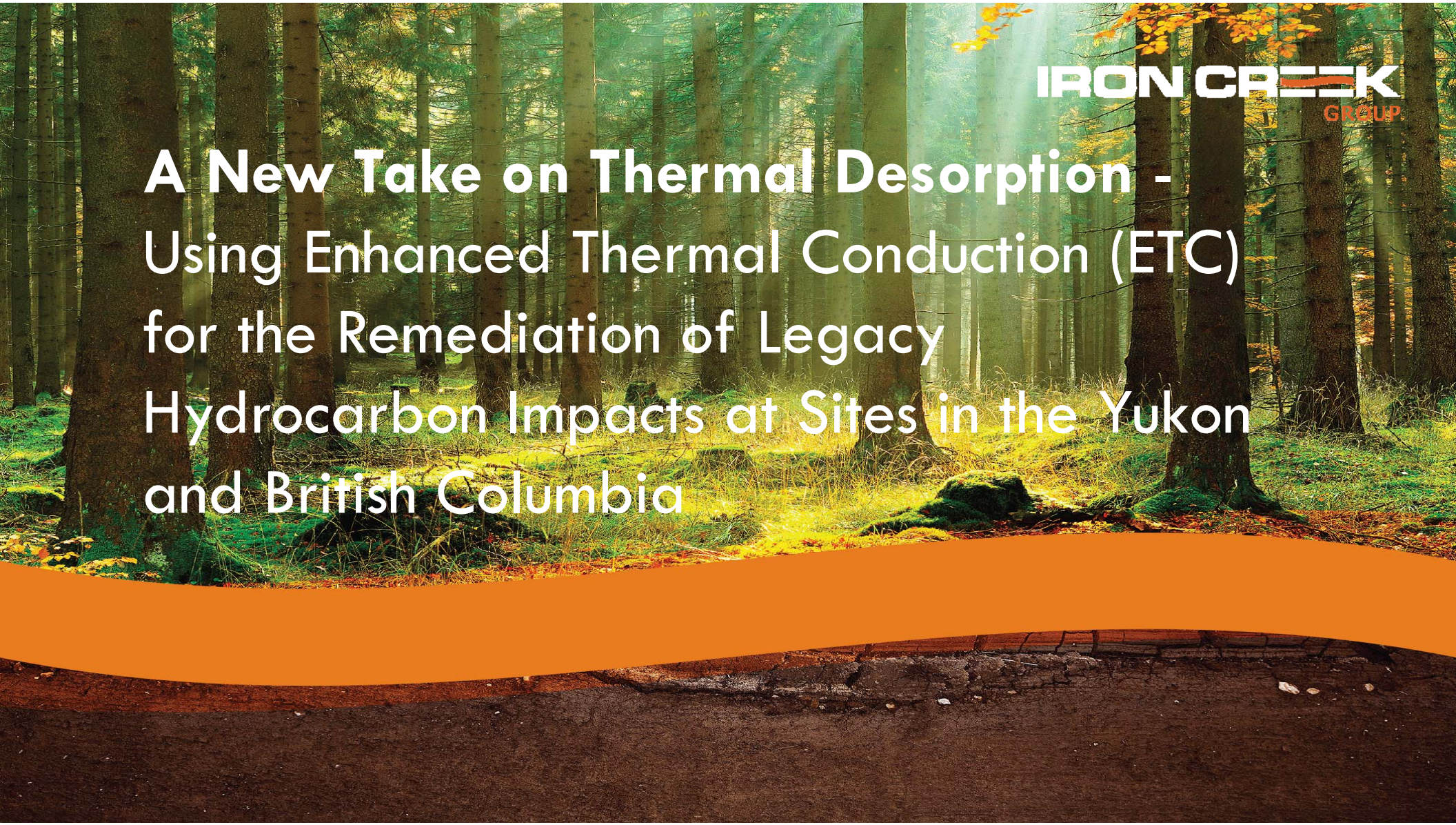


A New Take on Thermal Desorption - Using Enhanced Thermal Conduction (ETC) for the Remediation of Legacy Hydrocarbon Impacts at Sites in the Yukon and British Columbia

What is Enhanced Thermal Conduction (ETC) Technology?

- A thermal desorption batch process where impacted soils are treated ex-situ, in enclosed treatment cells;
- ETC infrastructure is incorporated into the treatment cells and multi fuel burners are utilized to heat the soil via conduction;
- As soil temperature increases, impacts are volatilized from the soil and collected under negative air pressure;
- Vaporized soil impacts can then be destroyed when they pass through a Thermal Oxidizer or condensed and recovered utilizing a quench;

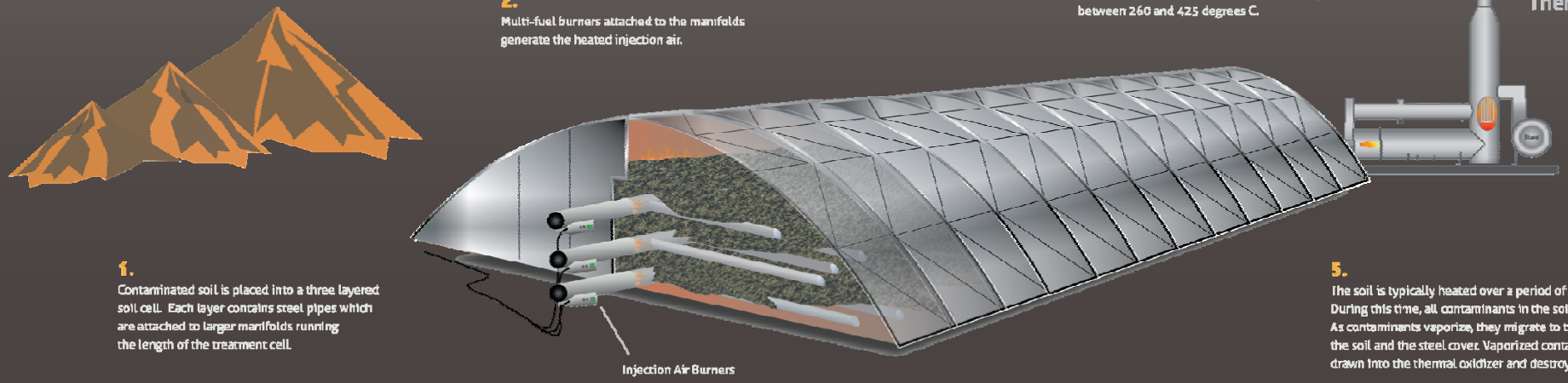
IRON CREEK GROUP

3.
A stainless steel Quonset Hut is assembled over the entire soil cell to prevent the escape of air during the soil treatment process.

4.
Heat is transferred from the pipes to the soil via conduction and the soil is heated to temperatures between 260 and 425 degrees C.

Thermal Oxidizer

2.
Multi-fuel burners attached to the manifolds generate the heated injection air.



1.
Contaminated soil is placed into a three layered soil cell. Each layer contains steel pipes which are attached to larger manifolds running the length of the treatment cell.

5.
The soil is typically heated over a period of 4 to 12 days. During this time, all contaminants in the soil will vaporize. As contaminants vaporize, they migrate to the space between the soil and the steel cover. Vaporized contaminants are drawn into the thermal oxidizer and destroyed.

SIDE VIEW OF BURNERS ATTACHED TO CELL

FRONT VIEW OF ASSEMBLED SOIL CELL

MULTI-FUEL BURNERS

THERMAL OXIDIZER

MULTIPLE CELLS RUNNING

800 CUBIC METER CELL

Location #1 – Yukon Territory

- Former mineral exploration site from the 1960's;
- Extremely remote and accessible only by air;
- Located in mountainous terrain along the Snake River, approximately 100 km south of the Arctic Circle;
- Unimproved 1,100' backcountry airstrip;
- Minimal infrastructure available at site.

Yukon Site Details

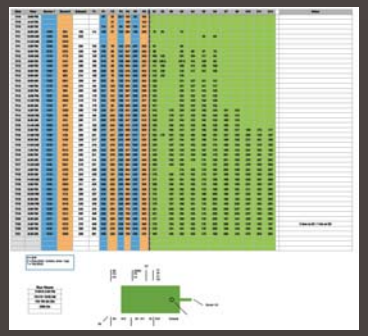
- Historical diesel storage tank release of unknown volume;
- Approximately 2,000 tonne of diesel impacted soil;
- Diesel Range Organics with concentrations up to 22,000 mg/kg;
- BTEX, $LEPH_{10-19}$ and $HEPH_{19-32}$ exceeding Yukon CSR guidelines;
- Soils ranging from gravel to tight clay with high moisture content.

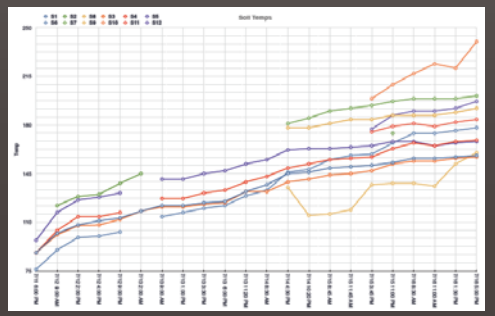
Custom ETC Solution Was Developed

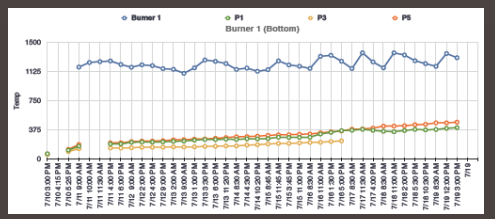
- ETC equipment was designed to be hand loaded onto a de Havilland Twin Otter aircraft;
- Treatment cell sizes were modified in order to reduce overall gear requirements;
- LPG (Propane) supplied from multi-tank arrays was used as burner fuel;
- Portable cell covers constructed of heat resistant silicone cloth and rolled sheet metal were utilized.

ETC Monitoring

- Real time monitoring was utilized to manage remediation parameters & treatment duration;
- LAN was setup to allow 24 hour remote monitoring.







Yukon Site - Treatment Results

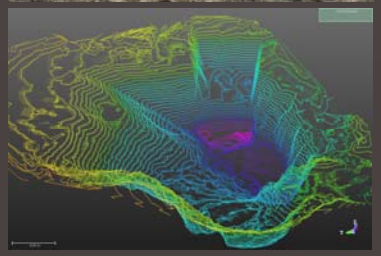
- Treatment was successfully completed within four weeks using two ETC cells;
- Post treatment soil analysis confirmed all samples met the Yukon CSR guidelines for hydrocarbons with the majority of the samples approaching detection limits;
- Soil treatment was able to continue through extended periods of severe weather and heavy rain;
- Contaminated site liability was removed from the client's inventory and closure was achieved at the site.

Location #2 – Northeastern British Columbia

- Legacy oil & gas location with multiple hydrocarbon impacted areas on site;
- Located in the Jedney gas field, approximately 175 kilometers northwest of Fort St John, BC;
- Site is accessed from the Alaska Highway via a network of resource roads;
- Abandoned location and the surrounding land use is forested public land.

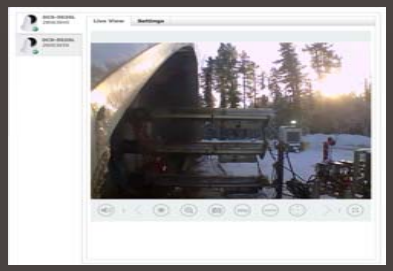
NE British Columbia – Site Details

- Approximately 22,000 tonne of impacted soil at the site;
- Impacts consisted of BTEX parameters as well as with VPH_{6-10} (Volatile Petroleum Hydrocarbons) and $LEPH_{10-19}$ (Light Extractable Petroleum Hydrocarbons) all exceeding provincial Contaminated Sites Criteria;
- Site impacts a result of historical operations and cumulative spill events.



ETC Process Description

- Impacted soil was excavated and placed into +/- 850 m^3 ETC treatment cells;
- LPG (Propane) was used for burner fuel;
- Treatment cell turnaround times ranged from 4-6 days, per cell;
- Alternate cell was constructed while treatment was underway on primary cell;
- Around the clock remote temperature and video monitoring provided data to ensure treatment goals were achieved.



Site Layout

Treatment Results

- Approximately 22,000 tonne of hydrocarbon impacted soil was treated with the ETC process;
- All post-treatment samples analyzed were below these standards for each sampling event during the entire project;
- Treatment commenced in the rainy season of June and ran into the extreme cold of January;
- Time to complete treatment was approximately 6 months.

Benefits of ETC Remediation

- Cost effective thermal treatment;
- Effective with persistent and difficult to treat waste matrices;
- Logistics simplicity;
- Scalability – Process can be just as effective for unique remote applications or larger scale, high throughput requirements.
- All weather capability;

Benefits of ETC Remediation (continued…)

- Zero reject, no matter the soil type or moisture content;
- Significantly reduced safety exposure (no rotating equipment – screeners, drums, conveyors, etc.);
- Eliminates liability and provides a guaranteed endpoint within a predictable time window;
- Post treatment hydrocarbon endpoints are typically below (100 ppm TPH) and often below laboratory detection limits.

Questions