



Landfarm Management Plan
Jericho Diamond Mine
Nunavut

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TABLE OF CONTENTS

	Page
1.0 INTRODUCTION.....	1
2.0 CONSTRUCTION.....	1
3.0 OPERATION.....	3
4.0 LANDFARM MANAGEMENT	3
4.1 PETROLEUM-CONTAMINATED MATERIALS CLASSIFICATION	3
4.2 MANAGEMENT RESPONSIBILITY	4
4.3 INTERNAL SPILL REPORTING.....	4
4.4 TYPES OF CONTAMINATED SOILS	4
4.5 LANDFARM OPERATION.....	4
4.5.1 Aeration Frequency	4
4.5.2 Security and Signage.....	5
4.5.3 Soils Testing	5
4.5.4 Bioremediation Product Addition.....	5
4.5.5 Runoff and Seepage Control.....	5
4.5.6 Standing Water Control	5
4.6 CONTAMINATED ROCK.....	6
4.7 CONTAMINATED SNOW AND ICE	6
4.8 MONITORING	6
5.0 CLOSURE.....	7
6.0 CONCLUSION	7
REFERENCES.....	8

LIST OF FIGURES

Figure 1	2
Drawing 1CT004.06-G12 Site General Arrangement	End of Report

LIST OF TABLES

Table 4-1: Petroleum-Contaminated Materials Classification.....	3
Table 4-2: Spill Log Information.....	4
Table 4-3: Annual Soils Analyses.....	5

LIST OF APPENDICES

A CCME 2003 Guidelines for Contaminated Soils – Industrial Sites	
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1.0 INTRODUCTION

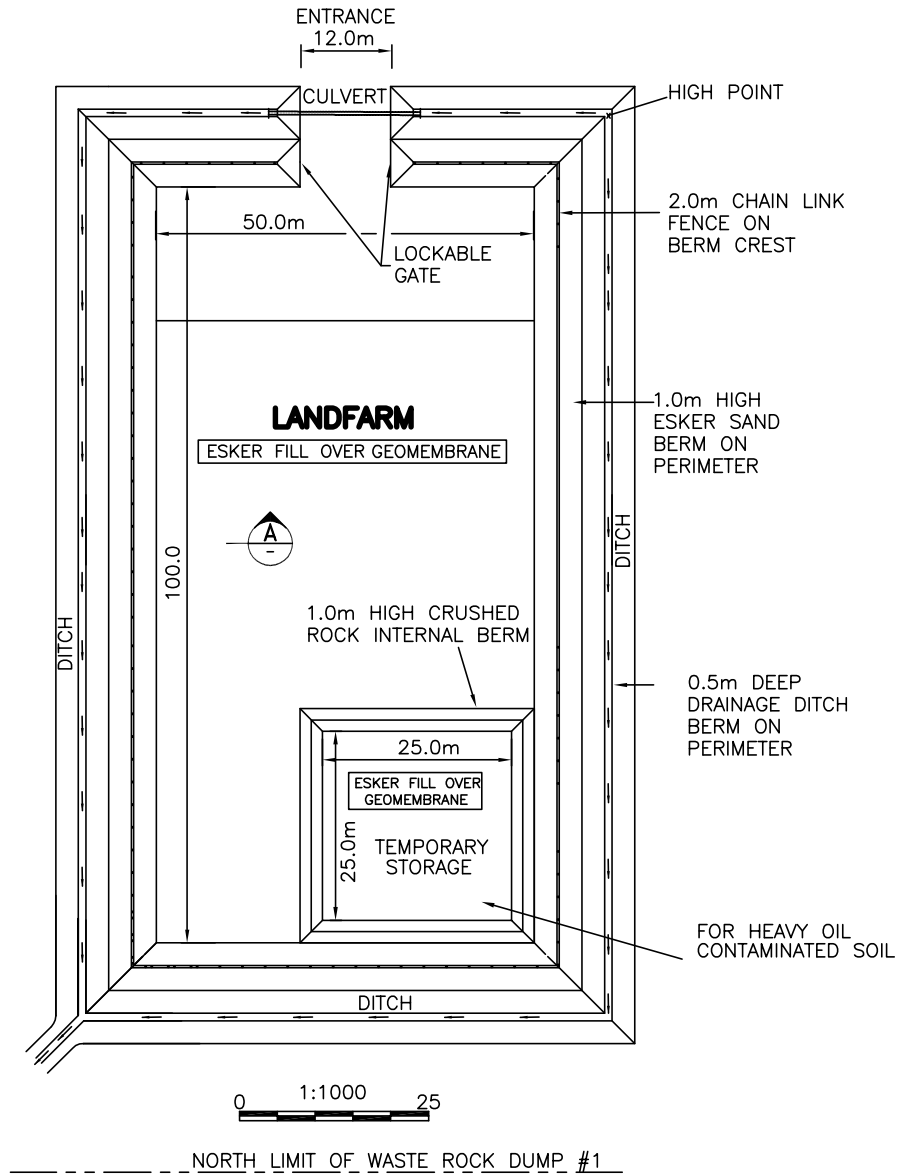
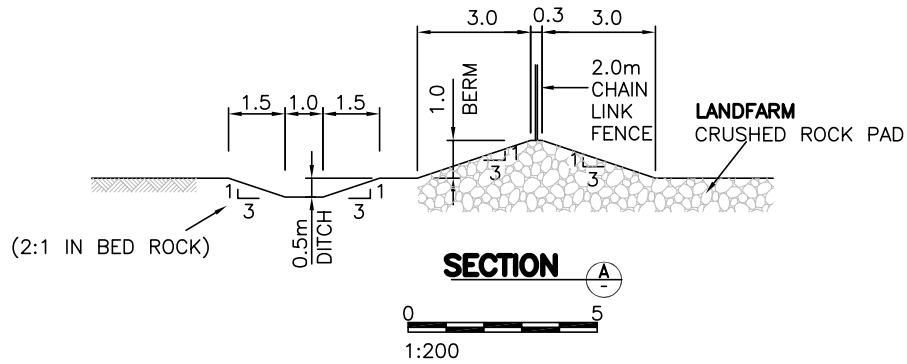
The Jericho Diamond Mine (Jericho) is planning to construct and operate a landfarm facility as part of waste management at the company's diamond mine in the West Kitikmeot, Nunavut. A generic layout for this facility was presented to the Nunavut Impact Review Board (NIRB) September 2003. In response to NIRB findings from the January 2004 Public Hearing, this plan has been developed to manage landfarm operation.

Landfarming is a form of bioremediation that uses naturally occurring microorganisms (yeast, fungi or bacteria) to metabolize or break down petroleum hydrocarbons. Natural processes include volatilization, aeration, biodegradation and photolysis. End products are microorganism protein, carbon dioxide and water. Stimulation of microbial growth and activity for hydrocarbon removal is accomplished primarily through the addition of air and nutrients (metabolism of hydrocarbons is mediated predominantly through aerobic microbes).

2.0 CONSTRUCTION

The area for landfarming will be prepared by removing surface debris, large rocks, and brush. A pad of run-of-mine rock will be laid down. Crushed rock and or esker material will be spread over the landfarm pad and levelled. The initial design will be for an area 50 m by 100 m (5000 m²) on the west side of Waste Rock Dump 2. The area will be graded to slope toward Pond B and the Open Pit. Sand will be laid down and a geomembrane placed on the floor of the landfarm and continued up into a berm completely surrounding the area. More sand will be placed on top of the geomembrane to protect it from damage. A layer of esker material will be placed on top of the sand as a separator from contaminated soil to be placed in the landfarm area. This will constitute initial construction.

Figure 1 provides a plan and cross section of the proposed landfarm. Drawing 1CT004.06-G12 shows the proposed location. The location and final shape may vary slightly from that proposed, based on a best field fit for the facility. For the initial construction period, contaminated soil will be placed in a lined, bermed area, possibly within the fuel farm containment dikes.



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CLIENT

JERICHO DIAMOND PROJECT

LANDFARM LAYOUT DRAWING
FOR WATER LICENCE

DWN BY: YC	CHK'D BY: BO	APP: BO	DATE: MAY 31, 2004
PROJECT NO: VE51295-500	REV. NO.: --	SCALE: AS SHOWN	FIGURE No. FIGURE 1

3.0 OPERATION

An oil bioremediation product that contains bacterial cultures and fertilizer, e.g., Oil Sponge™, will be added to the site to stimulate bacterial growth. The bioremediation product will be added as needed during the biodegradation process. Soil containing petroleum products will be spread uniformly over the surface of the prepared area. The contaminated soil will be incorporated into the top 15 to 20 cm of the soil, either manually or with a tiller or disc harrow if large quantities of contaminated soil must be treated. Soil will be watered to prevent dust generation and to enhance biodegradation; saturation will be avoided. The same site will be used throughout mine life and after closure, as required. Soil hydrocarbon concentrations will be regularly monitored to ascertain the point where soils are no longer considered contaminated, based on CCME guidelines. Ekati Diamond Mine's™ experience will be drawn on to determine monitoring intervals. There are no CCME guidelines for density of soil sampling, but one composite of ten samples per 25 m³ should adequately characterize the soil's hydrocarbon levels if soils have been well mixed during the decontamination process. Decontaminated soils will then be used for reclamation purposes. Ultimate degradation rates are site-specific and cannot be predicted, although Ekati's experience can be used as a guide.

4.0 LANDFARM MANAGEMENT

The information presented in this section is based on Ekati's experience over the past 5 years (Ekati Diamond Mine™, pers. comm. 2004) modified as appropriate to suite the Jericho situation.

4.1 Petroleum-Contaminated Materials Classification

Petroleum-contaminated materials will be classified into several categories prior to selecting a final destination as listed in Table 4-1.

Table 4-1: Petroleum-Contaminated Materials Classification

Material	Destination
Light hydrocarbon contaminated soil < 4 cm	Landfarm
Heavy hydrocarbon contaminated soil < 4 cm	Segregated – landfarm ¹
Rock >4 cm	Remove majority of petroleum; store in a segregated area of the waste rock dump ²
Hydrocarbon contaminated snow and ice	Place in segregated area of the coarse PK stockpile ³

¹ Small volumes backhaul to Yellowknife to licensed contractor for disposal; large volume management to be determined.

² Monitor seepage from waste rock dump(s); PAHs over CCME guidelines will be trigger for treatment with an oil-water separator or other management action to reduce residual petroleum.

³ Monitor seepage from coarse PK; PAHs over CCME guidelines will be trigger for treatment with an oil-water separator or other management action to reduce residual petroleum.

Soil contaminated with other substances, such as ANFO or ammonium nitrate will not be placed in the landfarm.

4.2 Management Responsibility

The mine manager will be responsible for management of the landfarm. When the mine manager is not on site, responsibility will fall to the plant manager.

4.3 Internal Spill Reporting

Per the Jericho Spill Response and Emergency Response Plan, any spills of petroleum products on soil or snow will be reported immediately by the person causing the spill to their supervisor. The supervisor will arrange for the soil or snow and ice to be picked up as soon as possible and at the same time notify the plant manager or engineer. The mine manager or engineer will make a decision as to where the contaminated soil or snow should be placed. The incident will be logged with the information listed in Table 4-2.

Table 4-2: Spill Log Information

Date and Time of Incident
Date and Time of Notification
Location
Product Spilled
Estimated Volume Spilled
Receptor (soil, rock, snow/ice)
Clean-up Undertaken
Destination of Contaminated Material
Date Report Completed
Name and Signature

4.4 Types of Contaminated Soils

Contaminated soils less than 4 cm will be divided into two types for treatment as indicated in Table 4-1. Based on Ekati's experience, soils contaminated with heavy fraction petroleum hydrocarbons, e.g. hydraulic oil, will not degrade substantially in the Arctic environment, thus landfarming is likely to be an ineffective method of treatment. Light fraction petroleum hydrocarbons (gasoline, jet fuel, diesel, stove oil, glycol) appear to be amenable to landfarm remediation and will be treated in the landfarm.

Heavy petroleum hydrocarbon contaminated soils will be temporarily stored in the landfarm in a designated area until a suitable treatment technology can be found or developed for these materials. One possible treatment technology is incineration, given that acceptable scrubbing of emissions can be economically achieved. Small volumes of these materials can be backhauled on the winter road for decontamination by a licensed contractor in Yellowknife.

4.5 Landfarm Operation

4.5.1 Aeration Frequency

In order for the landfarm to operate effectively over the short thaw season it will be necessary to frequently turn over the soil in the landfarm by means of a backhoe, crawler tractor or disk harrow device (depending on what is available at Jericho). The mine manager will ensure that the landfarm soil is turned over at a minimum of once every two weeks and a desirable frequency of once per week. This operation will be logged and the information kept with the plant manager.

4.5.2 Security and Signage

Based on Ekati's experience, the landfarm will be fenced and locked and access restricted with approval being required by the mine manager or designate. This measure will be instituted to prevent unauthorized dumping of contaminated materials into the landfarm area.

As more than one type of petroleum-contaminated soil will be placed in the landfarm, designated areas will be clearly signed and all users of the landfarm made aware of the segregation to be used for materials. For clarity and consistent with general signage policy at Jericho all signs will be multi-lingual (English, Inuinnaquatu, Inuktitut).

4.5.3 Soils Testing

Soils testing for decontamination is discussed in Section 3.0. Soils will be submitted for a complete suite of tests annually prior to commencement of the summer season. Analyses will include those listed in Table 4-3.

Table 4-3: Annual Soils Analyses

Nutrients (N, P, K)	Metals (ICP scan)
Bacteria (hydrocarbon metabolizing)	Particle size
PAH suite	pH
Major ions (salts) (Na, Ca, Mg)	

Sampling density will be as discussed in Section 3.0, initially, amended from practice as indicated.

4.5.4 Bioremediation Product Addition

Bioremediation product will be added the first season the facility is operated. As addition rate will need to be experimentally determined, advice will be sought from the supplier, Ekati or other Arctic mine operating a landfarm to determine an initial application rate. In the second and subsequent seasons, the previous year's experience as determined by soils analyses at the beginning of the current season will be used as a guide.

4.5.5 Runoff and Seepage Control

There will normally be no runoff from the landfarm, nor significant seepage. Should runoff or seepage occur, it will be directed to Pond B or the Open Pit and be pumped to the PKCA as part of mine water management. Samples will be obtained from a location downslope from the fuel farm for analysis of metals and PAHs.

4.5.6 Standing Water Control

Oil contaminated standing water in the landfarm facility is a concern because of the possibility of causing oiling of water using bird, e.g. ducks, which may land on the ponded water. Birds will be discouraged from landing on standing water in the landfarm, should it form, by stringing rope at approximately 2-m intervals across the ponded areas to which are affixed flagging at 1-m intervals. This approach has proved effective at Ekati.

4.6 Contaminated Rock

Contaminated rock (material greater than 4 cm) will be cleaned with sorbents to remove as much petroleum product as possible. Cleaning will take place in a designated area with a concrete pad and drainage control, possibly in a designated area of the hazardous materials warehouse. Cleaned rock will be placed in a prepared area of Waste Rock Dump 1 (see Drawing 1CT004.06-G12).

The site will be prepared by developing a depression in the dump. A layer of esker or crushed rock will be laid and a geomembrane over that, followed by more esker sand or crushed rock to protect the membrane. The cleaned contaminated rock will be placed in this designated area. Once the cell is filled, it will be covered by a sand-geomembrane-sand sandwich and waste rock to induce permafrost into the cell. The site will be signed to ensure all contaminated rock is placed in the same concentrated area. Any drainage from the waste rock dump will be tested and, if discharge criteria are not met, the drainage will report to the PKCA as previously discussed. Should elevated levels of PAHs appear in the waste rock drainage, the water will be treated, e.g., with an oil-water separator, before pumping to the PKCA.

4.7 Contaminated Snow and Ice

Contaminated snow and ice will be scraped up and placed in a prepared area of the coarse PK stockpile. A containment cell will be created by forming a depression in an interior area of the coarse PK stockpile large enough to contain the expected volume of contaminated snow and ice from one winter season. The contaminated snow and ice will be placed in the cell and allowed to melt during the summer season. If water ponds in the cell, it will be covered with flagged ropes as per the landfarm to discourage water using birds from landing in the ponded water. Seepage from the coarse PK will be collected and pumped to the PKCA (fines containment area). Based on Ekati's experience, no petroleum hydrocarbons should be present in the seepage from the coarse PK. Any seepage collected will be tested for PAHs and if present above CCME guidelines, the water will be collected and stored until it can be passed through an oil-water separator.

4.8 Monitoring

The performance of the contaminated soil management systems at Jericho will be monitored in the following ways (previously described):

- seepage from the landfarm and coarse PK will be analyzed for PAHs and metals and compared with seepage from areas not affected by de-contamination cells;
- soils in the landfarm will be analyzed annually for a suite of assays that will provide an indication of the performance of the facility in:
 - fostering bacterial growth
 - reduction in petroleum hydrocarbons
 - residual concentrations of fertilizer
 - pH
 - salt content (from major ions analyses)

Depending on results, procedures may be modified to improve effectiveness and/or efficiency.

5.0 CLOSURE

The landfarm facility will be operated until all the soil meets CCME criteria or the soil is decontaminated in some other way. At that point the landfarm will be covered with waste rock and incorporated into Waste Dump Site 2.

6.0 CONCLUSION

Ekati's system is relatively new and thus there is not a long experience base at the mine. Prior to construction of the contaminated soil management system at Jericho, Ekati Diamond Mine™ will be contacted for an update as to how well their newly installed system is performing. Some modification of this management plan may be indicated.

REFERENCES

CCME. 2003. Canadian Environmental Quality Guidelines Summary.

Ekati Diamond Mine™. 2004. Personal Communication, Ekati Diamond Mine™ environmental staff.

DRAWING

APPENDIX A
2003 CCME GUIDELINES FOR CONTAMINATED SOILS
Industrial Sites

Parameter	Industrial Guideline (mg/kg)
Arsenic	12
Barium	2000
Benzene	5
Chromium (Cr ⁶⁺)	1.4
Copper	91
Ethylbenzene	20
Ethylene glycol	960
Lead	600
Mercury	50
Nickel	50
Benzo(a)pyrene	0.7
Naphthalene	22
Zinc	360

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COMPANY: TAHERA DIAMOND CORPORATION

SITE: JERICO DIAMOND MINE

SPILL CLEAN UP PROCEDURES

*This is a "controlled" document.
Routine distribution is restricted to the approved
distribution at **Jericho Mine**. All other persons
in possession of this document have uncontrolled copies
and should call document control for revision level status.*

Approved by:
Approved Date:

Confidential

1.0 PERSONAL PROTECTION INFORMATION

Ventilation	Use adequate ventilation
Respiratory Protection	Not generally required unless needed to prevent respiratory irritation. In case of spill or leak resulting in unknown concentration, use NIOSH/MSHA approved supplied air respirator.
Eye Protection	For splash protection, use chemical goggles and face shield.
Skin Protection	Use gloves resistant to the material being used, i.e., neoprene or Nitrile rubber. Use protective garments to prevent excessive skin contact.

2.0 HEALTH HAZARD DATA

Recommended Exposure Limits	Not established
Acute Effects of Overexposure	Eye: May cause mild irritation, with stinging and redness of eyes
	Skin: May cause severe irritation. Repeated or prolonged contact may cause defatting of the skin, resulting in dermatitis. Dermal LD50 for diesel fuel is >5 ml/kg (rabbit)
	Inhalation: May cause irritation to nose, throat or lungs. Headache, nausea, dizziness, unconsciousness may occur
	Ingestion: Swallowing small amounts is not likely to produce harmful effects. Ingestion of larger amounts may produce abdominal pain, nausea and vomiting. Aspiration into lungs can produce severe lung damage and is a medical emergency.

3.0 FIRST AID AND EMERGENCY PROCEDURES

Eye	Flush eyes with running water for at least 15 minutes. If irritation or adverse symptoms develop, seek medical attention
Skin	Immediately wash skin with soap and water for at least fifteen minutes. If irritation or adverse symptoms develop, seek medical attention
Inhalation	Remove from exposure. If breathing is difficult, give oxygen. If breathing ceases, administer artificial respiration followed by oxygen. Seek immediate medical attention.
Ingestion	Do not induce vomiting. Seek immediate medical attention.

4.0 FIRE AND EXPLOSION DATA

Flash Point (Method Used)	>130F (>54C) (Estimated)
Flammable Limits (% by Volume in Air)	LEL: Not Established UEL: Not Established
Fire Extinguishing Media	Dry chemical, foam or carbon dioxide
Special Fire Fighting Procedures	Evacuate area of all unnecessary personnel. Shut off source, if possible. Use NIOSH/MSHA approved self-contained breathing apparatus and other protective equipment and/or garments described in Section 1.0 if conditions warrant. Water fog or spray may be used to cool exposed containers and equipment. Do not spray water directly on fire – product will float and could be reignited on surface of water.
Fire and Explosion Hazards	Carbon and sulphur oxides and various hydrocarbons formed when burned.

5.0 SPILL, LEAK AND DISPOSAL PROCEDURES

6.1 Large Spills

Evacuate the area of all unnecessary personnel. Wear protective equipment and/or garments described in Section 1.0 if exposure conditions warrant. Shut off source, if possible and contain the spill. Protect from ignition. Keep out of water sources and sewers. Absorb in dry, inert material (sand, clay, etc.) Transfer to disposal drums using non-sparking equipment. Report incident to your supervisor and complete incident report form.

6.2 Small Spills

Wear protective equipment and/or garments described in Section 1.0 if exposure conditions warrant. Shut off source, if possible and contain the spill. Protect from ignition. Transfer to disposal drums using non-sparking equipment. Report incident to your supervisor and complete incident report form.

6.3 Determine the Type of Petroleum Contaminant

Two basic types of petroleum products are used at the Jericho Mine: heavy oils and light fuels and glycols. Heavy oils include lubricating oil, hydraulic oil, transmission fluid for heavy duty vehicles and similar products. Light fuels and glycol include diesel, stove oil, gasoline, jet fuel and glycol as well as solvents such as Varsol™. Snow and ice and rock (greater than 4 cm diameter) are not segregated by contaminant type, however, soil is.

Contaminated soils are treated differently depending on the type of petroleum contaminant. Soils contaminated with heavy petroleum products are stored in a segregated area of the landfarm. Soils contaminated with light petroleum products are mixed in the landfarm soil for remediation.

6.4 Soil and Rock

The supervisor or mine manager or designate will arrange to have the contaminated material transferred to the landfarm in the designated area.

6.4.1 Treatment of Rock

This procedure is to be completed under the supervision of the mine Environmental Co-ordinator or designate.

Separate rock (greater than 4 cm) from soil. Transfer rock to another disposal drum and remove to the cleaning area [to be determined]. Clean the rock with sorbents to the extent possible. Collect waste sorbent for disposal via winter backhaul. Label the waste sorbent container and place in the designated temporary storage area. Place the rock into the disposal drum and transport to the designated storage cell in the Waste Rock Dump. Complete the incident report form if you have not done so.

6.4.2 Treatment of Soil

This procedure is to be completed under the supervision of the mine Environmental Co-ordinator or designate.

Determine whether the soil was contaminated with a light or heavy petroleum product. If contaminated with a heavy petroleum product the soil is to be stored in a designated area of the landfarm. If soil was contaminated with a light petroleum product continue with the following procedure.

Thoroughly mix the contaminated soil in the top 10 to 20 cm of the landfarm soil and spread evenly. Add high nitrogen fertilizer kept for the landfarm at the prescribed rate [to be determined]. Complete the incident report form if you have not done so.

6.5 Treatment of Snow and Ice

The supervisor or mine manager or designate will arrange to have the contaminated material transferred to the storage cell in the coarse PK stockpile.

Place the contaminated snow or ice in the centre area of the storage cell. Note if there is any ponded water and, if present, notify the Environmental Co-ordinator who will install the bird deterrent flagged ropes as soon as possible. Complete the incident report form if you have not done so.

INCIDENT REPORT FORM

Complete the following form for all accidental spills to ground, snow or ice. When completed give to your supervisor for signature and filing with the Mine Manager.

Date and Time of Incident	
Date and Time of Notification	
Location	
Product Spilled	
Estimated Volume Spilled	
Receptor (soil, rock, snow/ice)	
Estimated Volume of Contaminated Material	
Clean-up Undertaken	
Destination of Contaminated Material	
Date Report Completed	

Supervisor

Signature