Hottpad: Results from a Field Demonstration Project for Treatment of Heavy Oil Sludge and Oil-Impacted Soil

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Presentation Overview

- Heated Overland Thermal Treatment Pad (Hottpad) concept
- Field Demonstration System
- Summary of Operations
- Treatment Results
- Technology Summary

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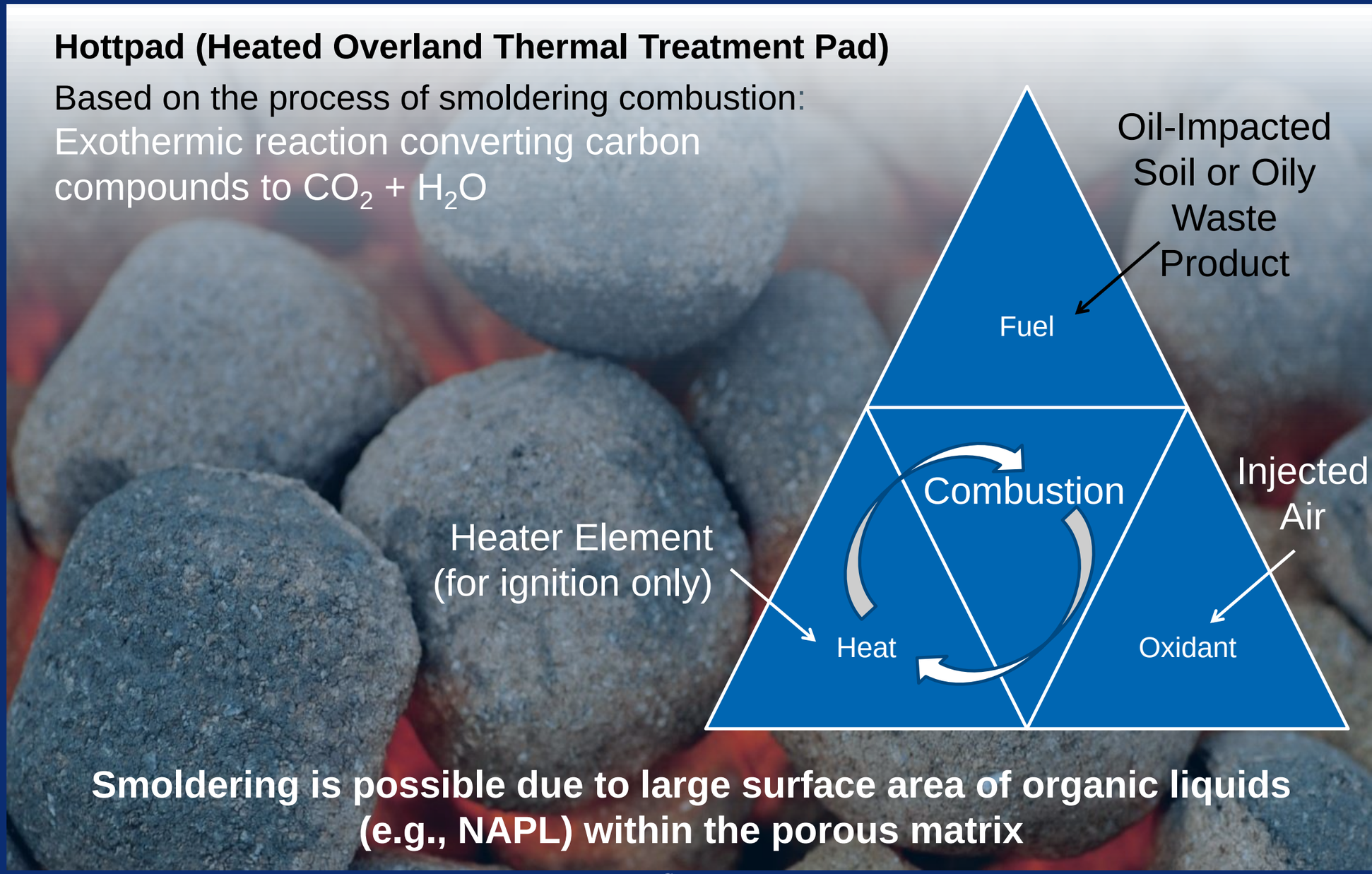
Smoldering Combustion

Hottpad (Heated Overland Thermal Treatment Pad)

Based on the process of smoldering combustion:
Exothermic reaction converting carbon compounds to $CO_2 + H_2O$



Smoldering is possible due to large surface area of organic liquids (e.g., NAPL) within the porous matrix

Overview of Hottpad Concept

Technology Objectives

- Low capital cost
  - Fabrication materials
  - Minimize handling and pre-processing equipment
- Provide adequate treatment capacity/volume
- Simplify and reduce O&M

Conceptual Cross-Section

- Heat and air to initiate the treatment
- Impermeable cover for emissions collection

- Continued air injection to sustain the treatment
- Injected air cools already treated material

Field Demonstration Project

Project Scope

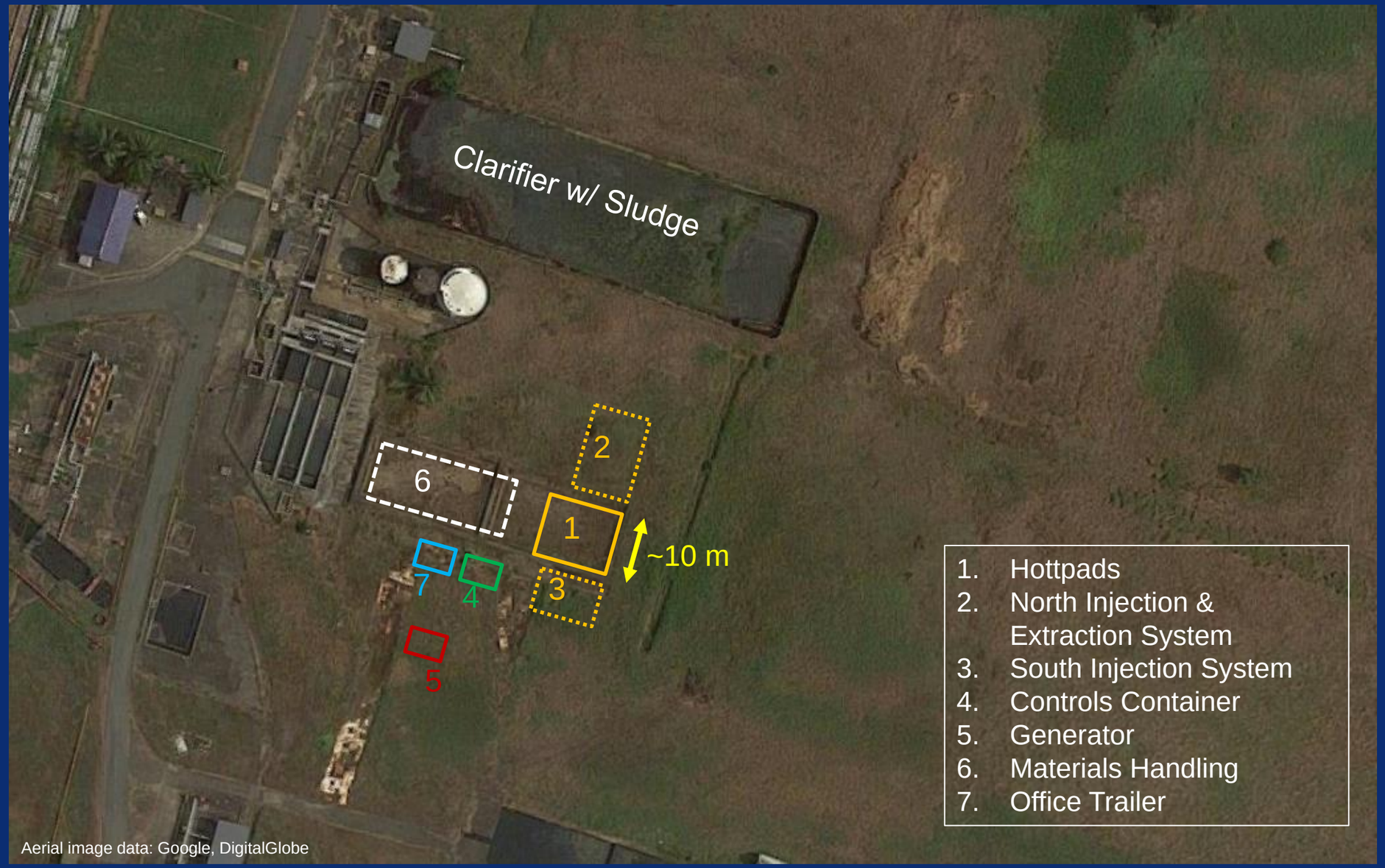
- Treat sludge from an API separator
- Treat oil impacted soil from the site

Project Objectives

- Demonstrate successful scale-up of the technology
- Develop a better basis for:
  - Full-scale costs (Capital and O&M)
  - System design improvements
  - System operational efficiencies
- Alternative to more costly remedial option

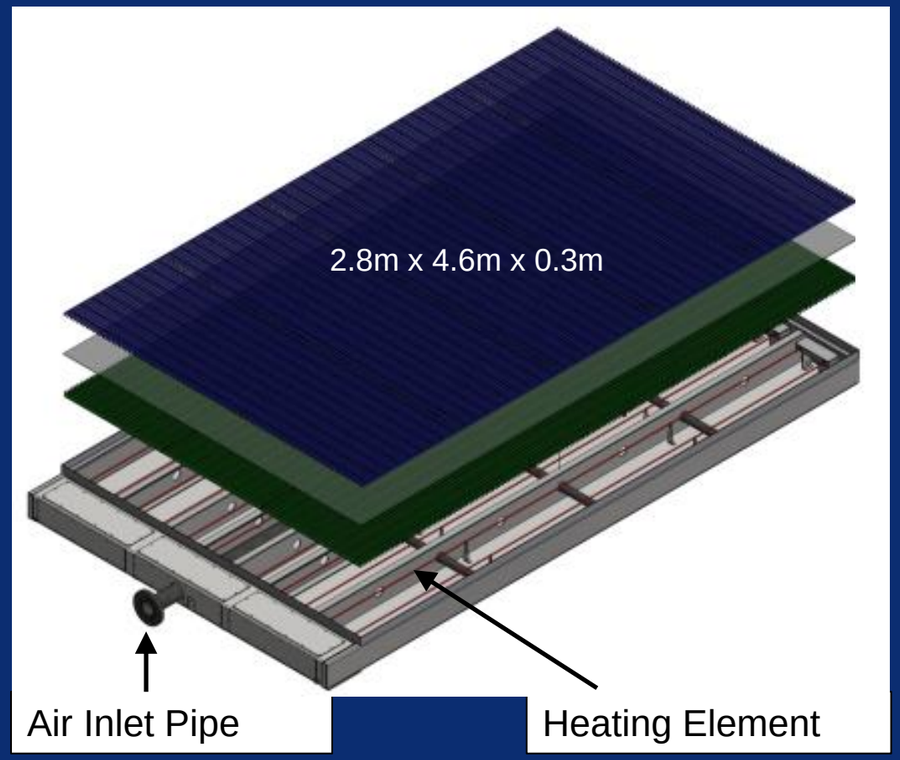
Facility in Southeast Asia

Field Demonstration System Layout



1. Hottpads
2. North Injection & Extraction System
3. South Injection System
4. Controls Container
5. Generator
6. Materials Handling
7. Office Trailer

Basics of Hottpad

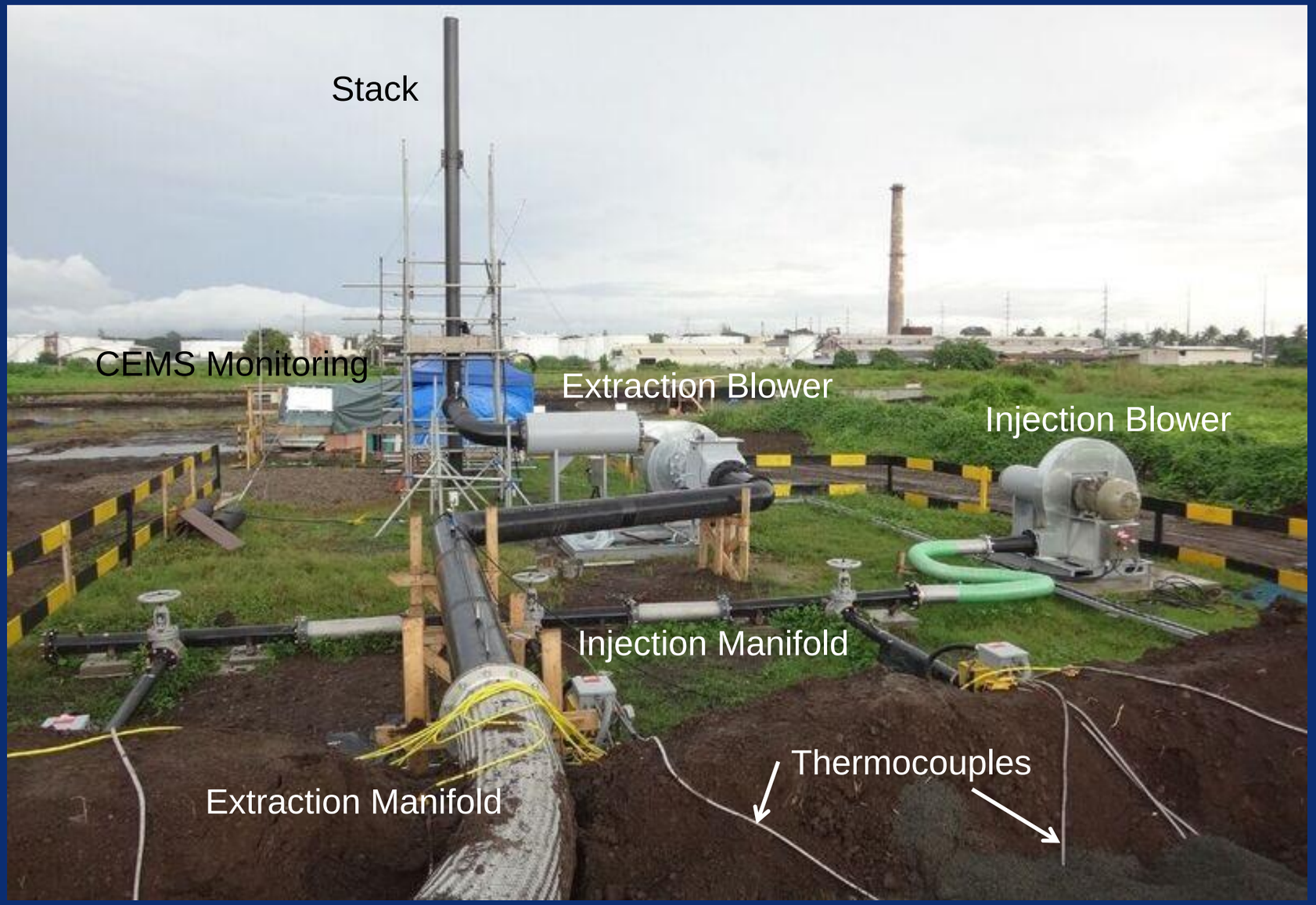


Field Demonstration 6 Pad System (~ 80 m^2)

Hottpad Base

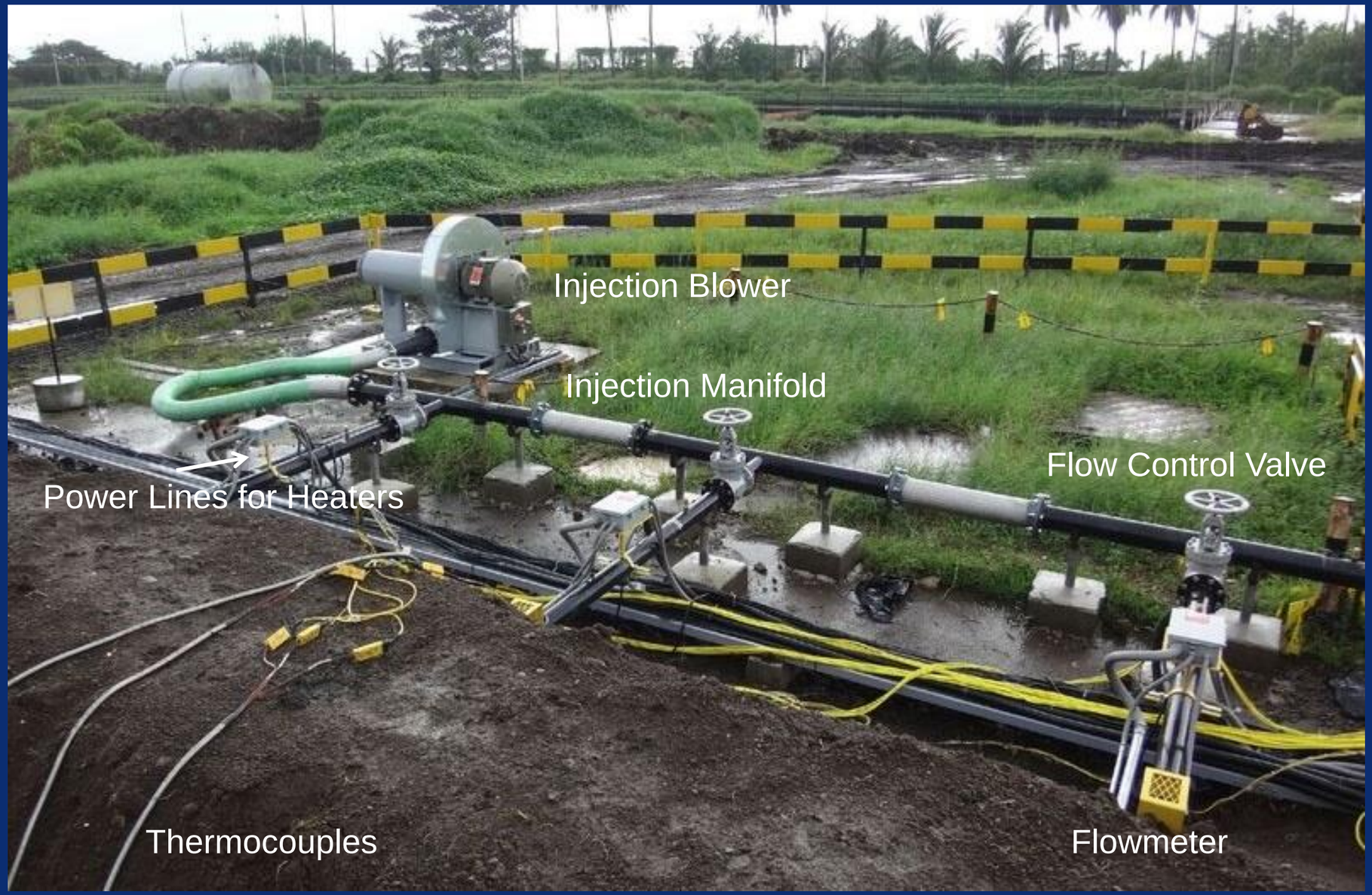
Trafficable Grate

Field Demonstration System – North Side



CEMS – Continuous Emissions Monitoring System

Field Demonstration System – South Side



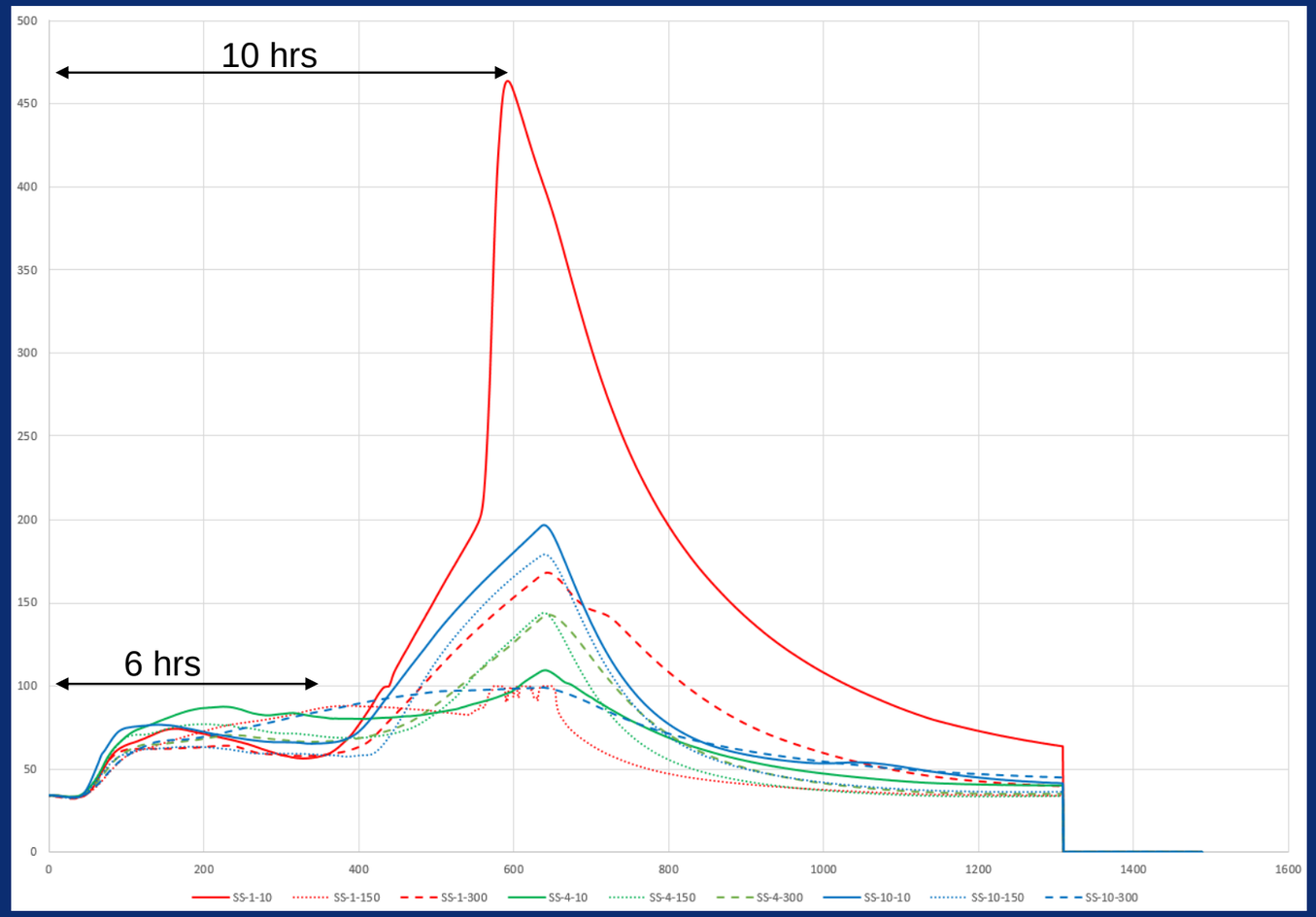
Summary of Operations - Loading

- Sludge & Solid matrix blended
  (~1:4 ➔ sludge:soil)
- Load blend onto Hottpad (~2 m)
- Place clean cover material (~0.5 m)
- Place emissions collection

Loading Blended Material

Placing Clean Cover Material

Summary of Operations – Start Up

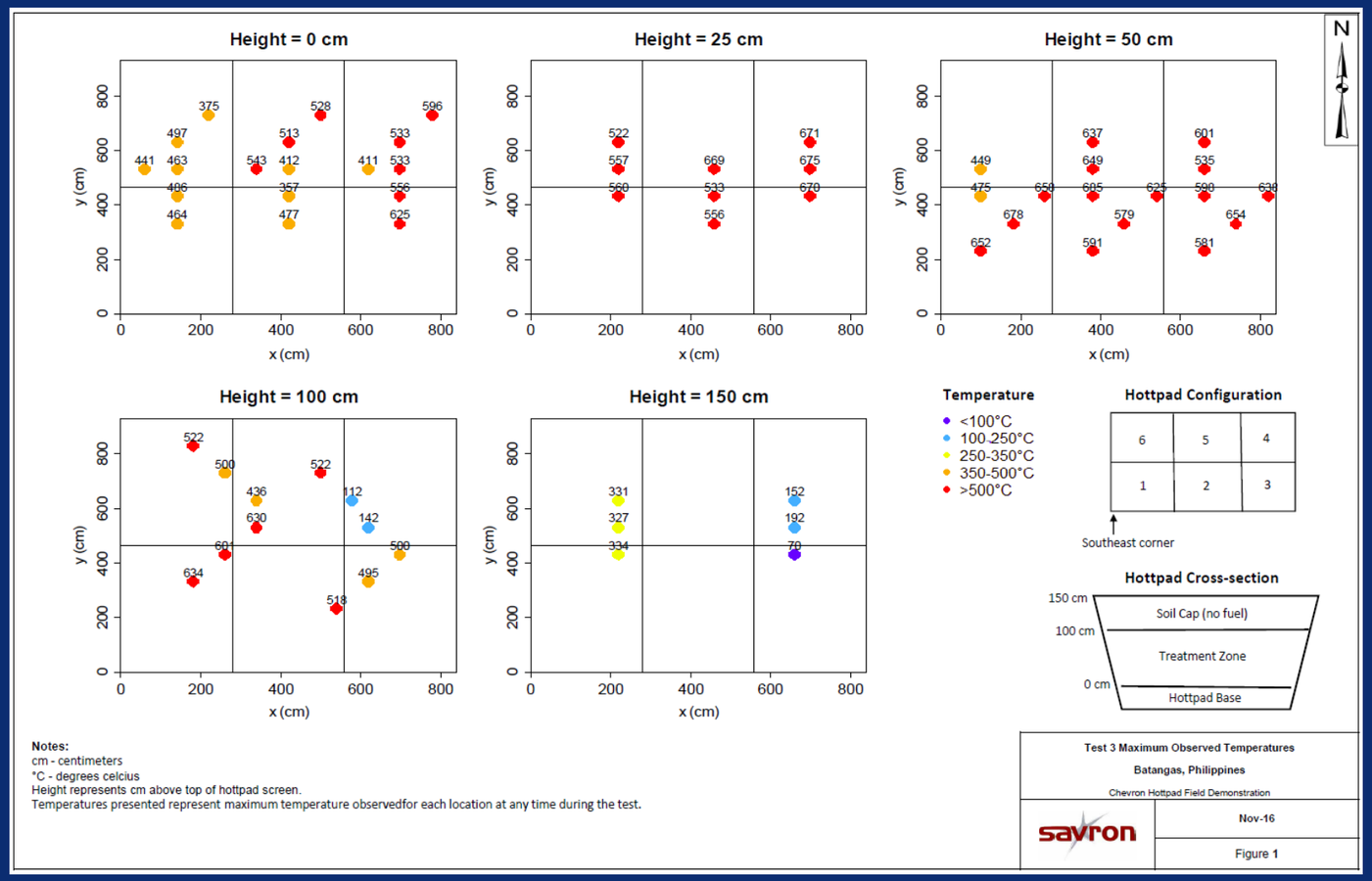


Test 1 Surface/Matrix Temperatures

- System start up
  - Extraction blower
  - Injection blowers
  - Heaters in Hottpads
- Confirm ignition
  - Carbon Monoxide (CO)
  - Temperature @ Hottpad surface/Materials interface

Combustion Gas Monitoring System

Summary of Operations – Sustained Treatment



Test 3 Maximum Observed Temperatures

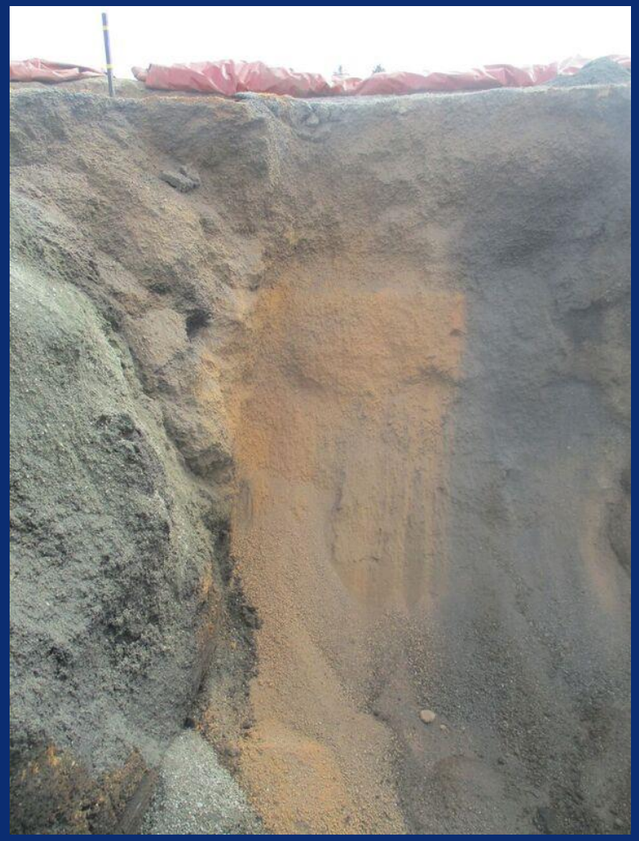
- Turn off heaters
- Maintain injection and extraction air flow
- Monitor emissions until treatment complete
  - CO returns to background
  - Temperature

Main Control Panel

Summary of Operations - Completion

- Increase injection to cool pile
- Remove emissions collection
- Remove treated soil
  - Reuse to blend or as clean cover
- Repeat the process

Removing Clean Cover Material



Exposure of Treated Blend Material

Demonstration Summary

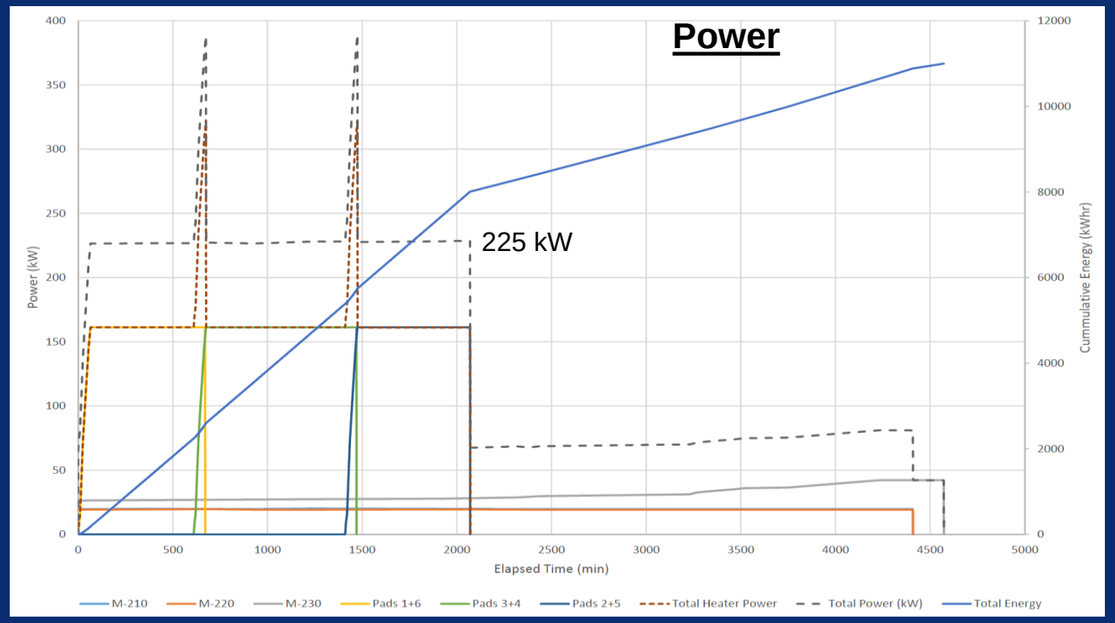
Run	Sludge Treated (m^3)	Hottpad Load Volume (m^3)	Moisture Content (% by wt)	Oil Content (% by wt)	Initial TPH Concentration (mg/kg)	Final TPH (mg/kg)	Comment
1	14	45	47	7	35,350	<150	Full start, S1 solid matrix*
2	31.5	135	12	3	14,670	<150	Rolling start (2 pads), S1
3	19.5	135	20	1.5	8,700	<150	Rolling start, S1
4	21	141	20	1.5	9,560	<150	Rolling start, site soils**

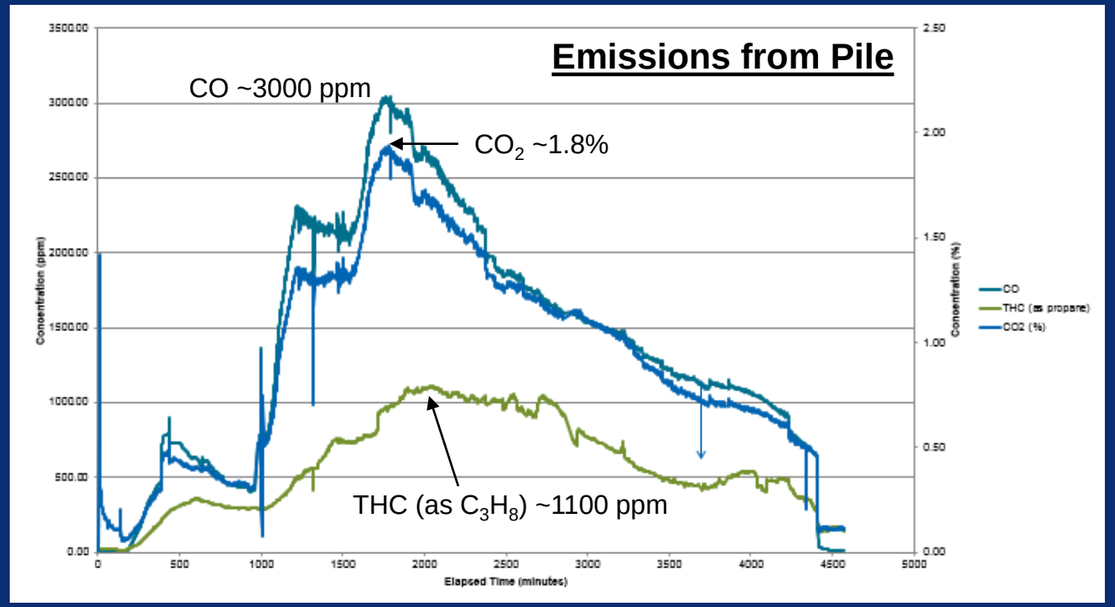
*S1 material was a crushed rock similar to a very coarse sand
** Site soil is kaolinitic material with silts, fine sands, and clay

Treatment Results

Learnings

- Scale-up from prototype was appropriate
  - Small-scale testing to support system design
- The treatment process is more robust at larger scale
- Opportunities for system refinement
  - Further reduce peak power (e.g. rolling start)
  - Additional system automation
  - Reduce processing time
- Emissions management
  - Treatment for odor abatement
- Operations is straightforward and transferrable





Test 3 – 3 Days of Monitoring Data

Technology Summary

Hottpad is effective for the treatment of oily waste and oil-impacted soil

Benefits:

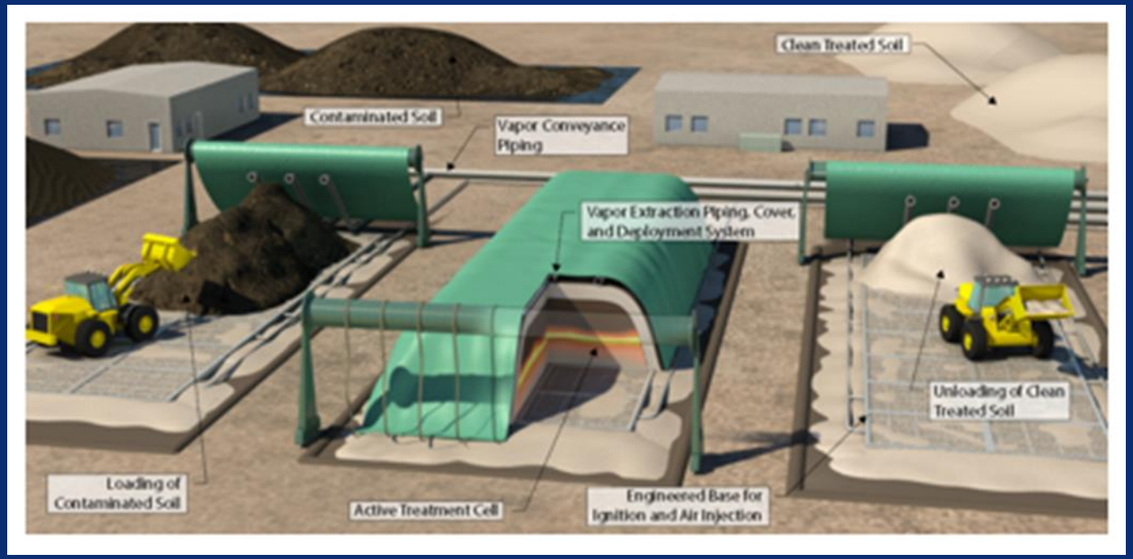
- Less costly than alternative thermal treatment technologies
  - For large volumes, costs ≤ “dig-and-haul” costs
  - Simultaneous treatment of sludge & impacted soil
- The process is robust:
  - Oil content of 1 to 20^{+}%
  - Can handle high water content
  - Relatively wide range of soil types
- Scalable
  - Large, centralized facilities
  - Mobile and portable systems
- On-site treatment
  - Reduce remediation Green House Gas (GHG) footprint
  - Minimize motor vehicle incidents (accident or spill)

Limitations:

- Batch process
- High fines content in solid matrix
- Emissions treatment
- Not intended for non-combustible materials (e.g. metals)

Thank You

Questions ?



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