TIBBITT TO CONTWOYTO

WINTER ROAD SPILL REMEDIATION

150KM NORTH OF YELLOWKNIFE, NT

As part of the role as lead consultant on the Tibbitt to Contwoyto Winter Road, EBA, a Tetra Tech Company, provided environmental engineering services during the assessment and remediation of the diesel spill (about 14,000 litres in Mar 2008) on Portage 32. The spill site is located along the primary winter road serving Canada's largest diamond mines and other operators.

EBA led soil excavation activities at the spill site to remove visually impacted soil prior to spring thaw. Approximately 9,700 L of diesel remained unaccounted for and assumed to remain on-site. No free-product was found but the local groundwater was found to be impacted. The lake water was not impacted. More delineation and monitoring was conducted and oxygen release compound (ORC) was added in the wells where hydrocarbons were detected.

In the summer of 2011, EBA conducted two groundwater sampling events. These tests were performed at the site in order to determine the feasibility of Natural Attenuation and to provide additional details that would assist in the design of a proactive remediation system in this challenging environment.

eba
A TETRA TECH COMPANY

Maxxam

Arctic West Adjusters Ltd.
Serving the NWT, Nunavut & Yukon for over 30 years

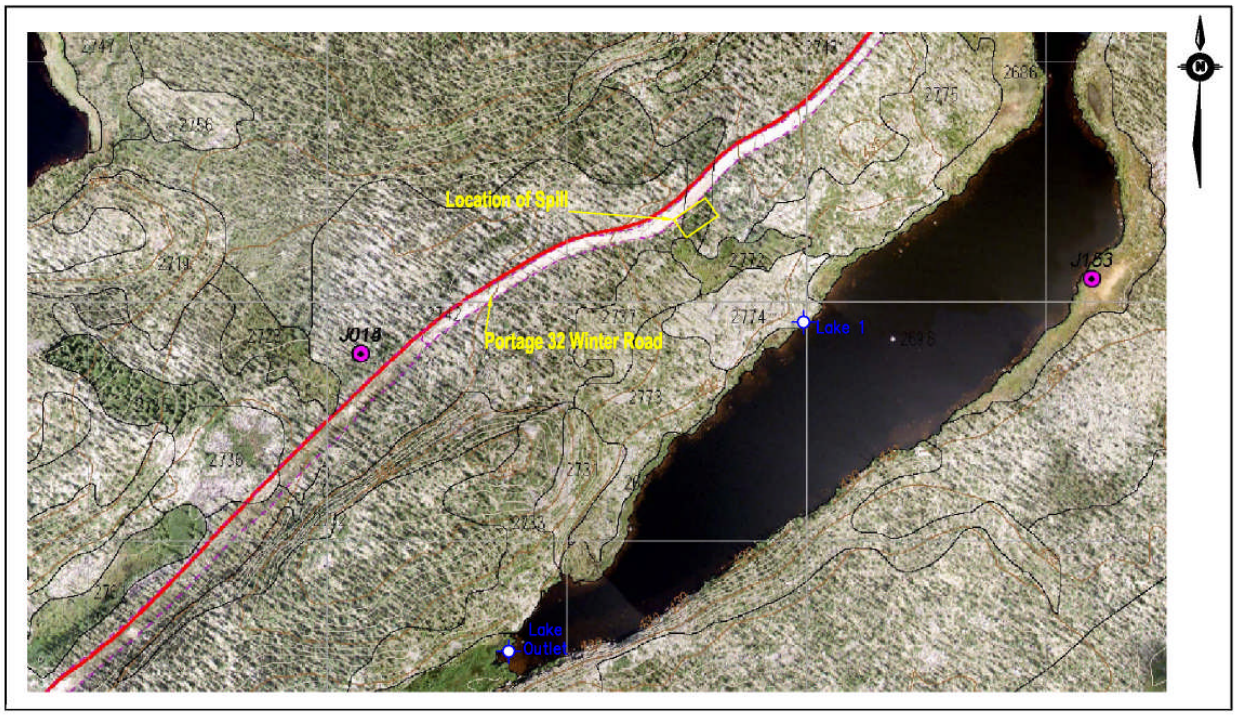
TIBBITT TO CONTWOYTO
WINTER ROAD JOINT VENTURE

2012 Canadian Consulting Engineers Award Submission

Support Team: Maxxam | Arctic West Adjusters Ltd. Serving the NWT, Nunavut & Yukon for over 30 years | Tibbitt to Contwoyto Winter Road Joint Venture

Environmental Cleanup of a Fuel Spill on Ice Road

150 km North of Yellowknife, Northwest Territories



LEGEND
Winter Road Route
Index Contour (5 m)
Intermediate Contour (1 m)
Sample Location

NOTES
Background image from *Tibbitt to Contwoyto Winter Road Biophysical Mapping*

TABLE OF CONTENTS

1.0 PROJECT BACKGROUND

The Tibbett to Contwoyto Winter Road is the world's longest heavy haul ice road, stretching some 600 km northeast from Yellowknife to the Lupin Gold Mine, situated at Contwoyto Lake just across the border between Northwest Territories and Nunavut. Some 87% of the road is over lake ice.

The road, made famous by the "Ice Road Truckers" program on the Discovery Channel, was originally developed 30 years ago to re-supply the Lupin Gold Mine. For three short months of each winter, from January to the end of March, thousands of heavy haul trucks, including thousands of "B" Train fuel trucks, transport supplies to four diamond mines, three of them fully operational. The winter road is a vital fuel and equipment re-supply link to these mines, without which they could not operate.

Road owner and operator, *Tibbett to Contwoyto Winter Road Joint Venture (JV)* is a joint venture of three of the four diamond mines. The road itself is constructed each winter and safety is of paramount importance. It is 50 m wide over lakes and 12-15 m wide on portages on land. The ice thickness must reach more than 107 cm by the time fully loaded trucks are permitted to begin hauling material to the mines.

Site access was a challenge

The Joint Venture stresses safety at every turn. Approximately 2.5 million of freight and fuel were hauled in more than 74,000 truckloads between 2001 and 2011. In 2007, the road's busiest year, almost 11,000 truckloads were hauled along the winter road with only nine minor incidents, including one minor injury. Speed limits and truck spacing are strictly enforced to prevent wave propagation, and unsafe driving is not tolerated.

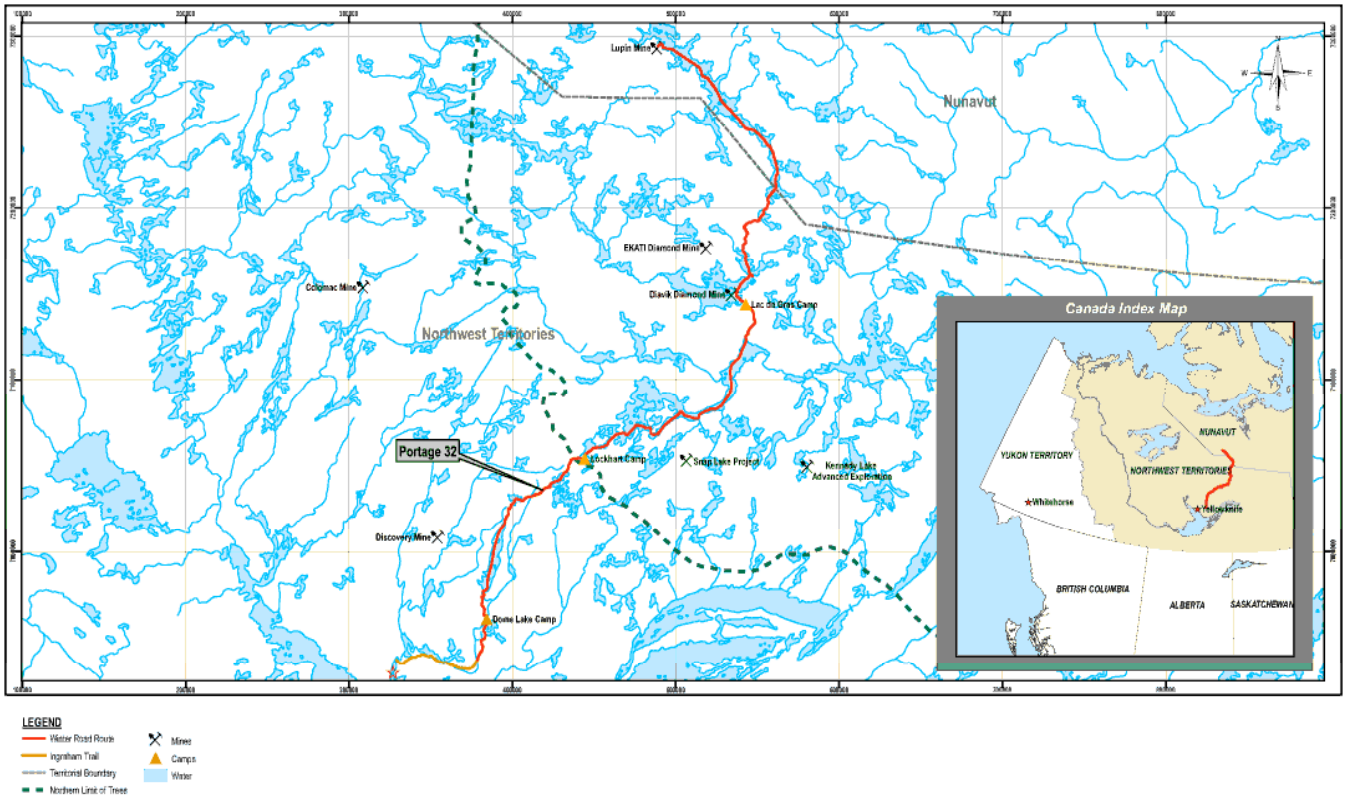
But occasionally, even the safest of drivers can have trouble on the winter road, which is not an easy drive. On March 9, 2008, a fuel truck went off the road along Portage 32, spilling 14,000 litres of diesel. EBA Engineering Consultants Ltd. (EBA) was retained by the Joint Venture to provide environmental engineering services during the assessment and subsequent remediation of the spill as part of the spill response plan.

Portage 32 is located approximately 150 km northeast of Yellowknife and is accessible by land only during the winter road operating season and by air otherwise. The remote site and difficult logistics made the detailed

assessment and subsequent remediation very challenging.

Adding to the challenge, the spill occurred near a lake southeast of the portage road. The spill was situated in a topographic bowl where the surrounding areas to the north, east and west are hydrogeologically up-gradient. The natural drainage is to the southeast, towards the lake that is down-gradient from the spill, thereby making it possible that released fuel could migrate along the same route as the natural drainage course or travel through the shallow groundwater system and above the permafrost.

The surficial geology of the immediate surrounding area comprises a combination of weathered fractured bed outcroppings, boulders and organic soils. Initial clean-up excavations encountered boulders and bedrock within the uppermost 1 to 1.5 m. Soil thickness varies from zero to about 1.5 m, depending on topography. Low-lying areas of the site tend to exhibit a thicker soil layer with varied vegetation.



A Land Use Inspector from Aboriginal Affairs and Northern Development Canada (AANDC) was present following the spill to document and report the incident. Environmental response crews, retained by the Joint Venture, handled the initial emergency spill response under EBA supervision. An estimated 3,000 litres of fuel was collected and removed during the initial response.

Spill area and lake close by

In addition to the spill clean-up, site monitoring and remediation has taken place every summer since the spill occurred. The project will likely continue for a number of years to come until all evidence of the diesel is gone and the site reclaimed.

2.0 PROJECT CHALLENGES

There were several major challenges to overcome to a successful completion of this project:

Complexities

- **Site access** - the winter road was used for site access for most supplies and equipment. For example, a heli-portable drill rig was not used, but instead a drill rig was hauled to site over the winter road to be used;

- Properly managed **logistics** and project planning were critical to project success. Yellowknife, the source of supplies and equipment, is 150 km from site;
- Availability of **proper equipment** was extremely limited due to the remoteness of the location;
- The presence of **potentially aggressive wildlife** such as bears was considered a safety risk for the crew;
- The **long winter season**, with most of it in almost 24-hour darkness and with extremely cold temperatures, and a short and bug-infested summer season made fieldwork more difficult;
- The **terrain** was sloped towards the lake, making it a potential receptor that required additional precautions; and
- **Difficult progress** as clean-up and reclamation has taken four years to date in a very sensitive environment, and could take several more years.

3.0 INITIAL FIELD ACTIVITIES

Availability of proper equipment was limited in this remote location

EBA conducted an initial environmental assessment to assess the diesel impacts at the site, and to implement interim remedial measures (as required) to mitigate immediate environmental issues. EBA coordinated soil excavation activities at the spill site with the contractor hired by the Joint Venture, and supervised removal of apparently impacted soil and snow prior to the spring thaw.

Excavation of the most highly impacted soil was conducted over an area of approximately 10 m by 5 m by 1 m deep where the truck rollover occurred, at which point excavation activities were halted due to frozen ground conditions, boulders and/or bedrock. Laboratory analytical results revealed that boundaries of the excavation had petroleum hydrocarbon concentrations greater than regulatory guidelines for soil quality, indicating that the diesel spill impact area was beyond the initially excavated area.

Based on the mass of soil excavated and an average hydrocarbon concentration (22,000 mg/kg), it was estimated that as much as 3,300 L of diesel were removed along with the excavated soil. It was estimated that another 1,000 L of diesel were removed with the impacted snow. This left an estimated 9,700 L of diesel unaccounted for and assumed to be still on-site. The excavation area was left open in as clean boundaries had yet to be established, and a berm was constructed around the excavation perimeter to prevent and control runoff water intrusion during the spring freshet.

Extended winter season and a short summer season added additional challenge to conduct fieldwork

EBA conducted follow-up site monitoring in May, at which time no free product was observed to be surfacing above grade, within the excavation area, or in the lake located approximately 100 m downgradient from the spill area. EBA began an assessment program in the summer using a track-mounted excavator, left on-site at the end of the winter road season. A series of day trips from Yellowknife to the site by helicopter resulted in the completion of 10 testpits, including installation of eight monitoring wells between the spill site and the lake, groundwater monitoring and sampling as well as lake and excavation water sampling.

Results indicated that shallow groundwater contained detectable concentrations of petroleum hydrocarbons (PHC) in three of the five sampled groundwater monitoring wells in amounts greater than that allowable by the Canadian Council of Ministers of the Environment (CCME) Canadian Water Quality Guidelines for the Protection of Aquatic Life (FAL) (CCME, December 2007), and Alberta Environment (AENV) Alberta Tier 1 Soil and Groundwater Remediation Guidelines (AENV, 2007). AENV guidelines were used where CCME guidelines for some parameters have not been developed. The lake water samples did not show any evidence of hydrocarbon impacts.

There is a potential receptor (lake) nearby so additional precautions were undertaken

The diesel-impacted area was not fully delineated during the first summer investigation, although it did provide evidence that the diesel had not migrated to the nearby lake. Based on this information, AANDC encouraged further delineation work at the site for the following summer.

4.0 2009 FIELD ACTIVITIES

Use of ODEX drilling method

In March of 2009, EBA installed 23 additional monitoring wells on-site with a track-mounted air rotary drill using the ODEX drilling method. One soil sample exceeded criteria, but no groundwater was collected at this time because of frozen conditions.

The winter road was used to bring drilling and any other heavy equipment to the spill site

Groundwater wells were monitored and sampled between June and September 2009. During each sampling event, two surface water samples were also collected from the lake downgradient of the spill site. The results showed that hydrocarbon was present in the groundwater in the fractured bedrock matrix on-site. In winter, the groundwater is frozen so any impacted groundwater is relatively immobile. As the frozen groundwater thaws during summer, the impacted water may migrate downgradient, generally towards the south.

Conclusions, based on the results of the monitoring program conducted in Summer 2009, were as follows:

The presence of potentially aggressive wildlife was considered for the safety of the crew.

- Hydrocarbon concentrations exceeding adopted guidelines were present within the groundwater in the overburden and the fractured bedrock on-site.
- Impacted groundwater was migrating through the overburden and fractured bedrock towards the lake, south of the subject site. However, impacts were not detected in the lake.
- Impacted groundwater could have been migrating through the

fractured bedrock below the road to the north of the spill site. Subsequent groundwater monitoring on-site was needed before this could be confirmed.

Based on this finding, EBA recommended:

- Installation of five monitoring wells south of identified hydrocarbon impacts to delineate the extent of dissolved hydrocarbons in groundwater.
- Installation of one monitoring well in the northwest portion of the site to delineate the occurrence of hydrocarbons identified at this location in September 2009.
- Continued groundwater and lake water monitoring on-site during the summer season of 2010 to assess the groundwater hydrocarbon plume and to confirm it was not migrating to the lake or to the north across the winter road.
- Installation of Oxygen Releasing Compound (ORC®) socks in the monitoring wells that were shown to contain detectable concentrations of hydrocarbons, as identified in 2009.

Challenging Wildlife Issues

5.0 2010 FIELD ACTIVITIES

In March 2010, six additional monitoring wells were installed at the site again with an air rotary drill using the ODEX drilling method. In June 2010, EBA completed another four sampling events at Portage 32. Displaced moss from the March drilling activities was spread back over the exposed areas during the June 2010 sampling event. ORC® socks were installed in monitoring wells where hydrocarbon impacts were previously observed.

Used oxygen release compound (ORC®) to degrade hydrocarbon in a northern environment.

In August of 2010, vegetation and moss growth was observed in areas that had been disturbed during prior fieldwork. Some tracks from the March drilling operations were still visible, but vegetation in the area was recovering and aesthetic impacts were minor. Water levels were observed to be at an all-time low, and the ponded, bermed area on-site had the lowest recovered water levels since the spill occurred.

Results from the 2010 sampling program indicated that hydrocarbon impacts were still present within the groundwater at the site. Results also showed that hydrocarbon impacts had not reached the spill site perimeter wells or the lake, downgradient from the subject site.

6.0 2011 FIELD ACTIVITIES

Hydraulic conductivity tests and a pump test were conducted to assist in the design of a potential pump and treat or other aggressive remediation system.

During the summer fieldwork program for 2011, EBA conducted two sampling events, hydraulic conductivity testing, a pump test, geological mapping of the area and groundwater sampling which took place in July and again in September 2011. Eight of the monitoring wells were still frozen in July, but all of the remaining wells were sampled at that time. No free phase product was observed in any well on site during this sampling event.

Twenty-six groundwater samples and two duplicates were collected from the monitoring well network on site and submitted to the laboratory for chemical analysis in July and 26 groundwater samples and two duplicates were also collected in September. A trip blank and a field blank for each sampling event were also submitted to the laboratory for quality assurance and quality control purposes.

Groundwater sampling, geological mapping and hydraulic conductivity and pump testing were performed at the site to determine the feasibility of natural attenuation and to provide additional details that would assist in the design of a proactive remediation system to assist in the design of a potential pump and treat or other aggressive remediation system.

During each site visit every year, the water levels were measured at each monitoring well prior to sampling. The wells were subsequently developed and purged of a minimum of three well volumes or until practically dry and allowed to recover prior to sampling.

Natural attenuation is being considered as a remediation option.

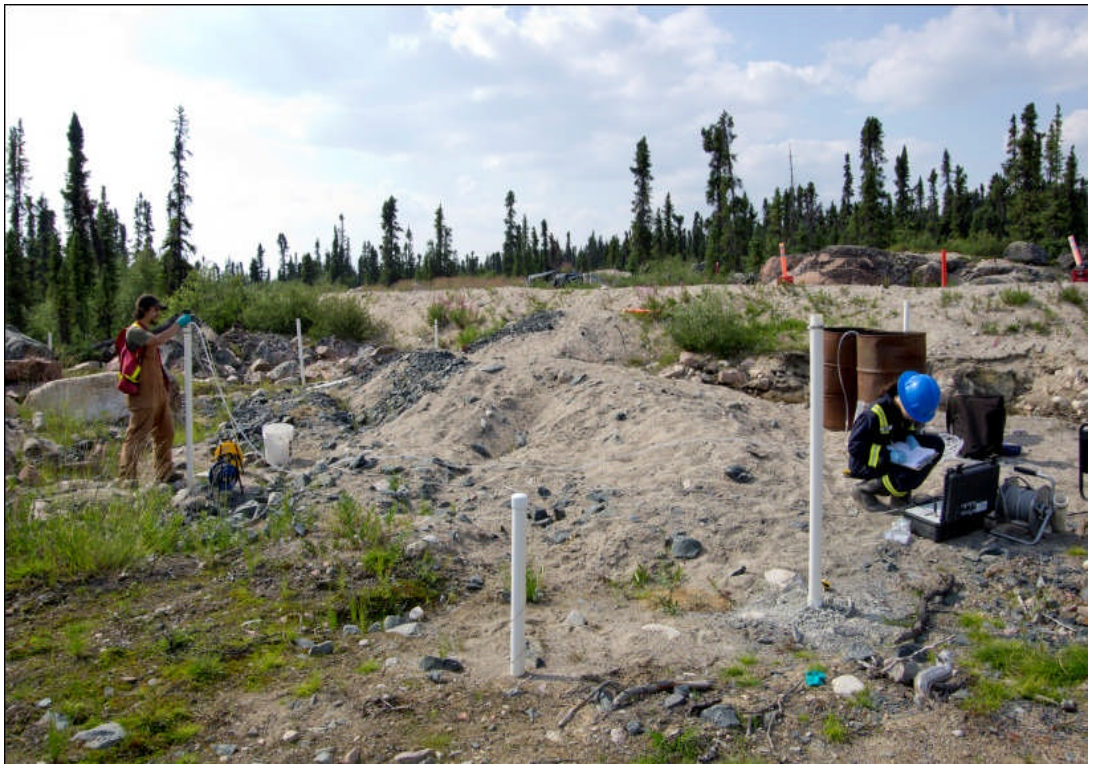
In any remediation project, the adopted technique and design must address two main issues: 1) the removal of the contaminant mass; and 2) the treatment of contaminated soils and groundwater.

These issues were addressed for this project. However, complete removal of spilled diesel was not possible because of the complicated and fractured geology underlying the spill area. The treatment of the contaminated soils and groundwater is ongoing, as remediation of this site will take several years. In the event that the impacts should be

discovered to be migrating towards the lake, an emergency contingency plan has been developed for implementation.

Environmental Impact

Based on the results of all the sampling conducted at the site from the spill date to 2011, EBA is conducting feasibility studies for several site-specific remediation options. These include a natural attenuation remediation option and a progressive remediation option.



7.0 CONCLUSION

Social and Economic Benefits

The Tibbett to Contwoyto road goes through beautiful and pristine sub-Arctic terrain. It is a crucial link for the fast and efficient re-supply of the diamond and precious metals mines that have significant economic impact on both the NWT and Nunavut economies and provide over 10,000 jobs, many of them for Aboriginal Peoples. Thousands of heavy haul trucks use the road each year, and without the care and attention that is paid to safety and the environment, the potential for environmental impact as a result of an accident or a fuel spill would be

high.

In the event of a fuel spill or other type of environmental impact, it is imperative that this be assessed, cleaned up and reclaimed to the fullest extent possible based on local conditions.

In every one of the four years that the project has been underway, EBA found that there was excellent communication among the various companies working on this project regulators, road users, and especially with the Joint Venture which owns and manages the Tibbett to Contwoyto Winter Road.

EBA's Steve Mailath was the senior hydrogeologist who advised on the remediation program. He has several years' experience in the North and throughout Canada, and has never lost sight of what motivates him to do the best clean-up and remediation work possible.

"It is satisfying to know that people care about the environment and not only about making money," he said. "It is also about protecting the North and Canada - Canadians protecting what belongs to them and preserving it for future generations."

As remarked by Ron Near, Director of Winter Road Operations for the Tibbitt to Contwoyto JV, "We are extremely pleased with EBA's technical capabilities and the professionalism through the project".

8.0 ACKNOWLEDGEMENTS

The following companies and agencies contributed to the project success:

EBA found there was excellent dialog amongst the various parties that worked on this project

- Aboriginal Affairs and Northern Development Canada (AANDC)
- Arctic West Adjusters Ltd. (Arctic West)
- Geotech Drilling
- Maxxam Analytics Ltd.
- Nuna Logistics
- Tibbitt to Contwoyto Winter Road Joint Venture (TCWR)

Meeting and exceeding owner's /client's needs

Reference letters from TCWR (Site Owner) and Arctic West (Client) are attached. They indicate that they are happy with EBA meeting their expectations.