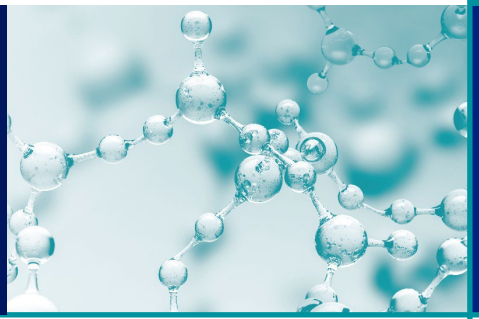
PFAS Fingerprinting

to Refine the Conceptual Site Model for an Unlined Landfill

Wei Liu, P.E.

July 27, 2022



CDM Smith

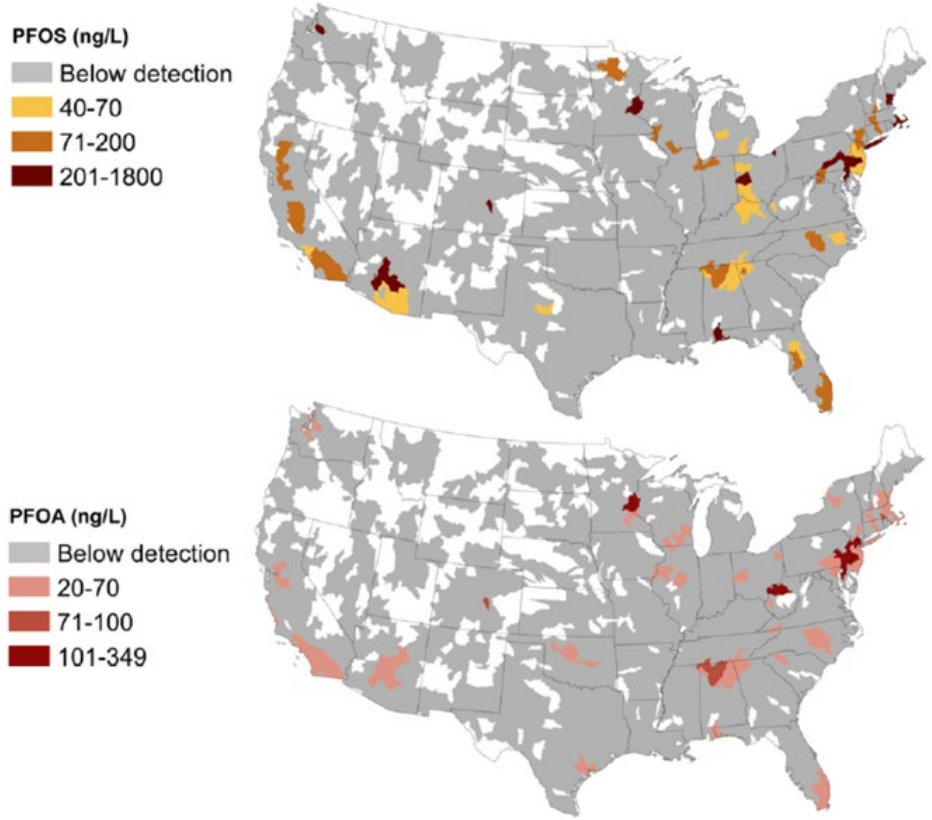
Acknowledgement

Christopher Gurr

Zubair Ghafoor

PFAS DETECTED IN ~4% OF PUBLIC WATER SUPPLIES

16.5M RESIDENTS AFFECTED



Environmental Science & Technology Letters

Letter

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Detection of Poly- and Perfluoroalkyl Substances (PFASs) in U.S. Drinking Water Linked to Industrial Sites, Military Fire Training Areas, and Wastewater Treatment Plants

Xindi C. Hu,[*,†,‡] David Q. Andrews,[§] Andrew B. Lindstrom,[∥] Thomas A. Bruton,[⊥] Laurel A. Schaider,[#] Philippe Grandjean,[†] Rainer Lohmann,[▽] Courtney C. Carignan,[†] Arlene Blum,[⊥,∇] Simona A. Balan,[●] Christopher P. Higgins,[○] and Elsie M. Sunderland[†,‡]

Many PFAS analytes

PRECURSORS

- 4:2 FTS
- 6:2 FTS
- 8:2 FTS
- FBSA
- FDSA
- FHxSA
- PFOSA
- N-EtFOSAA
- N-MeFOSAA

CARBOXYLATES

- PFBA
- PFPeA
- PFHxA
- PFHpA
- PFOA
- PFNA
- PFDA
- PFUdA
- PFDoA
- PFTrDA
- PFTeDA

SULFONATES

- PFBS
- PFPeS
- PFHxS
- PFHpS
- PFOS
- PFNS
- PFDS

A challenge…

We have many more compounds to track, evaluate, and communicate risk (not to mention unquantified "suspect" PFAS and precursors).

…and an opportunity

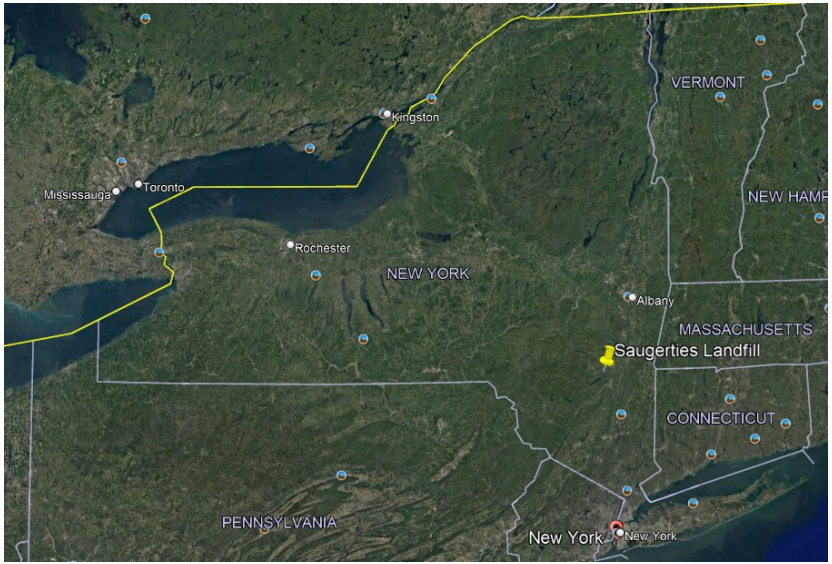
PFAS datasets are large,
with many variables.

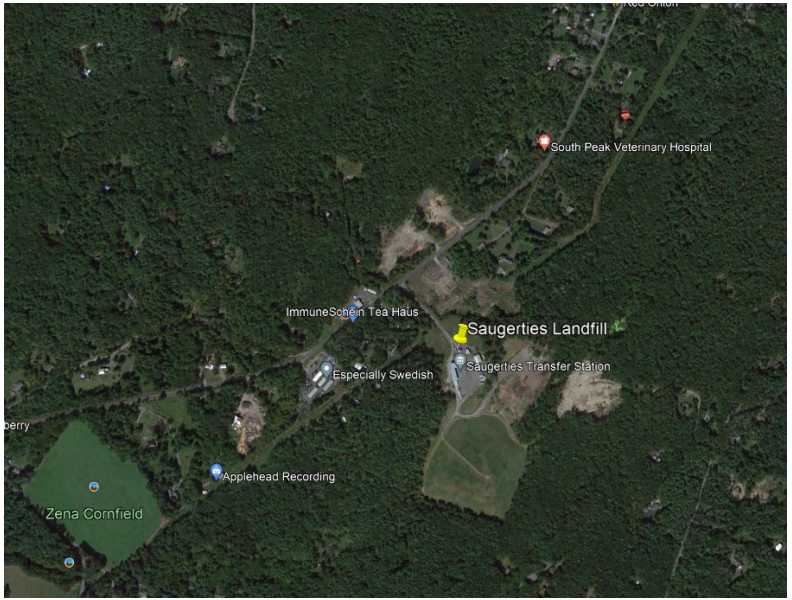
This opens the door
to more rigorous forensics.

PFAS Fingerprints

What about PFAS Chemistry lets us “fingerprint”?

Saugerties Landfill





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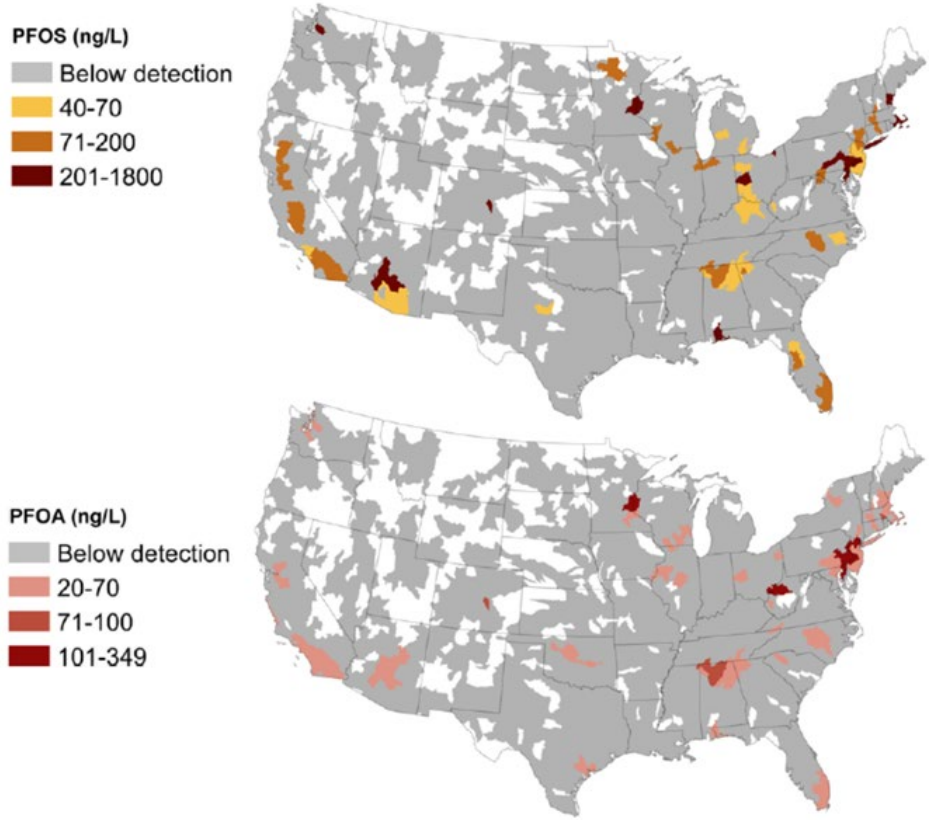

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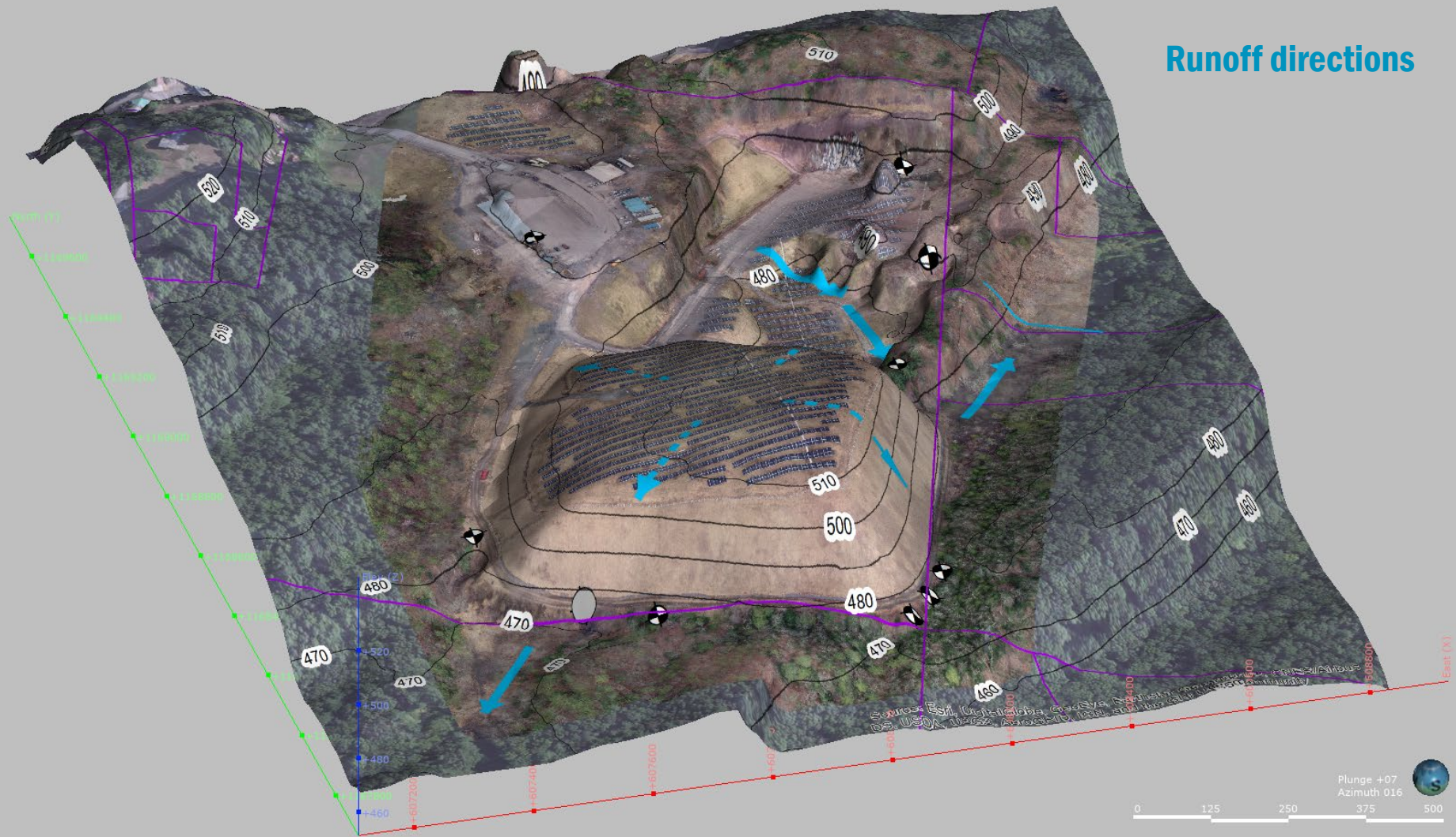
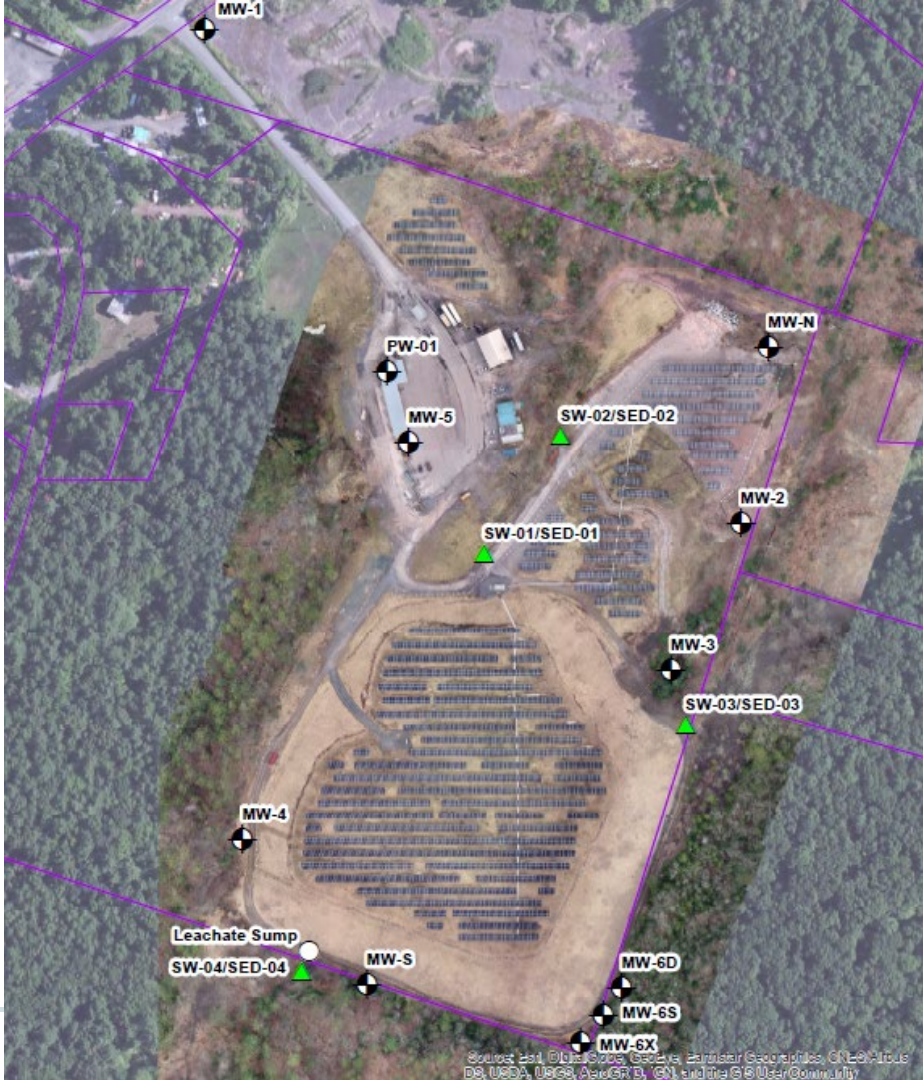
Runoff directions



Landfill characteristics

- No liner between landfill mass and subsurface
- Impermeable geomembrane cover
- No problems identified with cover per 2019 annual Landfill monitoring report
- Passive gas vents – methane still detected = waste is still decomposing
- Leachate system not effectively collecting landfill fluids
- Transfer Station upgradient of the landfill

PFAS sample locations

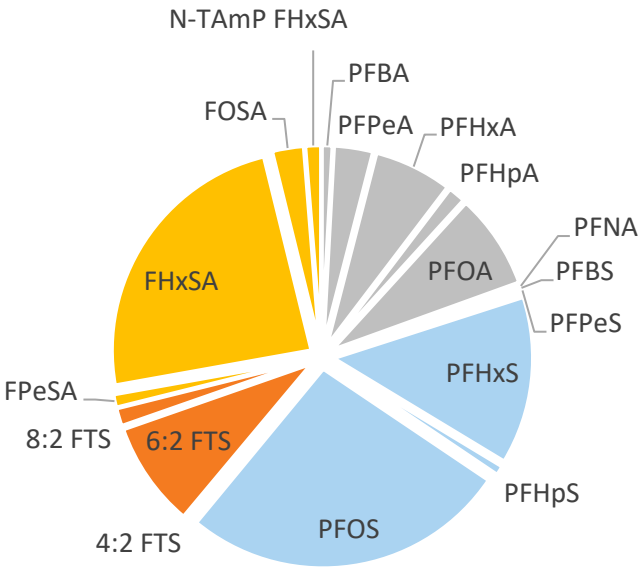


Conceptual site model (CSM) questions

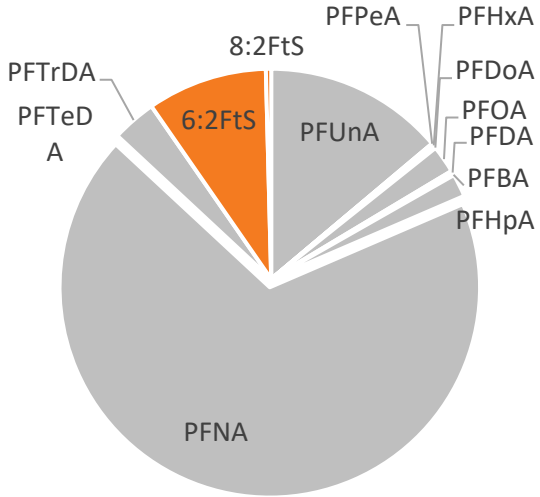
1. “Background” PFAS?
2. Groundwater to surface water pathway?
3. Vertical migration?

How can fingerprints help us?

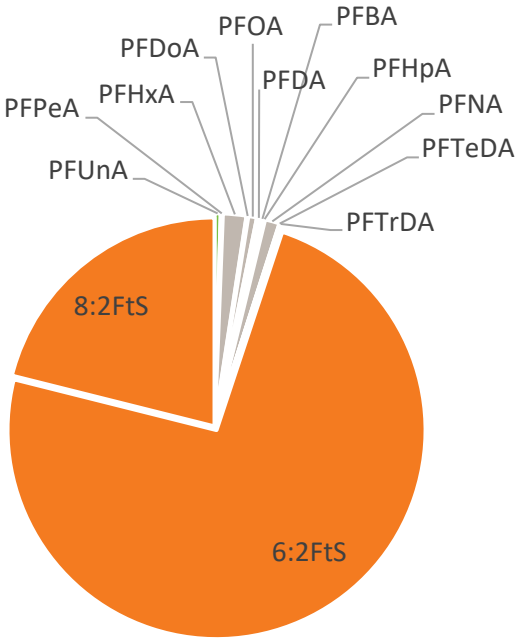
What does a fingerprint look like?



Example 1

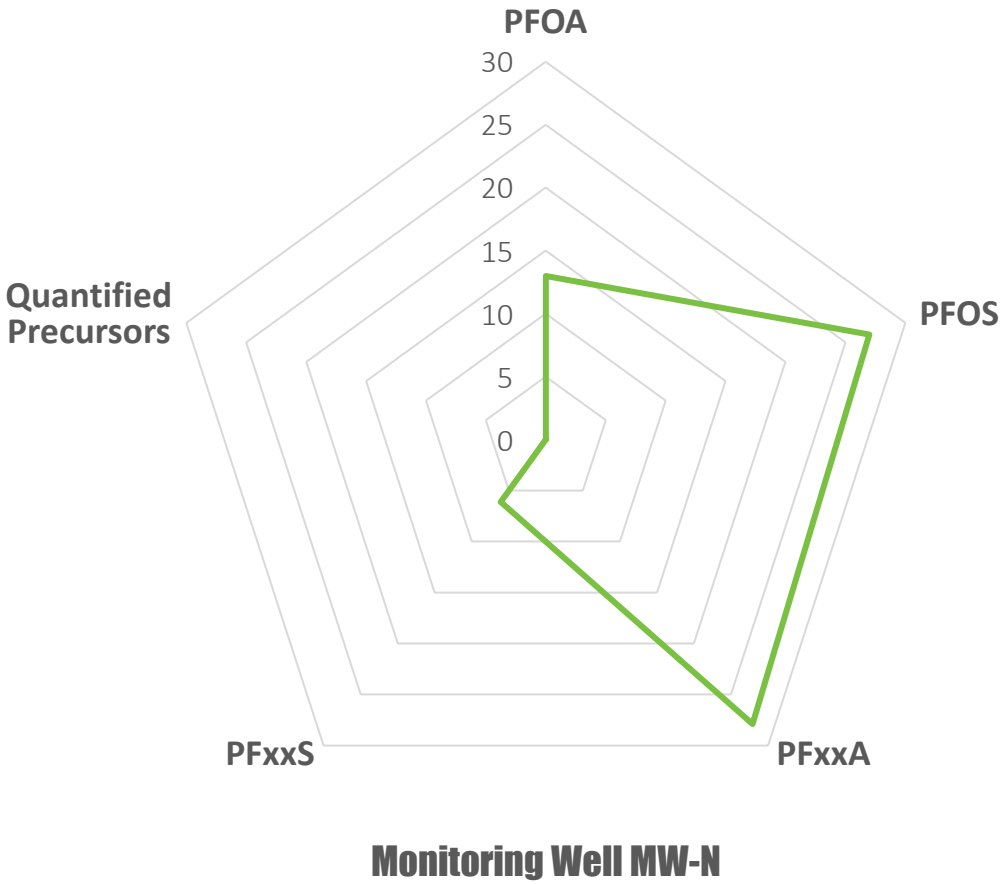


Example 2



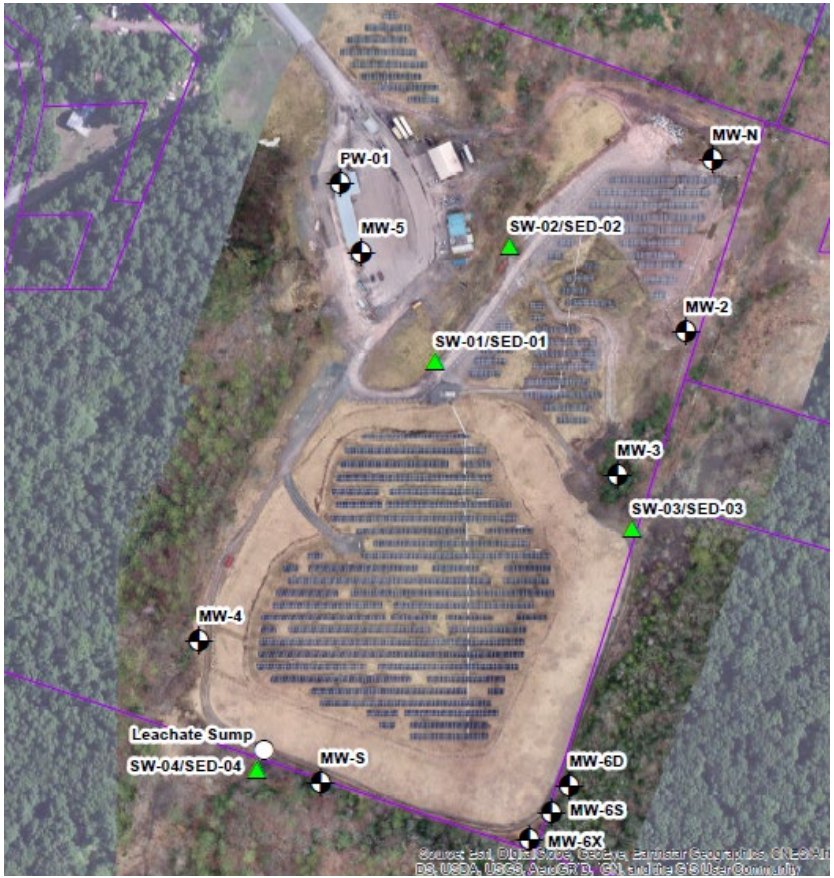
Example 3

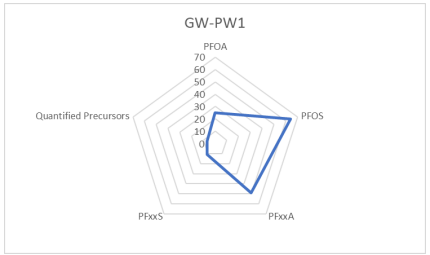
A better way:
THE RADAR PLOT

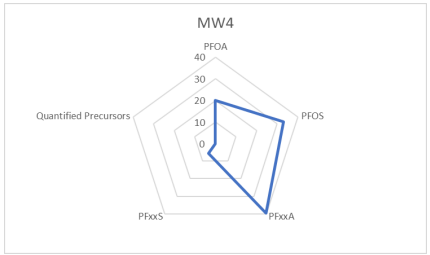


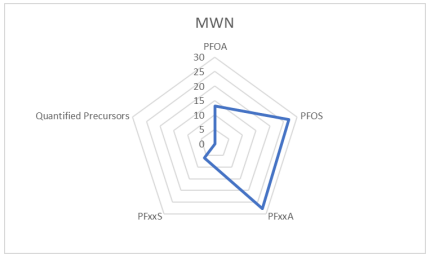
CSM QUESTION 1

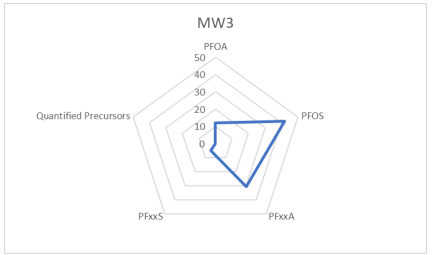
Background PFAS

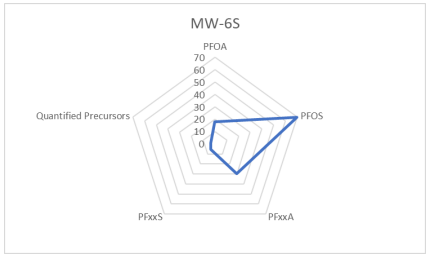












CSM QUESTION 2

Groundwater to surface water pathway

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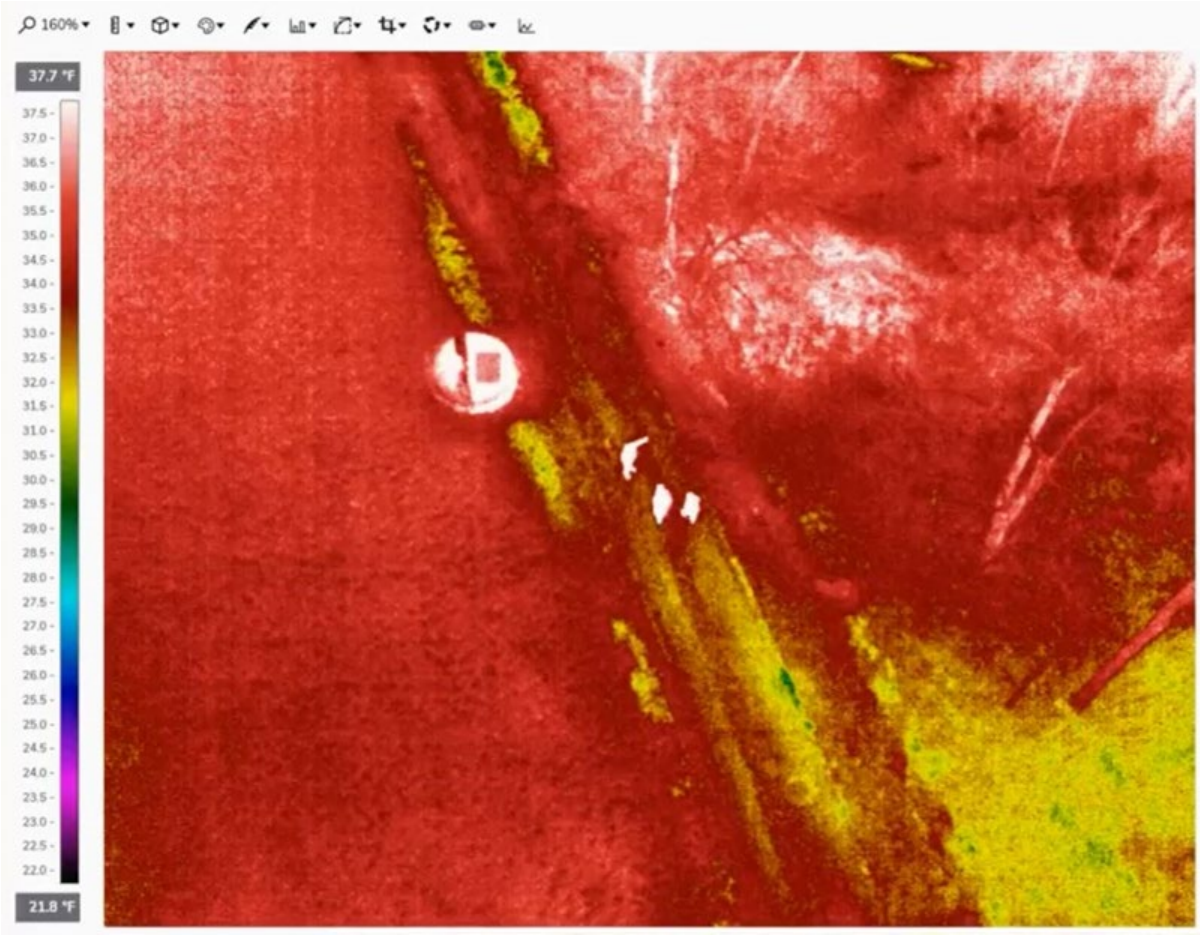

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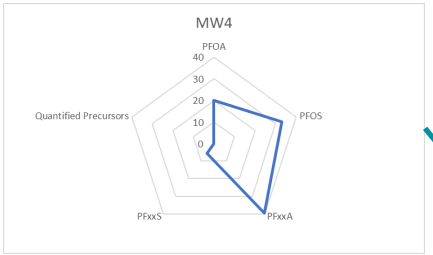
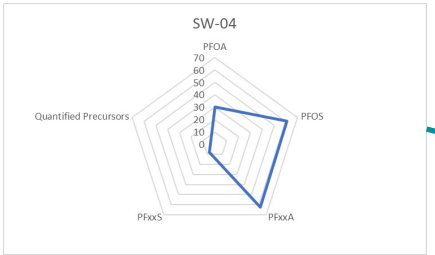
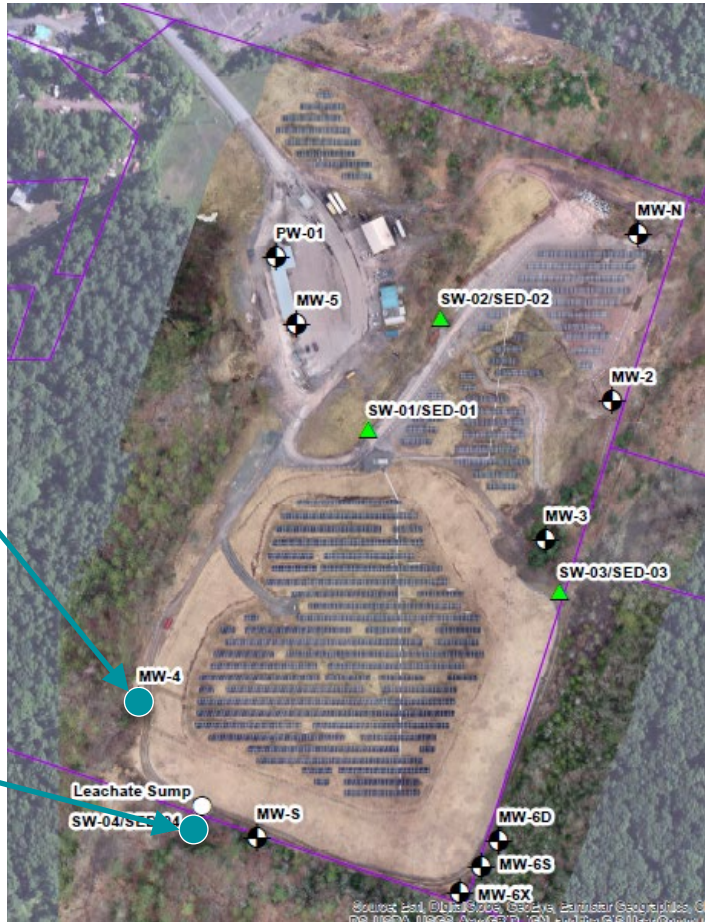
Groundwater to surface water pathway

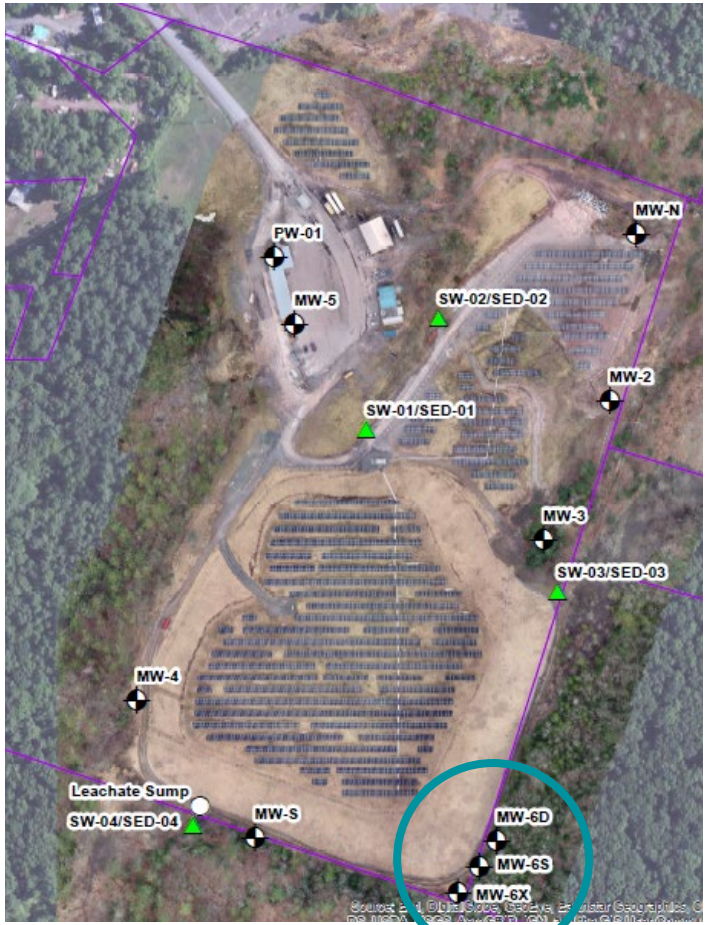


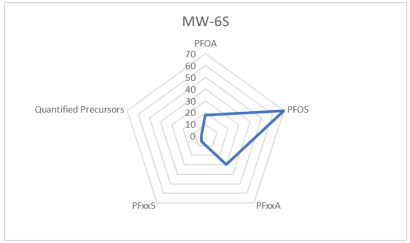


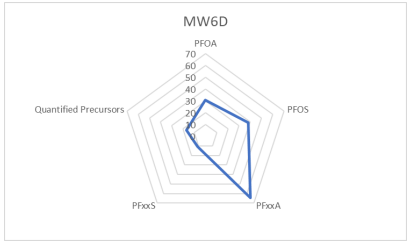


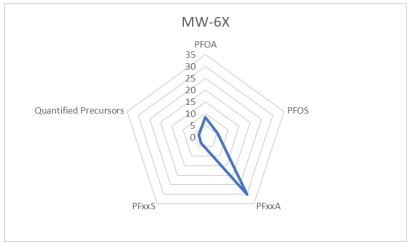
CSM QUESTION 3

Vertical migration







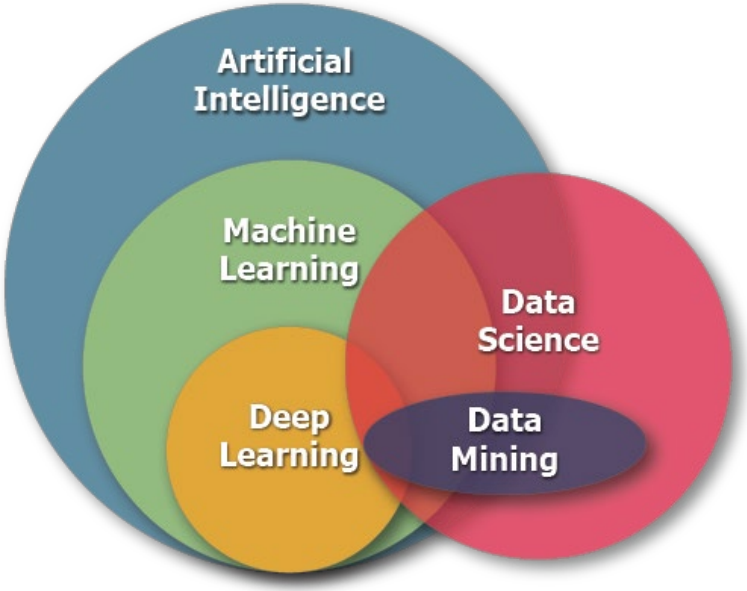


Where to?

Radar plots have value.

More advanced techniques
are on the horizon.

AI and Data Science



The Gartner Hype Cycle for Artificial Intelligence

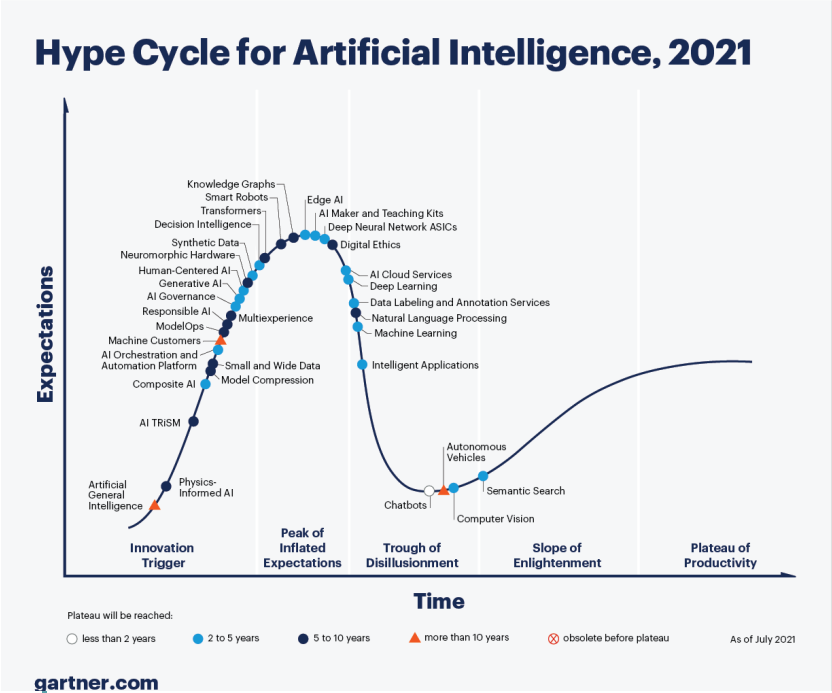
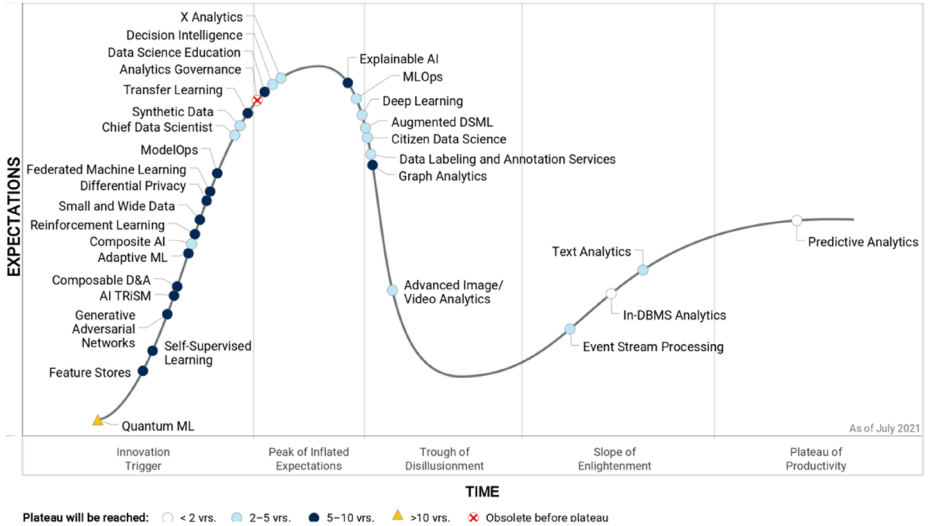
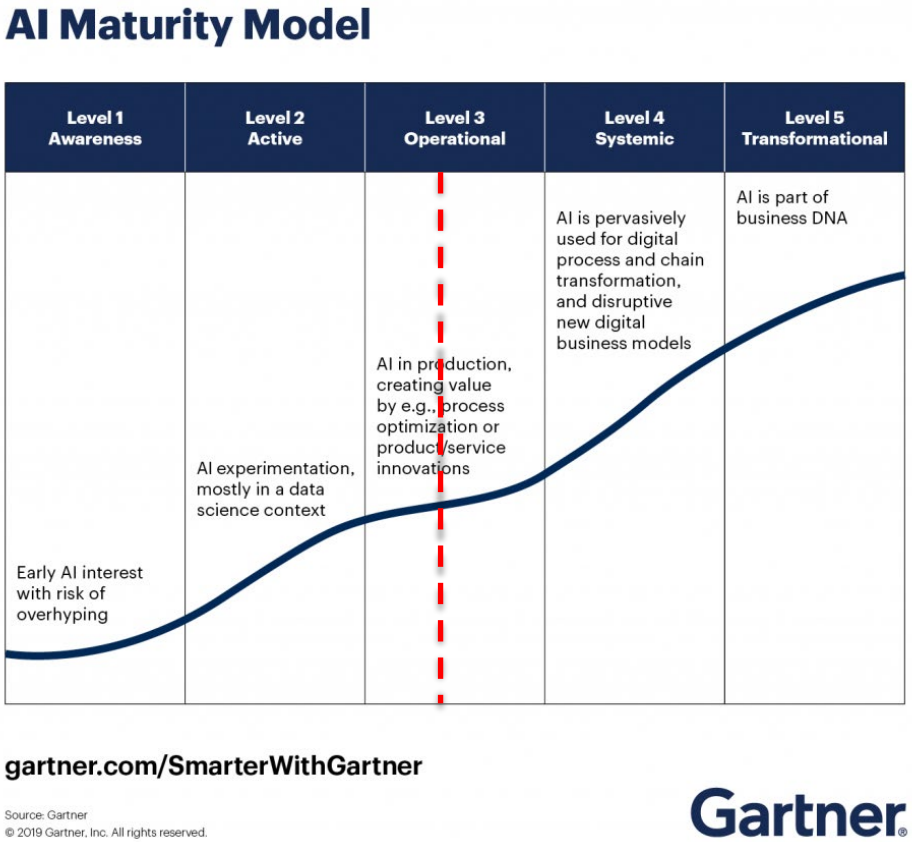


Figure 1: Hype Cycle for Data Science and Machine Learning, 2021



AI Maturity Model



Partial List of AI/ML Use Cases

Computer Vision

- Traffic analytics
- Abandoned mine site, imported soil
- Duckweed, dead trees
- Natural Disaster analysis

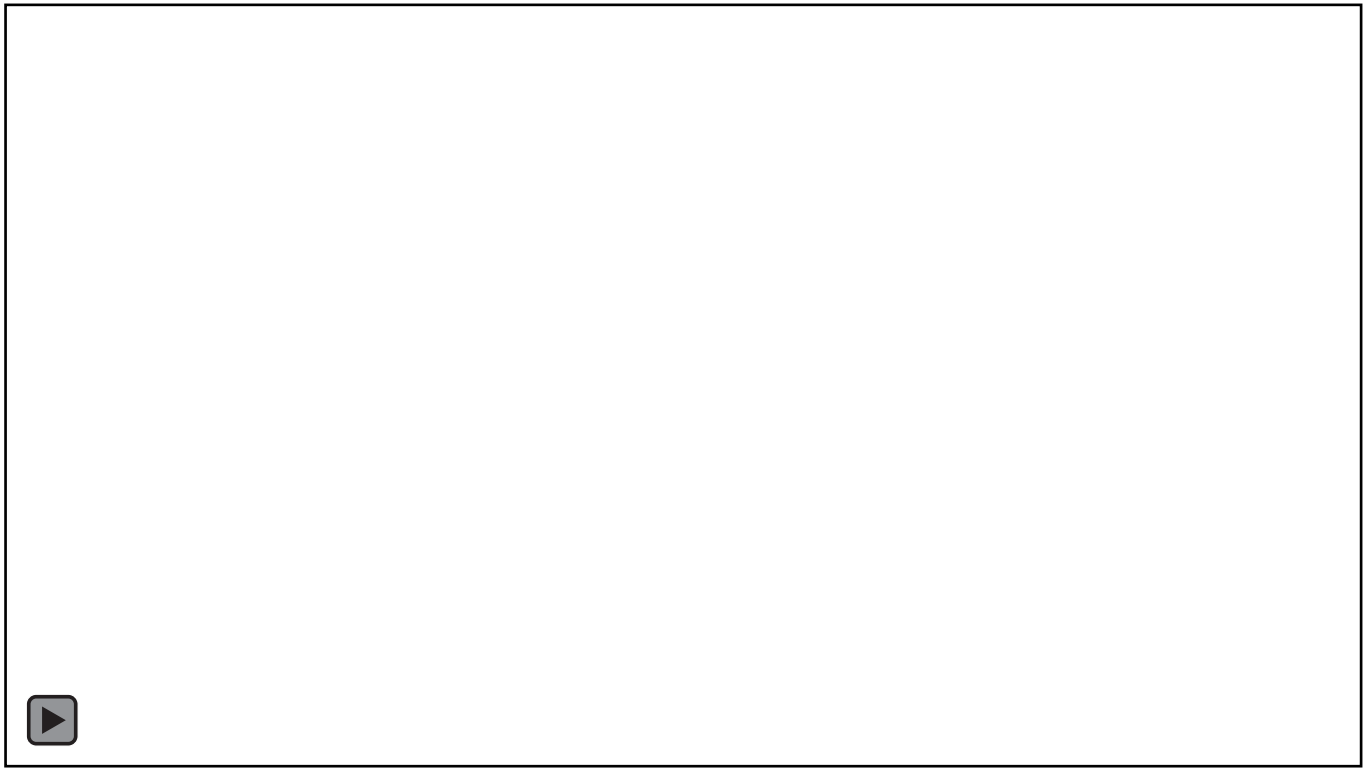
Data-Driven and Predictive

- PFAS Fingerprinting
- Principal Component Analysis for Mine Tailings
- Toll Transaction Analysis

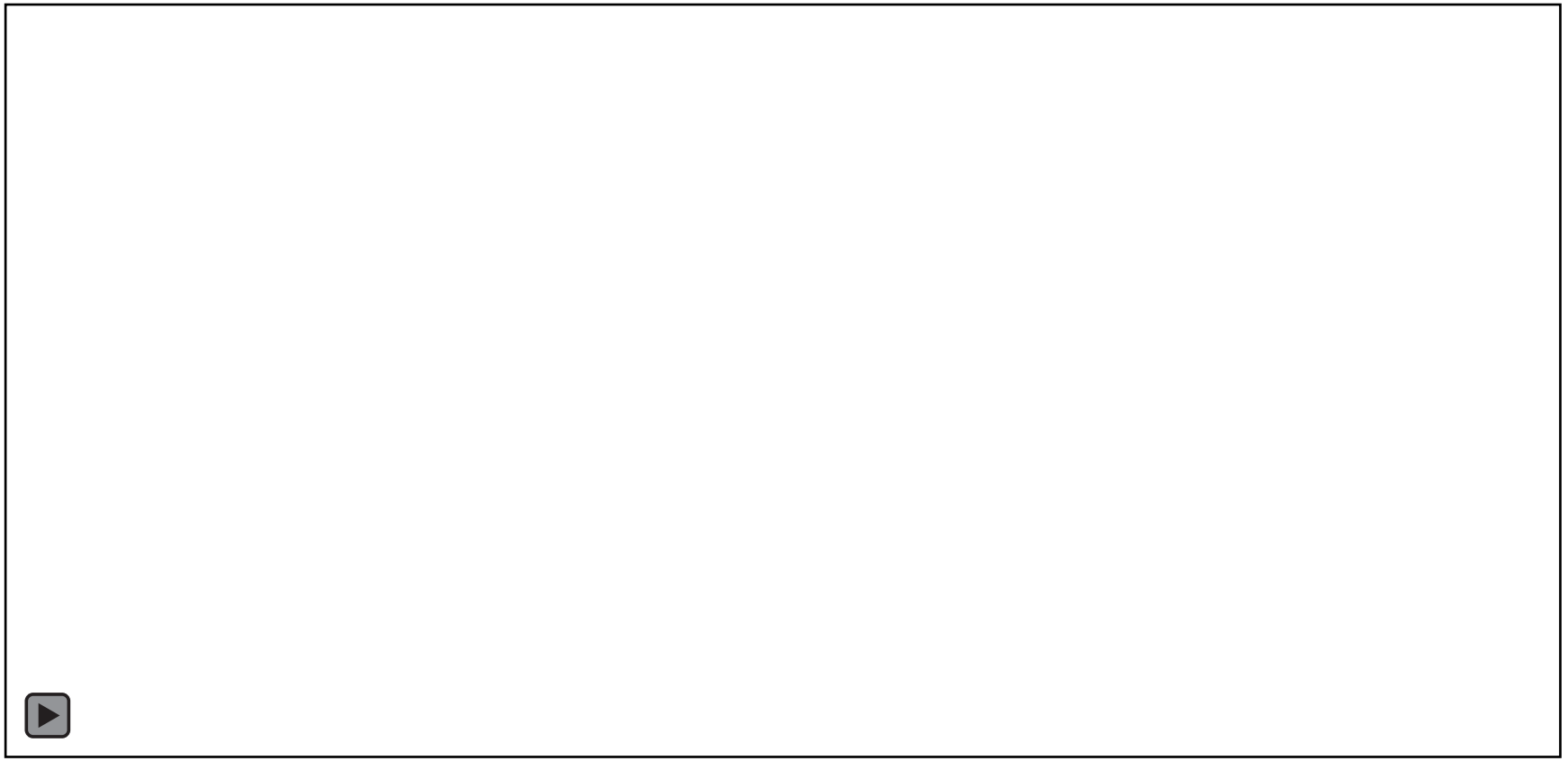
Automation

- Pump Optimization
- Ammonia level setting (wastewater)
- Electric bus battery modeling

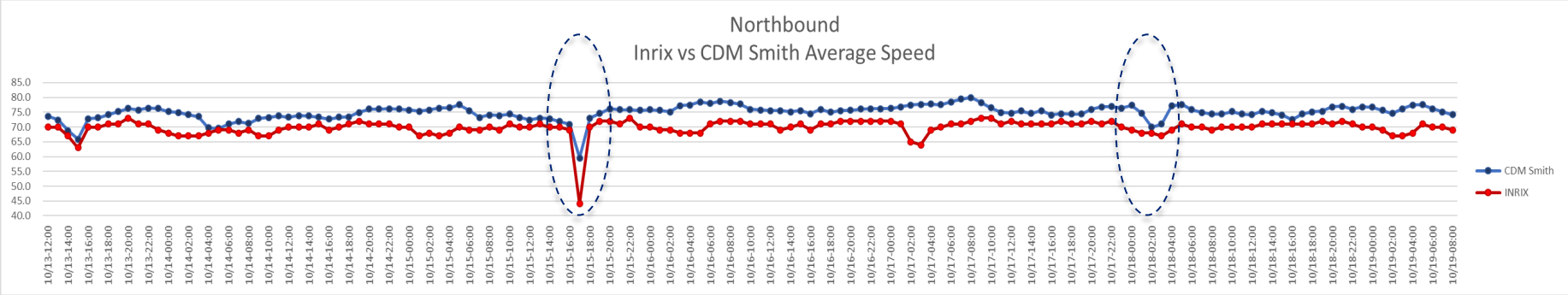
Visual Model Performance



Speed Analysis Dashboard



Evaluation of Speed Results Using Inrix (Northbound)

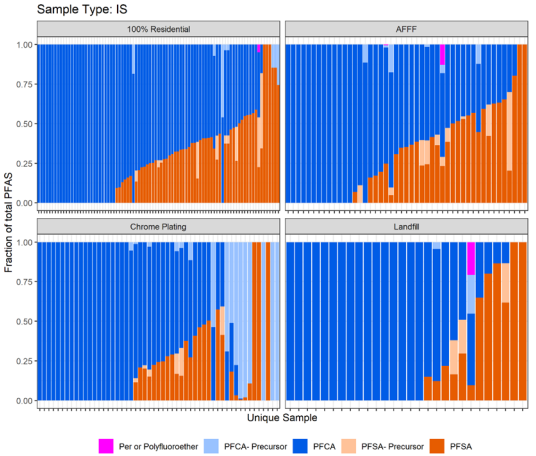


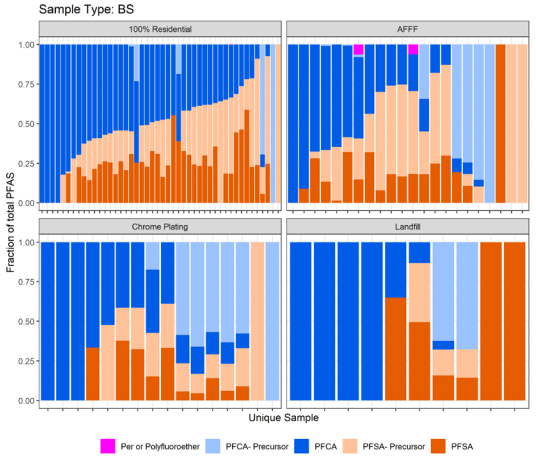
Environmental Remediation Using Drone Imagery

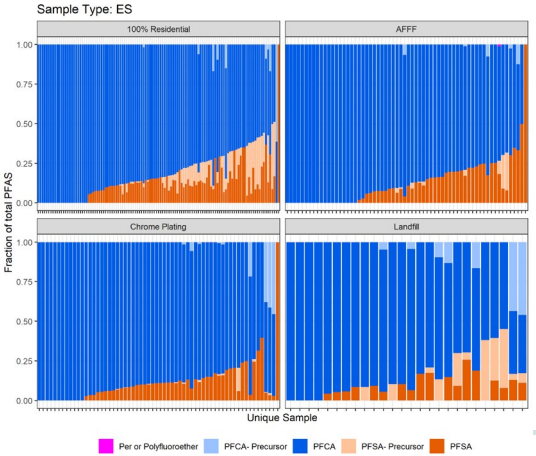
- Detect areas in abandoned mine sites that may have piles of disturbed soil
- Detecting areas without vegetation, unusual features such as, color, elevation, etc.
- Reduce the risk of contaminating underground water

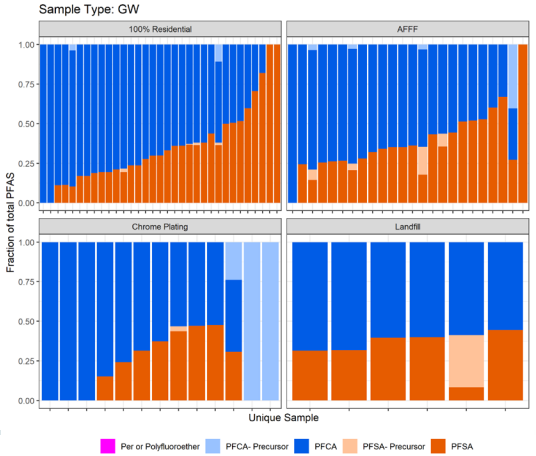
Wildlife Detection and Hazard Assessment

PFAS Fingerprinting



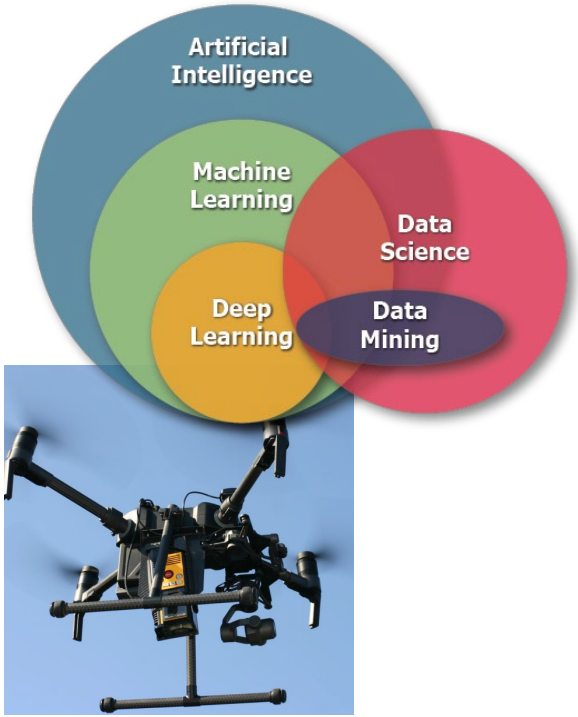






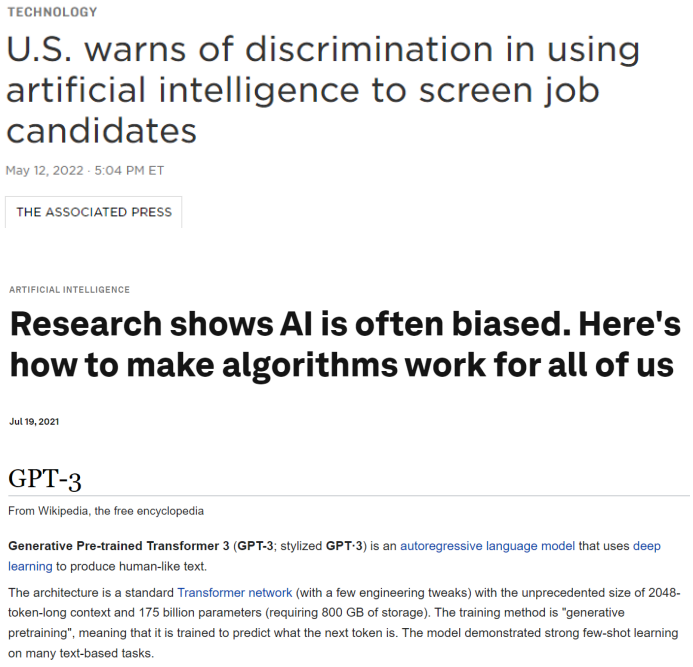
Where are we Headed??

- AI/ML-based analytics have become a mainstream activity.
- More Technology application is coming.
  - Users are more familiar
  - Automation of processes
- Cost
  - Not necessarily going down.
  - More time is spent on more value-added activities.



Cautionary Tales – Troughs of Disillusionment

- AI / Machine Learning



TECHNOLOGY

U.S. warns of discrimination in using artificial intelligence to screen job candidates

May 12, 2022 · 5:04 PM ET

THE ASSOCIATED PRESS

ARTIFICIAL INTELLIGENCE

Research shows AI is often biased. Here's how to make algorithms work for all of us

Jul 19, 2021

GPT-3

From Wikipedia, the free encyclopedia

Generative Pre-trained Transformer 3 (**GPT-3**; stylized **GPT·3**) is an autoregressive language model that uses deep learning to produce human-like text.

The architecture is a standard Transformer network (with a few engineering tweaks) with the unprecedented size of 2048-token-long context and 175 billion parameters (requiring 800 GB of storage). The training method is "generative pretraining", meaning that it is trained to predict what the next token is. The model demonstrated strong few-shot learning on many text-based tasks.

- Technology can be easily misused.
  - Lidar
  - Calibrations
  - Falsification is possible
- The tool is only as good the person using the tool.

A Parting Thought on Technology…

- Is it all pretty pictures?

Thank you

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