Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

2018 REMEDIATION SUMMARY

FORMER AKLAVIK POWER PLANT
68° 13’ 6.24” NORTH AND 135° 0’ 21.24” WEST
AKLAVIK, NORTHWEST TERRITORIES

Report Prepared for:
NORTHWEST TERRITORIES POWER CORPORATION

Prepared by:
MATRIX SOLUTIONS INC.

Version 1.0
January 2019
Calgary, Alberta

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68° 13’ 6.24” NORTH AND 135° 0’ 21.24” WEST
AKLAVIK, NORTHWEST TERRITORIES

Report prepared for Northwest Territories Power Corporation, January 2019

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January 22, 2019

Northwest Territories Permit to Practice

Permit No. 378

DISCLAIMER

VERSION CONTROL

Version	Date	Issue Type	Filename	Description
V0.1	14-Dec-2018	Draft	21784-546 R 2018-12-14 draft V0.1.docx	Issued to client for review
V1.0	21-Jan-2019	Final	21784-546 R 2019-01-22 final V1.0.docx	Issued to client

EXECUTIVE SUMMARY

The Northwest Territories Power Corporation retained Matrix Solutions Inc. to apply a biological method of soil remediation at its former electricity generation plant in Aklavik, Northwest Territories. The bioaugmentation program began with construction of a biotreatment cell in July 2017. A biotreatment cell was constructed to treat petroleum-impacted soils and to contain surface water runoff. The impacted soils were treated with Bio-Reclaim™ bioaugmentation solution in 2017.

Soil analysis from the biotreatment cell indicates a reduction in hydrocarbon concentrations and a discernable shift consistent with bacteria breaking down hydrocarbon molecules into smaller molecules. Trend analysis suggests concentrations in the top 0 to 2 m of the biotreatment cell will meet applicable guidelines within 2 to 4 years. The remaining 2 to 3 m of soils undergoing treatment have shown a shift from fraction 4 (F4; $C_{>34}$) to fraction 3 (F3; $C_{>16}$-C_{34}), to fraction 2 (F2; $C_{>10}$-C_{16}), concentrations, indicating degradation is occurring; however, the estimated time to meet the applicable guidelines is up to 54 years. It is anticipated the rate of degradation will increase in the bottom 2 to 3 m following the reduction in F4 concentrations.

Thermistor data indicated that soils within the biotreatment cell decreased below zero for the winter months, but were above zero during the summer months, suggesting permafrost did not infiltrate the bottom of the pile.

A water treatment system was recommissioned to treat surface water runoff from the biotreatment pile. Water was pumped through the treatment system from the collection sump in the biotreatment cell. Following treatment and approval from the Water Resources Officer, 59.8 m^3 of treated water was discharged to the drainage ditch along the north edge of the site. The system was winterized in October 2018, with plans to resume operations in summer 2019.

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1 INTRODUCTION

The Northwest Territories Power Corporation (NTPC) retained Matrix Solutions Inc. to apply a biological method of soil remediation at its former electricity generation plant in Aklavik, Northwest Territories. Bioaugmentation success has been reported for sites in northern Alberta, but this program marked the first time that Bio-Reclaim™ has been used in the Northwest Territories. The program began with construction of a biotreatment cell in 2017, and will continue until petroleum hydrocarbon (PHC) concentrations in soils undergoing treatment are sufficiently reduced or stop declining.

The project is governed by a water licence issued by the Inuvialuit Water Board (IWB 2016; Appendix A) and this licence requires a final report by June 30, 2019. Matrix prepared the following interim report to document activities completed in 2018.

2 BACKGROUND

2.1 Site Setting

The site is a former power station situated in the hamlet of Aklavik, located on the Peel Channel of the west side of the Mackenzie River Delta (Figure 1), approximately 100 km south of the Beaufort Sea and 55 km west of Inuvik. The site legal description is Lots 58, 58A, and 58B, LTO 33, Plan CLSR 40355.

A site plan is provided on Figure 2. The current land use is industrial. Surrounding land uses are residential to the north and commercial to the west. There is an Anglican Church cemetery south of the site. Areas to the east are undeveloped.

The site topography is flat, sloping gently to the southeast. Peel Channel bends around the south side of Aklavik. The distance between the channel shores to the east and the south of the site is approximately 250 m. A layer of gravel and clay fill covers most of the site, underlain by the original topsoil and clayey silt (Figure 3); the depth to permafrost is approximately 1.2 to 2.1 m below ground surface (bgs).

2.2 Operational History

The site historically had a power plant that used Bunker C to generate electricity. In the mid-1970s, a new powerhouse was constructed to support a switch to fuel oil (diesel). In addition to the powerhouse, former infrastructure included an aboveground diesel storage tank (AST) and an office. Remaining infrastructure includes a concrete dock used to support the original generator, a smaller concrete pad, and a chain-link fence around the perimeter.

2.3 Previous Investigations

The site has been the subject of four environmental site assessments (ESAs; Figure 2):

- A July 1997 Phase II ESA (EBA 1998) included digging 16 test pits; analytical results suggested that most of the soil impacts were south of the former AST. This observation was based on the highest total petroleum hydrocarbon (TPH) concentrations at the south property line, including 96,000 mg/kg at a depth of 0.6 m bgs from a test pit south of the former AST, and 39,000 mg/kg at a depth of 0.3 m bgs from a test pit located between the former AST and the concrete dock.

- A groundwater assessment in 2002 (Golder 2002) included digging five test pits to a depth between 1.8 and 2.2 m bgs and installing five groundwater monitoring wells (Golder 2002). The well farthest to the north had no detectable PHCs, while other wells on the site had benzene, toluene, ethylbenzene, and PHC fraction 2 (F2; $C_{>10}$-C_{16}) concentrations higher than applicable Canadian Council of Ministers of the Environment guidelines.

- A Phase III ESA in June and July 2003 included soil sampling from an additional 22 test pits and 8 manual boreholes offsite in the cemetery, plus groundwater sampling of the 5 wells (Biogenie 2004). The assessment concluded that an estimated 2,720 m^3 of hydrocarbon-impacted soils was present on NTPC's property at an average depth of 1.8 m bgs. Limited data suggested that site soils were also impacted with polycyclic aromatic hydrocarbons higher than the *Environmental Guidelines for Contaminated Site Remediation* (Northwest Territories 2003) for residential/parkland land use.

- In August 2015, Matrix used hand augers to collect soil samples to a depth of 1 m. Concentrations of hydrocarbons and metals exceeded *Environmental Guidelines for Contaminated Site Remediation* (Northwest Territories 2003). Impacts in the south portion of the site were consistent with the historical location of the Bunker C generator and included PHC fraction 3 (F3; $C_{>16}$-C_{34}; 280 to 42,300 mg/kg), fraction 4 (F4; $C_{>34}$; 7,710 to 25,800 mg/kg), and metals (copper, nickel, and zinc) consistent with historical fuel spillage and engine wear. Impacts in the north section of the site (where the 1970s powerhouse was built) were characterized by elevated levels of PHC F2 (1,660 to 22,700 mg/kg) indicative of diesel. Arsenic levels exceeded guidelines at multiple locations; this is attributable to imported gravel from a nearby quarry and is not considered a contaminant of concern.

2.4 Biotreatment Cell Construction

The biotreatment cell was constructed in July 2017 by K&D Contracting Ltd. under Matrix's supervision (Matrix 2017). Impacted soil was excavated from the northeast area of the site and stockpiled along the south area of the site to create the footprint of the biotreatment cell. The excavation was rectangular in shape, measuring approximately 17 m wide by 28 m long (Figures 4 and 5). The depth of excavation varied from 1.1 m on the north side to 1.6 m on the south. A water collection sump was created for surface water drainage along the west side of the biotreatment cell to allow pumping of surface water

runoff from the biotreatment soils and an earthen berm was constructed around the biotreatment cell for water containment. Following the excavation, approximately 280 m^3 of clean clay fill was hauled in to build a smooth base followed by a 30 mil impermeable geomembrane, underlain and overlain with geotextile. A 30 cm gravel layer was placed over the geotextile for drainage under the biotreatment pile (Figure 6). Overtop of the gravel is another layer of geotextile, upon which the contaminated soils were placed. The total soil volume from the excavation is estimated to be 920 m^3, which includes 180 m^3 from the former bioventing treatment cell that was decommissioned in 2015. This soil volume was spread across soil-bearing footprint of the biotreatment cell and was approximately 3.4 m above ground surface. An aerial photograph of the biocell on July 14, 2017 is provided as Figure 7.

The impacted soil was inoculated with a one-time treatment of Bio-Reclaim™ bioaugmentation solution as it was placed in the biotreatment cell. The Bio-Reclaim™ was mixed onsite with potable water in plastic drums and left to develop for 24 hours before being sprayed onto the soil along with a surfactant. The application was completed as the impacted soil was placed in the biotreatment cell in layers to uniformly distribute the Bio-Reclaim™ throughout the pile. Due to dry atmospheric and soil conditions, a local water truck was used to hydrate the impacted soils as they were placed in the biotreatment cell.

An array of temperature sensors was installed to monitor whether the soils have sufficient warmth in the summer months to achieve biotreatment, to monitor how and when the pile freezes and thaws, and to assess whether soils at the base of the biotreatment cell stay cold, ideally near freezing. Three sensors were placed in three locations at 1 m depth intervals and a reflectometer was placed outside of the pile in a radiation shield to measure atmospheric moisture content and temperature. The nine sensors and the reflectometer are wired into a CR1000 data logger mounted inside a storage box connected to an onsite power supply and solar panel.

2.5 Regulatory Framework

Construction and operation of the biotreatment cell is subject to a licence issued by the IWB for depositing waste in accordance with territorial water legislation (Appendix A).

Annex 1, Part B, Item 5 of the water licence required submitting a quality assurance (QA)/quality control (QC) plan for the project. Matrix prepared and submitted a QA/QC plan in 2016 (Appendix B) and received notice on May 29, 2017 from Taiga Environmental Laboratory, on behalf of the Government of the Northwest Territories, that the plan was acceptable.

Matrix prepared a remediation and reclamation action plan (Appendix C) to comply with Part G, Item 1 of the water licence. On June 16, 2017, the IWB provided approval of this plan. Operation of the water treatment system and discharge of treated water is subject to conditions of the approval.

3 2018 ACTIVITY SUMMARY

The objective of the 2018 program was to monitor and operate a biotreatment cell for remediating soils impacted by PHCs. This work included the following activities:

- sampling soils within the biotreatment cell to assess remediation progress
- collecting, treating, testing, and releasing water from the biotreatment cell
- monitoring temperature within the biotreatment cell
- providing health and safety leadership
- continued regulatory liaison related to the above

4 METHODS

4.1 Health and Safety

Matrix personnel were required to comply with legislated, Matrix, and NTPC health and safety standards.

Throughout the 2018 field program, Matrix fulfilled Prime Contractor duties and provided supervision/guidance to K&D Contracting Ltd. personnel retained to work at the site. This included an initial contractor orientation, daily tailgate meetings, and hazard identification discussions.

4.2 Water Collection, Treatment, and Release

The onsite water treatment system was used to treat the surface water captured within the biotreatment cell. The water treatment system includes submersible pumps, settling tank, water treatment unit, and a post-treatment 40 m^3 Terra Tank™ to store the water until release (Figure 4). The water was treated in a three-stage process. First, the water was passed through a bag filter to remove entrained particulates and sediment. Second, the water was passed through two vessels containing a clay medium. Third, the water was filtered through two vessels containing an activated carbon medium, to remove any liquid- or dissolved-phase hydrocarbons.

Following a rain event or accumulation of water in the biotreatment cell, personnel from K&D Contacting Ltd. were onsite to operate the water treatment system. This included operating the submersible pumps, monitoring pressures, and collecting water samples of the treated water for laboratory analysis. Water samples were collected from the water treatment system discharge port and from the post treatment holding tank. Samples were shipped to AGAT Laboratories in Edmonton, Alberta, for analysis of parameters specified in the water licence (Appendix A). Treated water was discharged to the drainage ditch to the north of the site following approval from the IWB. Water was gravity drained from the holding tank through a 50 mm hose and flow was monitored to ensure there was no erosion along the drainage ditch.

The water treatment system was recommissioned on June 19, 2018, following the spring thaw, and was operational through October 2, 2018, when it was winterized. Winterization of the system included draining water from the pumps, lines, treatment vessels, and tanks, and placing system components in the onsite sea-can for storage during the winter months.

4.3 Soil Sampling

During the spring site visit to recommission the water treatment system on June 19, 2018, a limited soil sampling program was conducted. Samples were collected at five locations at 1 to 2 and 2 to 3 m depth intervals.

Following the summer treatment season, 30 samples from within the biotreatment cell were collected on October 18, 2018, to compare to the base characterization samples. The samples were collected at ten locations at 0 to 1, 1 to 2, and 2 to 3 m depth intervals.

The samples were sent to AGAT Laboratories in Edmonton, for analysis of benzene, toluene, ethylbenzene, and xylenes (BTEX) and PHCs fraction 1 (F1; C_6-C_{10}, excluding BTEX), F2, F3, and F4.

5 RESULTS

5.1 Soil Quality

Concentrations in the soils before placement in the biotreatment cell exceeded the Northwest Territories guidelines for F2 and F3 concentrations in all samples collected. F1 and F4 concentrations were within guidelines for all samples collected.

In 2018, soils within the biotreatment cell were sampled in June (10 samples) and October (30 samples) to evaluate the effectiveness of treatment with Bio-Reclaim™. Results are provided in Table 1.

- In June (after 11 months of treatment), samples continued to exceed Northwest Territories guidelines for F2 and F3 concentrations in all samples and exceeded F1 concentrations in five of ten samples.

- In October (following 15 months of treatment), samples continued to exceed Northwest Territories guidelines for F3 concentrations in all samples and exceeded for F2 concentrations in 28 of 30 samples. F1 concentrations in two of the 30 samples collected exceeded guidelines.

Average concentrations since placement in the biocell are tabulated below in Table A.

TABLE A Average Petroleum Hydrocarbon Concentrations in Biocell Soil - All Depths

Constituent	Concentration (mg/kg)			
	July 2017	September 2017	June 2018	October 2018
F1 + BTEX (C_6-C_{10})	67	690	610	328
F2 (C_{10}-C_{16})	6,638	5,281	7,154	3,812
F3 (C_{16}-C_{34})	7,128	7,371	9,828	6,145
F4 (C_{34}+)	296	510	541	406
TPH (C_6-C_{34}+)	14,110	13,853	18,742	11,019

In October 2018 (after 15 months of treatment), TPH concentrations showed a 22% decrease since placement in the biocell. The apparent increase in concentrations in June 2018 is attributed to collecting only 10 samples, compared to 30 samples in all other sampling events.

Over the time there have been discernable shifts in composition. Histograms showing concentrations of each fraction during each 30-sample event are presented on Figure A.

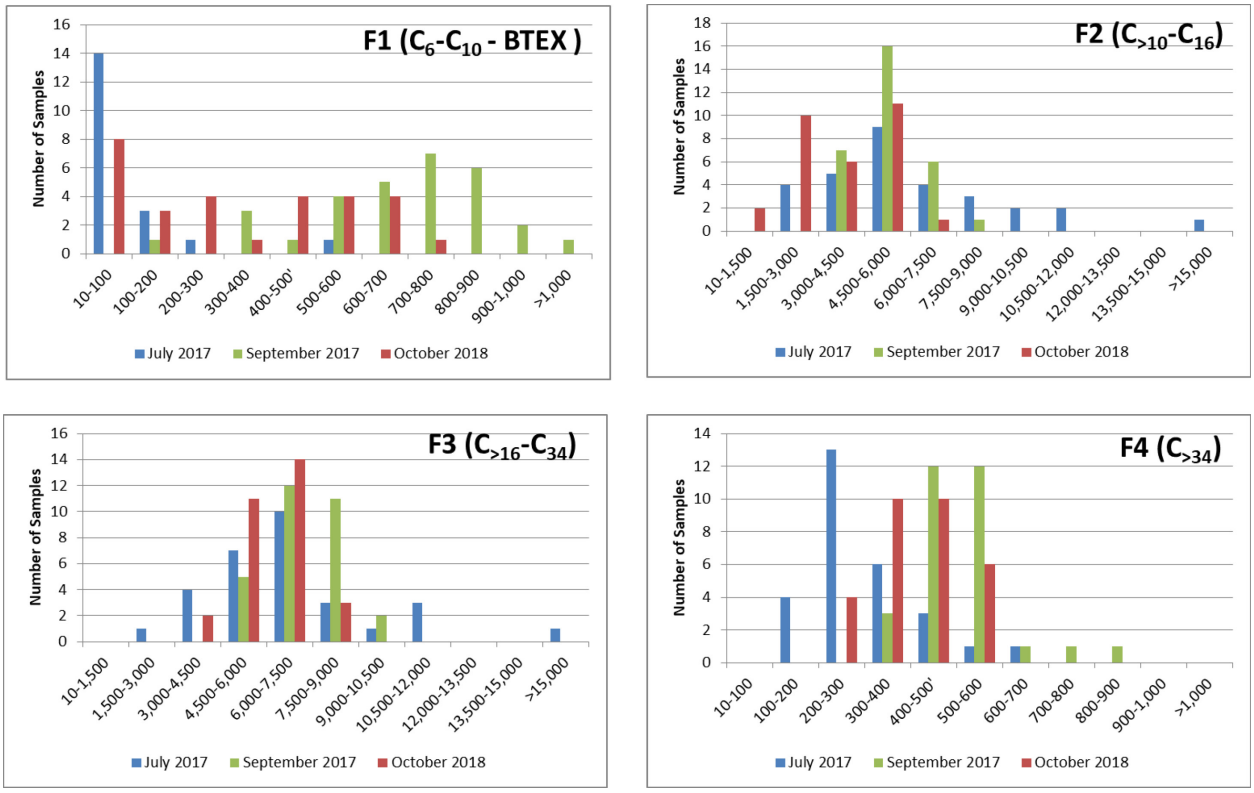

FIGURE A Histograms of Hydrocarbon Fraction Composition over Time

The increased concentrations of F1 and decreased concentrations of F2 between July and September 2017 suggest that some of the F2 degraded to F1, consistent with bacteria breaking down hydrocarbon molecules into smaller molecules. The October 2018 data show a reduction in all hydrocarbon concentrations, consistent with biodegradation.

The reduction of hydrocarbon concentrations varied by depth and is summarized in Tables B through D.

TABLE B Average Petroleum Hydrocarbon Concentrations in Biocell Soil - 0 to 1 m

Constituent	Concentration (mg/kg)		Reduction
	September 2017	October 2018	
F1 + BTEX (C_6-C_{10})	591	118	80%
F2 (C_{10}-C_{16})	5,191	2,751	47%
F3 (C_{16}-C_{34})	7,575	5,322	30%
F4 (C_{34}+)	461	400	13%
TPH (C_6-C_{34}+)	14,409	8,710	40%

TABLE C Average Petroleum Hydrocarbon Concentrations of in Biocell Soil - 1 to 2 m

Constituent	Concentration (mg/kg)		Reduction
	September 2017	October 2018	
F1 + BTEX (C_6-C_{10})	848	447	47%
F2 (C_{10}-C_{16})	5,977	4,479	25%
F3 (C_{16}-C_{34})	8,035	6,714	16%
F4 (C_{34}+)	481	429	11%
TPH (C_6-C_{34}+)	16,190	12,515	23%

TABLE D Average Petroleum Hydrocarbon Concentrations of in Biocell Soil - 2 to 3 m

Constituent	Concentration (mg/kg)		Reduction
	September 2017	October 2018	
F1 + BTEX (C_6-C_{10})	630	419	33%
F2 (C_{10}-C_{16})	4,676	4,205	10%
F3 (C_{16}-C_{34})	6,504	6,398	2%
F4 (C_{34}+)	589	390	34%
TPH (C_6-C_{34}+)	13,029	11,832	9%

As the tables show, the greatest reduction in F1 to F3 and TPH concentrations was observed in the top 0 to 1 m depth interval. The greatest reduction in F4 concentrations was in the 2 to 3 m depth of the

biotreatment cell. Remaining hydrocarbon concentrations in the 2 to 3 depth interval showed a smaller reduction in F1 to F3 constituents, suggesting degradation from F4 to F3 and F1.

Ambient air temperatures and average temperatures of the upper (0 to 1 m), middle (1 to 2 m), and bottom (2 to 3 m) are plotted on Figure 8. Thermistor data indicated that soils within the biotreatment cell trend with ambient temperature. As expected, the temperatures of the upper soils in the biotreatment pile were more variable, seeming to react to the ambient air temperatures. The middle and bottom soils were slower to react to changes in ambient temperature and were above freezing well after ambient temperatures dropped below freezing in late 2017 and were below freezing for approximately a month after the upper soils thawed in 2018. The bottom of the biotreatment cell was above freezing during the summer months of 2018, suggesting permafrost did not aggrade into the biotreatment pile.

Table E presents the estimated number of years remaining to reach the applicable soil guidelines, based on trend analysis.

TABLE E Estimated Time to Reach Applicable Guidelines by Depth in Biocell Soil

Constituent	Time to Meet Applicable Guidelines (Years) by Depth		
	0 to 1 m	1 to 2 m	2 to 3 m
F1 + BTEX (C_6-C_{10})	Not persistent; expected to reduce before heavier PHCs		
F2 (C_{10}-C_{16})	2	4	7
F3 (C_{16}-C_{34})	4	2	54
F4 (C_{34}+)	Does not exceed guidelines		

Trend analysis suggests F2 and F3 concentrations in the top 0 to 2 m of the biotreatment cell will meet applicable guidelines in 2 to 4 years; however, F3 concentrations in the bottom 2 to 3 m of the biotreatment cell are estimated to take up to 54 years. Concentrations of F3 in the bottom 2 to 3 m may be related to the degradation from F4 to F3 and it is expected the reduction rate of F3 will increase following the reduction in F4 concentrations. Based on the thermistor data, the hydrocarbon degradation in the bottom 2 to 3 m of the biotreatment cell was likely at a different stage than the rest of the pile during sample collection in October 2018, as temperatures were only above zero for two months before sampling. Based on previous thermistor data, it is assumed that degradation in the bottom 2 to 3 m of the pile was still ongoing after the upper soils froze, and subsequent sampling events will refine the estimated time to meet the applicable guidelines.

5.2 Water Quality

The analytical results of the water collected from the treatment system were compared to the site-specific water release criteria specified in the water licence (Table 2). As the table shows, all concentrations were within the site-specific release criteria except for the total suspended solids (TSS)

from August 5, 2018. Subsequent samples show the TSS reduced to below release criteria. Results were discussed with the Water Resources Officer designated by the IWB and approval was granted for the release of the water. On July 5, 2018, 30.2 m^3 of treated water was released, and on July 30, 2018, 29.6 m^3 was released. Treated water was discharged using gravity drainage to the ditch along the north side of the site.

The post-treatment sample collected on August 5, 2018 exceeded the release criteria for TSS. After discussions with the Water Resources Officer, release of the water was not permitted. Water was drained back into the biotreatment cell, so that the water treatment system could be winterized.

6 DISCUSSION AND CONCLUSIONS

After 15 months, soil testing indicated shifts and reductions in PHC composition consistent with bacteria breaking down hydrocarbon molecules into smaller molecules. It is expected that biodegradation will continue. Monitoring PHC concentrations over time will refine treatment rate and remediation timeline estimates. A total of 59.8 m^3 of treated water was released into the municipal ditch system in 2018. Water released from site met release criteria specified in IWB Licence N3L8-1838.

7 RECOMMENDATIONS

Following the remediation activities in 2018, Matrix has the following recommendations for further remediation of the site, in support of the remediation and reclamation action plan (Appendix C):

- Complete a soil sampling program on the biotreatment cell in the spring and fall of 2019 to refine treatment rates and efficacy.

- Operate the water treatment system as necessary in 2019.

8 REFERENCES

Biogenie S.R.D.C. Inc. (Biogenie). 2004. *Phase III Environmental Site Assessment, NTPC Powerplant, Aklavik, Northwest Territories*. Prepared for Northwest Territories Power Corporation. Sainte Foy, Québec. February 2004. 2004.

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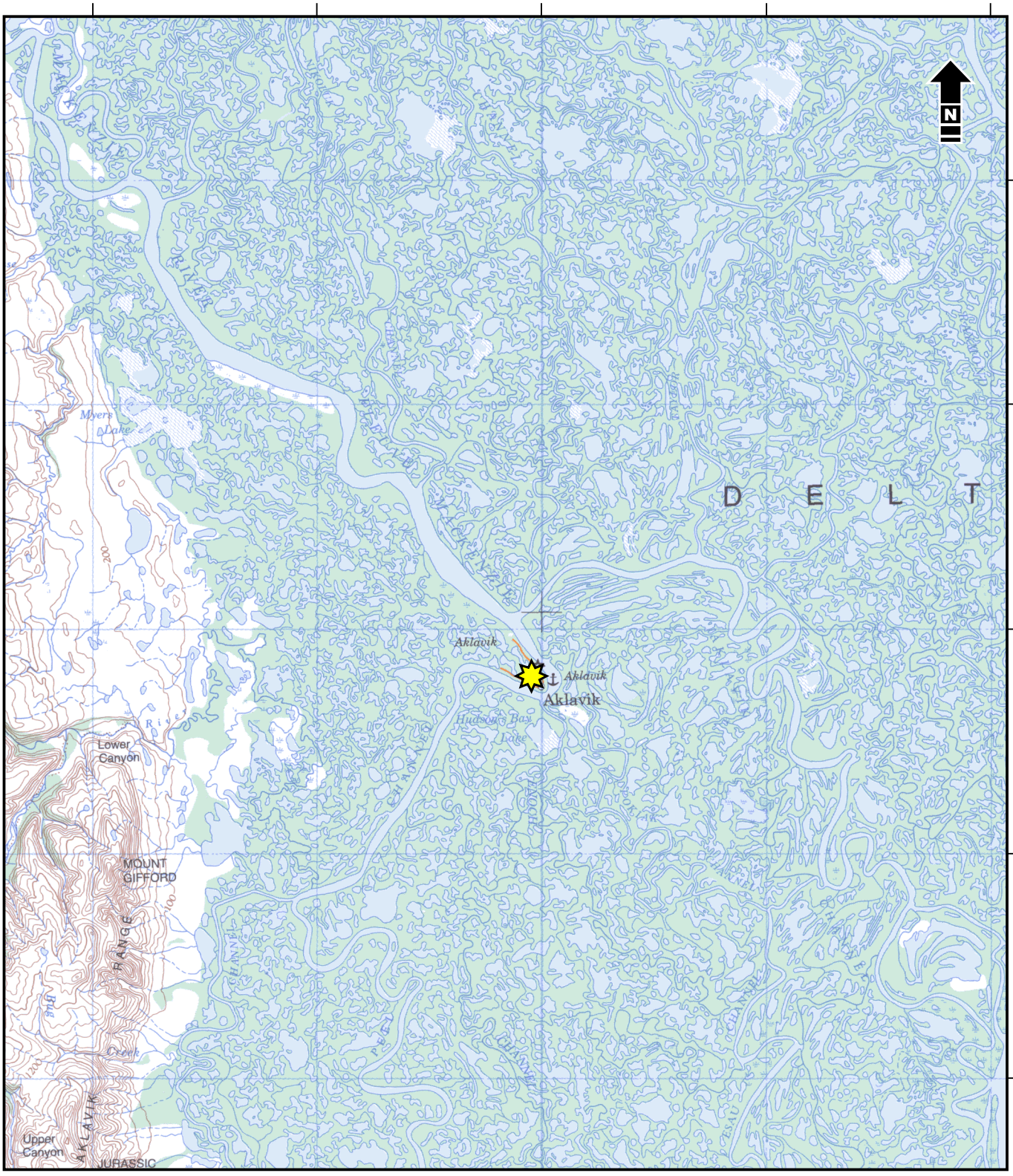
Northwest Territories Environment and Natural Resources (NWT ENR). 2003. *Environmental Guideline for Contaminated Site Remediation*. November 2003. http://mvlwb.com/sites/default/files/documents/Environmental-Guideline-for-Contaminated-Site-Remediation.pdf



Site Location

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Northwest Territories Power Corporation
Lot 58, 58A and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

Site Location Map

Date:	Project:	Technical:	Reviewer:	Drawn:
April 2016	21784-LP-16	D. Felske	M. Allan	J. Kern

Figure 1

Reference: 107 B (Aklavik), Edition 1.1, UTM Zone 08, NAD83

1:250,000 metres
2,500 0 2,500 5,000

F:\21784\Drafting\2016\21784-LP-16.cdr

Plot 1:1 = Tabloid (L)

Easting (m)

499740 499750 499760 499770 499780 499790 499800 499810 499820 499830 499840 499850

Northing (m)

7567250 7567240 7567230 7567220 7567210 7567200 7567190 7567180 7567170 7567160

Hvatum Rd

Gardlund Rd

Gate

Aklavik Anglican Cemetery

Lot 58

Lot 58A

Lot 58B

Former Powerhouse

Former Pad

Former Pad

Former Gravel Stockpile

Former Biopile (~180 m^3)

Tank #1102

Blower

Office

Dock

Log Shed

2008 Excavation

2003 Excavation

2004 Excavation

2003 Excavation

D1

D2

D3

A

A'

A02–5 A02–4 A02–3 A02–2 A02–1

15–H1 15–H2 15–H3 15–H4 15–H5 15–H6 15–H7 15–H8 15–H9 15–H10 15–H11 15–H12 15–H13 15–H14 15–H15 15–H16

TP1 TP2 TP3 TP4 TP5 TP6 TP7 TP8 TP9 TP10 TP11 TP12 TP13 TP15 TP16 TP17 TP18 TP19 TP20 TP21 TP22

TP–1 TP–2 TP14 TP–3 TP–4 TP–5 TP–6 TP–7 TP–8 TP–9 TP–10 TP–11 TP–12 TP–13 TP–14 TP–15 TP–16

MS1 MS2 MS3 MS4 MS5 MS6 MS7 MS8

SSC–1 SSC–2 SSD–1 SSE–1 SSE–2

N

- Monitoring Well
- Hand Auger
- Former Pile (Removed 2015)
- Test Pit (EBA - 1998)
- Hand Auger (Golder - June 2003)
- Test Pit (Biogénie - July 2003)
- Manual Borehole (Biogénie - July 2003)
- Grave Site
- Fence
- Former Site Feature
- Estimated Limits of Contamination
- A—A' Cross-section

Reference:
Historical site information referenced from Request for Proposals (RFP No. 21511) Soil Remediation Project report provided by Northwest Territories Power Corporation.

1:400 metres
4 0 4 8
UTM83-08

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

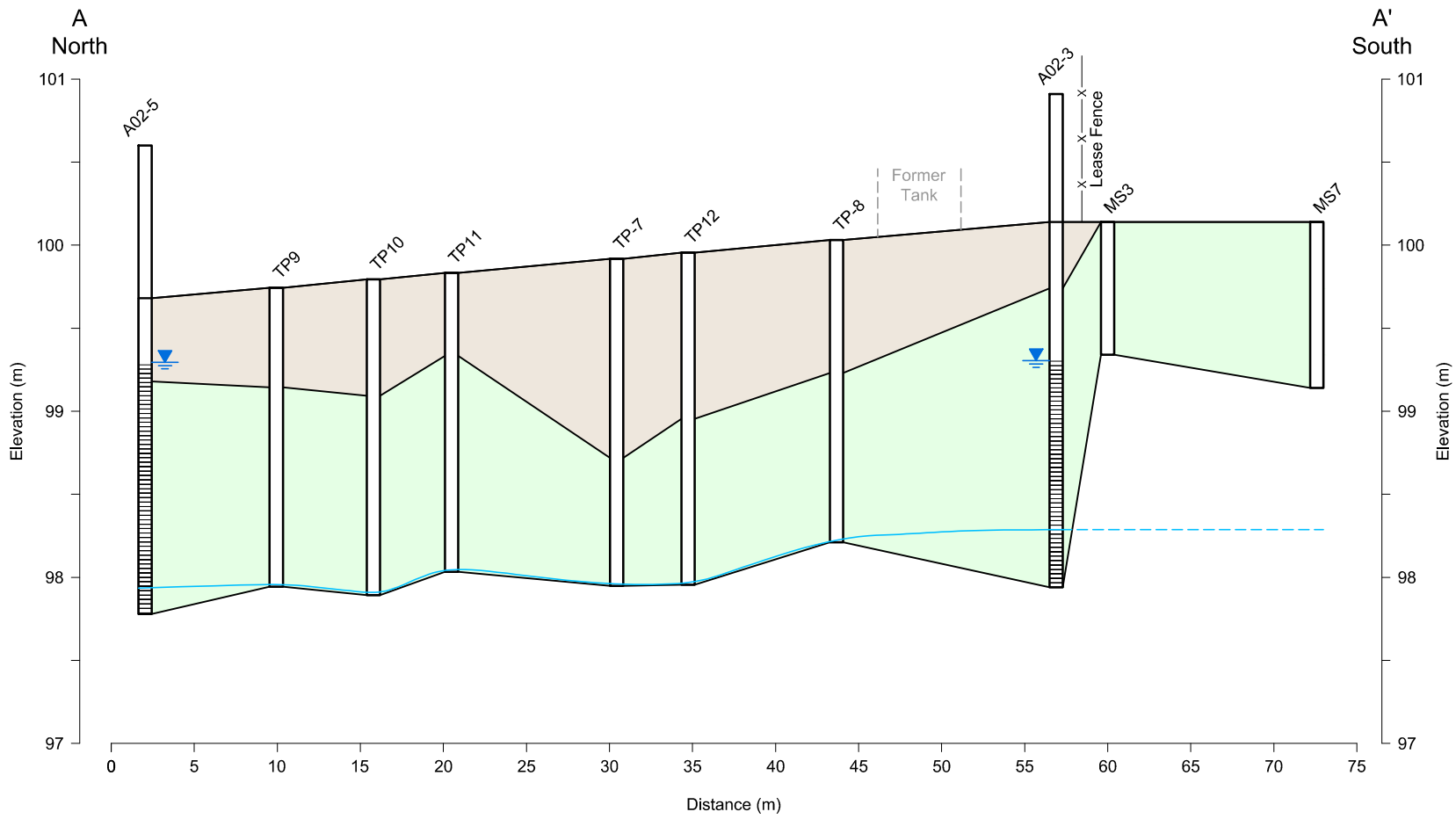
Northwest Territories Power Corporation
Lot 58, 58A, and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

Site Plan Showing Historical Information

Date:	Project:	Technical:	Reviewer:	Drawn:
April 2016	21784-SP-15	S. Pluim	M. Allan	E. Rugayan

Figure 2

\\matrix-solutions.com\public\Active_Projects\21784\Drafting\2015\21784-SP- 15.dwg - StiotCSM - Thursday, April 14, 2016 4:26:09 PM - Edward Rugayan



Fill

Silt

Permafrost - July 1, 2003

Permafrost Inferred - July 1, 2003

Monitoring Well

Groundwater Elevation (m) August 2002

Screened Interval

Test Pit

1:40 metres

0.4 0 0.4 0.8

Vertical Scale

1:400 metres

4 0 4 8

Horizontal Scale

Reference:

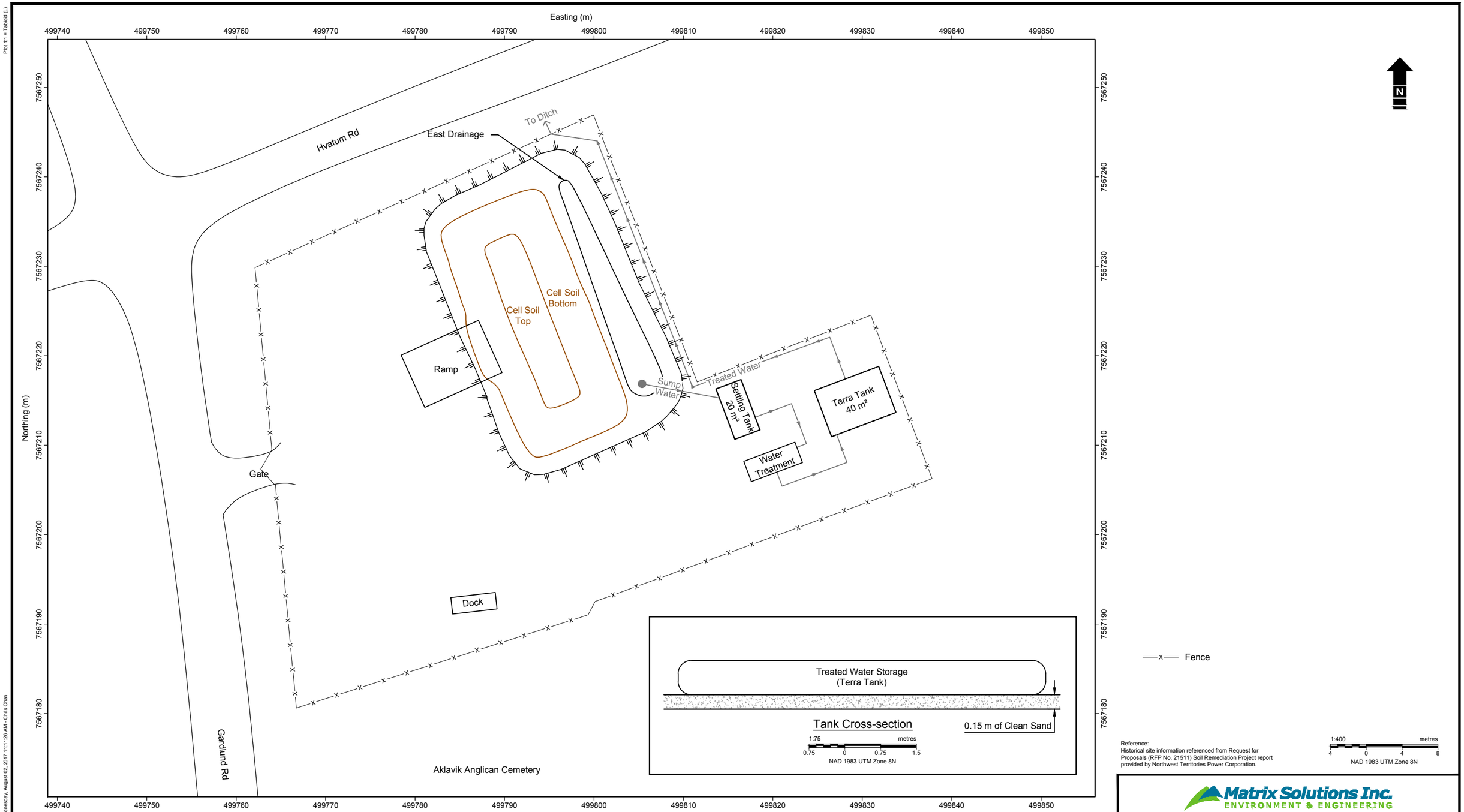
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Northwest Territories Power Corporation
Lot 58, 58A, and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

North - South Cross-section A - A'

Date:	Project:	Technical:	Reviewer:	Drawn:
April 2016	21784-SP-15	S. Pluim	M. Allan	E. Rugayan

Figure 3



Reference:
Historical site information referenced from Request for Proposals (RFP No. 21511) Soil Remediation Project report provided by Northwest Territories Power Corporation.

Notes:
Drawing(s) must be used in conjunction with the attached report, Remedial Action Plan dated April 18, 2016 and is subject to the limitations and conditions stated in the report.

STAMP

Permit to Practice No.: L3176

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
1		Issued for Review			

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Northwest Territories Power Corporation
Lot 58, 58A, and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

Plan View of Biotreatment Cell and Water Treatment

Date:	Project:	Submitter:	Reviewer:
July 2017	21784-SP-17	R. Wenzel	M. Allan

Figure 4

Easting (m)

499770 499775 499780 499785 499790 499795 499800

Northing (m)

7567240 7567235 7567230 7567225 7567220 7567215 7567210 7567205 7567200 7567195

N

A'

A

B'

B

To Ditch

Ramp

Water Collection Sump

Pump

Sump Water

Treated Water

Treated Water

Settling Tank
20 m³

Water Treatment

Notes:
1. Drawing(s) must be used in conjunction with the attached report, Remedial Action Plan dated April 18, 2016 and is subject to the limitations and conditions stated in the report.
2. The base of the Biotreatment Cell shall be graded to establish an approximate 1% slope towards the water collection sump.
3. Soil Internal Storage Capacity = 1,000 m^3 Soils
4. Internal Water Storage Capacity = 230 m^3 (Cell with Soil)

499790 499795 499800 499805 499810 499815 499820

—x— Fence

Footprint of Biotreatment Soils

1:150 metres

1.5 0 1.5 3

NAD 1983 UTM Zone 8N

STAMP

Permit to Practice No.: L3176

REVISION					
2		Issued for Review			
No.	DATE	DESCRIPTION	BY	CHK.	DRN.

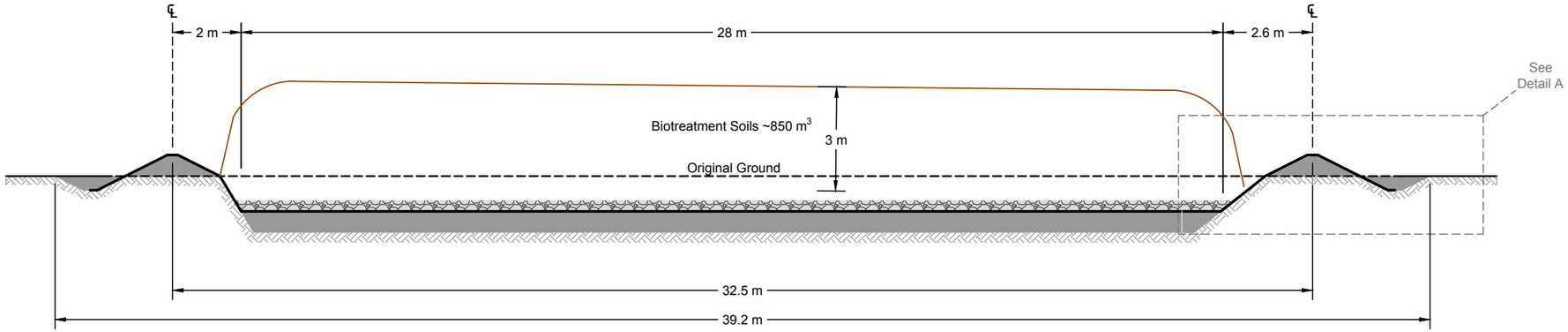
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Northwest Territories Power Corporation
Lot 58, 58A, and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

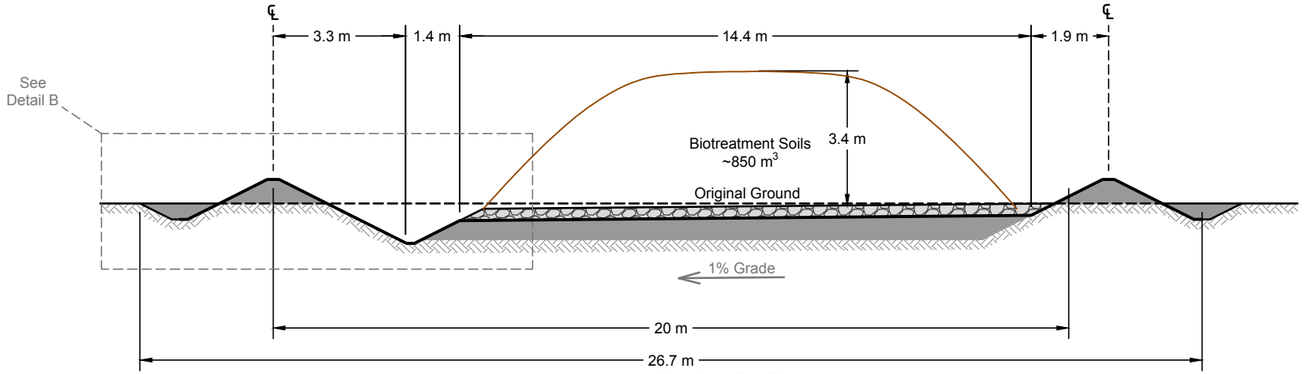
Plan View of Biotreatment Cell

Date:	Project:	Submitter:	Reviewer:
July 2017	21784-SP-17	R. Wenzel	M. Allan

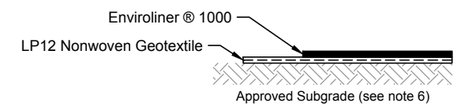
Figure 5



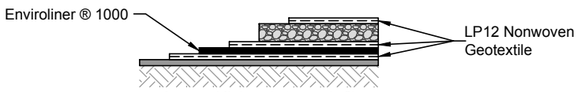
Section A - A'



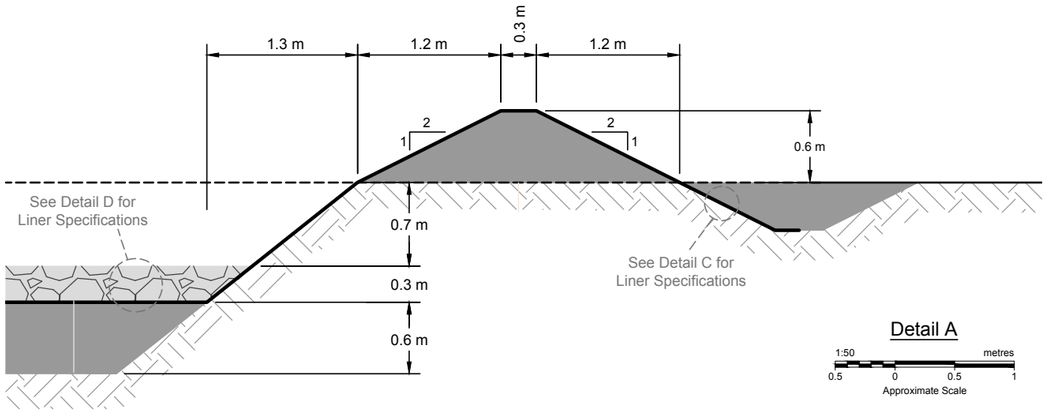
Section B - B'



Detail C
Not To Scale

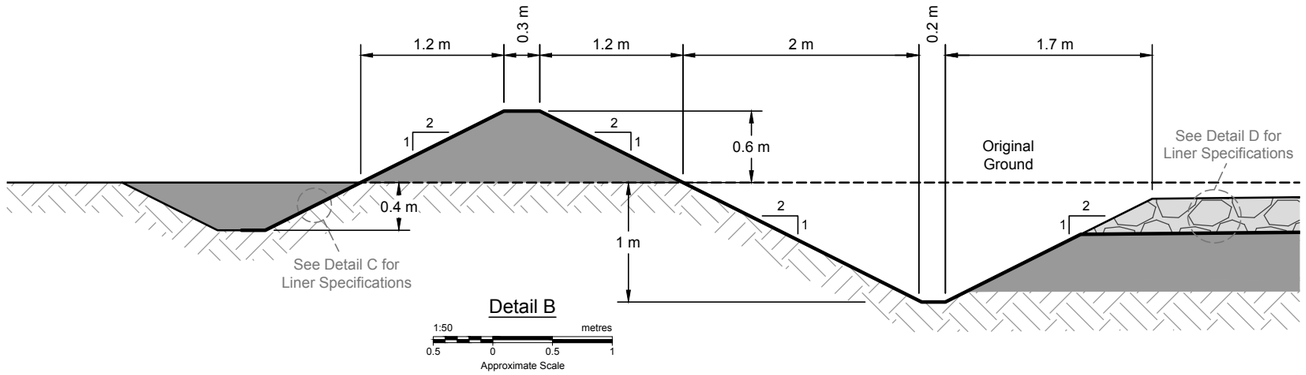


Detail D
Not To Scale



Detail A

1:50 metres
0.5 0 0.5 1
Approximate Scale



Detail B

1:50 metres
0.5 0 0.5 1
Approximate Scale

Fill

Gravel

Notes:
1. Drawing(s) must be used in conjunction with the attached report dated May 13, 2016 and is subject to the limitations and conditions stated in the report.
2. Scales and Dimensions are approximate.
3. Crest of perimeter Berm will be a minimum 0.6 m in height but may be increased to accommodate field conditions.
4. Geomembrane will be installed according to manufactures recommendations.
5. Existing grades assumed to flat and level.
6. The subgrade shall be smooth and free of sharp objects and rocks greater than 30 mm.
7. Liner and membrane to be anchored in place as shown or equivelent method.

1:150 metres
1.5 0 1.5 3
Approximate Scale

STAMP

Permit to Practice No.: L3176

REVISION

No.	DATE	DESCRIPTION	BY	CHK.	DRN.
3		Issued for Review			

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Northwest Territories Power Corporation
Lot 58, 58A, and 58B, LTO 33, Plan CLSR 40355, Aklavik, NT

Cross-section Details

Date:	Project:	Submitter:	Reviewer:
July 2017	21784-SP-17	R. Wenzel	M. Allan

Figure 6

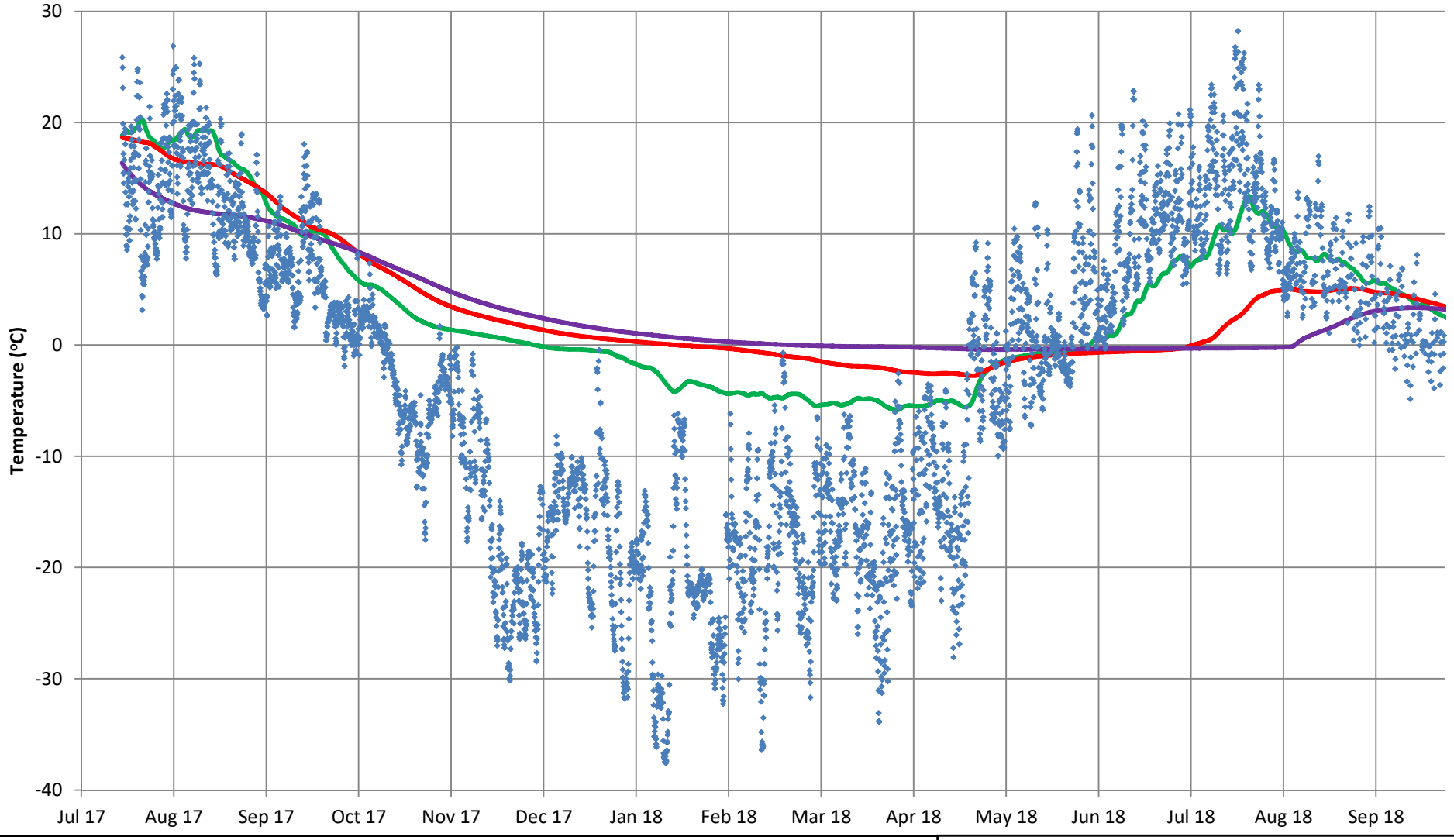
Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Northwest Territories Power Corporation
Lot 58, 58A, LTO 33, Plan CLSR 40355, Aklavik, NT

Aerial Photograph of Biotreatment Cell
July 14, 2017

Date:	Project:	Technical:	Reviewer:	Drawn:
November 2017	21784	S. McIntyre	M. Allen	S. McIntyre

Figure 7



Air Temp

Upper

Middle

Bottom

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

Northwest Territories Power Corporation
Lot 58, 58A, LTO 33, Plan CLSR 40355, Aklavik, NT

Biotreatment Thermistor Data

Date:	Project:	Technical:	Reviewer:	Drawn:
November 2017	21784	S. McIntyre	M. Allen	S. McIntyre

Figure 8

TABLE 1

Soil Quality Results - Hydrocarbons

Northwest Territories Power Corporation

Aklavik, N.W.T.

Sample Point	Start Depth m	End Depth m	Sample Date	MSI Sample Number	Benzene mg/kg	Toluene mg/kg	Ethylbenzene mg/kg	Xylenes mg/kg	F1 C_6-C_{10} - BTEX mg/kg	F2 $C_{>10}$-C_{16} mg/kg	F3 $C_{>16}$-C_{34} mg/kg	F4 $C_{>34}$ mg/kg	Moisture %
Biocell: Start of 2018 Season													
18-S1	1	2	19-Jun-18	21784180619001	0.024	<0.05	0.36	1.17	360	*7560*	*10900*	581	16.0
18-S1	2	3	19-Jun-18	21784180619002	0.041	<0.05	0.78	1.88	*690*	*8500*	*11200*	528	15.0
18-S2	1	2	19-Jun-18	21784180619003	0.019	<0.05	0.34	1.55	*670*	*7580*	*10300*	546	15.0
18-S2	2	3	19-Jun-18	21784180619004	0.027	<0.05	0.6	1.56	*680*	*7170*	*9710*	468	16.0
18-S3	1	2	19-Jun-18	21784180619005	0.012	<0.05	0.19	0.51	470	*7350*	*10200*	482	19.0
18-S3	2	3	19-Jun-18	21784180619006	0.031	<0.05	0.65	1.56	*760*	*6270*	*8420*	533	16.0
18-S4	1	2	19-Jun-18	21784180619007	0.011	<0.05	0.18	0.55	600	*7300*	*10000*	491	15.0
18-S4	2	3	19-Jun-18	21784180619008	0.032	<0.05	0.49	1.45	*760*	*6210*	*8280*	508	17.0
18-S5	1	2	19-Jun-18	21784180619009	0.014	<0.05	0.15	0.45	480	*6340*	*9170*	660	16.0
18-S5	2	3	19-Jun-18	21784180619010	0.044	<0.05	1	1.57	610	*7260*	*10100*	608	15.0
Biocell: End of 2018 Season													
18-X1	0	1	02-Oct-18	21784181002001	0.01	<0.05	0.09	0.23	40	*2960*	*5830*	410	18.0
18-X1	1	2	02-Oct-18	21784181002002	0.017	<0.05	0.61	1.19	590	*4980*	*6970*	540	18.0
18-X1	2	3	02-Oct-18	21784181002003	0.011	<0.05	0.15	0.22	10	1320	*5080*	410	24.0
18-X2	0	1	02-Oct-18	21784181002004	0.009	<0.05	0.08	0.14	50	*2800*	*5890*	460	19.0
18-X2	1	2	02-Oct-18	21784181002005	0.024	<0.05	1.76	3.35	*690*	*5460*	*6670*	340	17.0
18-X2	2	3	02-Oct-18	21784181002006	0.033	<0.05	2.84	3.92	*790*	*5240*	*6100*	270	18.0
18-X3	0	1	02-Oct-18	21784181002007	0.007	<0.05	0.1	0.15	90	*2150*	*4230*	310	19.0
18-X3	1	2	02-Oct-18	21784181002008	0.02	<0.05	1.47	2.17	490	*3520*	*4770*	340	17.0
18-X3	2	3	02-Oct-18	21784181002009	0.028	<0.05	1.67	2.26	500	*4810*	*6690*	440	17.0
18-X4	0	1	02-Oct-18	21784181002010	0.007	<0.05	0.11	0.16	70	*3240*	*5960*	480	18.0
18-X4	1	2	02-Oct-18	21784181002011	0.007	<0.05	0.15	0.3	140	*2250*	*6080*	510	17.0
18-X4	2	3	02-Oct-18	21784181002012	0.016	<0.05	0.39	0.68	160	*2990*	*6400*	530	20.0
18-X5	0	1	02-Oct-18	21784181002013	0.011	<0.05	0.41	0.78	410	*3310*	*4600*	270	18.0
18-X5	1	2	02-Oct-18	21784181002014	0.007	<0.05	0.33	0.65	380	*4710*	*6670*	360	16.0
18-X5	2	3	02-Oct-18	21784181002015	0.007	<0.05	0.12	0.22	70	1450	*4040*	280	18.0
18-X6	0	1	02-Oct-18	21784181002016	0.006	<0.05	0.17	0.31	220	*2970*	*5470*	330	16.0
18-X6	1	2	02-Oct-18	21784181002017	<0.005	<0.05	0.21	0.42	250	*4130*	*6670*	380	19.0
18-X6	2	3	02-Oct-18	21784181002018	0.006	<0.05	0.22	0.49	280	*3390*	*6180*	430	17.0
18-X7	0	1	02-Oct-18	21784181002019	<0.005	<0.05	0.1	0.15	70	*2240*	*5320*	470	20.0
18-X7	1	2	02-Oct-18	21784181002020	0.009	<0.05	0.39	1	570	*5150*	*7730*	500	16.0
18-X7	2	3	02-Oct-18	21784181002021	0.037	<0.05	1.05	1.9	650	*6050*	*7420*	400	16.0
NWT - Fine Grained Surface Soil - Industrial*					**5**	**0.8**	**20**	**20**	**660ES**	**1500ES**	**2500ES**	**6600ES**	**NS**

TABLE 1

Soil Quality Results - Hydrocarbons

Northwest Territories Power Corporation

Aklavik, N.W.T.

Sample Point	Start Depth m	End Depth m	Sample Date	MSI Sample Number	Benzene mg/kg	Toluene mg/kg	Ethylbenzene mg/kg	Xylenes mg/kg	F1 C_6-C_{10} - BTEX mg/kg	F2 $C_{>10}$-C_{16} mg/kg	F3 $C_{>16}$-C_{34} mg/kg	F4 $C_{>34}$ mg/kg	Moisture %
Biocell: End of 2018 Season													
18-X8	0	1	02-Oct-18	21784181002022	<0.005	<0.05	0.12	0.17	130	*2600*	*5220*	510	14.0
18-X8	1	2	02-Oct-18	21784181002023	0.013	<0.05	0.56	0.98	540	*5380*	*8220*	520	19.0
18-X8	2	3	02-Oct-18	21784181002024	0.014	<0.05	0.32	0.82	440	*5620*	*8490*	530	16.0
18-X9	0	1	02-Oct-18	21784181002025	<0.005	<0.05	0.06	0.1	40	*2570*	*5010*	410	18.0
18-X9	1	2	02-Oct-18	21784181002026	0.005	<0.05	0.12	0.23	230	*3920*	*6650*	460	20.0
18-X9	2	3	02-Oct-18	21784181002027	0.033	<0.05	1.22	1.99	620	*5730*	*7020*	310	16.0
18-X10	0	1	02-Oct-18	21784181002028	<0.005	<0.05	0.07	0.08	60	*2670*	*5690*	350	19.0
18-X10	1	2	02-Oct-18	21784181002029	0.011	<0.05	0.27	0.74	570	*5290*	*6710*	340	17.0
18-X10	2	3	02-Oct-18	21784181002030	0.027	<0.05	1.05	1.76	650	*5450*	*6560*	300	15.0
NWT - Fine Grained Surface Soil - Industrial*					**5**	**0.8**	**20**	**20**	**660ES**	**1500ES**	**2500ES**	**6600ES**	**NS**

Notes:

ES - Eco Soil Contact exposure pathway

F4 - F4 fraction shown represents either extractable, gravimetric or post-silica gel gravimetric petroleum hydrocarbons (PHC)

* - excludes Protection of Potable Groundwater exposure pathway; *Environmental Guideline for Contaminated Site Remediation* (Northwest Territories 2003)

Italics - values do not meet Environmental Guideline for Contaminated Site Remediation (Northwest Territories 2003) guidelines

TABLE 2

Water Quality Results - Water Characterization

Northwest Territories Power Corporation

Aklavik, N.W.T.

Sample Point		Pre-treatment	Post-Treatment	Holding Tank	Post-Treatment	Post-Treatment	Post-treatment	Post-treatment	Site Specific
Sample Date		19-Jun-18	19-Jun-18	19-Jun-18	17-Jul-18	05-Aug-18	01-Sep-18	23-Sep-18	Water Release
MSI Sample Number		21784180619101	21784180619102	21784180619103	21784180717001	21784180805001	21784180901001	21784180923001	Criteria*
General and Inorganic Parameters									
Lab pH		8.11	8.32	8.37	8.02	8.21	7.98	7.8	**6 to 9**
Lab Electrical Conductivity	µS/cm	785	759	939	845	987	898	947	**NS**
Calcium	mg/L	120	109	115	125	145	138	154	**NS**
Magnesium	mg/L	32.2	31.2	28.3	35.7	44.2	37.4	46.2	**NS**
Sodium	mg/L	5.5	9.4	27.1	7.9	7.7	6.6	7.8	**NS**
Potassium	mg/L	2.1	4.2	23.1	3.7	4	3.9	4.2	**NS**
Chloride	mg/L	2.3	2.5	41.9	4	3.2	3	3.8	**NS**
Sulphate	mg/L	295	265	293	323	366	335	377	**NS**
Fluoride	mg/L	0.14	0.21	0.34	<0.05	0.18	<0.05	0.2	**NS**
Nitrite-Nitrogen	mg/L	<0.01	<0.01	<0.01	<0.02	<0.01	<0.02	<0.01	**NS**
Nitrate-Nitrogen	mg/L	0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	**NS**
(Nitrite + Nitrate)-Nitrogen	mg/L	0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	**NS**
Total Alkalinity	mg/L	136	118	149	130	159	139	161	**NS**
Bicarbonate	mg/L	166	143	175	159	194	170	196	**NS**
Hardness	mg/L	432	401	404	459	544	499	575	**NS**
Total Dissolved Solids	mg/L	539	492	615	577	666	608	689	**NS**
Total Suspended Solids	mg/L	2	<2	8	4	*18*	---	3	**15**
Total Metals									
Aluminum	mg/L	0.048	0.06	0.123	0.047	0.053	0.031	0.022	**NS**
Antimony	mg/L	0.004	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	**NS**
Arsenic	mg/L	<0.001	<0.001	0.001	<0.001	0.001	<0.001	<0.001	**NS**
Barium	mg/L	0.07	<0.05	0.05	<0.05	<0.05	<0.05	<0.05	**NS**
Beryllium	mg/L	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	<0.001	<0.0005	**NS**
Boron	mg/L	0.12	2.1	4.6	0.71	0.35	0.33	0.31	**NS**
Cadmium	mg/L	0.000056	0.000038	0.000098	<0.000016	<0.000016	0.000021	<0.000016	**NS**
Chromium	mg/L	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	<0.001	0.0006	**NS**
Cobalt	mg/L	<0.0009	<0.0009	<0.0009	<0.001	<0.0009	<0.001	<0.0009	**NS**
Copper	mg/L	0.0015	0.0035	0.0036	0.003	0.0039	0.008	0.0033	**NS**
Iron	mg/L	0.3	1.3	1.7	2	4.3	1.6	0.8	**NS**
Lead	mg/L	<0.0005	0.0011	0.0014	0.0009	0.0006	0.0019	0.0006	**0.007**[H]
Lithium	mg/L	0.005	0.005	0.007	0.006	0.009	0.008	0.007	**NS**
Manganese	mg/L	0.419	0.297	0.294	0.169	0.176	0.059	0.013	**NS**
Mercury	mg/L	---	---	---	---	<0.000025	---	<0.000025	**NS**
Molybdenum	mg/L	0.002	0.002	0.002	0.002	0.002	0.002	0.002	**NS**
Nickel	mg/L	0.003	0.003	<0.003	<0.003	0.004	<0.003	0.003	**NS**
Selenium	mg/L	0.0011	0.001	0.0023	<0.0005	<0.0005	<0.0005	0.0007	**NS**
Silicon	mg/L	0.869	1.18	1.37	1.52	--	1.75	--	**NS**
Silver	mg/L	0.0002	<0.0001	<0.0001	<0.00005	<0.0001	0.00005	<0.0001	**NS**
Strontium	mg/L	0.268	0.37	0.562	0.356	--	0.391	--	**NS**
Thallium	mg/L	<0.0001	<0.0001	<0.0001	<0.0005	<0.0001	<0.0005	<0.0001	**NS**
Tin	mg/L	<0.0001	<0.0001	0.0005	<0.003	--	<0.003	--	**NS**
Titanium	mg/L	0.001	<0.001	0.001	0.015	0.002	<0.03	0.001	**NS**
Uranium	mg/L	0.003	0.003	0.004	0.003	0.003	0.003	0.003	**NS**
Vanadium	mg/L	<0.001	<0.001	<0.001	<0.001	0.001	<0.001	<0.001	**NS**
Zinc	mg/L	0.007	0.504	1.09	0.25	0.323	0.32	0.214	**NS**
Petroleum Hydrocarbons									
Benzene	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	---	<0.0005	**0.37**
Toluene	mg/L	<0.0003	<0.0003	<0.0003	<0.0003	<0.0003	---	<0.0003	**0.002**
Ethylbenzene	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	---	<0.0005	**0.09**
Xylenes	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	---	<0.0005	**0.03**
Styrene	mg/L	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	--	<0.0005	**NS**
VHw (C_6-C_{10})	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	--	<0.1	**NS**
EPHw (C_{10}-C_{19})	mg/L	0.5	<0.1	0.4	0.4	0.2	--	0.1	**NS**
LEPHw (C_{10}-C_{19})**	mg/L	0.3	0.1	0.4	0.4	0.2	--	0.1	**NS**
EPHw (C_{19}-C_{32})	mg/L	0.5	<0.1	0.4	0.2	0.2	--	<0.1	**NS**
HEPHw (C_{19}-C_{32})**	mg/L	0.3	0.1	0.4	0.2	0.2	--	<0.1	**NS**
Total Petroleum Hydrocarbons	mg/L	0.1	0.8	0.8	0.6	0.4	---	0.1	**5**
Oil & Grease	mg/L	0.8	<0.2	0.9	<0.2	0.4	0.6	0.5	**5**
Polycyclic Aromatic Hydrocarbons									
Acenaphthene	µg/L	<0.01	<0.01	<0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Acridine	µg/L	<0.05	<0.05	<0.05	<0.00005	<0.00005	--	<0.00005	**NS**
Anthracene	µg/L	<0.010	<0.010	<0.010	<0.000010	<0.000010	--	<0.00001	**NS**
Benzo[a]anthracene	µg/L	<0.01	<0.01	<0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Benzo[a]pyrene	µg/L	<0.007	<0.007	<0.007	<0.007	<0.007	---	<0.007	**0.015**
Chrysene	µg/L	<0.01	<0.01	<0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Fluoranthene	µg/L	<0.01	<0.01	<0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Fluorene	µg/L	<0.01	<0.01	<0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Naphthalene	µg/L	0.03	<0.01	0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Phenanthrene	µg/L	0.03	<0.01	<0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Pyrene	µg/L	<0.01	<0.01	<0.01	<0.00001	<0.00001	--	<0.00001	**NS**
Quinoline	µg/L	<0.04	<0.04	<0.04	<0.00004	<0.00004	--	<0.00004	**NS**

Notes:

NS - not specified

--- - not analyzed

[H] - dependent on hardness value

[†] - laboratory visual determination

* - *Water Licence N3L8-1838* (Inuvialuit Water Board 2016)

Italics - indicates values do not meet applicable guidelines

APPENDIX A
Inuvialuit Water Board, Licence N3L8-1838

INUVIALUIT SIVUNNIUQPAIT IMAKKUN

INUVIALUIT WATER BOARD

August 5, 2016

Mr. Joshua Clark
Environmental Analyst
Northwest Territories Power Corporation
4 Capital Drive
Hay River, NT X0E 1G2

Dear Mr. Clark:

Re: N3L8-1838 – Northwest Territories Power Corporation – Remediation and Reclamation of the former Aklavik Power Plant Site, Aklavik, NWT

The Inuvialuit Water Board (IWB) is pleased to attach Water Licence N3L8-1838 granted to the Northwest Territories Power Corporation in accordance with the *Waters Act* for the period commencing August 15, 2016 and expiring December 31, 2019. Included with the attached Licence are the Terms and Conditions applying to the licence and the General Procedures for the Administration of Licences in that portion of the Inuvialuit Settlement Region located in the Northwest Territories. Please review the Licence, the Terms and Conditions and the General Procedures carefully and address any questions to the IWB.

A copy of this Licence and all documentation associated with the application for and issuance of this Licence has been filed in the Public Register. Copies are available at the IWB office and on the IWB website. All inspection reports and other documentation related to the implementation of this Licence will also be filed in the Public Register. All Public Register material will be considered if an amendment to the Licence is requested.

The IWB appreciates the cooperation of Northwest Territories Power Corporation in complying with the Terms and Conditions of the Licence. Should you have questions or concerns, please contact Mardy Semmler, Executive Director at (867) 678-2942.

Sincerely,

Roger Connelly
Chairperson

Attachments

Copied to: Philippe Thibert-Leduc, Water Resources Officer – ENR, Inuvik Region

INUVIALUIT SIVUNNIUQPAIT IMAKKUN

INUVIALUIT WATER BOARD

INUVIALUIT WATER BOARD

Pursuant to the *Waters Act* and Waters Regulations the Inuvialuit Water Board, hereinafter referred to as the Board, hereby grants to

Northwest Territories Power Corporation

4 Capital Drive
Hay River, NT X0E 1G2
(Mailing Address)

hereinafter called the Licensee, the right to deposit waste as provided for under the *Waters Act* and Waters Regulations and subject to and in accordance with the terms and conditions specified in this Licence.

Licence Number	N3L8-1838
Licence Type	"B"
Water Management Area	Northwest Territories 03
Location	68° 13' 6.24" North and 135° 0' 21.24" West Northwest Territories
Purpose	Waste Disposal
Description	Miscellaneous Undertaking
Quantity of Water Not To Be Exceeded	Not Applicable
Effective Date of Licence	August 15, 2016
Expiry Date of Licence	December 31, 2019

This Licence issued and recorded at Inuvik includes and is subject to the annexed conditions.

INUVIALUIT WATER BOARD

Chairperson

August 5 2016
Date

PART A: SCOPE AND DEFINITIONS

1. Scope

a) This Licence entitles the Licencee to dispose of waste associated with a miscellaneous undertaking for the remediation and reclamation of the former power plant site located in Aklavik within the Inuvialuit Settlement Region (ISR) of the Northwest Territories and with coordinates 68° 13' 6.24" North and 135° 0' 21.24" West.

b) This Licence is issued subject to the conditions contained herein with respect to the depositing of waste of any type in any waters or in any place under any conditions where such waste or any other waste that results from the deposits of such waste may enter any waters. Whenever new Regulations are made or existing Regulations are amended by the Commissioner in Executive Council under the *Waters Act*, or other statutes imposing more stringent conditions relating to the quantity or type of waste that may be so deposited or under which any such waste may be so deposited, this Licence shall be deemed, upon promulgation of such Regulations, to be automatically amended to conform with such Regulations.

c) Compliance with the terms and conditions of this Licence does not absolve the Licensee from responsibility for compliance with the requirements of all applicable federal, territorial and municipal legislation for which any and all applicable licences and permits shall also be obtained by Licensee.

d) This Licence is issued subject to the conditions contained herein with respect to the deposit of waste as prescribed in Section 11 of the *Waters Act*.

2. Definitions

In this Licence: N3L8-1838

"Act" means the *Waters Act*;

"Amendment" means a change to any terms and conditions of this Licence as provided for under Section 36 (1)(b) of the *Waters Act*;

"Analyst" means an analyst designated by the minister under Section 65 (1) of the *Act;*

"Board" means the Inuvialuit Water Board continued under Section 13 (1) of the *Act;*

"Closure" means the permanent dismantlement of one or more components of the Project with the intent of making the components incapable of its intended use. This includes the removal of associated equipment and structures used in the construction or maintenance of the Project;

"Construction" means any activities undertaken to construct or build any component of, or associated with, the remediation, reclamation and closure of the Project;

"Discharge" or "Deposit" means the direct or indirect release of any waters or waste to the receiving environment;

"Engineer" means a professional engineer registered with the Northwest Territories and Nunavut Association of Professional Engineers and Geoscientists and whose principal field of specialization is appropriate to address the components of the undertaking at hand;

"Inspector" means an inspector designated by the minister under Section 65 (1) of the *Act*;

"Licence" means this Type B Water Licence N3L8-1838 as issued by the Board in accordance with the *Act*, to the Licensee;

"Licensee" means the holder of this Licence;

"Minister" means a duly appointed member of the Executive Council who is responsible for the *Act*;

"Modification" means an alteration to a physical work that introduces a new structure or replaces or eliminates an existing structure and does not alter the purpose or function of the work, but does not include an expansion;

"Monitoring Program" means any program designed to collect data on the quality or quantity of surface water or ground water to assess impacts on the environment of the Project;

"Project" means the remediation and reclamation activities to be carried out at the former Aklavik power plant site, Aklavik NT as defined in the Water Licence Application and associated documents, which includes the Description of Undertaking;

"Receiving Environment" means, for the purpose of this Licence, the natural environment that receives any deposit or discharge of waste, including seepage or runoff, from the Project;

"Reclamation" means the process of restoring the Project area as nearly as possible to the same condition as it was prior to the commencement of the licensed activity;

"Regulations" means Waters Regulations promulgated pursuant to Section 63 of the *Act*;

"Remediation" means the removal, reduction or neutralization of substances, wastes or hazardous materials from a site so as to prevent or minimize any adverse effects on the environment now or in the future;

"Seepage" includes water or waste that drains through or escapes from any structure designed to contain, treat, withhold, divert or retain water or waste;

"Spill" means to allow or accidentally release waste from containment vessels or structures into the receiving environment;

"Surveillance Network Program (SNP)" means a monitoring program established to define environmental sampling and analysis requirements, as detailed in Annex 1 of this Licence, to collect water quality data, and to assess discharge quality, compliance with Licence Terms and Conditions and potential for Licensee activity impact on the environment;

"Unauthorized Discharge" is a discharge of any water or waste not authorized under this Licence;

"Waste" means any substance defined as waste as defined by Section 1 of the *Act;*

"Water Licence Application" means the Type B Water Licence application received on June 13, 2016 and all supplemental information submitted to the Board;

"Waters" means any waters as defined by Section 1 of the *Act.*

PART B: GENERAL CONDITIONS

1. The Licensee shall file an Annual Report with the Board no later than January 31 of each year which shall contain the following information on Project related activities during the prior 12 month period January 1 to December 31:
    a) the monthly and annual quantities in cubic metres (m^3) of treated water discharged into the municipal drainage ditch;
    b) the monthly and annual quantities in cubic metres (m^3) of treated contaminated soil at the bio-treatment facility;
    c) a summary report which includes all data and information generated under the "Surveillance Network Program (SNP)";
    d) a list and description including location and volumes of all unauthorized discharges and spills, and summaries of all associated remediation activities and follow-up action taken;
    e) a description of any spill and operational training carried out;
    f) the results of any monitoring program undertaken (e.g. temperature, moisture of bio-treatment cell);
    g) a summary of remediation, reclamation and closure activities completed;
    h) A report complete with summary, conclusion and recommendation. The report will include analytical data and a description of any work anticipated for the next year.

2. The Licensee shall comply with the "Surveillance Network Program" annexed to this Licence, and any amendment to the said "Surveillance Network Program" as may be made from time to time, pursuant to the conditions of this Licence.

3. The "Surveillance Network Program" and compliance dates specified in the Licence may be modified at the discretion of the Board.

4. Any meters, devices or other such methods used for measuring the volumes of waste disposed and discharged shall be installed, operated and maintained by the Licensee to the satisfaction of the inspector.

5. The Licensee shall ensure a copy of this Licence is maintained at the site of operations at all times.

6. The Licensee shall, at a minimum, implement all of the policies, practices, mitigation measures, recommendations and procedures for the protection of the environment referred to in its application, Description of Undertaking and other documents submitted regarding the remediation and reclamation of the former power plant site in Aklavik. All field operations staff shall be provided with appropriate advice/training on how to implement these policies, practices, mitigation measures, recommendations and procedures.

7. The Licensee shall ensure that all contractors and sub-contractors conform to all Terms and Conditions of this Licence.

8. The Licensee shall take every reasonable precaution to protect the environment.

9. All equipment used during the Project activities shall be mechanically sound and free of leaks.

10. In a form acceptable to the Board, the Licensee shall submit two (2) copies of all reports, plans, maps and drawings in printed format accompanied by two (2) electronic copies (CD's).

PART C: CONDITIONS APPLYING TO WASTE DISPOSAL

1. The Licensee shall collect precipitation and groundwater seepage from the excavation and bio-treatment facility and pump it to the water treatment system for treatment.

2. All treated water discharged to the existing municipal drainage ditch north of the site at "Surveillance Network Program" Station Number 1838-1 shall meet the following effluent quality requirements:

Parameter	Maximum Concentration of any Grab Sample
Total suspended solids	15 mg/L
Oil and grease	5 mg/L and no visible sheen
Benzene	0.37 mg/L
Toluene	0.002 mg/L
Ethylbenzene	0.090 mg/L
Xylene	0.03 mg/L
Benzo*(a)*pyrene	0.000015 mg/L
Total Petroleum Hydrocarbons	5 mg/L
pH	Between 6 and 9
Total lead	When the hardness is 0 to ≤ 60 mg/L ($CaCO_3$), the maximum concentration is 0.001 mg/L At hardness >60 to ≤ 180 mg/L the maximum concentration is calculated using equation: $e^{[1.273[\ln(\underline{hardness})]-4.705]}$ At hardness >180 mg/L ($CaCO_3$), the maximum concentration is 0.007 mg/L, If the hardness is unknown, the maximum concentration is 0.001 mg/L

3. There should be no discharge of floating solids, garbage, grease, free oil, foam or sheen.

4. The Licensee shall inform the inspector at least five (5) days prior to initiating discharge of treated water to the municipal ditch system.

5. All analyses shall be conducted in accordance with methods prescribed in the current edition of "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, the American Waterworks Association and the Water Environmental Federation or by such other methods as may be approved by an analyst.

6. The Licensee shall contain all contaminated soil in such a manner as to minimize the potential for migration of contaminants into any waters to the satisfaction of the inspector.

7. Unless authorized by this Licence, the Licensee shall ensure that any wastes associated with this undertaking do not enter any water body.

8. Any contaminated soil that is not treated by a bio-treatment facility shall be shipped by the Licensee to a licenced disposal facility or remediated in another manner acceptable to and approved by the Board.

9. The Licensee shall dispose of all contaminated water that does not meet effluent criteria at a licenced disposal facility.

10. When transported off-site, contaminated soil or contaminated water shall be properly contained so as to prevent spillage or dispersal to the satisfaction of the inspector.

11. Where contaminated soils and/or water is to be transported to a licenced disposal facility, the Licensee shall provide to the Board, prior to shipment, copies of agreements or letters between the Licensee and the third parties where the third party has agreed to harbour, transport or dispose of such contaminated water and/or waste.

12. In the event that the surveillance station water quality exceeds the effluent standards outlined in this Licence the inspector shall be immediately notified.

13. The Licensee shall notify the Board and the inspector, in writing, at least forty-eight (48) hours prior to the shipping of any contaminated soil or contaminated water.

PART D: CONDITIONS APPLYING TO SPILL CONTINGENCY PLANNING

1. The Licensee shall submit to the Board for approval, at least five (5) days prior to mobilization, a Spill Contingency Plan in accordance with the "A Guide to the Spill Contingency Planning and Reporting Regulations, updated March 2011" found on the Government of the Northwest Territories, Department of Environment and Natural Resources website: http://www.enr.gov.nt.ca/node/3003.

2. The Licensee shall include in Part D, Item 1 additional information on contingency actions in the event discharge criteria are not achieved including information on the proposed storage capacity, contingency storage capacity and whether offsite disposal at an approved waste disposal location has been considered.

3. If not approved by the Board, the Spill Contingency Plan shall be revised and resubmitted within fifteen (15) days of receiving notification of the Board's decision.

4. The Licensee shall ensure that petroleum products, hazardous material and other wastes associated with the Project do not enter any waters.

5. If, during the period of this Licence, an unauthorised discharge of waste occurs, or if such a discharge is foreseeable, the Licensee shall:
    a) report the incident immediately via the 24 Hour Spill Reporting Line **(867) 920-8130**;
    b) report each spill and unauthorized discharge of waste to the inspector at (867) 678-0623 (Cell), within 24 hours; and
    c) submit to the inspector a detailed report on each occurrence not later than thirty (30) days after initially reporting the event.

6. All spills and unauthorized discharges of water or waste shall be cleaned up and the affected area reclaimed to the satisfaction of the inspector.

PART E: CONDITIONS APPLYING TO MODIFICATIONS

1. the Licensee may, without written approval from the Board, carry out modifications to the planned undertakings provided that such modifications are consistent with the terms of this Licence and the following requirements are met:
    a) the Licensee has notified the Board and the inspector in writing of such proposed modifications at least five (5) days prior to beginning the modifications;
    b) such modifications do not place the Licensee in contravention of either the Licence or the *Act*;

c) the Board has not, during the five (5) days following notification of the proposed modifications, informed the Licensee that review of the proposal will require more than five (5) days; and
d) the Board has not rejected the proposed modifications.

2. Modifications for which the conditions referred to in Part E, Item 1 have not been met may be carried out only with written approval from the Board.

3. The Licensee shall provide to the Board as-built plans and drawings of the modifications signed and stamped by an engineer referred to in this Licence within ninety (90) days of completion of the modifications.

PART F: CONDITIONS APPLYING TO CONSTRUCTION

1. The Licensee shall ensure that construction of the bio-treatment facility and water treatment systems are supervised by an engineer.

2. The Licensee shall undertake necessary corrective measures to mitigate negative impacts on surface drainage resulting from the Licensee's activities to the satisfaction of the inspector.

3. The Licensee shall construct and operate all components of the Project designed to contain, treat, withhold, divert or retain water or waste in accordance with all applicable federal or territorial legislation and industry standards.

4. The Licensee shall provide to the Board, at least five (5) days prior to the mobilization, information for the bio-augmentation product intended to be used as part of the remediation (Bio-Reclaim) including how much of this product will be used, where will be stored, and how and when it will be applied.

5. A minimum of ten (10) days prior to commencement of construction of the bio-treatment facility and water treatment system, the Licensee shall provide written notification to the inspector.

PART G: CONDITIONS APPLYING TO RECLAMATION, CLOSURE AND MONITORING PLAN

1. The Licensee shall, at least five (5) days prior to mobilization, submit a Remediation and Reclamation Action Plan for the Project to the Board for approval.

2. A minimum of six (6) months prior to the expiry of the Licence, the Licensee shall provide to the Board a compilation report containing analytical data and effectiveness of the remediation and reclamation undertaken and water treatment system with summary, conclusion and recommendations.

INUVIALUIT WATER BOARD

Chairperson

August 5. 2016
Date

ANNEX 1: SURVEILLANCE NETWORK PROGRAM

LICENSEE: Northwest Territories Power Corporation
LICENCE NUMBER: N3L8-1838
EFFECTIVE DATE OF LICENCE: August 15, 2016
EFFECTIVE DATE OF SURVEILLANCE NETWORK PROGRAM: August 15, 2016

A. Sampling Stations

Station Number	Description of Sampling Stations
1838-1	Prior to discharge of treated water from storage container to municipal drainage ditch north of the site

B. Sampling and Analysis Requirements

1. Effluent at "Surveillance Network Program" shall be sampled and analyzed prior to discharge for the following parameters:

Station Number and description	Parameters
1838-1: Prior to discharge of treated water from storage container to municipal drainage ditch north of the site	Total suspended solids, Oil and Grease, Benzene, Toluene, Ethylbenzene, Xylene, Benzo*(a)*pyrene, Total Petroleum Hydrocarbon, Hardness, Chloride, Sulphate, pH, Total Cadmium (Cd), Total Chromium (Cr), Total Copper (Cu), Total Iron (Fe), Total Lead (Pb), Total Mercury (Hg), Total Molybdenum (Mo), Total Nickel (Ni), Total Zinc (Zn)

2. Sample collection requirements such as sampling location, frequency and parameters in accordance of the Surveillance Network Program may be modified by the inspector.

3. All sampling, preservation, and analyses shall be conducted in accordance with methods prescribed in the current edition of "Standard Methods for the Examination of Water and Wastewater" published by the American Public Health Association, the American Waterworks Association and the Water Environmental Federation or by such other methods as approved by an analyst.

4. All analysis shall be performed in a laboratory as approved by an analyst.

5. The Licensee shall, within ten (10) days of Licence issuance, submit to an analyst for approval a Quality Assurance/Quality Control Plan, a copy of the approved plan shall be submitted to the Board.

6. The Quality Assurance/Quality Control Plan shall be implemented as approved by an analyst.

C. Flow and Volume Measurement Requirements

1. The Licensee shall measure and record in cubic metres (m^3) the daily, monthly and annual quantities of treated water discharged to the municipal drainage ditch.

D. Reports

1. The Licensee shall submit the following information in electronic and printed formats as part of the **Annual Report** required in Part B, Item 1 of the Licence:

   a) all laboratory results and analysis of all data collected during each SNP sampling period for the previous year;
   b) tabular summaries of all data and information generated under Part B and C of the SNP;
   c) rationale where samples were not collected from the SNP site;
   d) Quality Assurance/Quality Control results and interpretations, in accordance with the approved Quality Assurance/Quality Control Plan;
   e) any interpretive comments and calculations; and
   f) identification of any anomalies and trends.

INUVIALUIT WATER BOARD

Chairperson

August 5, 2016

Date

SUPPLEMENTAL INFORMATION TO BE SUBMITTED BY LICENSEE AS REQUIRED THROUGH LICENCE CONDITIONS

Licence Condition	Report/Others	Timeline for Submission	Required Board Action/Others
Part B, Item 1	Annual Report	Not later than January 31 of each year	Acceptance
Part C, Item 4	Notice of initiating discharge of treated water	At least five (5) days prior to initiating discharge	Inform the inspector
Part C, Item 12	Notice of shipment of any contaminated soil or contaminated water	At least forty-eight (48) hours prior to the shipping	Notify the Board and the inspector in writing
Part D, Item 1	Spill Contingency Plan	At least five (5) days prior to mobilization	Submit to the Board for approval
Part E, Item 1a)	Notice of modification	At least five (5) days prior to beginning the modification	Notify the Board and the inspector
Part E, Item 3	Submission of as-built plans and drawings of the modifications	Within ninety (90) days of completion of the modification	Provide to the Board for acceptance
Part F, Item 4	MSDS of bio-augmentation product	At least five (5) days prior to mobilization	Provide to the Board for acceptance
Part F, Item 5	Notification of construction of the bio-treatment facility and water treatment system	A minimum of ten (10) days prior to commencement	Provide written notification to the inspector
Part G, Item 1	Submission of Remediation and Reclamation Action Plan for the Project	At least five (5) days prior to mobilization	Submit to the Board for approval
Part G, Item 2	Submission of a compilation report	A minimum of six (6) months prior to the expiry of the Licence	Submit to the Board for acceptance
Annex 1: SNP Part B, Item 5	A Quality Assurance/Quality Control	Within ten (10) days of Licence issuance	Submit to an analyst for approval and submit approved plan to the Board

GENERAL PROCEDURES FOR THE ADMINISTRATION OF LICENCES ISSUED UNDER THE *WATERS ACT* IN THAT PORTION OF THE INUVIALUIT SETTLEMENT REGION LOCATED IN THE NORTHWEST TERRITORIES

1. At the time of issuance, a copy of the Licence is placed in the Public Register at the Inuvialuit Water Board (IWB) Office in Inuvik and on the IWB website.

2. To enforce the terms and conditions of the Licence, the Minister of Environment and Natural Resources has appointed Inspectors in accordance with Section 65(1) of the *Waters Act*. The Inspectors coordinate their activities with officials of the Water Resources Division of the Department of Environment and Natural Resources. The Inspector responsible for the Licence is located in the Department of Environment and Natural Resources Office in Inuvik.

3. To keep the IWB and members of the public informed of the Licensee's conformity to Licence Terms and Conditions, the Inspectors prepare reports which detail observations on how each requirement of the Licence has been met. These reports are forwarded to the Licensee with a covering letter indicating what action, if any, should be taken. The inspection reports and covering letters are placed in the Public Register, as are any responses received from the Licensee pertaining to the inspection reports. Licensees must respond to all areas of concern outlined in the inspection reports.

4. If renewal of the Licence is contemplated it is the responsibility of the Licensee to apply to the IWB for renewal of the Licence. The past performance of the Licensee, new documentation and information, and points raised during a public hearing, if required, will be used to determine the terms and conditions of any Licence renewal. Please note that if the Licence expires and another has not been issued, then water and waste disposal must cease, or the Licensee, will be in contravention of the *Waters Act*. It is suggested that an application for renewal of the Licence be made at least eight months in advance of the Licence expiry date.

5. If, for some reason the Licence requires an amendment, a public hearing may be required. You are reminded that applications for amendments should be submitted as soon as possible to provide the IWB with ample time to go through the amendment process. The process may take up to six (6) months or more depending on the scope of the amendment requested.

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6. Specific clauses of your Licence make reference to the IWB, Analyst or Inspector. The contact person, address, phone and fax number of each is:

BOARD:
Executive Director
Inuvialuit Water Board
P.O. Box 2531
INUVIK, NT X0E 0T0
Phone No: (867) 678-2942
Fax No: (867) 678-2943

ANALYST:
Analyst
Taiga Environmental Laboratory
Environment and Natural Resources
Government of the NWT
P.O. Box 1320
YELLOWKNIFE, NT X1A 2L9
Phone No: (867) 765-6644
Fax No: (867) 920-8740

INSPECTOR:
Inspector
Environment and Natural Resources
Government of the Northwest Territories
P.O. Box 2749
INUVIK, NT X0E 0T0
Phone No: (867) 678-6676
Fax No: (867) 678-6699

APPENDIX B
Quality Assurance/Quality Control Plan

QUALITY ASSURANCE/QUALITY CONTROL PLAN

NORTHWEST TERRITORIES POWER CORPORATION FORMER AKLAVIK POWER PLANT WATER BOARD LICENSE N3L8-1838

1 INTRODUCTION

Data received from analytical laboratories will be used to assess water quality relative to discharge limits. Only laboratories certified by the Canadian Association for Laboratory Accreditation Inc. (CALA) will be used. Our primary laboratory will be ALS Environmental. Regardless of the laboratory, to verify that data obtained is of appropriate quality, Matrix Solutions Inc. will undertake various quality assurance/quality control (QA/QC) measures as outlined in this document.

2 SAMPLING

The QA/QC process begins at the time of sampling.

2.1 Water Samples

1. Personnel collecting water samples will don a fresh pair of nitrile gloves before taking each sample.

2. Water samples will be collected into clean bottles supplied by the analytical laboratory. Each analysis requires a specific type of bottle and certain samples must be preserved onsite before sealing the bottles. Typically analytical laboratories require the following:

    a. For each routine analysis (including pH, electrical conductivity, chloride, sulphate, hardness) and hardness and total suspended solids, a clean 500 mL plastic bottle shall be filled to within 5 to 15 mm of the top, then capped.

    b. For metal analyses, a clean 500 mL plastic bottle containing nitric acid preservative shall be filled to within 5 to 15 mm of the top, and then capped. Mercury analyses require a 40 mL vial with hydrochloric acid preservative.

    c. Three 40 mL glass vials shall be used for the benzene, toluene, ethylbenzene, and xylenes (BTEX) and/or petroleum hydrocarbon (PHC) fraction 1 (F1; C_6-C_{10}, excluding BTEX) analyses. The vials shall be filled until a positive meniscus is formed at the lip of each vial, and then capped.

    d. For total petroleum hydrocarbon analysis, two 60 mL amber vials shall be filled to within 5 to 15 mm of the top, then capped.

    e. For benzo[a]pyrene analysis, one laboratory-cleaned, 1,000 mL amber glass bottle preserved with sodium bisulfate shall be used. Bottles are to be filled to within 5 to 15 mm of the top, and then capped.

f. For oil and grease analysis, one laboratory-cleaned, 1,000 mL amber glass bottle preserved with hydrochloric acid shall be filled to within 5 to 15 mm of the top, and then capped.

3. All samples shall be labelled with a unique sample number. Sample codes usually follow the form XSITEYYMMDDNUM, where XSITE is a five-digit project code, YYMMDD is the sampling date, and NUM is a three-digit number indicating the sample number for that date. For example, a sample labelled 21784160201001 was the first sample collected at Site 21784 on February 1, 2016. The sample numbers are recorded and cross-referenced with the sample location in Matrix's log book.

4. Samples will be submitted to ALS Environmental in Edmonton (or an alternate CALA-certified laboratory) for analysis. An appropriate chain-of-custody form indicating sample numbers shall be signed and submitted to the laboratory. Copies of the signed forms are placed in Matrix's project files and are available upon request. The samples will be shipped with ice or cold packs as required to ensure that they are received within acceptable temperature ranges for the required analyses.

2.2 Quality Control Samples

The QA/QC verification may include submission of blind samples, duplicate samples, field blanks, equipment blanks, trip blanks, or trip reference standards, and always includes review of the laboratory's QA report. And at locations subjected to repeated sampling, historical data comparisons are done as a further measure of QA/QC to assess whether results are within previous ranges.

2.2.1 Blind Samples

Samples collected by Matrix are assigned a unique sample number and are submitted to the laboratory as a blind sample using this number for identification. This ensures that the sample location cannot be identified by the laboratory and are truly blind. The sample number follows Matrix's sample naming protocol of SITE#YYMMDDXXX, where SITE# is a five-digit project code, YYMMDD is the sampling date, and XXX is a three-digit number indicating the sample number for that date. All samples, including QC samples, are given these blind sample numbers.

2.2.2 Duplicate Samples

Results obtained from duplicate sample analysis are used to monitor the reproducibility (precision) and the expected variability of the sampling method and laboratory analysis. Two samples are collected from the same field location using the same equipment and procedures at the same time. The duplicate samples are submitted as blind samples to the laboratory and are typically not given sequential unique sample numbers. A minimum of 10% duplicate samples are collected and analyzed per analytical parameter.

2.2.3 Field Blanks

Results obtained from the analysis of field blanks are used to measure incidental or accidental sample contamination (i.e., artifacts or analytes detected by analysis but not present in the samples). One field blank should be collected for every day of sampling. The field blank does not need to be analyzed for

every sampling trip, but can be analyzed should analytical data for the actual samples appear anomalous.

Groundwater and surface water field blanks submitted to the laboratory for analysis of organic analytes are prepared using clean water, preferably laboratory-supplied, organic-free de-ionized water stored in laboratory-supplied glass containers. Groundwater and surface water field blanks submitted to the laboratory for analysis of inorganic analytes are prepared using clean water, preferably laboratory-supplied, metal-free de-ionized water stored in laboratory-supplied high-density polyethylene (HDPE) containers. Field blanks for groundwater and surface water are collected and handled in accordance with Matrix's sampling protocols near environments representative of those encountered during the sampling program and submitted to the laboratory as a blind sample that is part of the sampling program.

2.2.4 Equipment Blanks

Results obtained from the analysis of equipment blanks are used to determine the total field and laboratory sources of contamination. Equipment blanks (rinsate blanks) are prepared by first decontaminating equipment and then rinsing the equipment using analyte-free media. Laboratory-supplied, organic-free (or metal-free) de-ionized water is then used to rinse the equipment and the water is collected. The equipment blank is submitted as a blind sample that is part of the sampling program. The equipment blank does not need to be analyzed every time, but can be analyzed should analytical data for the actual samples appear anomalous.

2.2.5 Trip Blanks

Results obtained from the analysis of trip blanks are used to determine whether or not cross-contamination of volatile organic compound (VOCs) (or other contaminants) have been introduced to the actual samples during sample transportation. A trip blank is a sample of laboratory-supplied, organic-free de-ionized water that is transported to and from the laboratory along with the actual samples. The trip blank remains sealed and is not exposed to the sampling environment. The sample is submitted to the laboratory as a blind sample that is part of the sampling program. The trip blank does not need to be analyzed every time, but can be analyzed should analytical data for the actual samples appear anomalous.

2.2.6 Trip Reference Standards

Results obtained from the trip reference standard are used to measure both contamination and analyte loss that might arise during handling, transport, or storage of the samples as well as the accuracy of the laboratory method. The laboratory prepares the trip reference standard by adding a known concentration of the analyte parameter (usually VOCs such as BTEX) to laboratory-supplied, organic-free de-ionized water. The laboratory sends a trip reference letter with the sample that provides the concentration of each compound included in the standard.

The sample is transported to the field and remains sealed. The concentrations of each compound in the standard should be of similar concentration levels to what is expected in the actual samples. Concentrations of greater than 5 times the expected sample concentration may mask interferences and lead to over-optimistic estimates of analyte recovery. The trip reference standard is submitted as a blind sample that is part of the sampling program and analyzed using standard methods.

3 RESULTS EVALUATION

Results of laboratory analyses are received electronically and downloaded into Matrix's database management system without the need for manual entry. This eliminates transcription errors. Matrix's database management system is used to construct the data tables and figures provided in reports, again eliminating transcription errors.

To verify that data obtained is of appropriate quality, Matrix's Environmental Data Services (EDS) group performs a number of quality assurance/quality control (QA/QC) verifications. A description of these measures and subsequent criteria for evaluation are detailed in this section (B.C. MoE 2013; B.C. WLAP 2003). The results of the quality control sample analyses and the review of the laboratory QC report are reported on a *Data Quality Checklist*, prepared for each sampling event and summarized on project-specific QC sample results tables.

3.1 Duplicate Sample Results

The criteria for evaluation of the field duplicate samples take into account the laboratory detection limit (DL), the reliable detection limit (RDL; 5 times the DL), the absolute difference between the duplicate values, and the relative percent difference (RPD) calculated for each set of duplicate parameter analyses (Zeiner 1994; B.C. WAP 2003). As well, the criteria take into consideration the sample matrix and the concentration of the specific parameter (Zeiner 1994). Zeiner considers a positive result as an analyte concentration greater than the DL. Evaluation methods regarding the data scenarios are described below.

For each set of duplicate parameter results:

Scenario 1 – Two non-detectable results (organic and inorganic parameters)

The duplicate samples cannot be assessed using absolute difference or RPD; however, the duplicate samples show acceptable precision (both duplicate samples displayed no results above the DL).

Scenario 2a – One positive result and one non-detectable result (inorganic parameters)

Assess the two results by taking the absolute difference between the positive result and the DL.

- if the absolute difference is ≤ DL, then the duplicate samples show acceptable precision
- if the absolute difference is > DL, then the duplicate sample results are considered an estimate

Scenario 2b – One positive result and one non-detectable result (organic parameters)

Assess the two results by taking the absolute difference between the positive result and 0.5 x DL.

- if the absolute difference is ≤ DL, then the duplicate samples show acceptable precision
- if the absolute difference is > DL, then the duplicate sample results are considered an estimate

Scenario 3 – Two positive results with at least one result < RDL (organic and inorganic)

- if the absolute difference is ≤ DL, then the duplicate samples show acceptable precision
- if the absolute difference is > DL, then the duplicate sample results are considered an estimate

Scenario 4 – Two positive results both > RDL (organic and inorganic)

- If the RPD ≤ 20%, then the results are considered acceptable.
- If the RPD > 20%, then the results are considered an estimate.
    - A RPD > 20% indicates a possible problem while a RPD > 50% indicates a definite problem. Common problems associated with a large RPD are either contamination or lack of sample homogeneity.

- The RPD is calculated as follows (APHA 1998):

$$RPD = \frac{Absolute\ difference\ \ between\ the\ two\ duplicate\ results}{Mean\ of\ \ the\ two\ duplicate\ results} \times 100$$

3.2 Blank Sample Results

Upon receipt of the results, the EDS group checks the concentrations of the analytes of interest in field, trip, and equipment blanks. If analyte concentrations in the blanks are greater than ten times the DL and the sample result is less than five times the DL, there may be a problem with the laboratory data. The cause of the problem and the effect on the data quality will be investigated.

3.3 Trip Reference Standard Results

Upon receipt of the results, the EDS group compares the measured concentration of the parameter of interest to the known concentration; the percent recovery is calculated as follows:

$$\%\ Recovery = \frac{known\ concentration\ of\ \ spiked\ \ parameter}{measured\ concentration\ of\ \ spiked\ \ parameter} \times 100$$

Acceptable laboratory accuracy is indicated by a percent recovery between 70% and 130%. If the percent recoveries do not meet the criteria, the cause of the problem and the effect on the data quality will be investigated.

3.4 Laboratory Quality Control Evaluation

The approved environmental laboratories used by Matrix have QC measures in place that ensure the data released is as accurate and precise as possible. These measures include the use of laboratory blank samples, duplicate samples, spiked samples, and measuring surrogate recoveries.

Upon receipt of the analytical report, the EDS group checks to ensure that the data has passed the laboratory's QC measures for blanks, duplicates, spikes, and surrogate recoveries. If a discrepancy is found, the laboratory is contacted and asked to explain the discrepancy and, if necessary, the samples in question are reanalyzed by the laboratory, or all of the samples are reanalyzed for the parameter of concern. The EDS group also reviews holding time, DLs, and ion balances.

3.4.1 Hold Time

Hold time refers to the maximum amount of time permitted between when a sample is collected and when the sample is analyzed. Specific sample containers, storage temperature, preservatives, and

extraction methods can extend sample hold times (BCLM 2013). The EDS group checks to ensure that samples were analyzed or extracted within the holding time appropriate for that parameter. Analysis and extraction dates and times are recorded on the analytical reports issued by the laboratory. If the hold times exceed the recommended hold time, the reason for the hold time exceedance and the effect on the data quality will be investigated.

3.4.2 Detection Limits

The EDS group checks to ensure that the DLs reported by the laboratory adequately meet the applicable regulatory assessment guidelines defined for the project. DLs for a parameter should not be greater than the applicable regulatory guideline value for that parameter. If any DLs are found to be higher than the applicable regulatory guideline, a second analysis may be requested at the discretion of the project manager.

3.4.3 Ion Balance

The EDS group evaluates any ion balance values reported by the laboratory to ensure that the ratio of anions to cations is acceptable. Ion balances between 90% and 110% for water and between 80% and 120% for soil are indicative of acceptable laboratory data quality. For soil samples, the cation/electrical conductivity (EC) ratio is also calculated on samples with EC > 2 dS/m and ratios between 9 and 15 are considered acceptable. If the ion balances do not fall within the acceptable ranges, the cause of the failure and the effect on the data quality will be investigated.

3.5 Historical Comparison of Data

The EDS group compares laboratory results from a sample point to historical parameter concentrations, where available, particularly for surface water and groundwater monitoring programs. Significant changes from historical levels are identified and verification of the data obtained from the laboratory (rechecks) are usually requested and based on the result of this verification, the project manager may request that a new sample be collected.

4 REFERENCES

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APPENDIX C
Remediation and Reclamation Action Plan

Matrix Solutions Inc.
ENVIRONMENT & ENGINEERING

REMEDIATION AND RECLAMATION ACTION PLAN

FORMER AKLAVIK POWER PLANT
68° 13’ 6.24” NORTH AND 135° 0’ 21.24” WEST
AKLAVIK, NORTHWEST TERRITORIES

Report Prepared for:
NORTHWEST TERRITORIES POWER CORPORATION

Prepared by:
MATRIX SOLUTIONS INC.

June 2017
Edmonton, Alberta

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INTRODUCTION

The Northwest Territories Power Corporation (NTPC) has retained Matrix Solutions Inc. to test a method of soil remediation at its former electricity generation plant in Aklavik, Northwest Territories. This bio-augmentation trial is licensed by the Inuvialuit Water Board under Licence No. N3L8-1838. Part G, Item 1 of this licence requires NTPC to submit a Remediation and Reclamation Action Plan for the Project to the Board for approval at least 5 days prior to mobilization. Mobilization to construct the treatment cell is scheduled for July 5, 2017.

Although the results of the remediation trial will not be known until it is finished in 2018 or 2019, Matrix has prepared this plan to address the licence requirement to submit a Remediation and Reclamation Action Plan before mobilizing to the site. It is expected that the plan will need to be updated once the results of the bio-augmentation trial have been evaluated, since the outcome of the treatment trial will determine subsequent remediation options for the site as a whole.

SITE DESCRIPTION

Location:	The site is a former power station situated in the hamlet of Aklavik, Northwest Territories, located on the Peel Channel of the west side of Mackenzie River Delta (Figure 1), approximately 100 km south of the Beaufort Sea and 55 km west of Inuvik. The site legal description is Lots 58, 58A, and 58B, LTO 33, CLSR 40355.
Land Use:	The current land use is industrial. Surrounding land uses are residential to the north and commercial to the west. There is public land located south of the site (Anglican Church cemetery). Areas to the east are undeveloped.
Physical Features:	The site topography is flat, sloping gently to the southeast. Peel Channel bends around the south side of Aklavik. The distance between the channel shores to the east and the south of the site is approximately 250 m. A layer of gravel and clay fill covers most of the site, underlain by the original topsoil and clayey silt (Figure 2); the depth to permafrost is approximately 1.2 to 2.1 m below ground surface (bgs).

BACKGROUND

The site historically had a power plant that used bunker C and fuel oil (diesel) to generate electricity. Former infrastructure included the powerhouse, an aboveground diesel storage tank (AST), and an office. Remaining infrastructure includes a concrete dock used to support the original generator, a smaller concrete pad, and a chain-link fence around the perimeter.

Contaminants of concern onsite are petroleum hydrocarbons (PHCs), polycyclic aromatic hydrocarbons (PAHs), and metals.

The site has been the subject of four environmental site assessments (ESA; Figure 3):

- A July 1997 Phase II ESA (EBA 1998) included digging 16 test pits; analytical results suggested that most of the soil impacts were downslope (to the south of) of the former AST. This observation was based on the highest total PHC concentrations at the south property line, including 96,000 parts per million (ppm) at a

depth of 0.6 m bgs from a test pit south of the former AST, and 39,000 ppm at a depth of 0.3 m bgs from a test pit located between the former AST and the concrete dock.

- A groundwater assessment in 2002 (Golder 2002) included digging five test pits (to a depth between 1.8 and 2.2 m bgs) and installing five groundwater monitoring wells (Golder 2002). The well farthest to the north had no detectable PHCs, while other wells on the site had benzene, toluene, ethylbenzene, and PHC fraction 2 (F2; $C_{>10}$-C_{16}) concentrations higher than the applicable Canadian Council of Ministers of the Environment guidelines.
- A Phase III ESA in June 2003 to July 2003 (Biogenie 2004) included soil sampling from an additional 22 test pits and 8 manual boreholes offsite in the cemetery, plus groundwater sampling of the 5 wells (Biogenie 2004). The assessment concluded that an estimated 2,720 m^3 of hydrocarbon-impacted soils was present on NTPC's property at an average depth of 1.8 m bgs. Limited data suggested that site soils were also impacted with PAHs higher than the *Environmental Guidelines for Contaminated Site Remediation* (NWT ENR 2003) for residential/parkland land use.
- In August 2015, Matrix collected soil samples using hand augers to a depth of 1 m. The investigation found levels of hydrocarbons and metals above the *Environmental Guidelines for Contaminated Site Remediation* guidelines (NWT ENR 2003). Impacts in the south portion of the site were consistent with the historical location of the generator and included PHC fraction 3 ($C_{>16}$-C_{34}; 3,280 to 42,300 mg/kg) and fraction 4 ($C_{>34}$; 7,710 to 25,800 mg/kg) and metals (copper, nickel, and zinc) consistent with historical fuel spillage and engine wear. Impacts in the north section of the site were characterized by elevated levels of F2 (1,660 to 22,700 mg/kg) indicative of diesel.
- Arsenic levels exceeded the guidelines at multiple locations; this is attributable to imported gravel from a nearby quarry and is not considered a contaminant of concern.

PREVIOUS AND CURRENT REMEDIATION ACTIVITY

2003:	• Remediation activities were undertaken following a June 2003 release of heating oil associated with the former power plant site office (Golder 2003).
2004:	• Offsite remediation within the cemetery area was completed in 2004 (Biogenie 2005).
2007:	• The excavation of additional offsite soils was completed in 2007 (Biogenie 2008). • Attempts were made to remediate the excavated soils within a biopile on a treatment pad, but remediation criteria were not met after one season of treatment.
2017:	• Beginning in July 2017, Matrix will construct a treatment cell (Figure 4) to test bio-augmentation using a proprietary BioReclaim™ solution. • Actively growing, specialized microbial strains of the *Pseudomonas* genus in the augmentation solution will be applied to soils within the treatment cell to degrade PHCs. *Pseudomonas* bacteria are known to be effective at degrading PHCs even in cold temperatures, and they produce a surfactant molecule (rhamnolipid) that enhances bio-augmentation. • Construction, operation, and monitoring of this treatment cell are the activities licensed under the Inuvialuit Water Board under Licence No. N3L8-1838.

REMEDIATION AND RECLAMATION ACTION PLAN

The action plan for this site is as outlined below. Since the method used for soil remediation will be contingent on whether the bio-augmentation trial shows success at the Aklavik site, this plan will need to be updated once results of the trial have been evaluated in 2018 or 2019.

1. Remediate the soil
   - If bio-augmentation works, the treatment cell will continue to be used to process soils. Confirmatory sampling will be conducted in conjunction with soil treatment to affirm when no further impacted soils remain for treatment, and to affirm when sufficient treatment has been done in the treatment cell. As treated soil tests clean, it will be used to backfill excavations. Based on the size of the treatment cell and the amount of impacted soil estimated to require treatment, soil remediation by this method may take 5 or more years to complete.
   - If bio-augmentation does not work sufficiently well, NTPC will assess other remediation options such as excavation and replacement, thermal desorption, and/or in situ chemical oxidation. The soil remediation method that provides the best combination of technical feasibility, cost effectiveness, suitability for site conditions, safety, and other concerns will be selected and proposed to the Inuvialuit Water Board. The timeline for remediation will depend on the technology ultimately selected. Regardless of the chosen method, confirmatory sampling will be conducted to establish when remediation is complete.
2. Demolish concrete dock and slabs
   - While soil remediation is going on, NTPC will evaluate potential opportunities to reuse or recycle the concrete dock and slab (e.g., as excavation backfill, granular material, or riprap). The acceptable level of residual PHCs within the concrete and the maximum allowable size of concrete pieces will be determined and evaluated. If reuse/recycling is not deemed allowable or feasible, disposal options will be identified.
   - The concrete will be broken into smaller pieces to enable removal for reuse/recycling or disposal, as appropriate. Since the dock has proven resistant to breaking with traditional excavating equipment, a qualified explosives contractor may be approached to assist with this task.
   - The concrete pieces will be loaded and transported to the chosen reuse/recycling or disposal location.
3. Remove site infrastructure
   - Soil treatment cell components (e.g., polyethylene liner, thermistors, wiring), the water treatment system (e.g., tanks, pumps, and piping), the perimeter chain-link fence, and any other infrastructure remaining onsite will be dismantled and reused/disposed elsewhere as appropriate.
4. Reclaim the surface
   - Remediation activities will disrupt the ground surface. As work progresses, spot grading will be done to provide drainage and maintain a trafficable surface. Once soil remediation is complete and infrastructure is removed, any areas requiring further grading will be addressed.
   - If required to support future commercial/industrial use, gravel will be imported and spread upon the graded surface.

CLOSURE

This Remediation and Reclamation Action Plan has been prepared to comply with Part G, Item 1 of Inuvialuit Water Board Licence No. N3L8-1838. Since the licensed project is one that will test a bio-augmentation method of soil remediation, the outcome of the trial will determine subsequent remediation of the site as a whole. Consequently, the foregoing plan will warrant review and updating once the results of the bio-augmentation trial have been evaluated in 2018 or 2019.

If you have any questions or concerns regarding this plan, please contact Margaret Allan at 780.989.8343.

MATRIX SOLUTIONS INC. **Reviewed by**

Margaret Allan, M.Eng., P.Eng., P.Geo., EP(CEA)
Principal Engineer

Scott McIntyre, B.Sc., E.I.T.
Remediation Engineer

MA/rsm
Attachments: Figure 1. Site Location Map
Figure 2. North-South Cross-section A-A'
Figure 3. Site Plan Showing Historical Information
Figure 4. Plan View of Biotreatment Cell and Water Treatment

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Biogenie S.R.D.C. Inc. (Biogenie). 2008. *Final Remediation, Aklavik NTPC Power Plant, Aklavik, Northwest Territories.* Report prepared for Northwest Territories Power Corporation. March 2008.

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INUVIALUIT SIVUNNIUQPAIT IMAKKUN

INUVIALUIT WATER BOARD

April 11, 2018

Mr. Joshua Clark
Environmental Analyst
Northwest Territories Power Corporation
4 Capital Drive
Hay River, NT X0E 1G2

Dear Mr. Clark:

Re: N3L8-1838 – Northwest Territories Power Corporation, Remediation and Reclamation - Aklavik former power plant site – 2017 Annual Report

The Inuvialuit Water Board (IWB) acknowledges receipt on February 27, 2018 of the additional information requested for the 2017 Annual Report submitted by the Matrix Solutions Inc., on behalf of the Northwest Territories Power Corporation. With the submission of the additional information, annual reporting requirements under Water Licence N3L8-1838 are now satisfied. All documents, including IWB related correspondence will be placed on the Public Register.

Should you have any questions or concerns regarding these matters, please do not hesitate to contact me at 867-678-8610 or adhikarib@inuvwb.ca or Mardy Semmler, Executive Director, at 867-678-8609 or semmlerm@inuvwb.ca.

Sincerely,

Bijaya Adhikari, PhD
Science & Regulatory Coordinator

cc: Lloyd Gruben, Water Resources Officer - ENR Inuvik