



**Dominion
Diamond Mines**



***Successful Bioremediation of Long
Chain Hydrocarbons in the Arctic***

2020 RemTech Presentation

October 15, 2020

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- Ekati mine operations History
- Explanation of Ekati challenges and environmental management
- Delta Remediation Overview
- BioLogix Bioremediation – Delta Remediation’s primary focus
- Discuss Bioremediation candidacy and applicable project types
- Discuss BioLogix application at Diamond Diamonds Ekati Mine
- Discuss results environmental and economic benefits
- Conclusions and questions



- Canada's first diamond mine, in operation since 1998
- Located 300 km NE of Yellowknife, NT (200 km south of Arctic Circle)
- Remote mine accessible by air and by winter road 2-3 months a year

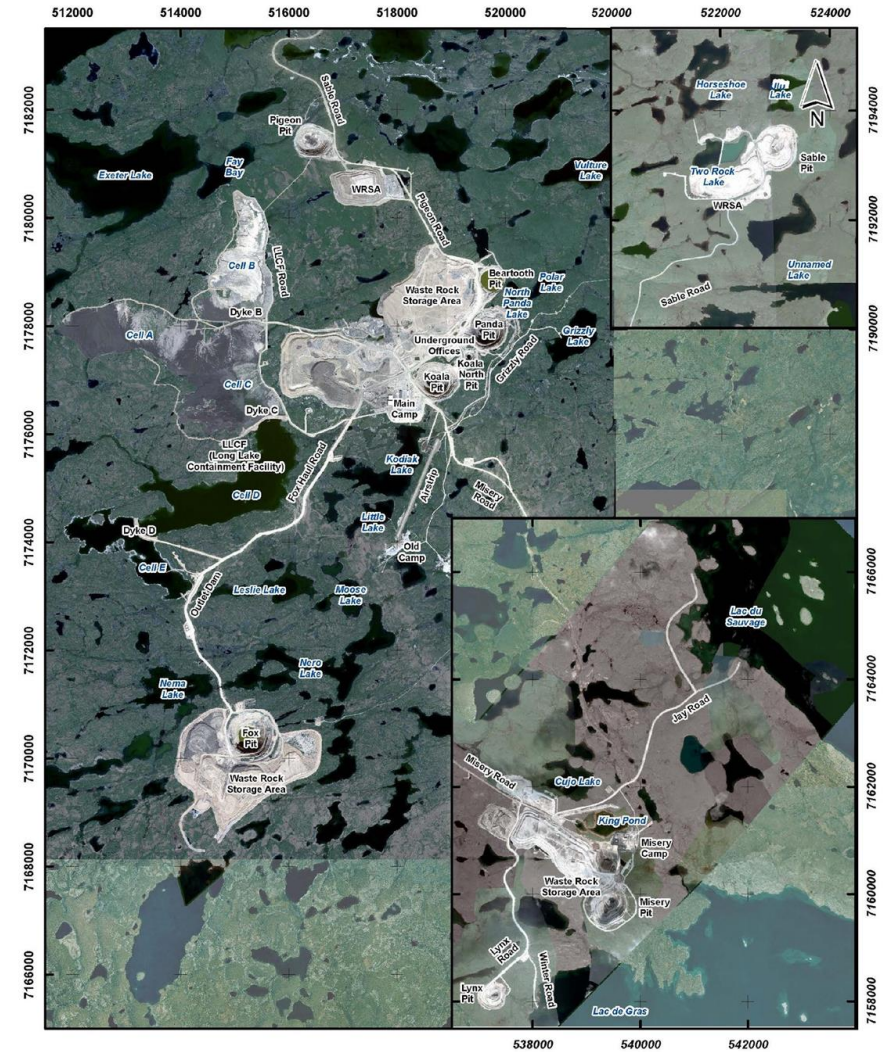


Tibbit to Contwoyto Winter Road

- Operated through a Joint Venture with the Diavik Diamond Mines Inc, Dominion Diamond Mines ULC, and De Beers Canada Inc.
- Total length of TCWR is > 600 km
- ~400 km of winter road to Ekati



- Original planned LOM was 1998-2013 (4 kimberlites, Panda, Koala, Misery, and Fox)
- Mine life just completing active kimberlites 2025 (Sable, Pigeon, Misery UG)
- Permitted Jay project pushes LOM to 2035
- 10 total kimberlites as of 2020
 - 3 Active
 - 1 Permitted and approved by WLWB
 - 6 Complete



- Designated location for remediation of contaminated materials
- Based on original LOM projections of 2013 closure
- Built to a capacity of 3400 m³
- Overcapacity causing the facility to functionally operate only as a containment facility
- Screener purchased to facilitate the bagging and removal of landfarm soils in 2017.



Ekati Landfarm, 2017

- Landfarm capacity issues and high costs of winter road utilization for contaminated soil disposal (\$464/m³) led to search for alternatives
- Potential solution: treating contaminated soils through microbial augmentation
- Initial trial of 1000 m³ treated with Biologix solution (2018) in partnership with Delta Remediation
- Naturally occurring microbes selected for ability to degrade hydrocarbons
- Potential to be cost effective remedial method to pass CCME Agricultural Guidelines



Biologix application in June, 2018

About Delta Remediation

- Completed hundreds of successful Bioremediation projects from the Arctic to Africa
- Background in civil earthworks and industrial recycling
- Vertically integrated remediation services & technology
 - *High degree of bioremediation technical understanding*
 - *Boots on the ground field and project management experience*
- BioLogix Bioremediation – Delta’s primary focus
- Innovation in progress
 - Delta Remediation Eco Binder – secondary circular economy technology
 - ScreenLogix Field Test Kit – advancing environmental assessment



Bioremediation (definition)

“The use of naturally occurring or deliberately introduced microorganisms or other forms of life to consume and break down environmental pollutants”

Bioremediation technologies fall into two categories:

1. Bio-Stimulation (trying to stimulate existing microbes)
1. Bio-Augmentation (introducing specific microbes)
 - BioLogix (pseudomonas bacteria) (archaea)



Bioremediation Opportunities in Canada

- DOW declassification
- Landfarm remediation
- Large volume projects
- Complex sites
- Remote sites
- Water treatment facilities
- Primary markets:
 - Oil and Gas
 - Mining
 - Brownfields



BioLogix Remediation (Proprietary Technology)



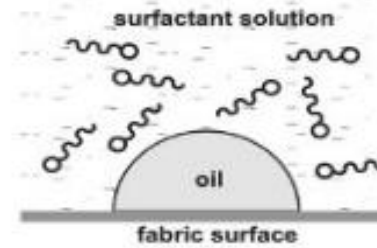
BioLogix Competitive Advantages

- Proprietary blend 6 Species of Pseudomonas bacteria
 - Worlds most effective degrading bacteria (3rd party publications)
- World renowned manufacturing facility
 - High levels of QA/QC
- Manufactured on Dextrose carrier Powder
 - High populations with less weight
 - Carbon Source for Inoculation
- Ability to customize the approach for site specific conditions
 - Addition of nutrients and surfactants where necessary
 - Ability to omit surfactants/nutrients when necessary
- BioLogix Inoculation process
 - Ability to maximize populations under controlled conditions



Chemistry

- Surfactants (Surface Active Agent)
 - Wetter water
 - Surface tension reduction
 - Release of sorbed contaminants
- Nutrients
 - Locally Sourced Nitrate (REDOX)

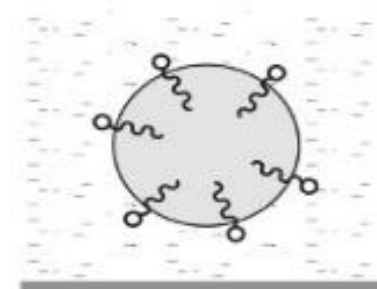


The surfactant contains molecules with hydrophilic and hydrophobic portions.

hydrophilic hydrophobic



Surfactant molecules are absorbed into the surface of the oil and so remove it from the fabric surface.



The surfactant molecules remain surrounding the oil once it has been removed, so helping to prevent its redeposition onto the cleaned surface.

Figure 2 Action of a surfactant.

BioLogix Optimal Conditions and Applicable Ranges

| Aspect | Optimal | Range |
|----------------------|---------------------------------|---|
| Temperature | 37 Celsius | 3-45 Celsius |
| Moisture | 15% – 20% | 3% - 40% |
| pH | 7 | 4.5-9.5 |
| Oxygen (groundwater) | Dependant upon type of molecule | N/A |
| Depth (Soils) | Ex Situ above Surface | 5 Meters BGS |
| Pressure | Atmospheric | Up to 2000 PSI |
| Nutrients | Site Specific (Cell Mass) | None available- upper limit not met yet |
| Soil Types | Coarse grain | Clay - Gravel |
| Metals tolerance | Solid metals ok | Metal dependant |
| Salinity tolerance | No salinity present | Up to 50,000 ppm |

Candidacy for Bioremediation

Site selection – the right tool for the right site

- 1) **Value** – Sites that are remote, or otherwise difficult to access will have a great value proposition
- 2) **Understood** – Sites that have been properly assessed and well understood are more applicable for any on site treatment
- 3) **Timing** – Due to the weather in Canada, Spring and Summer are the best times for doing bioremediation
- 4) **Ecoscape** – PH / DO / ORP / Organics / Soil Grain etc...



Ex Situ Application Methods

Ex Situ (excavating and treating)

- On site soil mixing
- Landfarming / disking
- Allu bucket
- Screeners
- Windrow turners
- Soil remediation machine



In Situ Application Methods

In Situ (treating in place)

- High/low pressure broadcasting
- Holding/floc tanks
- Drill and saturate
- High/low pressure direct injection
- Hydraulic fracturing



Dominion Diamonds Ekati Landfarm Bioremediation

Equipment

- 270 excavator
- 5 yard wheel loader
- 312 Finlay Hydrascreen
- Tanks Pumps Hoses



Personell

- Local/indigenous operators x3
- Labor x 1
- Supervision x 2
- Summer student x 1



Treatment Methods Used



2019 Landfarm Bioremediation Results

| Sample ID | Sample Date | Parameter Concentration (mg/kg or ppm) | | | | | | | |
|--|-------------|--|---------|--------------|---------|--|--|--|---------------------------|
| | | Benzene | Toluene | Ethylbenzene | Xylenes | F1 (C ₆ -C ₁₀) | F2 (>C ₁₀ -C ₁₆) | F3 (>C ₁₆ -C ₃₄) | F4 (>C ₃₄) |
| CCME SQG and CWS Agricultural Surface Soil Guideline (Coarse Texture) | | 25* | 75* | 55* | 95* | 210** | 150** | 300** | 2,800** |
| CCME SQG and CWS Agricultural Subsoil Guideline (Coarse Texture) | | 62* | 150* | 110* | 190* | 700** | 1,000** | 2,500** | 10,000** |
| LF-2019-1 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 69 | 1870 | 505 |
| LF-2019-2 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 53 | 1630 | 446 |
| LF-2019-3 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 50 | 1670 | 444 |
| LF-2019-4 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 57 | 1770 | 466 |
| LF-2019-5 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 83 | 1860 | 494 |
| LF-2019-6 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 83 | 1880 | 496 |
| LF-2019-7 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 78 | 1860 | 497 |
| LF-2019-8 | 05-Sep-19 | <0.0050 | <0.014 | <0.015 | <0.071 | <10 | 62 | 1820 | 485 |

Notes:

- *CCME SQG = Canadian Soil Quality Guidelines for the Protection of Environmental and Human Health for agricultural land use, coarse grained soil.
- **CCME CWS = Tier 1 Canada Wide Standards for Petroleum Hydrocarbons (PHC) in Soil (2001, updated June 2012) for agricultural land use, coarse-grained

- 2018 Landfarm samples did not pass CCME Agricultural Guidelines (F3 exceedances)
- Microbes degraded trial windrow further and 2019 samples pass CCME Agricultural Subsoil Guidelines (2019)
- 1000 m³ removed from the landfarm (utilized below 1.5 m of cover)
- Bioremediated material used to cap waste within the landfill – **no need to haul offsite**



Landfarm Trial Windrow Passing CCME Agricultural Subsoil Guidelines

Days on site 6

BioLogix treatment days 4

Oversize materials 400 m³ (approx.)

Total treated volume 1000 m³ (approx.)

Total client savings \$194,000 (\$194/m³)

Greenhouse Gas Reduction 69,888 KG



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