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December 22, 2014

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permits@mvlwb.com
jmorse@mvlwb.com

Attention: Mr. Julian Morse, Regulatory Officer

Re: Water License MV2002L2-0019 – Biopile Management Plan Submission

As per section Part E. 25 of the water license MV2002L2-0019 NATCL is submitting the design and management plan related to land farming soil for remediation. This plan is being submitted for review and approval, such that the remediation program can begin in the summer of 2015.

The soil remediation at Cantung being proposed is a modified biopile design, and not a classic land farm. Key aspects outlined in the plan are:

- Design,
- Site characteristics,
- Geotechnical stability,
- Leachate management, and
- Operational plans

The plan is to do an initial remediation program which can be expanded and modified after the first year, as needed.

Please contact Deborah Flemming, Environmental Superintendent (dflemming@natcl.ca) or Cantung Environmental Department (cantungenviro@natcl.ca) should you have any questions or concerns regarding the information contained within the attachments.

Yours truly,
North American Tungsten Corporation

Deborah Flemming
Environmental Superintendent

CC: J. McKenzie, B. Delaney, Cantung Enviro, Allan Krasnick (NATCL), Jarret Hardisty (GNWT - Lands)
Rod Ambrosie – Wenck Associates Inc.

NORTH AMERICAN TUNGSTEN CORPORATION LTD

CANTUNG MINE

PREPARED BY NORTH AMERICAN TUNGSTEN CORPORATION LTD.

BIOPILE (LANDFARM) MANAGEMENT PLAN
CANTUNG MINE, GNWT

ISSUED FOR USE

DECEMBER 22, 2014

COPY #:__________________________ ASSIGNED TO:__________________________

RECORD OF REVISIONS AND DISTRIBUTION LIST

Record of Revisions

REVISON NUMBER	DATE	SECTION REVISED, ADDED OR DELETED
0	30/09/2014	Initial Plan
1		
2		
3		

Distribution List

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1.0 INTRODUCTION

The *Biopile (Landfarm) Management Plan* was developed to formalize the soil remediation practices and procedures to be employed by North American Tungsten Corporation Ltd. (NATCL) at the Cantung Mine. Phase I and II Environmental Site Assessments (Gartner Lee Limited, 2002; EBA, 2009) revealed petroleum hydrocarbon (PHC) contamination as a result of the extension of Tailings Pond 4 (TP4) into a historic waste disposal area. This soil was excavated and stored on top of Tailings Pond 3 (TP3). NATCL has committed to remediating or removing this, and any additional contaminated soil, as part of its *Closure and Reclamation Plan*.

The purpose of this plan is to ensure the proper management, treatment, and monitoring of contaminated soils during biopile operations and that all regulatory requirements pertaining to biopile operations are followed. The *Biopile (Landfarm) Management Plan* should be read in conjunction with the overall site *Waste Management Plan*.

1.1 REGULATORY BACKGROUND

This Biopile (Landfarm) Management Plan has been developed in accordance with the requirements that are outlined in the Mackenzie Valley Land and Water Board Water License MV2002L2-0019;

> Part E.25. "The Licensee shall provide to the board for approval 60 (sixty) days prior to the construction of any new landfarm an engineered design for the landfarm that includes but is not limited to:
>
> **a.** A description of the site characteristics, including surface and subsurface characteristics, geotechnical characteristics and site Water Management plans;
>
> **b.** Construction and materials specifications including the Licensee's Quality Assurance and Quality Control program;
>
> **c.** A geotechnical analysis, which may include, but is not limited to: settlement, slope stability, groundwater seepage and contaminant transport, and any liner performance;
>
> **d.** The details of a volume balance and Landfarm sizing that considers expected hydrocarbon contaminated soil and snow to be contained;
>
> **e.** The details of leachate management that includes but is not limited to: estimation of leachate generated; leachate collection and disposal; and leachate sampling and monitoring;
>
> **f.** An operational plan that details, but is not limited to: acceptable soil types to be deposited in the Landfarm; remediation standards; and methods and frequency of any soil conditioning to promote remediation;

g. The spatial and temporal monitoring program for soil chemistry within the Landfarm;

h. The location for the proposed Landfarm on a map to scale with GPS coordinates; and

i. A detailed closure plan for the Landfarm."

Annual reporting of treated soil is required in the Water License as per Section B.2 (g) "…the monthly and annual quantity in cubic meters of soil treated in the Landfarm."

2.0 GENERAL SITE INFORMATION

NATCL has operated the Cantung Tungsten Mine at Tungsten, NWT since 2001. Mining operations at the Cantung Mine commenced in 1962 as an open pit mine, with suspensions in 1962 and 1966. The discovery of the "E zone" ore body in 1971 resulted in the development of an underground mine from 1973 onwards. The mine was in operation until its temporary closure in 1986, and finally re-opened in 2001. The mine was then again temporarily closed in 2009 and re-opened in 2010 with an extended mine life.

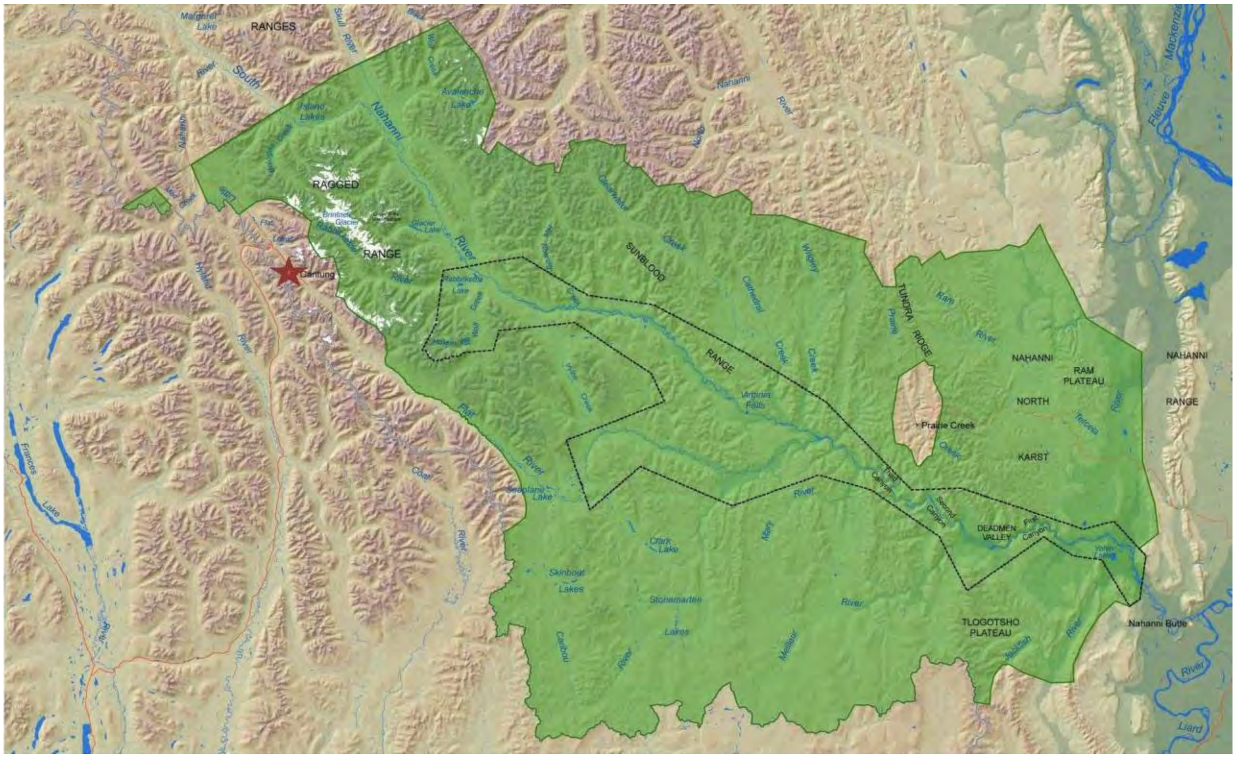
Prior to the 1986 closure, mine personnel lived in the town site of Tungsten with their families. The mine is now operated on a fly-in/fly-out basis and parts of the former town site are still used to house staff.

2.1 LOCATION

The Cantung Mine is located in the Mackenzie Mountains, approximately 5 km from the NWT-Yukon Territory border and approximately 310 km northeast of Watson Lake (**Figure 1**). The Cantung Mine is located near the headwaters of the Flat River in a narrow valley surrounded by the mountains of the Mackenzie range. The elevations of the mountain peaks in the immediate area of the property range from 1,981 to 2,750 m above sea level. The main rivers are northwest-southeast trending at elevations of 914 to 1,067m above sea level.

The Flat River Valley has been in-filled with unconsolidated sediments, largely deposited by glacial meltwater associated with the last phase of the continental ice retreat. The deposits are interbedded sand and gravels, with occasional silty sand layers, to a depth of roughly 30 m. These sediments are overlain by fluvial sands and gravels from the Flat River and tributary streams emanating from the valley sides. There is no evidence of permafrost at the Site.

FIGURE 1 MINE SITE LOCATION MAP



2.2 CLIMATE

Climatic conditions in this area are typically sub-arctic. Average temperatures during the winter period from November to March range from -6°C to -40°C. Blizzard conditions during January and February are frequent but usually of short duration. Maximum snow depth in the valleys during the winter averages about 127 cm. The snow-free season extends from mid-May to early October. Total annual precipitation averages about 636mm, with approximately half occurring as rain and half as snow.

3.0 BIOPILE DESIGN

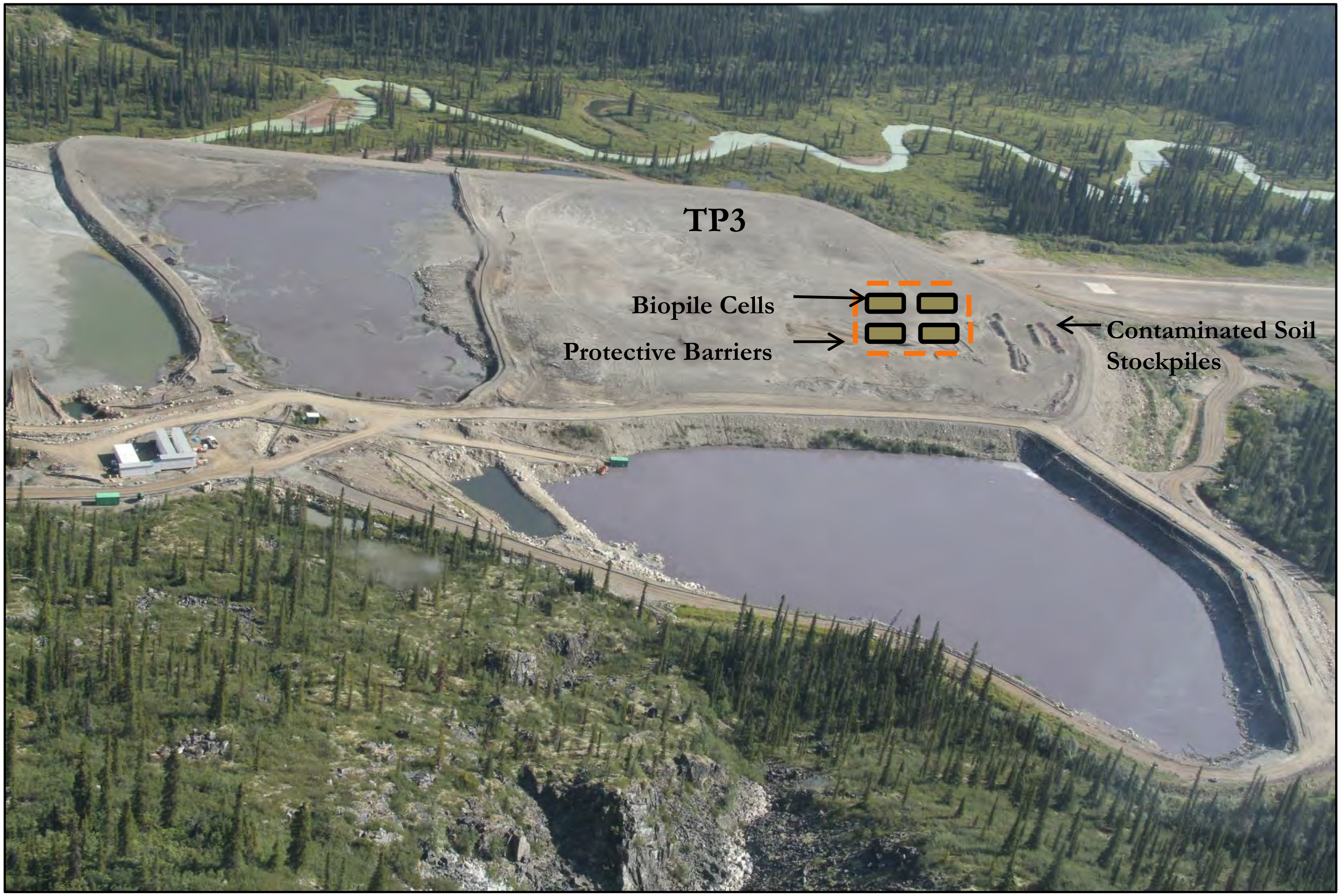
Landfarming has a demonstrated success record in treating petroleum hydrocarbon (PHC) contaminated soil, even in cold climates with short summer seasons. A traditional landfarm is typically an engineered berm where soil is aerated and fertilized to allow for biodegradation and oxidation of PHC contaminants. A large surface area is typically required, as well as lining and ditching to prevent infiltration of leachate to groundwater and contamination of surface water features. This type of structure has high capital costs that would be prohibitive to a small mining operation such as Cantung. Additionally, the footprint of the Cantung Mine is relatively small and confined in a narrow mountainous valley. As such, space for a traditional landfarm is limited.

The contaminated soil requiring remediation is currently stockpiled on top of Tailings Pond 3 (TP3). Locating a "landfarm" here is advantageous in that it does not require the disturbance of any new land and eliminates the need to transfer the soil to a different location. There are used fuel tanks on site that are no longer usable for their intended purpose. These tanks will be used to house the "landfarm" or, more accurately, biopile. The biopile cells will operate on the same principles as a traditional landfarm (i.e. requiring aeration and fertilization) but will be contained within steel tanks. This eliminates the need for a lined system with drainage ditching. This will significantly decrease construction time.

3.1 BIOPILE LOCATION

The proposed biopile operation on the top of TP3 is located at 541263 E and 6870035 N (**Figure 2).** The design and location of the biopile have been selected to minimize geotechnical issues relating to stability, seepage, contaminant transport and settlement. Since the material will be stored in steel tanks, the effects of seepage and contaminant transport have been mitigated. Therefore, since the tanks themselves will provide collection of leachate, a liner system will not be needed. The proximity of the tanks to the tailings slopes is such that the effects of the tanks on TP3 are negligible. In addition, the tanks will provide support for the material, mitigating any possible failures of material as it will be constrained by the tank walls. The tailings themselves consist of fine sand that can provide adequate bearing capacity for the tanks to sit on. Settlement of the tanks will be negligible and will not affect the integrity of the tanks.

FIGURE 2 BIOPILE LOCATION MAP



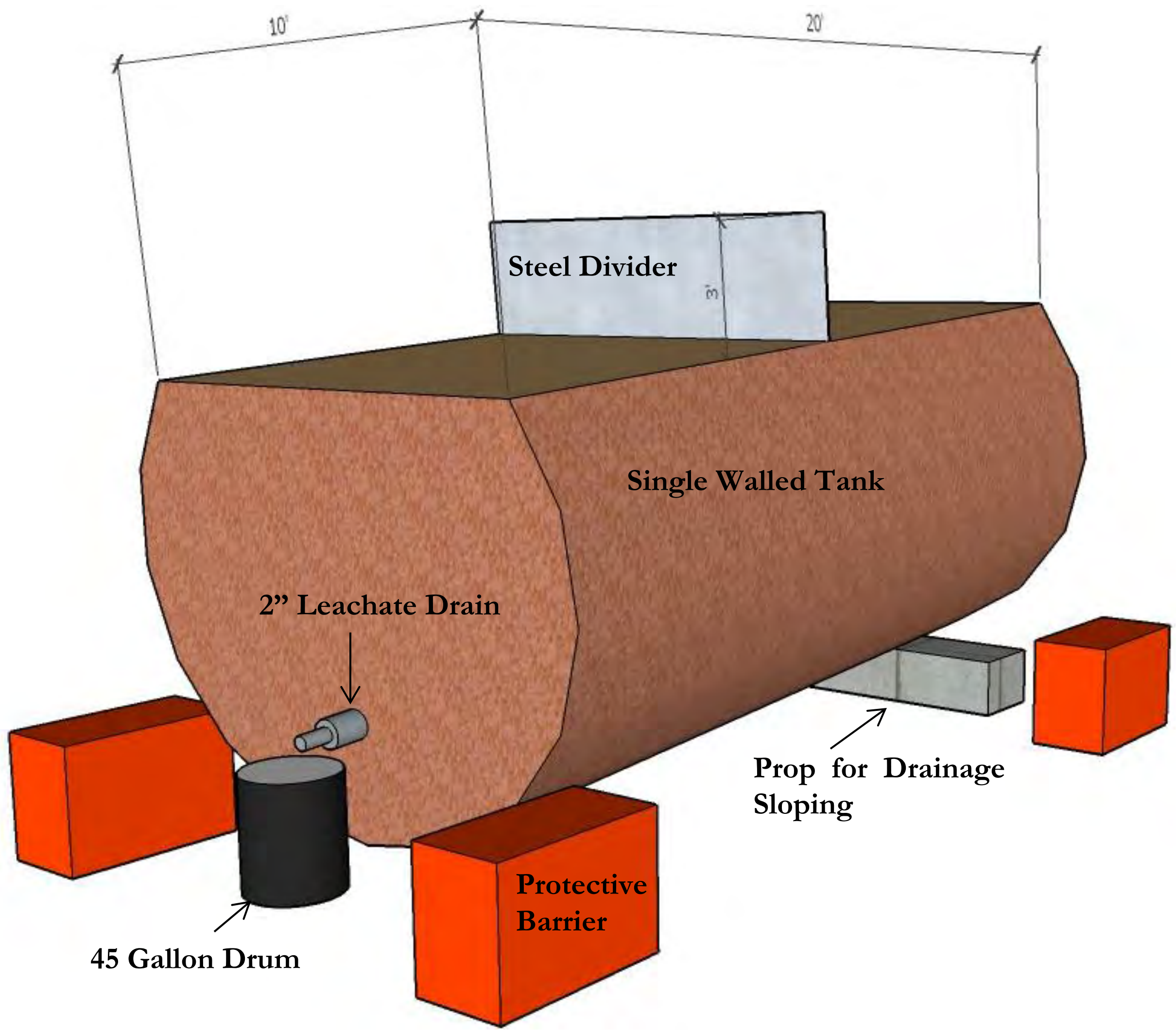
3.2 BIOPILE CELLS

The biopile cells will be contained within single-walled fuel tanks stored on site that are no longer usable for their original purpose. Two tanks with a 45 m^3 capacity will be halved length-wise to create four cells, allowing approximately 90 m^3 of soil to be treated at any given time. Each of the four cells will be further divided in half with a welded section of steel to provide a total of eight individual cells (**Figure 3**). Field trials will be conducted during the first active working season of the biopile, with each individual cell receiving differing treatments (Section 4.3). This will allow NATCL to determine the optimal treatment regime, which will be applied to all eight cells in subsequent active working seasons.

Each tank will be fitted with a 2-inch drain with shut-off valve, to allow for leachate drainage and collection. One end of the fuel tanks will be propped to slope the cells slightly and promote leachate drainage to the drainage valves (**Figure 3**). A 2" slotted PVC pipe will be wrapped in geotextile cloth and fitted into the bottom of the steel divider, to allow drainage from both halves of each biopile cell. Any excess moisture will be drained into totes or 45 gallon drums, and sampled to determine leachate quality (Section 5.2)

Aeration and soil mixing will be achieved through the use of heavy equipment. To ensure that the tanks are not damaged by heavy equipment during this process, the tanks will be surrounded by a perimeter of cement blocks or other appropriate barriers.

FIGURE 3 BIOPILE CONCEPTUAL DRAWING



4.0 BIOPILE OPERATIONS

4.1 SOIL CHEMISTRY

Sampling of the PHC contaminated soil was conducted in 2009 as part of a Phase II Environmental Site Assessment (EBA, 2009). Discrete and composite samples were taken from the three stockpiles of contaminated soil that existed at that time (an approximate volume of 415 m^3). The results of the investigation revealed that contaminants of concern included petroleum hydrocarbon fractions F2 and F3 and select metals (arsenic, copper, nickel, selenium, and zinc). F2 fractions are hydrocarbons with 10 to 16 carbon atoms (i.e., C_{10}-C_{16}) and F3 fractions are hydrocarbons with 16 to 34 carbon atoms (i.e., C_{16}-C_{34}).

An estimated 600 m^3 of PHC contaminated soil currently exists on site. The three preexisting stockpiles were re-sampled in May 2014 to determine their current contaminant levels. This revealed that contaminants of concern are very similar to those identified in 2009 (Appendix A – Tables 1 and 3). Hydrocarbon fractions F2 and F3, as well as arsenic, copper, selenium and zinc are present in concentrations exceeding industrial remediation objectives (see Section 4.2).

Background samples of undisturbed soil were also obtained and analyzed for metals, BTEX, and F1-F4 fractions. The sampling results (Appenidx A – Tables 2 and 4) indicate elevated levels of select metals (arsenic, copper, and zinc), although these are limited. There are no hydrocarbon exceedances in the background samples.

4.2 ACCEPTABLE MATERIALS

In light of the May 2014 sampling results, the focus of the treatment at the biopiles will be light hydrocarbon fractions such as gasoline, diesel, and jet fuel. Heavier petroleum hydrocarbon fractions (i.e. F4) such as waste oils are not as readily degradable and may remain in contaminated soils for extended periods of time (Sanscartier et al., 2009; DeBeers, 2013). The results of the 2009 and 2014 investigations did not however, reveal F4 fractions as a contaminant of concern. Should soil become contaminated with heavy fraction PHC products, they will not be accepted at the biopile for treatment, and will be shipped off-site as hazardous waste.

As metals are not biodegradable, the soil will not be treated for metals removal in the biopiles. When a batch of soil has been successfully remediated for PHC's, the soil will be resampled for metals. A strategy for disposal of any metals contaminated soil will be developed at that time, with disposal to tailings being a possible consideration.

4.3 TIME REQUIREMENTS

An estimated 600 m^3 of PHC contaminated soil currently exists on site. Given that the total soil volume that can be treated at any one time is approximately 90 m^3, the contaminated soil will be treated in about six batches. Landfarming studies conducted in the Canadian

Arctic (McCarthy et al., 2004; Sanscartier et al., 2009) have successfully remediated contaminated soils in minimal timeframes (i.e. one to three working seasons). The actual time required to fully remediate a batch will, however, be highly variable and dependent on the contaminant levels and treatment regime chosen. The results of the field trials will serve to identify the most efficient remediation strategy and its approximate time requirements.

4.4 REMEDIATION STANDARDS

The results of the soil and leachate sampling programs (Section 5.1 and 5.2) will be compared to remediation objectives based on GNWT and CCME guidelines, as well as criteria defined in NATCL's Closure and Reclamation Plan as it is developing.

4.4.1 Soil Standards

Laboratory analysis will be conducted for both petroleum hydrocarbon (PHC) fractions F1-F4 and BTEX compounds in order to capture all possible petroleum contaminants. The results for PHC fractions F1-F4 will be compared to the Canada Wide Standard (CWS) for petroleum hydrocarbons in soil established by the Canadian Council of Ministers of the Environment (CCME, 2001).

BTEX compounds are specific aromatic compounds falling within the F1 fraction (i.e. benzene, toluene, ethyl benzene and xylene) that are normally managed separately (GNWT, 2003). Remediation objectives for BTEX compounds are not included in the CWS; therefore sampling results will be compared to the criteria established by the GNWT for coarse grained surface soil (GNWT, 2003).

Results will be compared to both Industrial and Residential/Parkland land use criteria. Soil will be remediated to the most stringent set of criteria for both sets of parameters, namely the Residential/Parkland standards (Table 1). Sampling results will be compared to the Industrial land use criteria internally, as a measure of progress and to allow for a better understanding of the time requirements for remediation.

TABLE 1 SOIL REMEDIATION OBJECTIVES

Parameter	Tier 1 CCME Canada Wide Standards for Petroleum Hydrocarbons in Soil (mg/kg)		Parameter	GNWT Environmental Guideline for Contaminated Site Remediation (mg/kg)	
	Residential/Parkland	Industrial		Residential/Parkland	Industrial
PHC F1	30	320	**Benzene**	0.5	5
PHC F2	150	260	**Ethyl Benzene**	1.2	20
PHC F3	300	1700	**Toluene**	0.8	0.8
PHC F4	2800	3300	**Xylene**	1	20

Once the contaminated soil has been treated to the Residential/Parkland remediation objectives in Table 1, it will be considered clean and appropriate for closure/reclamation activities.

4.4.2 Leachate Standards

The compliance parameter limits set for Station S4-43 in Table E2 of the Type A Water License (Table 2) will be used as a guideline for acceptable biopile leachate quality. Leachate that complies with parameter limits set out in Table 2 will be discharged to TP5 and treated at the wastewater treatment facility. Leachate that exceeds these limits will be appropriately labelled and shipped off site as hazardous waste (Section 4.4).

TABLE 2 LEACHATE PARAMETER LIMITS

Parameter	Type A Water License MV2002L2-0019, Section E.21.	
	Maximum Average Concentration	**Maximum Concentration of any Grab Sample**
EPH	4.00 mg/L	5.00 mg/L
Benzene	4.00 ppm	
Ethyl Benzene	2.00 ppm	
Toluene	0.39 ppm	

4.5 REMEDIATION METHODS

The three pre-existing stockpiles characterized in 2009 by EBA and again in 2014 by NATCL will be remediated first, as more is known about their origins and contamination level. It is anticipated that this volume of soil (approximately 415 m^3) will take a number of years to remediate. At that time, the remaining stockpiled soil will be sampled and characterized. The appropriate method of remediation, whether it is biopile treatment or off-site disposal, will be determined at that time. If any new contaminated soil is generated, it will be stored separately on TP3 with its origins, type of contamination, and location in the stockpile storage area documented. All soil will be sampled prior to treatment in the biopile cells to determine initial contaminant levels and appropriate treatment methods.

To determine the optimal treatment regime, NATCL will conduct field trials on eight individual biopile cells during the first working season. The different treatment regimen will vary the aeration levels, nutrient levels, and the application of a cover during the summer months.

4.5.1 Cover

Four biopile cells will receive a cover during the summer months in the form of a dark coloured tarp to trap heat and warm the biopile. Tires will be placed on top of the pile to create airspace and allow for air circulation under the tarp. Providing a warm environment for soil microorganisms can not only extend the length of the working season, but can possibly aid in enhanced bioremediation (Paudyn et al., 2008).

The other four biopile cells will remain uncovered and exposed to the elements. This may negate the need for watering of the piles as they will be exposed to precipitation, and can enhance volatilization of lighter hydrocarbon fractions (Sanscartier et al., 2009). The benefits of warming the pile via use of a cover are also not proven, and this trial will help determine its necessity.

4.5.2 Aeration

In each set of four biopiles (covered and uncovered), two cells will receive biweekly aeration and two cells will receive monthly aeration. Mixing the soil provides oxygen to microorganisms, enhances volatilization of lighter hydrocarbons, and evenly distributes fertilizer amendments. Aeration will be achieved through the use of heavy equipment, and should also be conducted when adding amendments to ensure uniform mixing. Some studies have shown that an aggressive aeration schedule can significantly decrease the time required for remediation (McCarthy, 2004), although low maintenance landfarms are typically aerated once per month (Sanscartier et al., 2009; De Beers, 2013). Access to heavy equipment during the busy summer months may be limited, thus it will beneficial to determine whether additional aeration has any impact on remediation time.

4.5.3 Nutrients

It is well documented that the addition of nutrients stimulates the biodegradation of hydrocarbon contaminants. Nitrogen and phosphorous will be added to the biopile cells in the form of fertilizer. Studies have shown that low level nutrient addition is most beneficial, as high levels can actually inhibit microbial activity (Braddock et al., 1997). The recommended nitrogen to phosphorous ratio varies from anywhere between 2:1 and 15:1.

Within each set of four biopiles, two cells will receive fertilization with an N:P nutrient concentration ratio of 10:1, while the other two will receive fertilization with an N:P nutrient concentration of 2:1. While nitrogen is typically the limiting nutrient in landfarm systems (Braddock et al., 1997), it will be useful to determine whether increasing the amount of nitrogen will have any significant benefit.

4.5.4 Moisture

The contaminated soil will be monitored regularly by visual inspection for moisture content during the working season. Dry soils can promote volatilization of hydrocarbons, but moisture is essential for biodegradation (Sanscartier, 2009). The soil in all biopile cells, regardless of treatment regime, should remain moist but not fully saturated. It is likely that the uncovered cells will not require the addition of moisture as they will be exposed to precipitation. Should either covered or uncovered cells require moisture addition, the water will be sourced from the waste water treatment facility, transferred in totes to TP3, and sprayed onto the biopiles.

4.6 LEACHATE MANAGEMENT

Excess moisture within the biopile cells will be collected in totes or 45 gallon drums via the 2" drainage valves installed on the fuel tanks. The leachate will be sampled as it is produced to determine water quality (see Section 5.2). Should the sampling results meet the criteria as defined in Part E, Table E2 of the water license, the leachate will be discharged to TP5 and treated at the wastewater treatment facility. Should the sampling results exceed these criteria, the totes or drums will be appropriately labelled and shipped off site as hazardous waste.

All biopile cells, regardless of treatment regime, will be covered with tarps during the winter months. The tarps will be erected so as to ensure snow and rain run off the cells, and the soil does not absorb this excess precipitation.

5.0 SAMPLING AND MONITORING

5.1 SOIL SAMPLING

Soil characterization and tracking of remediation progress will be achieved through a soil sampling program. Initial sampling of the three pre-existing stockpiles has been conducted in May 2014 to confirm the results of the 2009 Phase II ESA and to further characterize the contaminated soils. At the beginning of the first working season, soil from these stockpiles will be homogenized using heavy equipment and placed into the eight individual biopile cells. The soil in each cell will then be re-sampled to determine initial contaminant levels.

The soil will be sampled twice per working season – once at the beginning and once at the end. Samples will be analyzed for both PHC fractions F1-F4 and BTEX compounds by AGAT Laboratories in Burnaby, BC. The results of these sampling events will be compared to the remediation objectives outlined Section 4.2.1. Once the soil has been remediated to the Residential/Parkland guidelines, it will be considered clean. The cell will be emptied and re-filled with contaminated soil and the process will begin again.

5.2 LEACHATE SAMPLING

Sampling of leachate will occur as needed throughout the working season as totes/drums become full. At the end of the active working season, all remaining leachate will be sampled to determine its disposal method prior to the winter months. Leachate samples will be analyzed for extractable petroleum hydrocarbons (EPH) and BTEX compounds by AGAT Laboratories in Burnaby, BC. The results of sampling events will be compared to the parameter limits set out in Section 4.2.2. If leachate does not exceed these limits it will be disposed of in TP5, otherwise it will be appropriately labelled and shipped off site as hazardous waste.

6.0 QUALITY ASSURANCE AND QUALITY CONTROL

Soil and leachate samples will be collected, preserved, stored, and shipped as per the *Water Quality Sampling Quality Assurance and Quality Control Manual* issued under separate cover. All samples will be analyzed by AGAT Laboratories, an accredited lab by the Canadian Association for Laboratory Accreditation Inc.

Once per working season, duplicate soil and leachate samples will be collected in order to monitor the precision and accuracy of the laboratory conducting the analyses, and to identify any deficiencies in sampling techniques.

To ensure that each biopile cell is clearly delineated and receives its appropriate treatment regime during the field trials, durable signage will be erected at each cell indicating the treatment regime. The steel sections dividing each tank in half will be taller than the height of the tank to ensure that cells are clearly divided and that no mixing across cells occurs during field trials.

Prior to loading soil, the fuel tanks will be partially filled with water and checked for leaks. Any leaks found will be patched and rechecked prior to loading soil into the cells. Locating the biopile cells on TP3 also minimizes risks to human and ecological receptors in the event of a leak or spill of leachate. The contaminated stockpiles are also already located here, so transporting the contaminated soil over large distances will not be necessary.

7.0 CLOSURE AND RECLAMATION

The creation and use of biopiles will contribute to the *Closure and Reclamation Plan* by addressing site wide (SW) closure and reclamation plan objectives as approved by the Mackenzie Valley Land and Water Board, specifically:

> SW 3 "Surface soil quality on-site is safe for future land uses," and
>
> SW 4 "Contaminated soils are removed and remediated."

To achieve these objectives NATCL has committed to the closure options of in-situ treatment or removal of contaminated soils. In order to fulfill these commitments, in-situ treatment will be conducted as outlined in this plan. To ensure that soil quality is safe for future land uses, NATCL has chosen to adhere to the Residential/Parkland criteria for PHC contaminated soils as established by the CCME and GNWT.

Any persistently contaminated soil that cannot be remediated on site as per these guidelines will be shipped off site as hazardous waste. Any leachate that exceeds the criteria outlined in section 4.2.2 will also be appropriately labelled and shipped off site as hazardous waste. The successfully remediated soil may be used for cover or fill applications for progressive reclamation activities or at mine closure.

The construction of the biopile cells is not resource intensive, and will actually extend the life of fuel tanks that are no longer usable for their original purpose. At the end of the soil remediation program, minimal material will require disposal. The tarps used for cover will be landfilled on site and the tires and steel fuel tanks will be shipped off site for recycling.

On site remediation of contaminated soils through the use of low maintenance biopiles will help to resolve a contamination issue in a cost effective manner, provide clean fill for mine site activities, and achieve closure and reclamation objectives as set out in the Closure and Reclamation Plan.

8.0 SIGNATURE

The Report has been based on the knowledge and experience of both the staff of the Cantung mine and Mr. Ambrosie. Throughout the development of the report Mr. Ambrosie has reviewed and discussed the content of the report with the staff at the mine.

I hereby certify that this plan, or report was prepared by me or under my direct supervision, and that I am a duly registered Professional Engineer under the laws of the Northwest Territories and Nunavut.

Print Name: Rodney W. Ambrosie

Date: 12-22-2014

NWT and Nunavut Registration Number L2550

Rodney W. Ambrosie, P. Eng.

Wenck Associates, Inc.

REGISTERED PROFESSIONAL ENGINEER
R.W. AMBROSIE
LICENSEE
NT/NU

PERMIT TO PRACTICE
WENCK ASSOCIATES INC.
Signature
Date 12-22-2014
PERMIT NUMBER: P 825
NT/NU Association of Professional Engineers and Geoscientists

9.0 REFERENCES

Braddock, J., Ruth, M., Catterall, P., Walworth, J., and McCarthy, K.A. (1997). Enhancement and inhibition of microbial activity in hydrocarbon contaminated Arctic soils: Implications for nutrient-amended bioremediation. *Environmental Science and Technology*, 31 (7): 2078-2084.

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APPENDIX A

Table 1. Contaminated Soil Sampling Results - British Columbia Metals Schedule 4 and 5

Parameter	Unit	Residential Guideline	Industrial Guideline	RDL	BP-Comp-1	BP-Comp-2	BP-Discrete-1	BP-Discrete-2	BP-Discrete-3	BP-Discrete-4
Antimony	µg/g	20	40	0.1	0.3	1.2	0.4	0.5	0.5	0.5
Arsenic	µg/g	12	12	0.1	14.4	14.0	15.5	11.6	27.4	12.2
Barium	µg/g	500	2000	0.5	47.7	451	135	272	170	161
Beryllium	µg/g	4	8	0.1	1.1	1.3	1.1	1.1	1.4	1.5
Boron (Hot Water Soluble)	µg/g			0.1	0.6	0.3	0.7	0.5	0.8	0.8
Cadmium	µg/g	10	22	0.01	5.49	2.41	2.82	1.29	3.17	2.35
Chromium	µg/g	64	87	1	8	16	18	20	15	18
Cobalt	µg/g	50	300	0.1	66.3	24.9	18.0	18.3	19.9	18.6
Copper	µg/g	63	91	0.2	2280	1270	507	510	907	716
Lead	µg/g	140	600	0.1	9.1	11.3	16.6	18.6	15.3	60.1
Mercury	µg/g	6.6	50	0.01	3.82	3.59	3.47	3.62	5.27	4.29
Molybdenum	µg/g	10	40	0.2	4.1	4.3	5.2	3.9	3.5	2.6
Nickel	µg/g	50	50	0.5	13.4	23.2	14.7	18.5	13.4	12.2
Selenium	µg/g	1	3.9	0.1	9.2	4.1	1.8	1.5	2.2	2.4
Silver	µg/g	20	40	0.5	1.1	0.8	<0.5	<0.5	0.6	0.6
Thallium	µg/g	1	1	0.1	0.5	0.4	0.5	0.4	0.5	0.5
Tin	µg/g	50	300	0.2	3.8	2.9	2.9	2.9	3.7	3.4
Vanadium	µg/g	130	130	1	11	41	22	26	22	20
Zinc	µg/g	200	360	1	578	249	198	154	300	223
pH 1:2	pH units			0.1	6.5	6.5	8.0	8.1	7.8	7.7

Residential Guideline Exceedance (pink)
Industrial Guideline Exceedance (yellow)

Table 2. Background Soil Sampling Results - British Columbia Metals Schedule 4 and 5

Parameter	Unit	Residential Guideline	Industrial Guideline	RDL	BP-Background-1	BP-Background-2	BP-Background-3
Antimony	µg/g	20	40	0.1	0.3	0.3	0.3
Arsenic	µg/g	12	12	0.1	6.3	11.6	32.1
Barium	µg/g	500	2000	0.5	268	310	56.1
Beryllium	µg/g	4	8	0.1	0.6	1.4	1.9
Boron (Hot Water Soluble)	µg/g			0.1	<0.1	0.2	0.5
Cadmium	µg/g	10	22	0.01	0.65	0.76	1.58
Chromium	µg/g	64	87	1	15	19	35
Cobalt	µg/g	50	300	0.1	7.1	10.5	20.5
Copper	µg/g	63	91	0.2	16.1	11.0	63.5
Lead	µg/g	140	600	0.1	9.7	8.3	8.5
Mercury	µg/g	6.6	50	0.01	0.02	0.12	0.23
Molybdenum	µg/g	10	40	0.2	0.4	0.5	1.7
Nickel	µg/g	50	50	0.5	17.0	23.1	34.8
Selenium	µg/g	1	3.9	0.1	0.3	0.3	0.3
Silver	µg/g	20	40	0.5	<0.5	<0.5	<0.5
Thallium	µg/g	1	1	0.1	0.2	0.2	0.3
Tin	µg/g	50	300	0.2	0.4	0.6	2.7
Vanadium	µg/g	130	130	1	16	20	43
Zinc	µg/g	200	360	1	47	60	217
pH 1:2	pH units			0.1	7.6	7.8	7.6

(pink)	Residential Guideline Exceedance
(yellow)	Industrial Guideline Exceedance

Table 3. Contaminated Soil Sampling Results - Petroleum Hydrocarbons (BTEX/F1-F4)

Parameter	Unit	Residential Guideline	Industrial Guideline	RDL	BP-Comp-1	BP-Comp-2	BP-Discrete-1	BP-Discrete-2	BP-Discrete-3	BP-Discrete-4
Benzene	mg/kg	0.5	5	0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Toluene	mg/kg	0.8	0.8	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
Ethylbenzene	mg/kg	1.2	20	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Xylenes	mg/kg	1	20	0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
C6 - C10 (F1)	mg/kg	30	320	10	<10	<10	<10	40	<10	10
C6 - C10 (F1 minus BTEX)	mg/kg			10	<10	<10	<10	40	<10	10
C10 - C16 (F2)	mg/kg	150	260	10	<10	3200	3530	5200	3940	4550
C16 - C34 (F3)	mg/kg	300	1700	10	73	3560	4180	6170	5320	5510
C34 - C50 (F4)	mg/kg	2800	3300	10	29	716	675	816	879	910

Residential Guideline Exceedance
Industrial Guideline Exceedance

Table 4. Background Soil Sampling Results - Petroleum Hydrocarbons (BTEX/F1-F4)

Parameter	Unit	Residential Guideline	Industrial Guideline	Reported Detection Limit	BP-Background-1	BP-Background-2	BP-Background-3
Benzene	mg/kg	0.5	5	0.005	<0.005	<0.005	<0.005
Toluene	mg/kg	0.8	0.8	0.05	<0.05	<0.05	<0.05
Ethylbenzene	mg/kg	1.2	20	0.01	<0.01	<0.01	<0.01
Xylenes	mg/kg	1	20	0.05	<0.05	<0.05	<0.05
C6 - C10 (F1)	mg/kg	30	320	10	<10	<10	<10
C6 - C10 (F1 minus BTEX)	mg/kg			10	<10	<10	<10
C10 - C16 (F2)	mg/kg	150	260	10	<10	<10	<10
C16 - C34 (F3)	mg/kg	300	1700	10	<10	<10	21
C34 - C50 (F4)	mg/kg	2800	3300	10	<10	<10	18

Residential Guideline Exceedance
Industrial Guideline Exceedance