

TRS Group PFAS and Thermal Remediation



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Accelerating Value

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PFAS Projects & Lessons Learned

Thermal conduction heating

- Ex situ soil: Eielson AFB, AK (2021)
- In situ soil: Beale AFB, CA (2022)

PerfluorAd

- Firetruck: Connecticut DEEP
- Firetruck: Tyndall AFB, FL
- Groundwater: NAS Whidbey Island, WA



PerfluorAd® technology at Connecticut

Thermal Remediation Services

FlexHeater[®] Thermal Conduction Heating

OptiFlux[®] Electrical Resistance Heating

Steam Enhanced Extraction

Energetics Chlorinated Petroleum PAHs
Pesticides Solvents Hydrocarbons PCBs
———— PFAS ————

Temperature

HEPA[®] Remediation



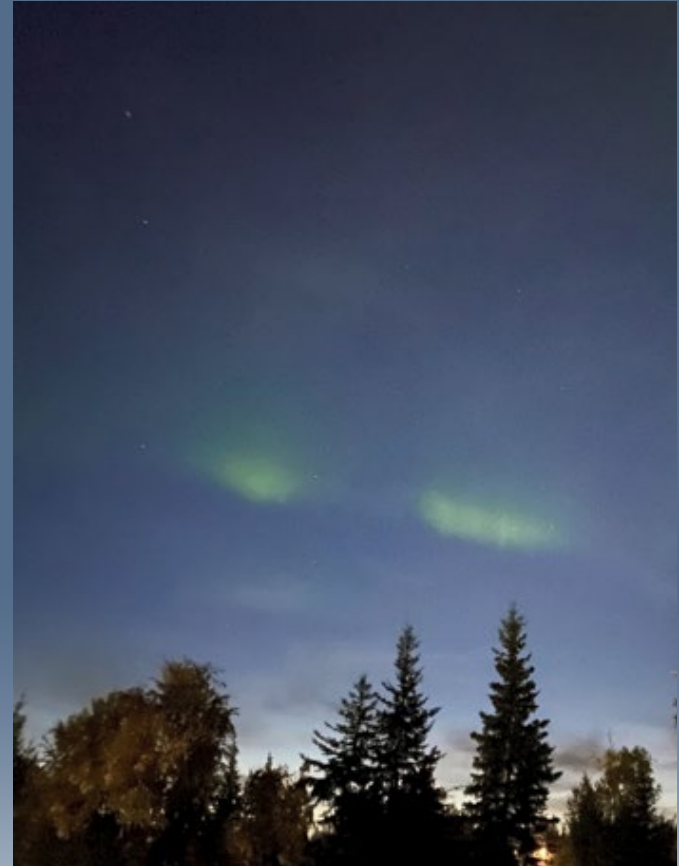
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Thermal Remediation Value

- Certainty in difficult soil matrices
- Fast: 3 to 6 months
- Reduce concentrations by >99%
- Far less expensive than dig & haul
- Decrease in liability



Northern lights from Eielson AFB



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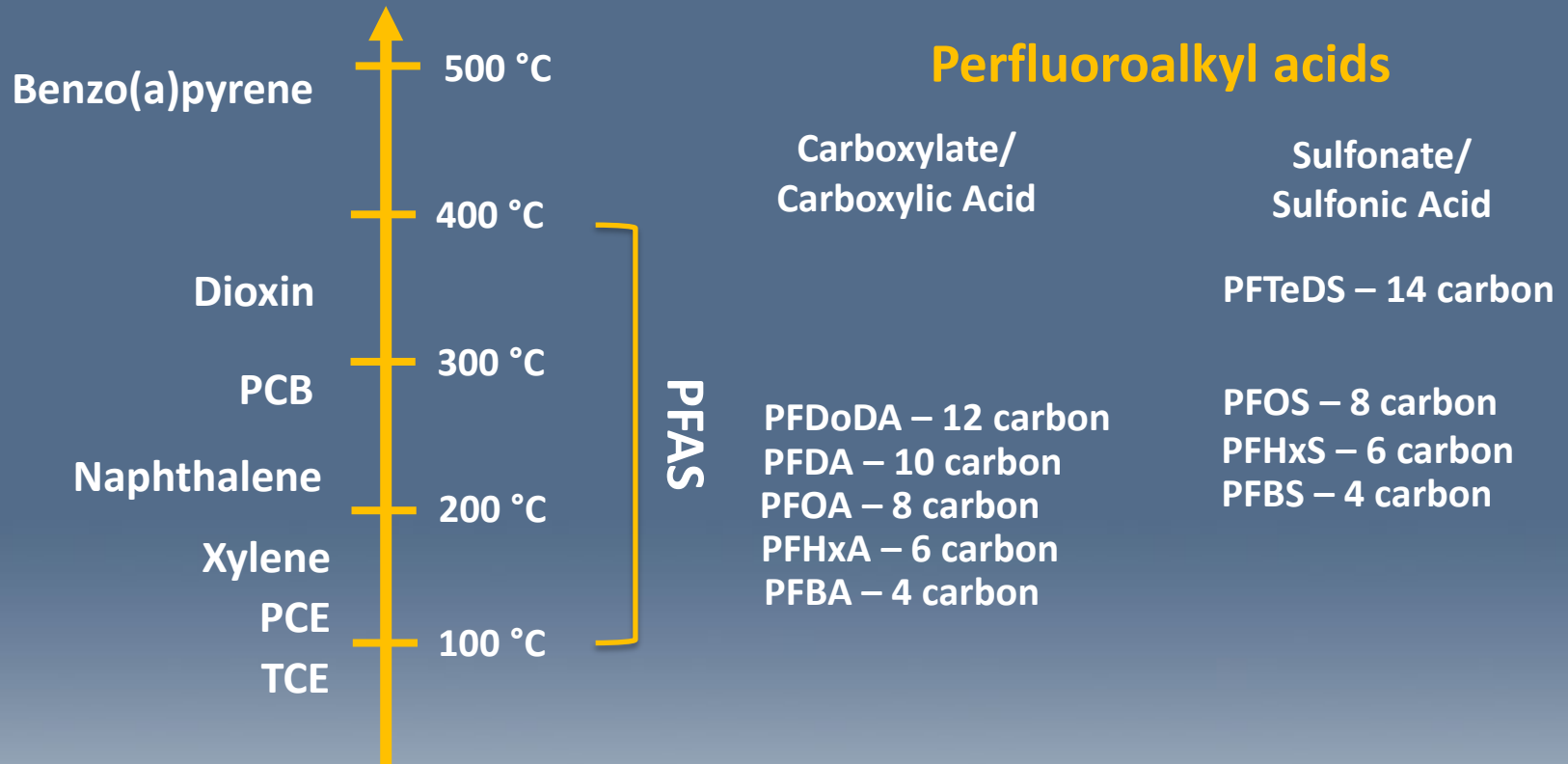
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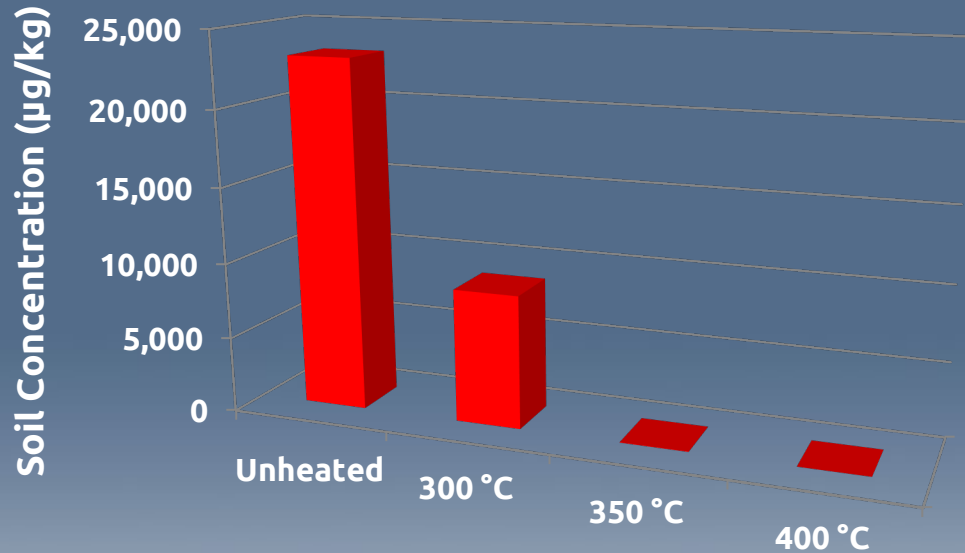
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Contaminant Boiling Points



PFAS Removal from Soil

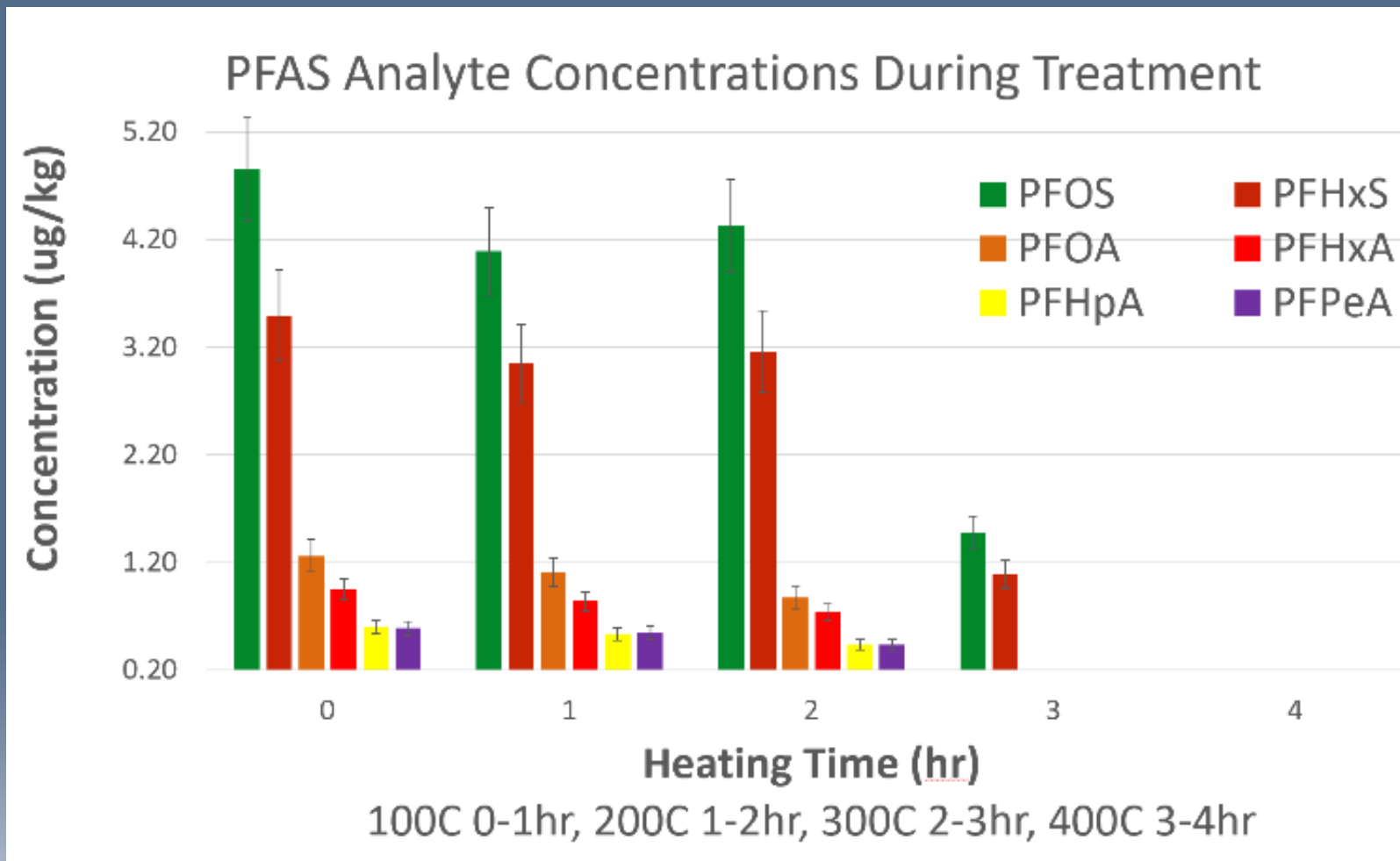


Two Weeks of Heating at Target Temperatures

PFAS	Starting Concentration (ppb)	300 °C % reduction	350 °C % reduction	400 °C % reduction
PFOS	21000	61.90%	99.92%	>99.999%
PFBA	91	93.85%	99.82%	>99.999%
PFPeA	100	92.60%	<99.8%	>99.999%
PFBS	41	58.54%	99.80%	>99.999%
PFHxA	200	95.30%	99.96%	>99.999%
PFHpA	27	86.67%	98.63%	>99.998%
PFHxS	1600	51.88%	99.84%	>99.999%
PFNA	16	96.81%	<98.75%	>99.997%
PFDS	48	75.00%	<99.58%	>99.999%
PFOA	64	92.97%	99.22%	>99.865%

Remediation 2019; 29:77-81

PFAS Volatilization – Time & Temperature



Kurt Pennell, Ph.D., Brown University



Soil Pile #377-1

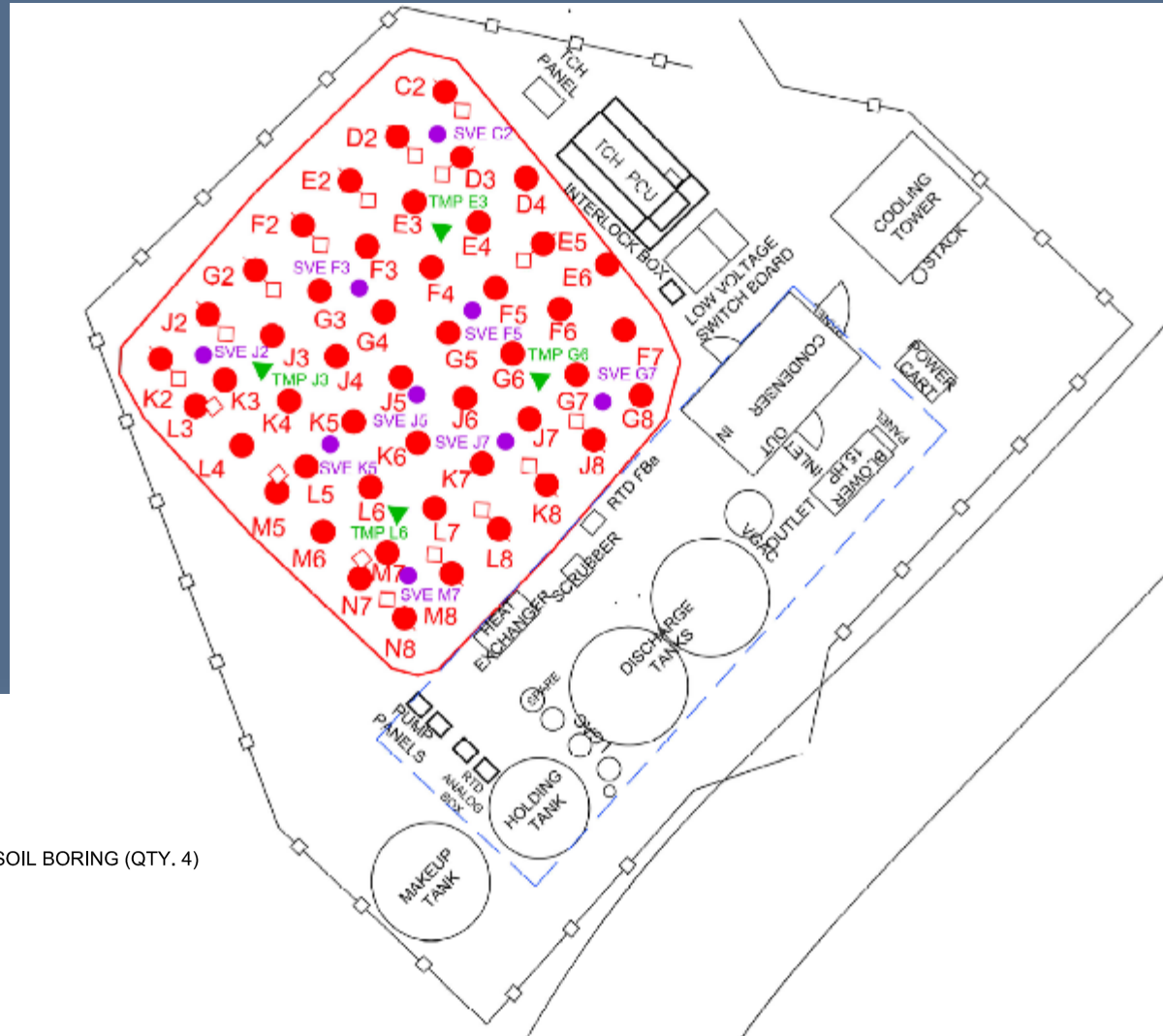
1,500,000 cy of PFAS-laden soil in 52 piles



Soil Pile #377-2



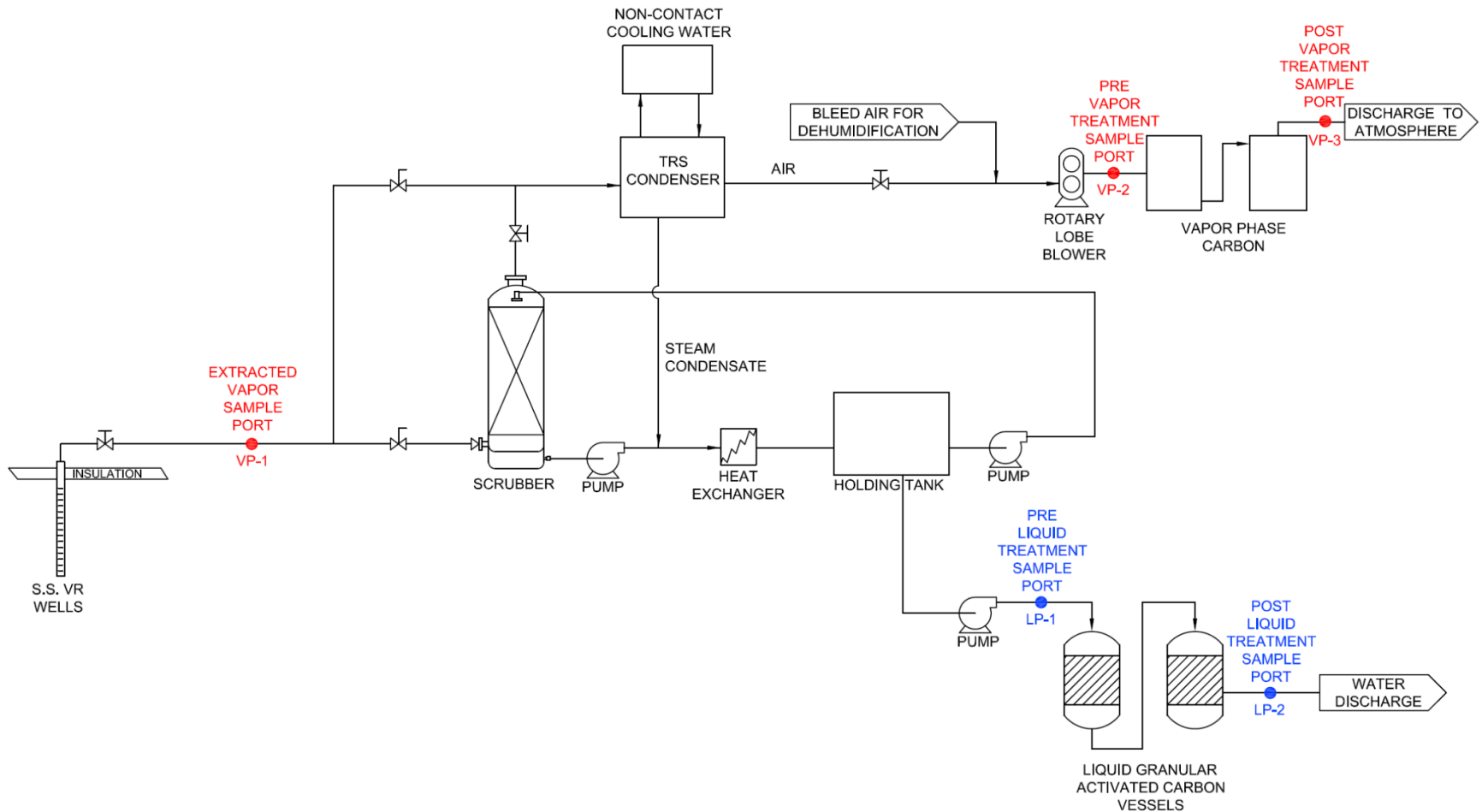
Stockpile Treatment Design



LEGEND

- HEATER (QTY. 34)
- ◻ HEATER (QTY. 14)
- ▼ TEMPERATURE MONITORING POINT/SOIL BORING (QTY. 4)
- SVE POINT (QTY. 9)
- FENCE
- - - SECONDARY CONTAINMENT

Process Flow Diagram



Field Demonstration Process

- Baseline soil sampling
- Sub-surface installation
- Equipment installation
- Implementation and analysis
- Post-treatment soil sampling
- Decommissioning



Heater Casing Installation



Casings installed to 4 feet below ground surface

Thermal Barrier Construction



Stockpile covered with impermeable barrier & insulating mineral wool

Stockpile Construction Complete



Water resistant outer layer and sealed edges

Make-up water tank
(behind)

Scrubber
(behind
tanks)

Discharge water
holding tanks

Scrubber holding
tank

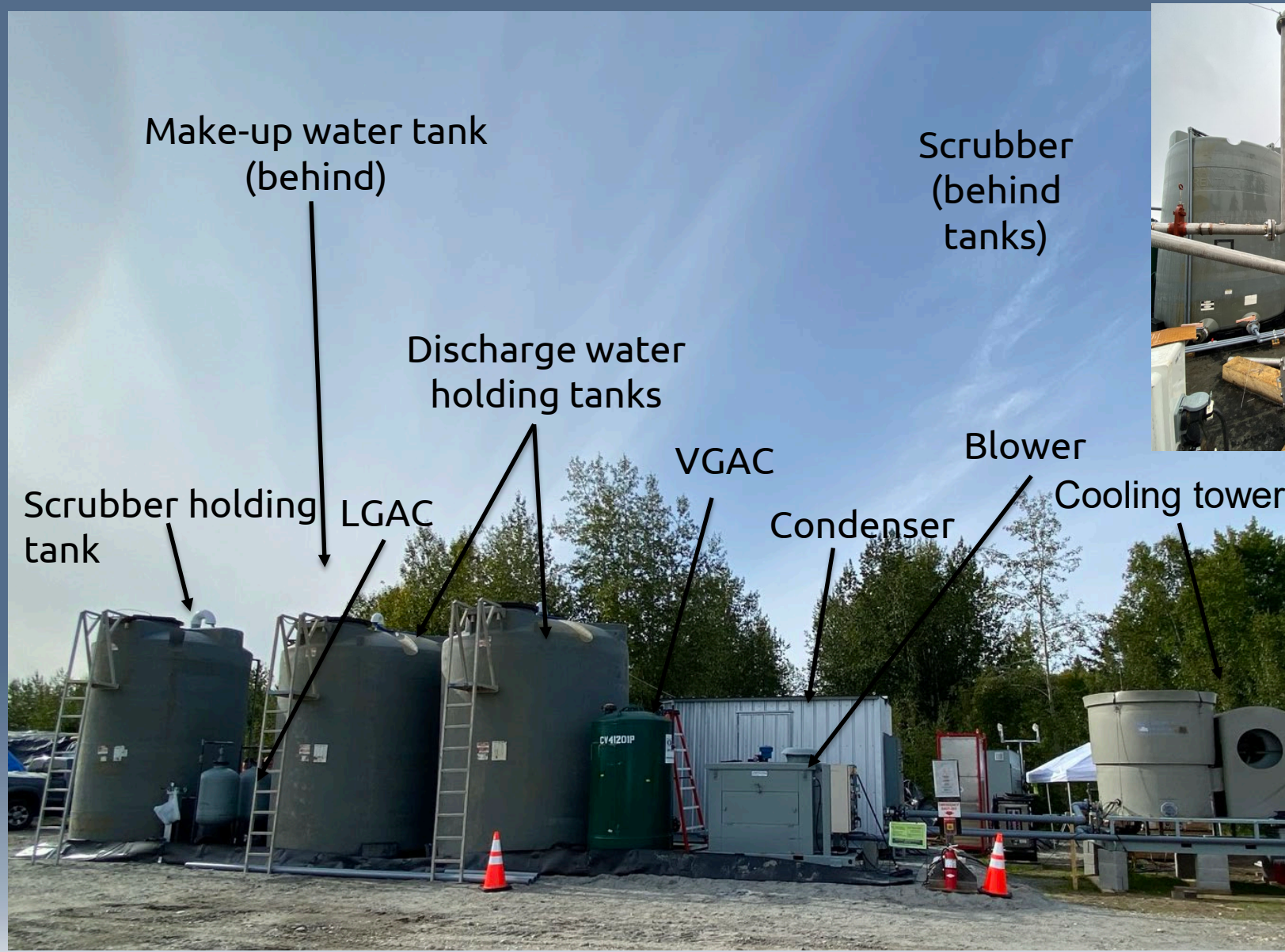
LGAC

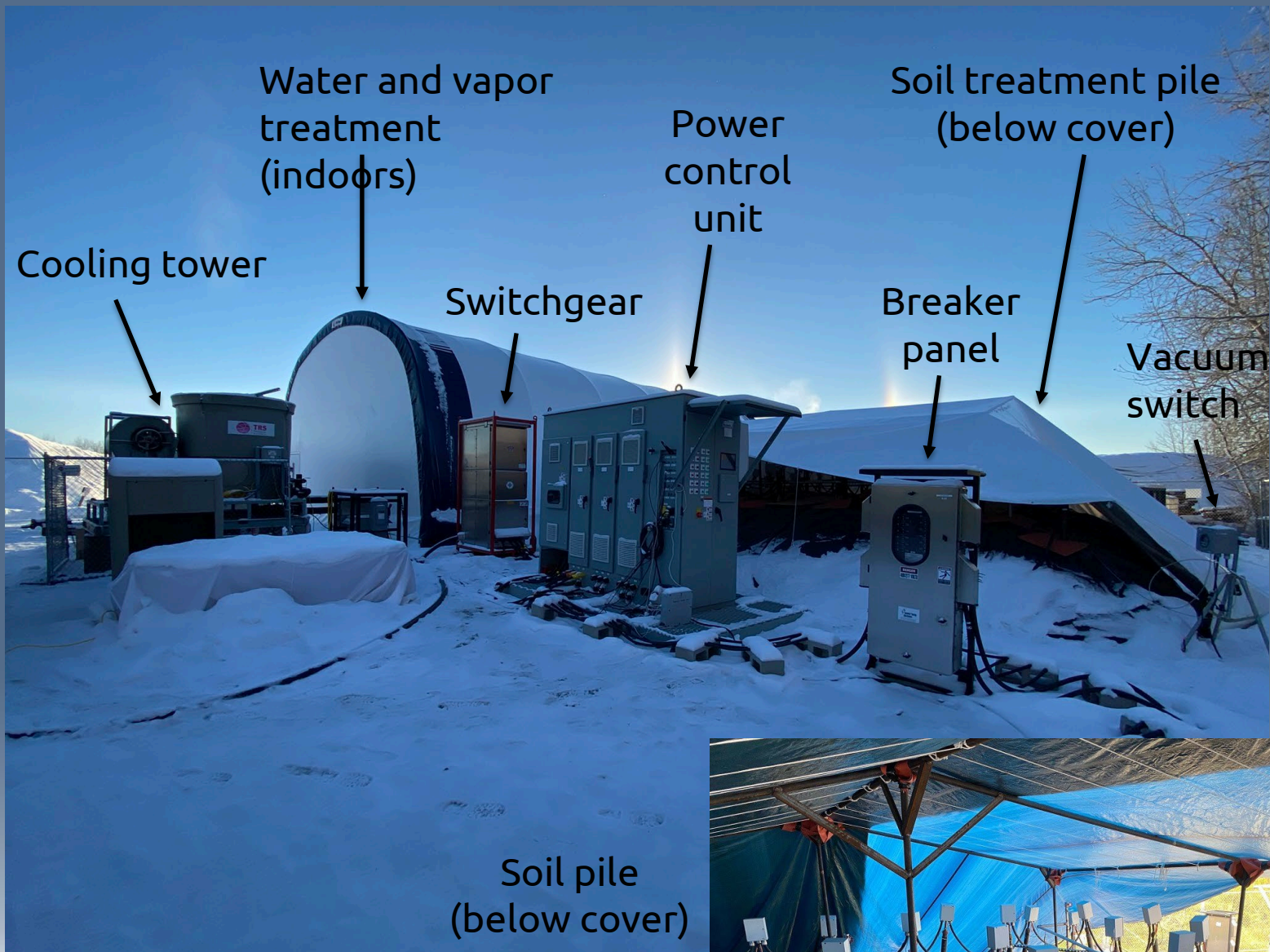
VGAC

Blower

Condenser

Cooling tower





Construction Challenges

- Schedule delays and logistics
- Keeping the pile and insulation dry
- Schedule delays forced winter operation
 - Freeze protection
 - Cover for soil pile
 - Equipment tent

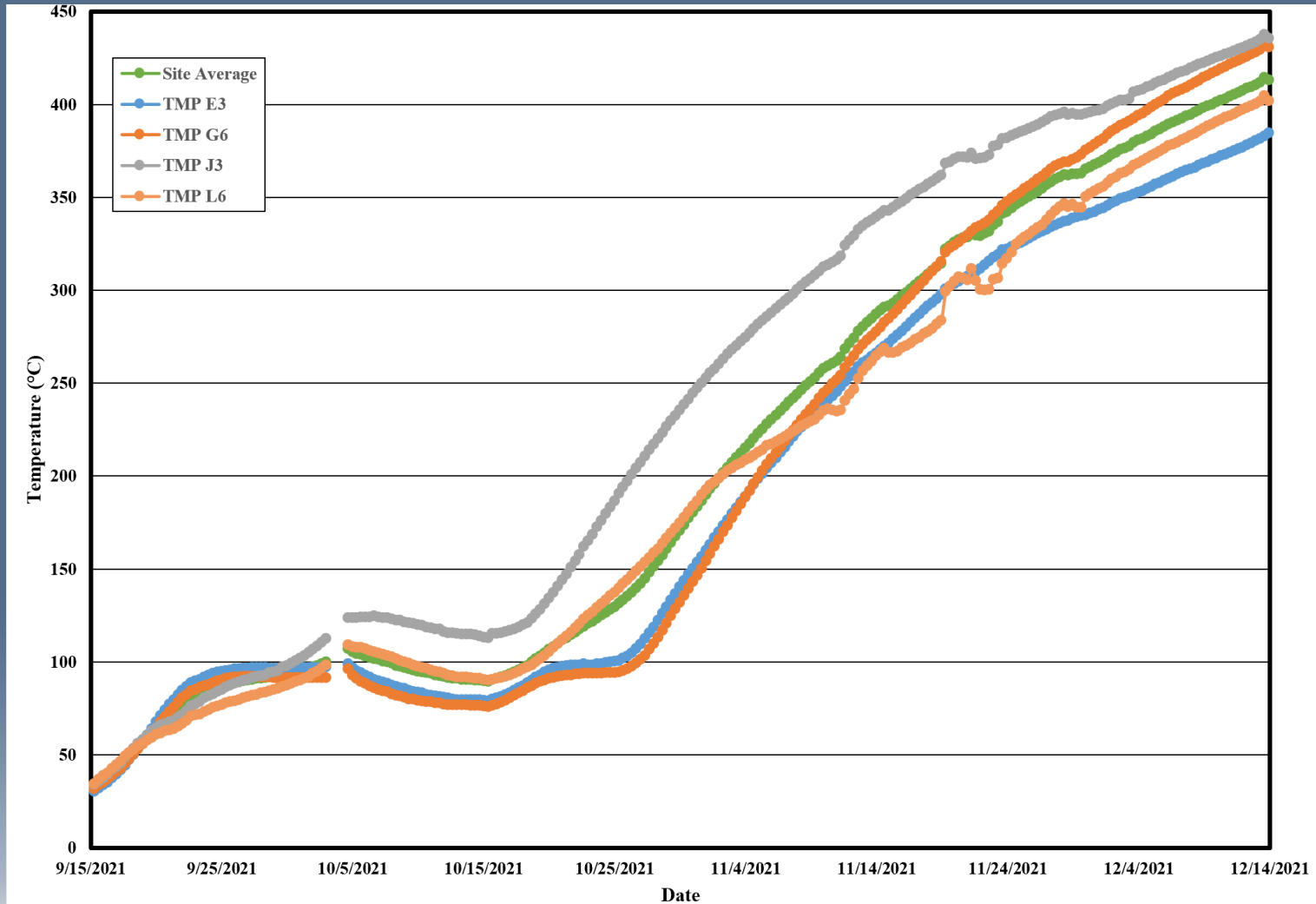


Site Operational Objectives & Analysis

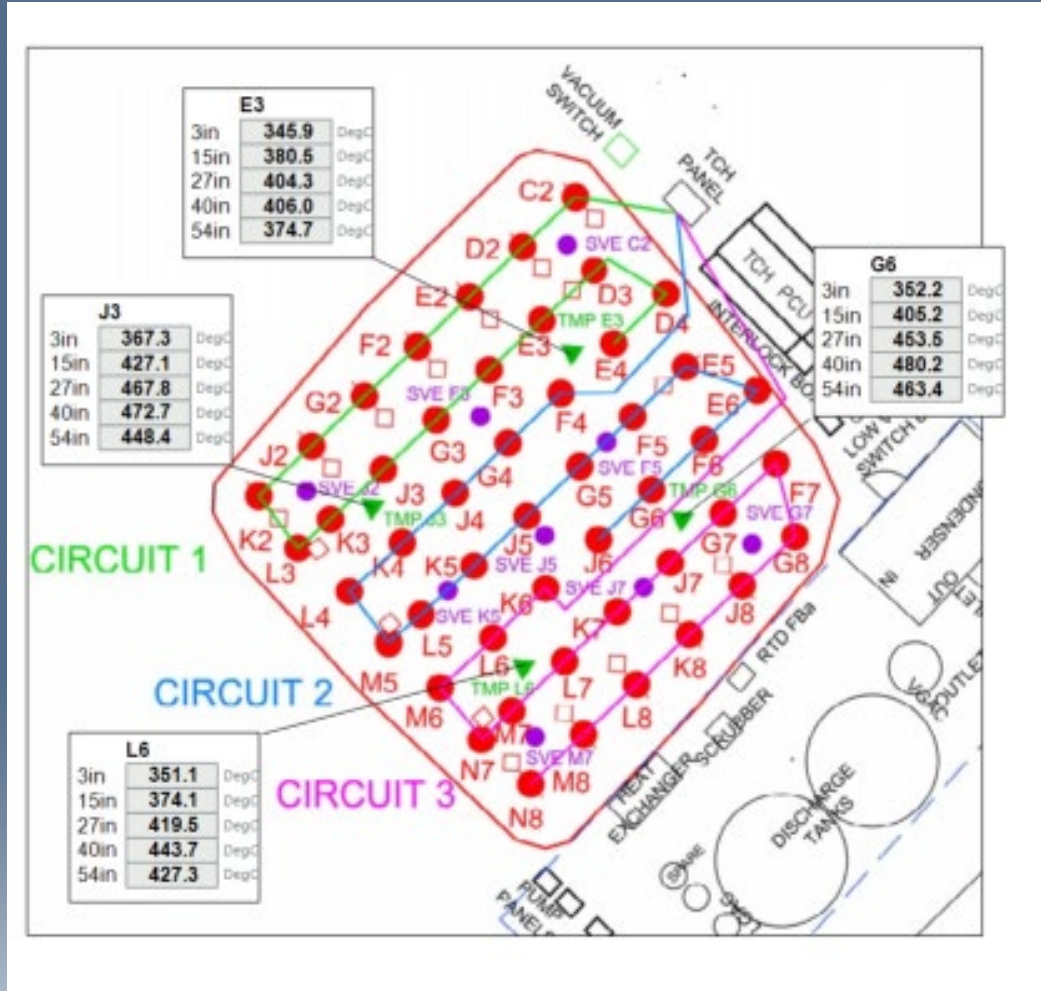
- Maintain average 350°C for 10 days
- Pre-/Post-treatment soil
- Vapor influent & effluent monitoring
- Liquid influent & effluent monitoring



Soil Pile Temperatures



December 13, 2021, Temperatures



- Ambient Air Low
 - -38 °C
- Soil Pile TMP Average
 - 413 °C
- Soil Pile TMP Maximum
 - 482 °C
- Heater Casing Maximum
 - 850 °C+

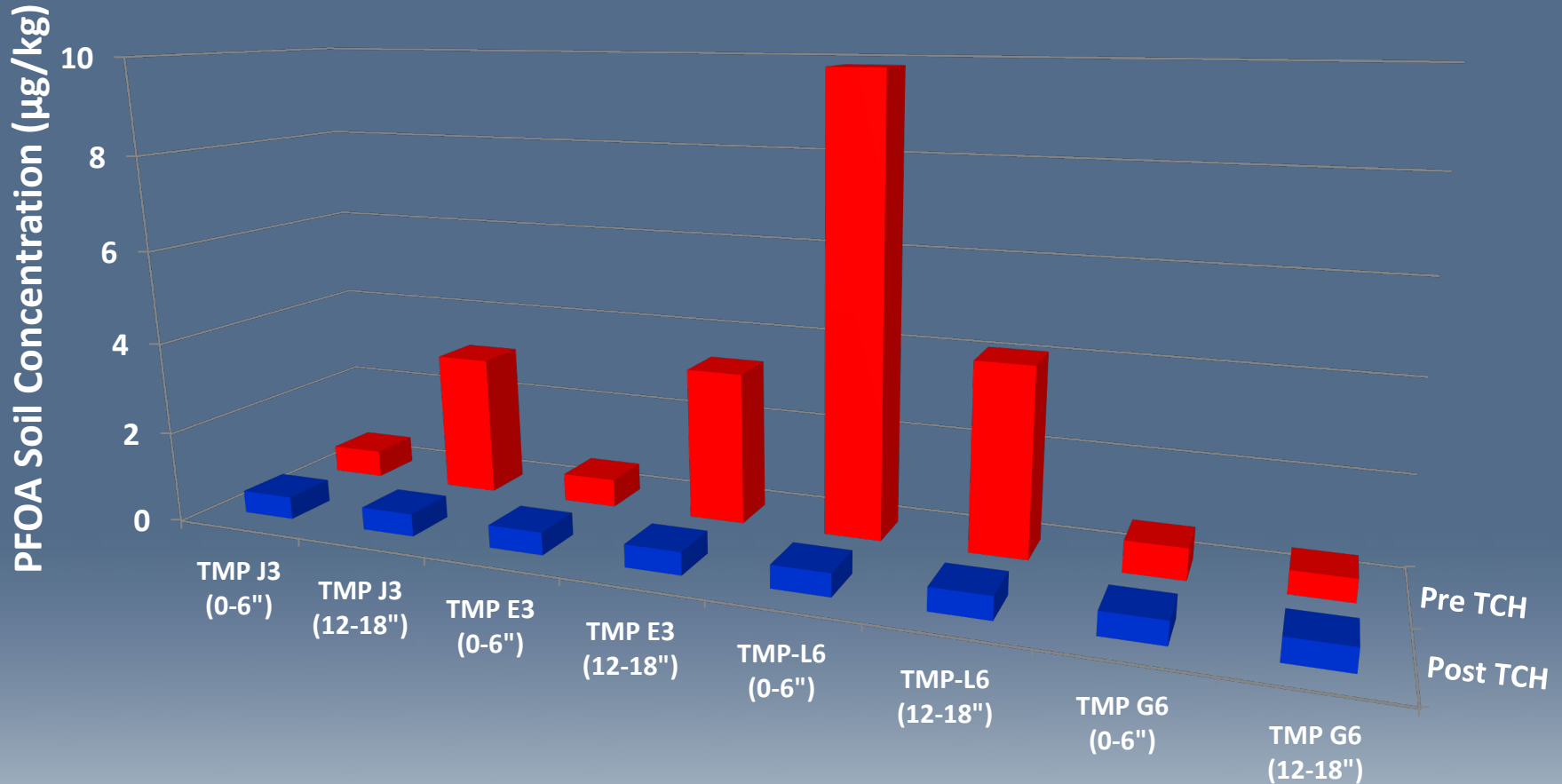
Soil Sampling



- PFAS-free PPE
- Limited pile top access
- Soil consistency

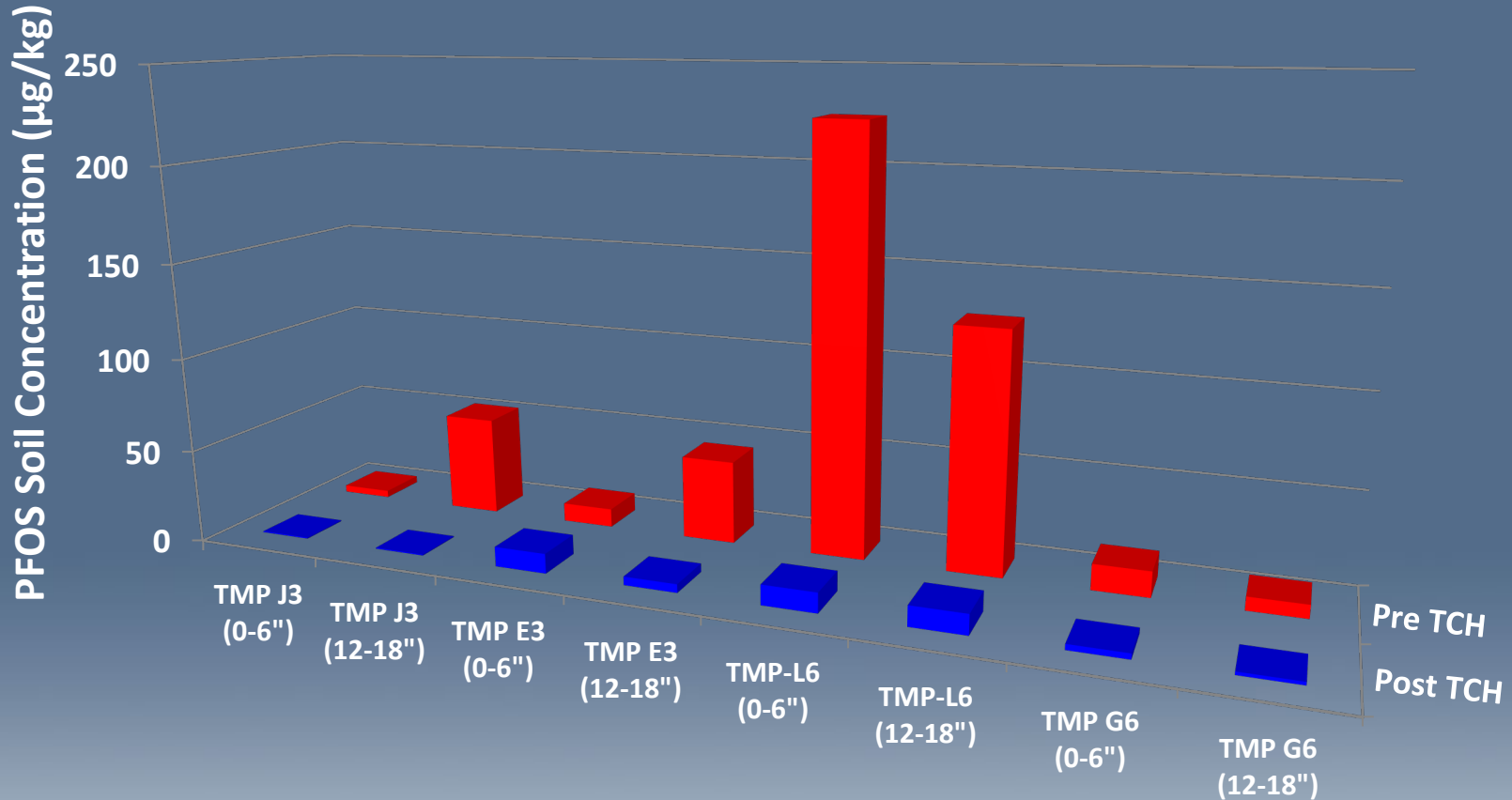
- 8 of 16 initially sampled
- Drill rig mobilized
- 16 composite samples

PFOA Preliminary Results



*all post treatment samples below PFOA detection limits

PFOS Preliminary Results



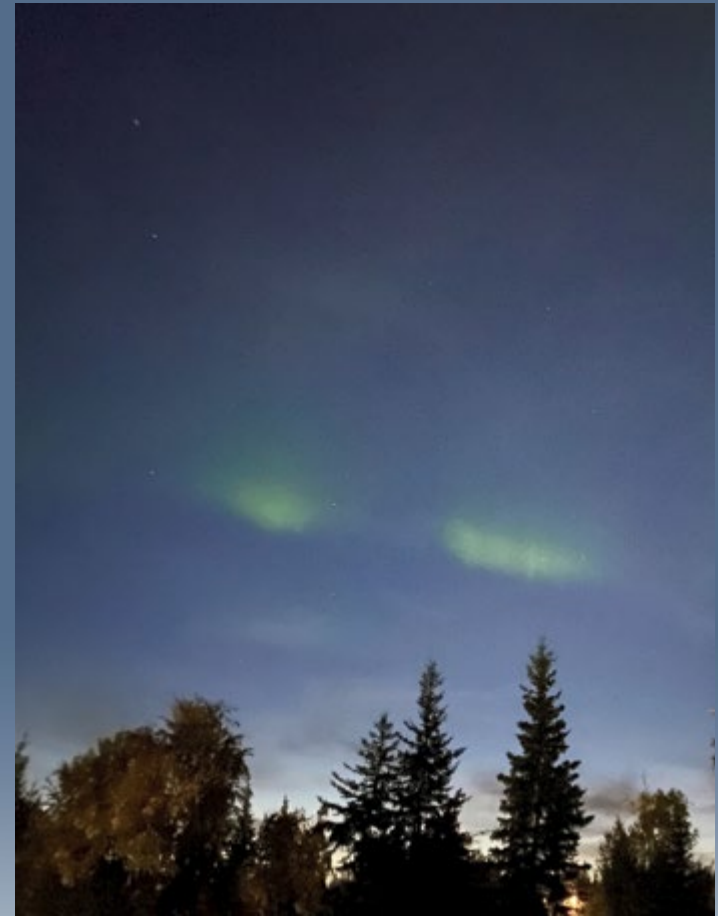
*heating shallow samples to above 400°C below PFOS detection limits

Additional Analytical Results Pending

- Water Discharge: all non-detect for PFOS/PFOA
- Post-treatment Soil (partial)
- Vapor Extraction (OTM 45)
- Water Treatment (Pre/Post LGAC)
- Vapor Effluent (Stack)
- Waste LGAC, VGAC, tank sludge (partial)

Lessons Learned

- Significant PFAS reductions in soil
- Verification of bench testing
- Extracted vapors captured & treated
- Soil sample collection
- Technology is scalable
- Other PFAS projects: CT DEEP



Contact Information

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