



ADAPTIVE SITE MANAGEMENT
LESSONS LEARNED FROM REMEDY IMPLEMENTATION

ISS of Chlorinated/ Brominated DNAPL at a Park Development Site

BATTELLE CHLORINATED CONFERENCE 2024
DENVER, COLORADO

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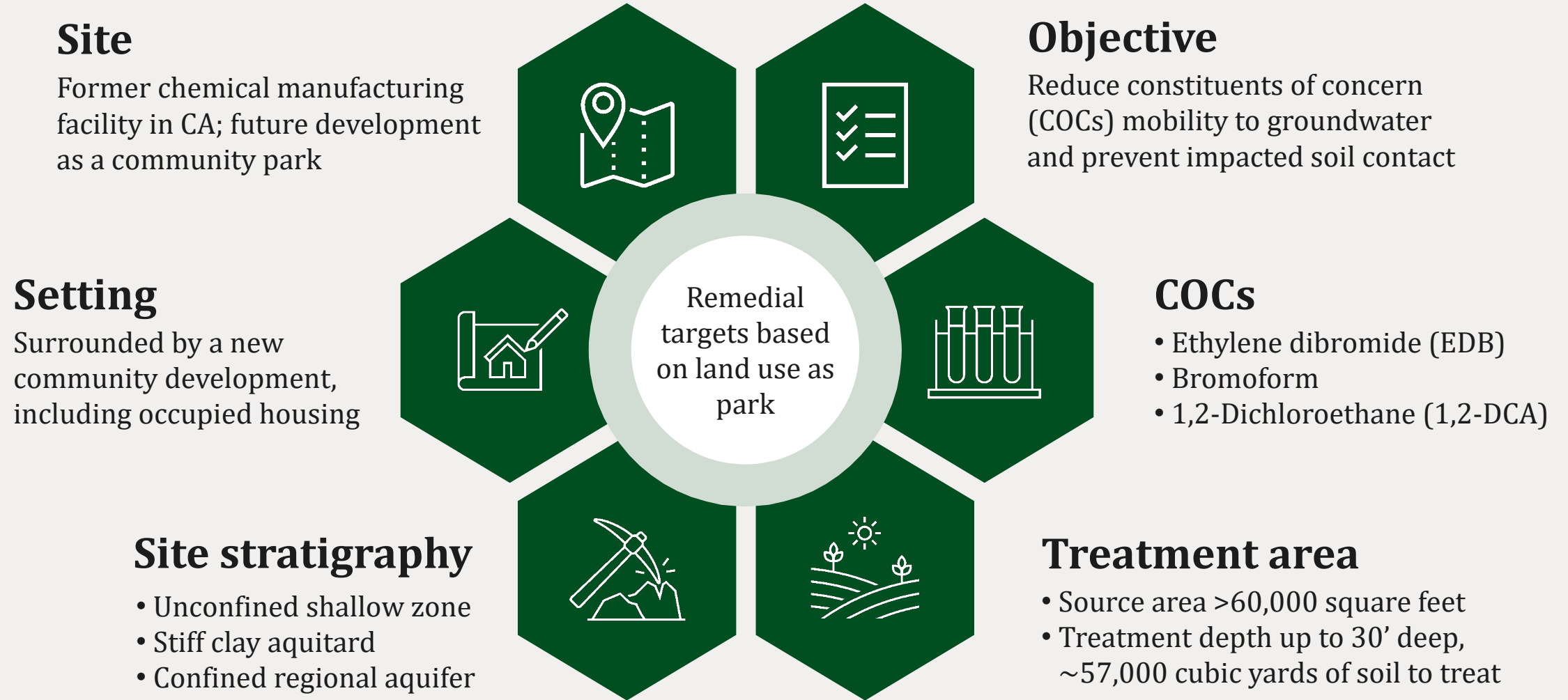
Agenda

- 1 Project background
- 2 ISS approach and activities
- 3 Challenges to overcome
- 4 Results and closing
- 5 Questions



1. Project background

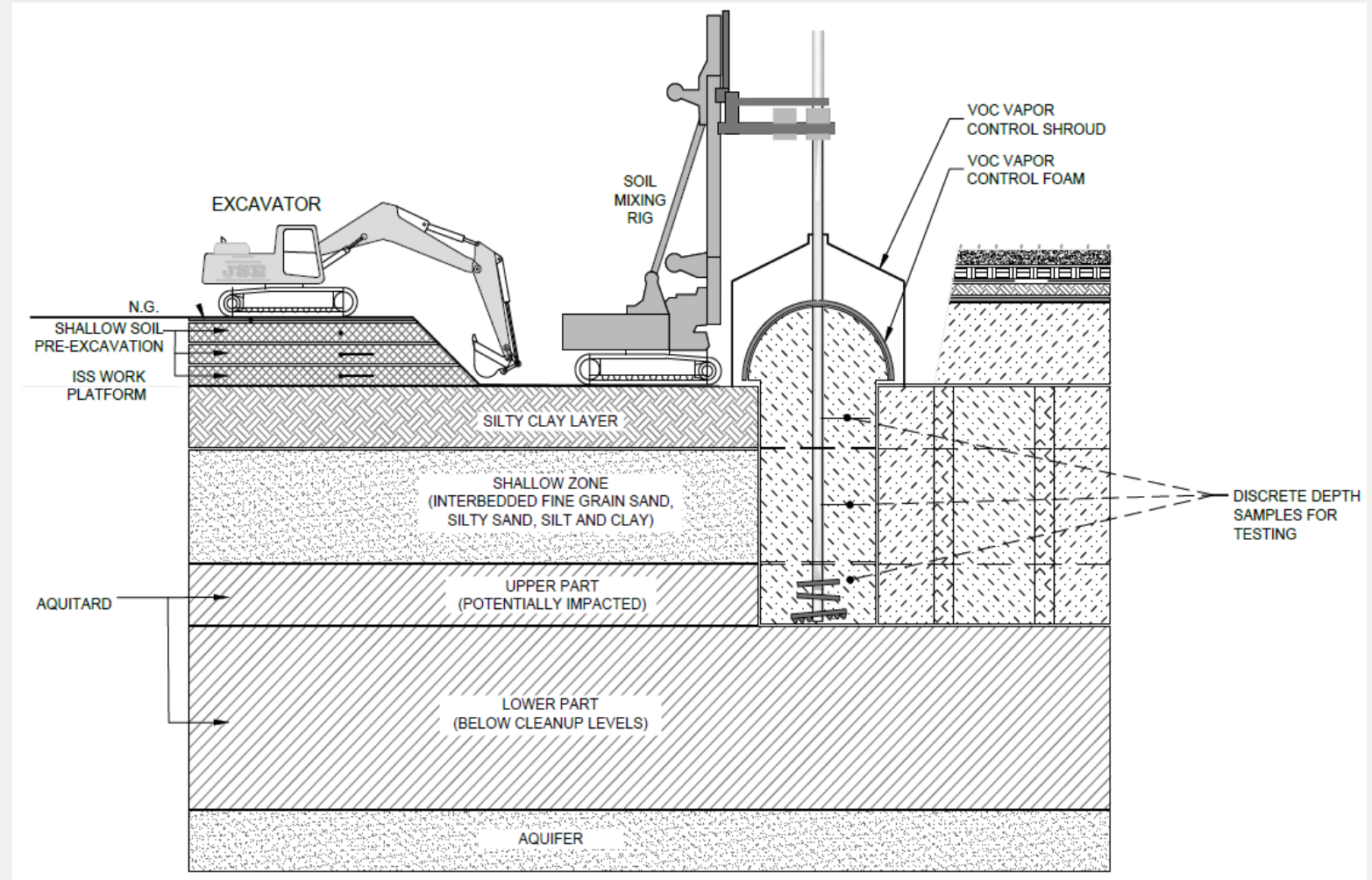
Existing conditions



Selected remedy: in situ stabilization/solidification (ISS)

ISS of impacted soil in project area

- Best overall fit to meet:
 - Site Remedial Objectives
 - Site Constraints
 - Sustainability and Community Impact
 - Worker and Offsite Receptor Safety
 - Future Land Use
 - Cost





2. ISS approach and activities

Deep soil mixing



Batch plant and reagents



Deep Soil Mixing (DSM)

Deep soil mixing

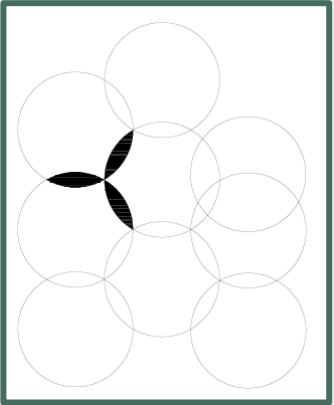


Onsite batch plant

DSM result



Cement soil mixture



Typical drill pattern

Sequence

Sequential activities:	Overburden soil removal	Soil ISS	Soil cap placement
	Excavate unimpacted overburden soil to: • Contain soil expansion (swell) • Create stockpile for cap • Allow for overhead clearance	Use DSM to solidify/stabilize soil	Place soil on top of ISS to prevent future exposure pathways
			



3. Challenges to overcome

Overview

Worker protection

- Volatile organic compounds (VOCs)
- Phased implementation
- Small work area
- Communication
- Summer factors



Technical

- Overhead clearance
- 30-foot depth and hard drilling
- Vapor collection shroud
- Tight schedule demands
- Maintaining drill rig working surface stability

Community

- Potential health risks (VOCs, odors, dust)
- Concentration limits
- Informing without alarming
- Regulatory requirements for public complaints
- Minimizing impacts (noise, traffic, appearance)

Challenges to overcome

Worker protection

Challenges

- VOCs in work area
 - EDB strict requirements
 - Other VOCs add challenges
- Phased implementation due to conflicting third-party project
- Small work area
- Communication: multiple crews, PPE, and loud equipment
- Summer implementation
 - Compressed schedule
 - Heat stress



Exclusion zone



Mechanical repairs



Approaching equipment



Articulating truck

Worker protection

Solutions (1/2)

EDB hazard analysis resulted in:

- Strict exclusion zone (EZ) and signage
- Level B supplied air
- Personal/work area sampling
- EDB-specific real-time monitoring

Manage work in small footprint:

- Frequent coordination of equipment, hoses (slurry, VOC, and supplied air), and ground personnel
- Clear Communication Protocol
- MCE Safety Procedures (operator practices; barriers; dedicated haul routes)



Breathing air filter



Communication planning



Level B supplied air

Worker protection

Solutions (2/2)

Compressed schedule and overlapping operations:

- Strategic sequencing, planning, and coordination to safely manage site operations
- Robust heat illness prevention program, including:
- Supervised worker rotation schedule
 - Physiological monitoring
 - Chilled supplied breathing air
 - Shade structure with evaporative cooler



Physiological Monitoring

Time	Sample Location	Temp (°C)	Humidity (%)	CO2 (ppm)	CO (ppm)	NO2 (ppm)	O3 (ppm)	SO2 (ppm)	PM10 (µg/m³)	PM2.5 (µg/m³)	Bound Level
17:04	North of Shovel on Access	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:10	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:15	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:20	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:25	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:30	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:35	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:40	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:45	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:50	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
17:55	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:00	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:05	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:10	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:15	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:20	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:25	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:30	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:35	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:40	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:45	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:50	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
18:55	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1
19:00	"	26.1	65	1000	0.0	0.0	0.0	0.0	1.0	0.5	1.1

Air monitoring



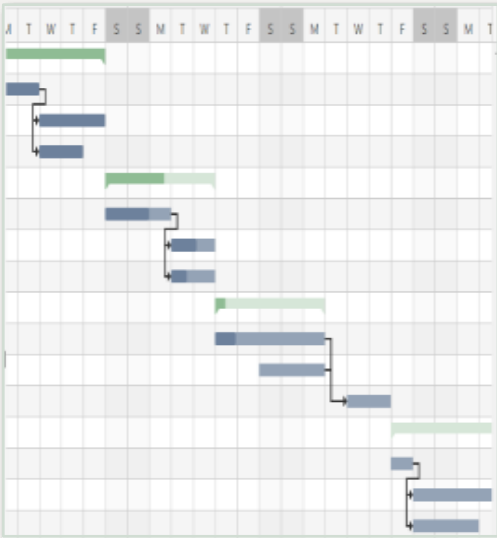
Level B PPE



Worker rotation



Breathing air

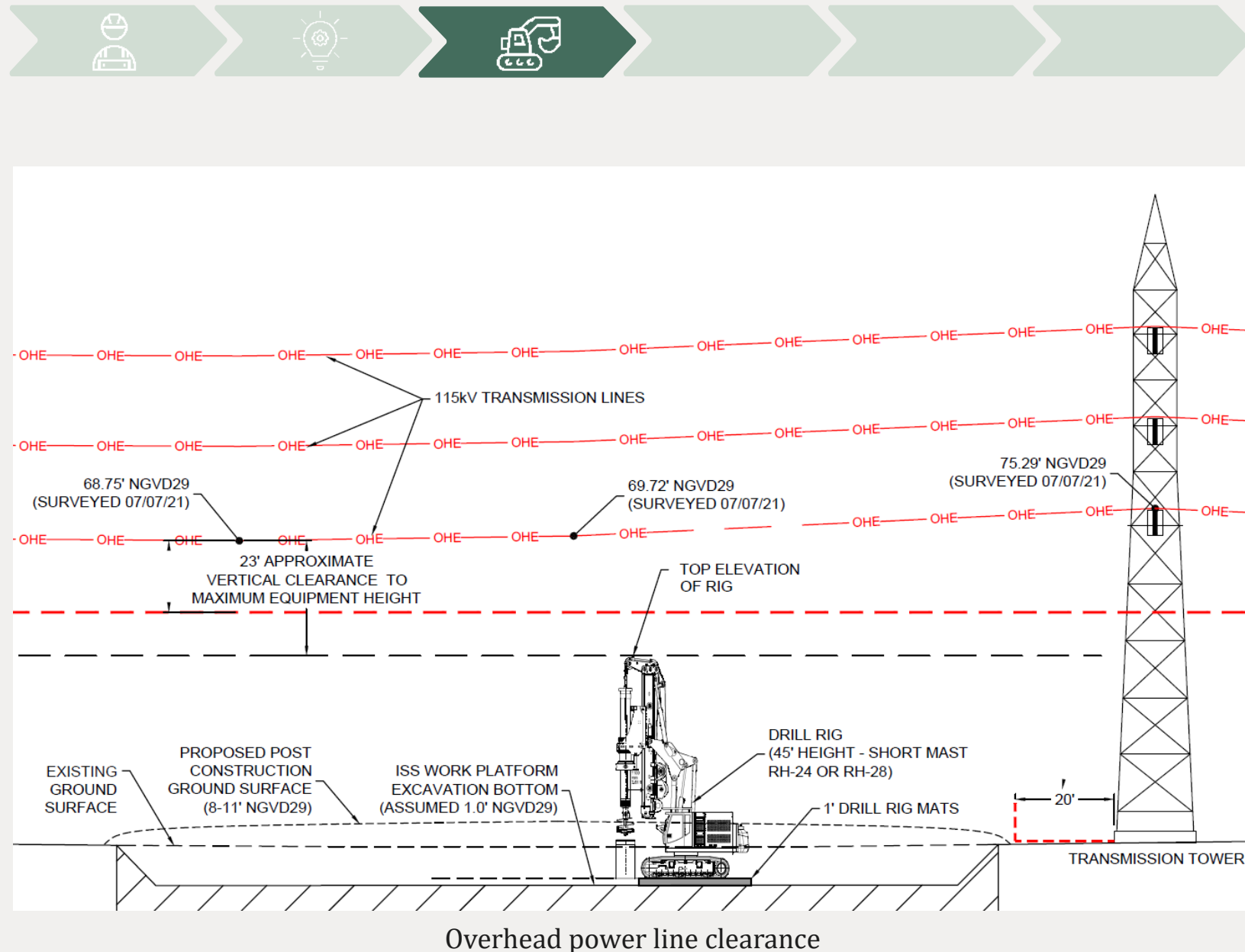


Scheduling

Technical

Challenges

- Clearance under high-voltage overhead power (OHP) lines
- Reach 30-foot deep and hard drilling
- Incorporate source vapor collection device
- Drill rig working surface must maintain stability
- Select optimal rig(s) to meet schedule demands & site constraints



Technical

Solutions (1/2)

Two custom configured DSM rigs used:

- A tracked crane with mounted Hain drill platform
- An excavator type drill rig with low OH clearance configuration

Ground conditions:

- Frequently adjusted mixing surface elevation
- Used crane mats, solidified DSM columns, and reagent slurry bucket mixing of surface soil to maintain rig stability



Solidifying surface soil



Excavator mounted shroud



Excavator type drill rig



Crane type drill rig

Technical

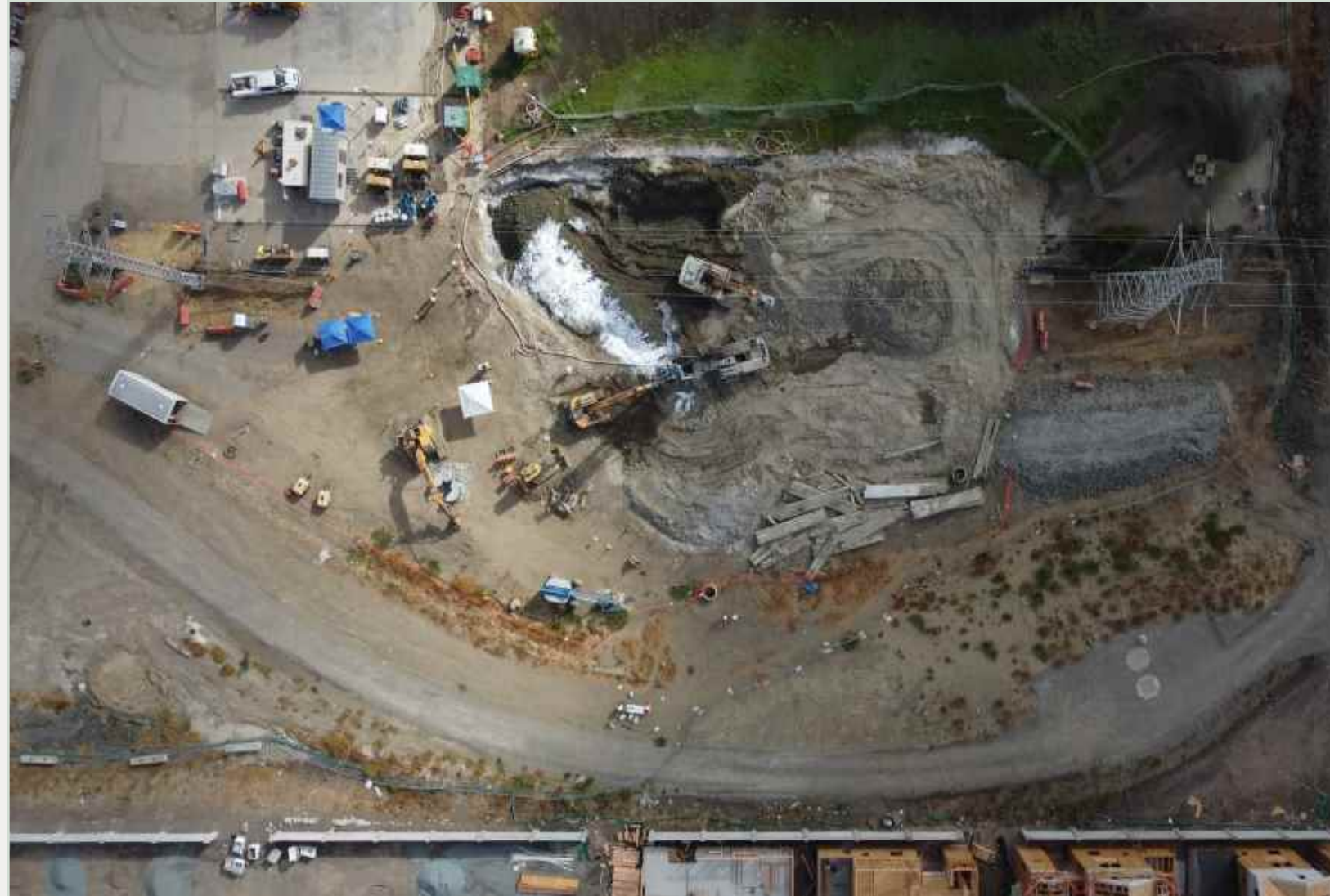
Solutions (2/2)



Crane mat use



Swell management



Work below OH power lines

Community

Challenges

- Remedial work emissions (e.g., VOCs, odors, dust) may pose health risk to nearby residents
- Strict fenceline emission limits
- Keeping surrounding communities informed of the work without causing alarm
- Complying with regulatory requirements for public complaints (maximum of one allowed)
- Minimizing impacts to the community from implementation operations (e.g., noise, traffic, visual appearance)



Community site map

Community

Solutions (1/4)

Source vapor controls during ISS mixing

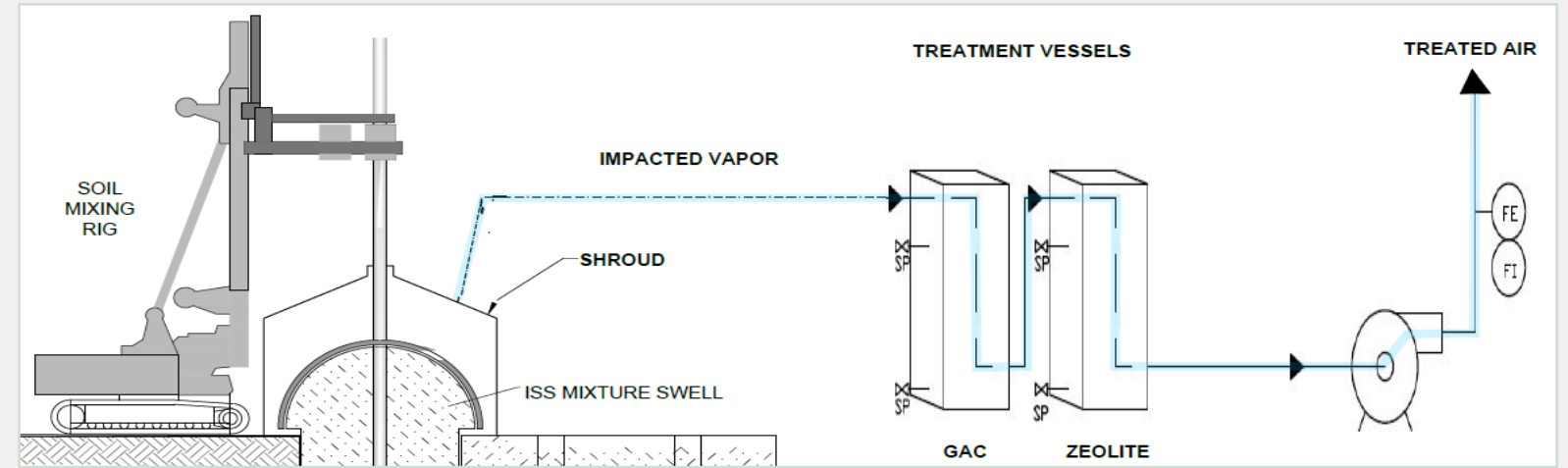
- Vapor collection shroud above ISS column
- Captured vapor treated before discharge
- Perimeter misting system with odor neutralizer



Clam shell style shroud



Misting system



Vapor collection process flow diagram



Shroud and hose



GAC and zeolite filters

Community

Solutions (2/4)

VOC controls for soil and swell

- Vapor suppressant foam
- Cellulose fiber spray
- Cement slurry cover
- Slurry excavation



Slurry excavation



Foam



Foam after ISS



Cellulose fiber spray



Reagent slurry cover

Community

Solutions (3/4)

Community outreach

- Performed a social risk assessment on the surrounding communities
- Developed stakeholder engagement plan

Community impact management

- Minimizing off haul and developing project-specific haul routes



Banner mock-up



Surrounding community

Community

Solutions (4/4)

Perimeter Monitoring/Sampling Program

- Establish air VOC & dust limits
- Daily air samples for VOCs and SVOCs
- Real-time monitoring to quickly identify trends and adjust work
- Weather stations



Power for AMS



Air Monitoring Station (AMS)



Portable GC



PID = 0



VOC sampling



4. Results and closing

Adaptive site management

Results

Regulatory approval

The project met all applicable cleanup criteria and was accepted by the lead regulatory agency.

Under budget

The project was completed under budget thanks to the extensive planning and field adjustments made throughout implementation.

Project emissions

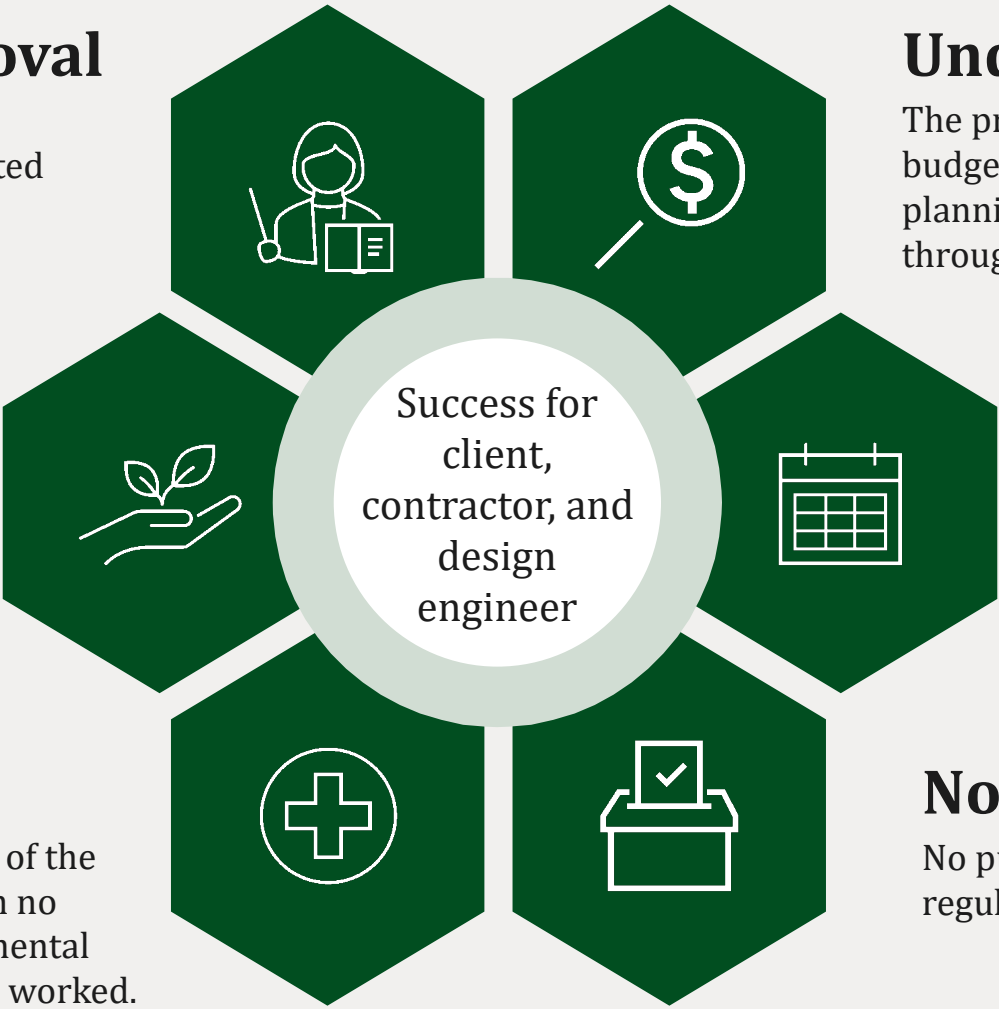
Fenceline sample concentrations were below the conservative targets set by the air monitoring program.

On schedule

Each phase of the project was completed on schedule and within regulatory time limits and seasonal constraints.

Zero recordable safety incidents

Despite the hazardous nature of the project, it was completed with no recordable safety or environmental incidents after 58,000+ hours worked.



No public complaints

No public complaints to project team or to regulatory agencies occurred.

Project results



Closing





5. Questions

ADAPTIVE SITE MANAGEMENT

Thank you

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