Achieving Site-Specific Remedial Goals for PHCs, PAHs, and VOCs through a Collaborative Multidisciplinary Approach

GeoTactical Remediation

RemTech 2023 Presentation
Denise Hourd- Kehewin Cree Nation
Gord Guest - Geo Tactical Remediation Ltd.

Kehewin Cree Nation #123

General Site Description

- KCN site contaminated due to UST's requiring removal

- Site is located on Kehewin Cree First Nation Reserve No. 123
  - Former gas station, currently inactive and unoccupied
  - Centrally located with several administrative facilities and schools located nearby.

Image of Area

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Environmental Work

- UST's had been installed in early 1990s
- Phase II ESA conducted after tank removal.
  - Tanks were pulled and 2 monitoring wells were installed in 2017
  - Detailed Phase II performed in 2020 and elevated LNAPL free phase found elevating site priority under FCSAP
- Hydrocarbon impacts were found in the soil and weathered bedrock:
  - BTEX's, PHC's and naphthalene were detected at concentrations above reference guidelines.

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Project Objective

- Main site objective for project was to advance the site in the Federal Contaminated Sites Action Plan:
  - Remediation of site to functional land use
  - Source removal and subsequent risk management

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GeoTactical Remediation

Geo Tactical Remediation Ltd.

Who we are

- Environmental service company
  - Speciality: In-situ injection remediation
- Based in Calgary, AB
- Service backed by science

What we do

- In Situ Injection Services
  - Permeation (Matrix) Injection
  - Fracture Injection
- 3D Tiltmeter Mapping
- Assist with developing in-situ remediation programs

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APEGA Permit Holder

WORKPLACE SAFETY COR CERTIFICATE OF RECOGNITION

ENERGY SAFETY CANADA

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Stakeholders

- **Client and Project Oversight** – Kehewin First Cree No. 123
- **Funding** – Indigenous Services Canada
- **Overall Project Management** – Bosgoed Project Consultants
- **Technical Project Management** – Associated Environmental Consultants
- **Injection Services** – Geo Tactical Remediation Ltd.
- **Thermal Services** - Nelson Environmental Remediation

- Site goals
  - CCME guidelines
  - Community engagement

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Community Business Engagement

- Local contractors
  - Personnel to assist with injection
  - Snow clearing
  - Fuel
  - Site cleanup
  - Security
  - Aided in sourcing additional community-based services

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Effective Collaboration

- Flexibility in site schedule and plan adjustments due to unexpected site conditions
- Close communication and transparency allowed for rapid site plan adjustments
  - E.g., adjustment in sampling event time to allow for clearer picture of amendment effectiveness.
- All stakeholders involved in significant site plan adjustments.
  - Allowed rapid implementation and reduced delays

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Technology Disciplines Applied

- Onsite ex-situ thermal desorption by Nelson for areas with free phase and small volume near surface contamination.

- In-situ bioremediation injections selected at depths greater than 2 metres (GTR) outside and under of free phase footprint.

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Why Bioremediation

- Bioremediation approach chosen for:
  - Contaminant type: BTEX, F1 and F2, naphthalene, MTBE…
  - HP highly reactive and limited longevity- geology concerns with clays
  - Alternate Oxidants: Residuals concern

- Bioamendments are safer to handle and provides longevity.
  - Safety aspect of site location and allowed for onsite local engagement (oxidant has significant training requirements)

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Bioremediation Amendments Injected

- PTS – Biostimulation package (nutrients)
- PTBac – Microbial bioaugmentation blend of aerobic and anaerobic microbes
- iPAC – Activated Carbon
  - Adsorption, enhanced biofilm production, increased residence time
- Sand proppant – Provide permeable pathways for multiple injections without the need to re-mobilize drilling equipment.

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Site Geology and Contaminants

- Geology
  - GW between 1.5-2m bgs
    - No GW gradient
  - Soils are primarily clay and silts with some layers of sand and gravel.
  - Silty clay shale bedrock in contaminated site are

- Contaminants
  - GW- BTEX, PHC fractions F1 and F2, naphthalene
  - MTBE
  - Soil- BTEX, PHC fraction F1, and naphthalene

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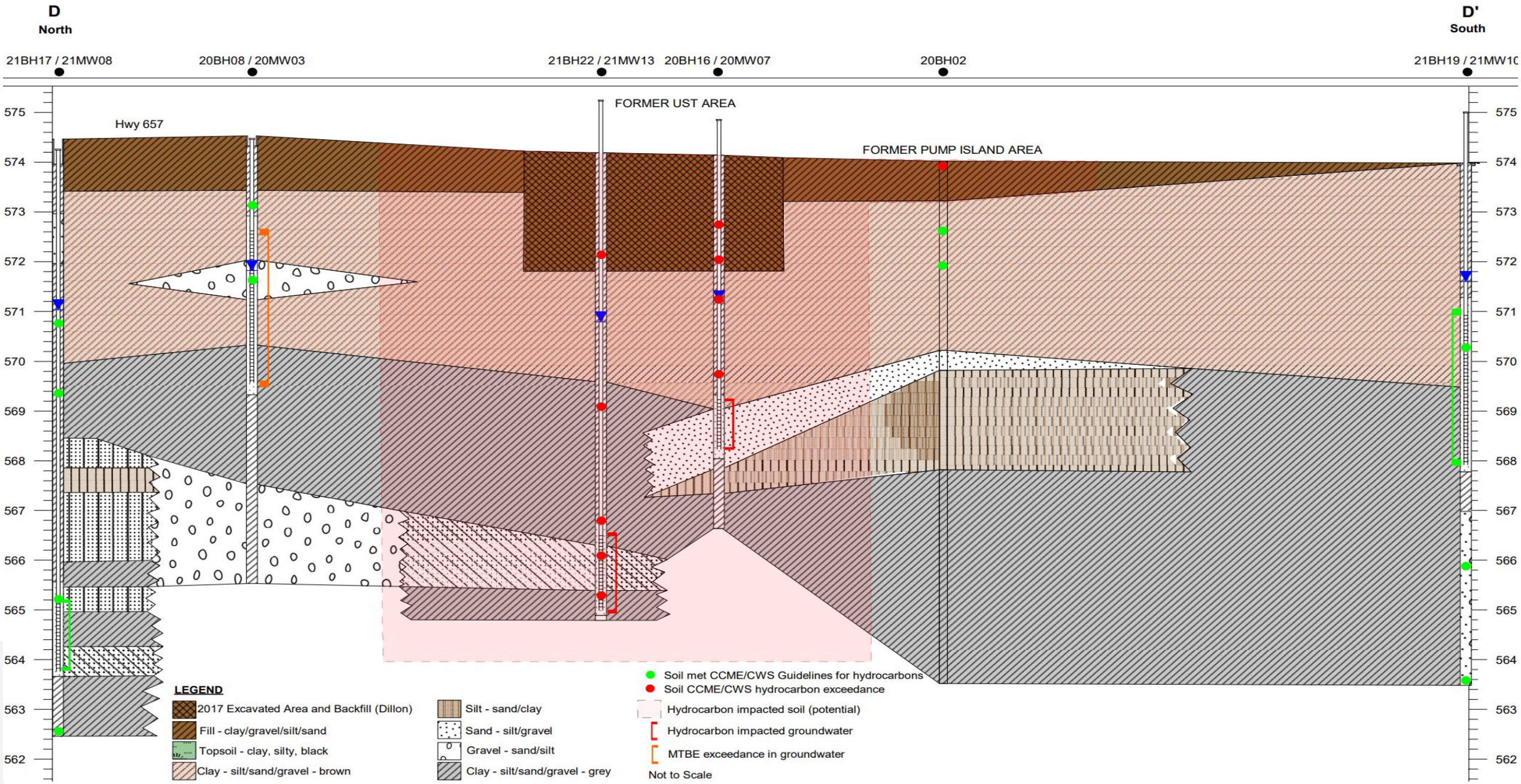
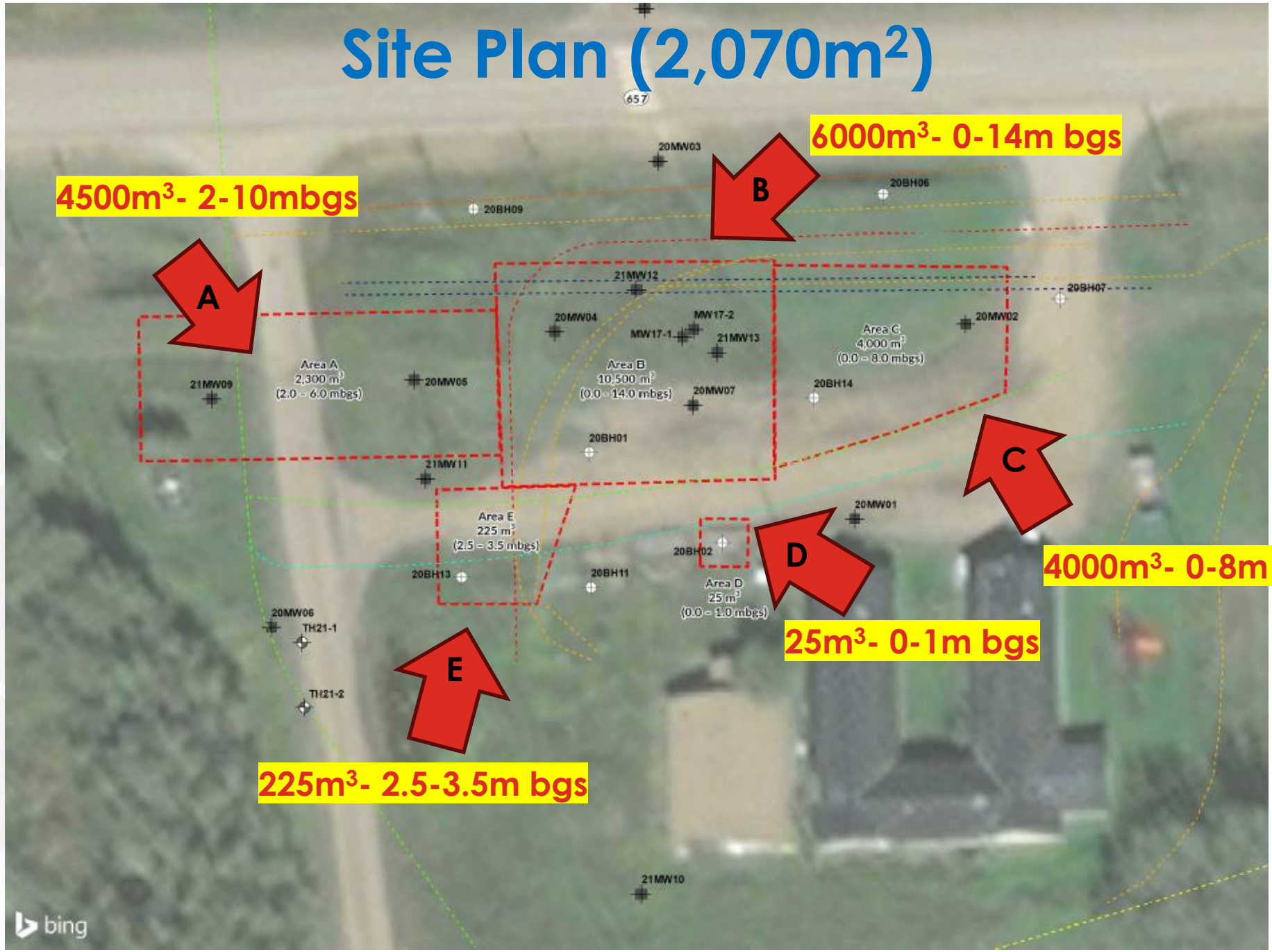
2020-8714.000

Figure B5

Associated Environmental



Site Plan (2,070m²)



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Injection: Modes of Emplacement

- Fracture Injection
  - Direct emplacement of remediation amendment
    - PTS, PTBac and iPAC
  - Sand propped fractures (Area B) – for multiple solution injections
    - iPAC included
- Permeation Injection into sand propped fractures (Area B)
    - PTS and PTBac

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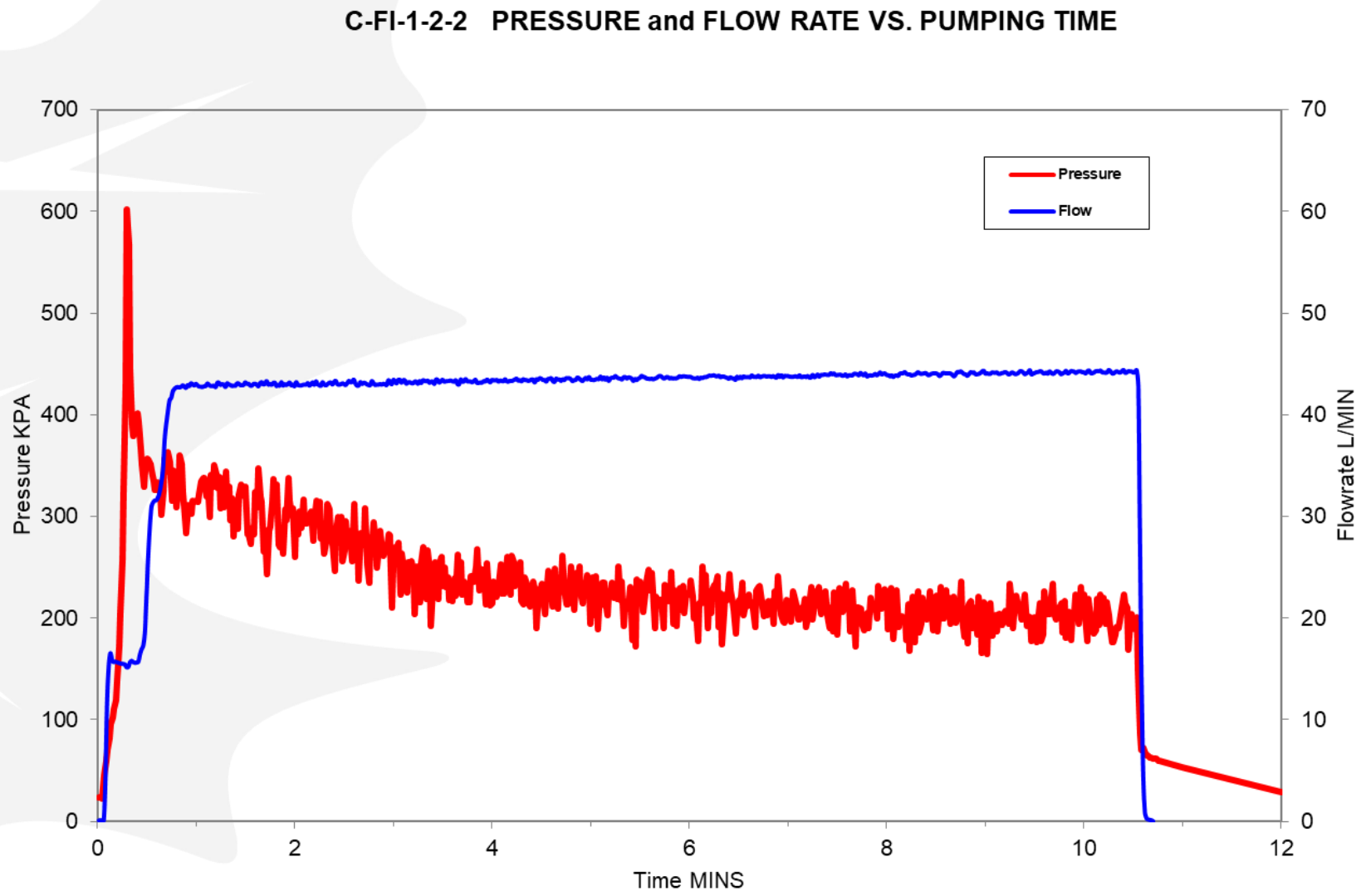
Pressure-Flow Rate – Time Plot of Fracture Injection



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Injection Summary

Injection Event, Area, Completion Date	Number of Injection Locations	Number of Injection Intervals	Number of Wells Injected	Total Injection Volume (m^3)	Total PTS Injected (kg)	Total PTBac Injected (kg)	Total iPAC Injected (kg)	Total Sand Injected (kg)
1 (All Areas), March 2022	72	352	20	229	11,170	128	10,995	59,575
2 (B &C) October 2022	22	111	2	51	5,125	27	1,020	NA
3 (B&C) August 2023	43	264	NA	108	2,335	66	4,710	NA
Total All Injections	**137**	**727**	**22**	**388**	**16,295**	**155**	**16,725**	**59,575**

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20BH06
20BH09
20BH07
20MW02
20MW01
20MW04
20MW05
20MW06
20MW07
21MW11
21MW12
21MW13
21MW10
MW17-1
MW17-2
20BH01
20BH02
20BH04
20BH11
20BH13
20BH14
A1S
A1D
A2S
A2D
A3S
A3D
A4S
A4D
A5S
A5D
A6S
A6D
A7S
A7D
A8D
A9S
A10S
A11S
A12S
A13S
A14S
A15S
Area A
2,300 m³
Area A location referenced to 20MW05 revised location
Area B
9,750 m³
Area B location referenced MW17-1 location
C1S
C2S
C3S
C4S
C1D
C2D
C3D
C8S
C5S
C6S
C7S
C7D
C4D
C6D
C13S
C9S
C12S
C5D
C10S
Area C
4,000 m³
Area C location referenced 20MW02 location
E1
E2
E3
E4
E5
Area E
225 m³
Area E location referenced to 21MW11 location
Area D
25 m³
Access Road
Area A - Approximate shallow iPAC slurry Injection locations
Area A - Approximate deep iPAC slurry injection locations
Area B - General approximate locations of the sand slury injection, step-offs, and deep injection well locations associated with [B]# location
Area B - Approximate shallow injection well locations
Area B - Approximate iPAC make-up boreholes
Area C - Approximate shallow iPAC slurry injection locations
Area C - Approximate deep iPAC slurry injection locations
Area E - Approximate iPAC slurry injection locations
20 MW05 Revised location based on measurments taken in field
0
10
20
30
40
Meters

Results after Second Injection Event

Area	Soil	GW
A	Below MCL after first injection event	Below MCL after first injection event
B	BTEX-reduction 40%-ND	BTEX reduction 40-99% Limited F2 reduction (longer timeframe treatment) MTBE- 70-90% reduction - 2 wells no significant impact
C	40-90% reduction shallower zone 90-99% reduction deeper zone	Benzene below guideline MTBE- 75% reduction
E	Below MCL after first injection event	Below MCL after first injection event

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Challenges Encountered

Challenge	Action
Coinciding projects- Lift station build occurring at the same time	Clear communication between all contractors and stakeholders to move forward with minimal delays
Surfacing in some parts of Area B and C.	Additional injection locations were used.
Sand propped fracture network less effective for permeation injection than expected due some surfacing and a high degree of interconnection.	Amendment injected with fracture injection was increased, particularly for Injection 2.
Unmarked, difficult to locate, and conflicting As Builts resulted in encountering unexpected utilities.	Injection 3 adjusted to accommodate amendment mass not used in Injection 2 and remaining mass of PTS used to treat open excavation.

Conclusion

- Collaboration is "KEY" for projects with multiple stakeholders
  - Clear and consistent communication important when project adjustments need to be made
- Injection services benefited from local engagement
- Multi-discipline approach to reach remediation and risk management goals

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Thank you to all partners!!

Merissa Knapton

Denise Hourd

Brent Schmidt

John Tucker

Bosgoed Project Consultants

Gary Bosgoed

Questions??

Contact information:
Denise Hourd- Kehewin Cree Nation – denise@kehewin.ca
Gord Guest- Geo Tactical Remediation – gguest@geotactical.ca
Brent Schmidt- AE – schmidtb@ae.ca