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NUNATTA ENVIRONMENTAL SERVICES INC.
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PROTECTING OUR ARCTIC ENVIRONMENT

Quality Assurance and Quality Control Plan

Hydrocarbon-Impacted Soil Landfarm Facility
1575 Federal Road.
City of Iqaluit, Nunavut

Water Licence Number - NWB4NUN0511-Type "B"

Prepared for:

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1.0 INTRODUCTION

Nunatta Environmental Services Inc. (Nunatta) owns and operates a Hydrocarbon-Impacted Soil Landfarm Facility within the City of Iqaluit, Nunavut.
On August 4, 2004, an application for a water license was filed with the Nunavut Water Board by Nunatta for water use and waste disposal activities at Nunatta's Hydrocarbon-Impacted Soil Landfarm Facility located at 1575 Federal Road, Industrial Park, within the City of Iqaluit, Nunavut (City of Iqaluit Lot 1, Block 229)
The NWB License number for the Hydrocarbon-Impacted Soil Landfarm Facility is NWB4NUN0511 "B"

This treatment facility is commonly referred to as the 'landfarm'. Nunatta's operations consist of accepting soils impacted with petroleum products at various concentrations at the landfarm's geosynthetic lined platform (Cells) and with addition of fertilizers, aeration, and moisture control, allow indigenous soil microorganisms to degrade petroleum products to break them down into compounds such as water, carbon dioxide and hydrogen sulphide. Soils accepted at the landfarm are contaminated with diesel, gasoline and various automotive and construction/mining oils.
The site where the land farm is located is in the industrial part adjacent the old metal dump where all old equipment and cars and trucks were junked. Many rotting barrels of unknown products are still visible on adjacent properties around the landfarm and through out the dump site to the west. Photo's from 1998 show the landfarm site was used as crushing grounds for any old waste barrels and storage of unclaimed or rejected freight.
One water test well located in the north east corner of the lot has always tested high in hydro carbons it is believed this is contamination from previous operation conducted at this site.

2.0 Water Treatment and Discharge

Melt water collected from treatment Cells will have been in contact with contaminated soil. Due to the fact the snow melts before the ground thaws the contact time is minimal. This melt water will contain low concentrations of hydrocarbons but must be tested and treated prior to releasing it.
Water is brought to the land farm to be polished so it can be released into the environment. This water is from contaminated sites where water has pooled and must be removed in order to allow excavation to continue.
Contaminated water is transported to the landfarm in either barrels (205 litre barrels) or large tanks (5000 litre) which will be passed through a water/fuel separator and the water either polished and released to the environment or will be dumped into one of our cells to be used for dust control or for moisture control within the soil piles.

Each year prior to freeze up all separated hydrocarbon contaminant is containerized and shipped south to an approved disposal company.

Prior to releasing any water into the environment, it must be polished clean. We accomplish this by passing it through a filtering medium of modified clay and or activated Carbon. The clay has the ability to remove as much as 5 times the hydrocarbons as activated carbon but it does not polish the waters to meet CCME standards. Carbon will polish the waters to meet the 15ppm requirements so it has to be used as a final filter to assure the CCME requirements are met. Discharge water is tested to be sure the carbon filter has not reached its breaking point.
Nunatta Environmental Services keeps activated carbon in stock and is able to replace spent carbon when the breaking point is near. Filtering vessels are purchased as complete units from ERE Environmental Supplies. and we maintain on going maintenance.
When concentrations of hydrocarbons are low we have been able to use only carbon filtering.

All water to be discharged is sampled, (Be it runoff or filtered water) and when CCME levels are achieved, test results are forwarded to Inspectors at INAC and when granted permission all waters will be pumped out through activated carbon filters even if it meets CCME standards to guard against accidental contamination.

Water stored in the holding tanks for the summer months is pumped out before winter. This allows room for spring runoff/melt containment and to prevent tanks from being ruptured by the freezing action of the water.

2.0 Rock Disposal Plan

Impacted soils enter the landfarm into Cell #1 where cobbles and rocks are screened out.
Rocks and cobbles are screen down to ¾ inch.
These rocks are piles into cell #2 to weather off any soils or hydrocarbons that might be adhered. The freezing, thawing and wetting, drying action as well as movement of air will expel hydrocarbons and contaminated soils from the stones. These stones will be screened again at a later date to remove all rocks larger than 2 inches. These will be tested and when confirmed clean will go to the crushers to be used in gravel for road construction. The smaller rocks will require additional time to expel contaminates and will be re screened to further reduce soil and when found to be clean will be used around land farm for levelling, road building, and backfilling excavated work sites.
The screened soil removed from the rock piles will be added to one of the cells being remediated as it will take longer to expel hydrocarbons than the cobbles and stones.
This procedure was developed from speaking with Dr. Steve Siciliano, Professor of Soil Toxicology, at the University of Saskatchewan.
Since 2009 approximately 800 $m^{3\ of}$ rock rejects have been extracted from the Cells.

4.0 Treated Soil Disposal

Nunatta anticipates that the contaminated soil treatment will require 5-6 summer seasons to lower TPH concentrations to CCME's residential or commercial levels. Once treated, if acceptable by the applicable legislation the remediated soil will be disposed of as follows:
Sent to the municipal landfill for daily cover use
Foundation material for road construction
Used to back fill excavation sites where spills have occurred and are being cleaned up
**Used as inoculants for incoming soils.

**Proper hydrocarbon breakdown is difficult to achieve without the proper microorganisms. Once these microorganisms have become established in the soil it is faster to inoculate incoming soil.

This will speed up the breakdown of hydrocarbons and allow soil to be removed from Landfarm much quicker than waiting for these organisms to develop on there own each time new soil is added to the pile.

To date no soils have been removed from the landfarm.

5.0 Standard Operating Procedure for Water Sampling

5.1 Test Well Sampling

An inertia system such as Waterra is used for purging and sampling a groundwater monitoring well. Equipment required includes polyethylene tubing and a foot valve.

Nitrile gloves are worn to handle the tubing and to attach a foot valve to the bottom of the polyethylene tube.

The foot valve and tubing are inserted into the well until it reaches the bottom of the well.

The tube is cut so that approximately 0.5 to 1 m extend above top of the well.

The polyethylene tubing is not permitted to touch the ground.

The tubing is moved up and down, forcing water up the tubing.

Purging is done prior to taking sample.

The foot valve and tubing are stored inside the well for subsequent use by folding the tube to fit inside the well.

chill samples ASAP after collection

- VOC sample vials are to be completely filled to allow no headspace
- Metals need to be field filtered through 0.45 media prior to preservation if dissolved components are required

5.2 Surface Water Sampling

Depending upon the depth of the water body, one or more samples may be collected at each location.

Clean, laboratory-supplied containers should be immersed in the water body just below the surface and be allowed to fill.

Disturbance of bottom sediments should be avoided.

Samples should be packed carefully into laboratory-supplied containers of the appropriate type and with the appropriate preservative for the test parameters.

Any information on colour, turbidity, and odour should be noted.

Shallow sub surface samples may also be obtained by immersing the bottle to the desired depth and open the lid.

VOC sample vials are to be completely filled to allow no headspace
- Don't dip containers pre-charged with preservative in surface water. Rather, dip an new, unpreserved container and transfer immediately to the preserved container.

Surface water samples for laboratory analysis should be collected in appropriately labelled containers and stored in coolers with ice (at approximately 4°C) while in transit to an accredited laboratory.

6.0 Water testing must include the following

Total Petroleum Hydrocarbons (CCME PHC- F1 to F4 fractions)
B-tex
Total Petroleum Hydrocarbons (TPH)
Poly Aromatic Hydrocarbons (PAH)
Heavy Metals (HM - Cd, Cr, Cu, Ni, Zn and Pb)
PCB

7.0 Standard Operating Procedure for Soil Sampling

There are two common methods of soil sampling: grab samples and composite samples. A grab sample is a sample taken from one specific location, at one time. A composite sample is a combination of smaller samples taken at different locations or at different times. For the identification of hydrocarbon contamination, grab samples should be taken.

The sampling should proceed from the least contaminated to the most contaminated site.

The number of field samples that are required, as well as the type and size of the sample vial, is dependent upon the type of contaminant that is being sampled

To prevent loss of volatiles, samples should be gathered from freshly exposed soil and preserved as soon as possible, after the excavation.

Clean gloves should be worn and should be changed before each new sample is collected.

Completely fill each sample vial so that no headspace exists. Minimize aeration and air contact.

Clean threads of jar thoroughly.

Cap the vial.

Label the vial.

Place on ice in a covered cooler or refrigerate (do not freeze)

Complete the necessary documentation

8.0 Soil Sampling

All soils have been impacted with fuel oil typically from residential or commercial fuel spills (i.e. heating oils and diesel fuels.)
Most of the soils brought to land farm are from spill sites Nunatta is cleaning up and tests are taken at the site, results of these tests confirm the hydrocarbon content. Chemical testing is done on all soils where contamination is not a known source. These soils are kept separate until lab results confirm contamination.

Additional testing is done spring and fall on all soils at landfarm to determine degradation rate and fertilizer requirements. Sample results are used to determine the correct measures to be taken in the remediation process and if changes are required to make process more effective.

In order to document the chemical characteristics of the soil samples will be analyzed for the following parameters twice yearly. The samples will be sent to an approved Laboratory for analysis and results kept on file at landfarm.

Total Petroleum Hydrocarbons (CCME PHC- F1 to F4 fractions)
Heavy metals (6)
Mercury
PCB
PAH
Microbial type and count
Nitrogen, Phosphorus, Potassium

If reluctant contaminants are encountered that do not respond to our remediation process. These soils will be containerized and shipped to an approved disposal facility.

9.0 Sample Handling and Storage

Keep samples cool (4 degrees C) and in the dark. Use ice cubes or crushed ice to chill samples as soon as they are collected, and ice packs to maintain internal temperatures in shipping containers. Deliver samples to the laboratory as soon as possible after collection.

When shipping samples to the lab, notify the lab of the impending shipment and provide flight info so that sample pick at the airport can be arranged.

The following documents available from CCME. Were used as reference in preparing this plan

- CCME Protocol Manual for Water Quality Sampling - PN 1461

- CCME Guidance Manual on Sampling, Analysis, and Data management for Contaminated Sites - PN 1101

Also, we use a Paracel Labratories shipping document that we reference for additional storage and shipping details. This is availlable upon request from Paracel or from Nunatta Environmental Services Inc.

10.0 Chain of Custody Requirements

This procedure describes the requirements for completing a chain of custody for environmental sampling.

To ensure timely and complete laboratory analysis, the chain of custody must be properly completed. Records of the chain of custody must also be kept for auditing purposes. The following is a guideline to proper recording practices.

Project Contact information includes address where results and invoice are to be sent, telephone and fax numbers of the contact in case the laboratory has questions regarding the sample(s) or analytical request.

Site and Sampler information includes site name and/or location, project number and name(s) of individuals collecting the samples.

Additional info should include submission date, laboratory quote number, any additional forms in which the results are required (e.g. fax, electronic).

Sample Details should include for each sample submitted sample identification, sample date and time, sample matrix (groundwater, surface water, soil, sediment, etc.), number of containers filled, any field filtering and preservation completed, any lab filtering and/or preservation required, requested analyses.

Special Instructions includes any required detection limits, specific methodology, hazards of the sample(s) to laboratory personnel.

Required Guidelines includes indicating to which criteria or guidelines the results will be compared and allows the laboratory to aim for the required detection limits.

Include the date that the results are required, be specific (not ‘ASAP’ or ‘next week’).

Also include any other information that may be useful to the laboratory in the ‘Notes’ area.

When the sampler gives the samples to another individual (e.g. courier, laboratory staff) he/she must complete the ‘Relinquished by’ section including the date, time and signature and the person who accepts the samples must complete the ‘Received by’ section including the date, time and signature.

Every time the samples are given to another individual the ‘Relinquished by’ and the ‘Received by’ sections must be completed until the samples are received by the laboratory.

11.0 Packaging and Handling of Samples

11.1 Packing Bottles for Transportation

Label all the bottles to be sent to the lab for analyses. Double check the labels are properly filled out using a pen or marker that is not water-soluble. Do not write on the septum of Forty (40mL) BTEX/Vials. If you do write on the cover always double check, so that the bottle and cap have the same sample ID.
Forty (40 mL) vials should be wrapped in bubble wrap. Three 40 mL vials usually fit into the laboratory supplied bubble wrap pouch. To prevent breakage, place the vials so that there is no room for movement.
One (1) litre, or 500 mL bottles should be wrapped individually in small bubble wrap.
Fifty (150) mL soil jars should be placed one on top of each other in a ziplock bag. Seal the bags and tape tight.

11.2 Packing Coolers for Shipment

Check the cooler to see if it has a water drain outlet at the bottom; seal it with tape to prevent water from leaking out. (Couriers will refuse to ship a leaking cooler)
Place a large piece of thick bubble wrap on the bottom of the cooler; make sure there is adequate bubble wrap so as to extend up the sidewalls of the cooler.
Line the cooler with two large industrial strength garbage bags (one inside the other) so that all the packing will be performed in the bags.
The bottles should be placed in such a way that they do not touch each other.
As a general rule all bottles should be placed in an upright position.
If you are packing soil jars, placing a layer of bubble wrap between every row of samples.
If there is any void space it should be filled with a layer of bubble wrap.
Remove the last sheet from the filled out Chain of Custody form (COC). Place the remaining page of the COC in a Ziploc bag and place it inside the cooler on top of everything. Only one COC is required even if there are more than one cooler.
Close the lid, wrap the cooler with sufficient packing tape at all points of entry.
Place a shipping label (usually supplied by lab), indicate 1 of 2, or 1 of 3, etc. if there is more than one cooler being sent on the same way bill.

Parameters set out by waterboard for Landfarm.

Station	Location	Parameter [1]	Frequency	Flow Measurement Required (cu.m)
MW 1	Monitoring Well South West of Cell 3 (Downgradient)	TPH BTEX HM PAH PCB	Twice per year (after freshet and end of treatment season)	NA
MW 2	Monitoring Well North West of Cell 3 (Upgradient)	TPH BTEX HM PAH PCB	Twice per year (after freshet and end of treatment season)	NA
MW 3	Monitoring well North of Cell 3 (Downgradient)	TPH BTEX HM PAH PCB	Twice per year (after freshet and end of treatment season)	NA
MW 4	Monitoring Well North East of Cell 2 (Upgradient)	TPH BTEX HM PAH PCB	Twice per year (after freshet and end of treatment season)	NA
MW 5	Monitoirng Well North East of Cell 1 (downgradient)	TPH BTEX HM PAH PCB	Twice per year (after freshet and end of treatment season)	NA
MW 6	Monitoring Well South West of Cell 1	TPH BTEX HM PAH PCB	Twice per year (after freshet and end of treatment season)	NA
NUN 1	Discharge from the Activated Carbon Treatment Facility		EC once per year	Required volume discharged to the Cells and/or the Receiving Environment
NUN 2	Discharge from Cell 1		EC once per year	Required Volume discharged to the Receiving Environment

Parameters set out by waterboard for Landfarm.

Station	Location	Parameter [1]	Frequency	Flow Measurement Required (cu.m)
NUN 3	Discharge from Cell 2		EC once per year	Required Volume discharged to the Receiving Environment
NUN 4	Discharge from Cell 3		EC once per year	Required Volume discharged to the Receiving Environment
NUN 5	Incoming Soils to the Landfarm Treatment Facility	TPH C_{10}-C_{50} Heavy Metals (6) Mercury PCB PAH	For every 500 cubic metres, prior to deposition in the LTF unless they originate from a well-documented spill.	.
		Nitrogen Phosphorus Potassium		To assess nutrient content optimal for biodegradation assess amount of fertilizer needed
		PAH PCB	Testing only if soil suspected of containing contaminants other than heating fuel, Diesel or gasoline.	
NUN 6	Soils within LTF Cell No. 1	TPH C_{10}-C_{15} C_{16}-C_{35} C_{36}-C_{50} Total Micro-organism count and type Nitrogen Phosphorus Potassium	1 sample at the end of the field season (end of September)	

Parameters set out by waterboard for Landfarm.

Station	Location	Parameter [1]	Frequency	Flow Measurement Required (cu.m)
NUN 7	Soils within LTF Cell No. 2	TPH C_{10}-C_{15} C_{16}-C_{35} C_{36}-C_{50} Total Micro-organism count and type Nitrogen Phosphorus Potassium	1 sample at the end of the field season (end of September)	
NUN 8	Soils within LTF Cell No. 3	TPH C_{10}-C_{15} C_{16}-C_{35} C_{36}-C_{50} Total Micro-organism count and type Nitrogen Phosphorus Potassium	1 sample at the end of the field season (end of September)	
NUN 9	Rock Reject Stockpile	TPH	Once per year or prior to use	

1. Parameters:
TPH (Total Petroleum Hydrocarbons)
PAH (Polycyclic aromatic hydrocarbons)
PCB (Polychlorinated biphenyls) Total
BTEX (Benzene, toluene, ethybenzene and xylene)
HM (Heavy Metals) as defined by CCME

Nunatta Environmental Services Inc was given the previous 3 pages of items to report on these items are referred to as stations. (MW1-Mw6 and NUN1-NUN9)

Station MW 1 through MW 6 (Refers to monitoring wells 1 through 6.)

These wells were installed in 2004 and proved to be dry in 2005, 2006, 2007 and 2008. (Map #1)
Franz Environmental from Ottawa were commissioned to install new wells in 2008. These wells were assigned the designation of MW08-01 to MW08-04. A complete report from Franz is included in the Monitoring wells Installation report, included with this renewal application in report Labelled Installation and Construction of Monitoring wells October 2011.

These wells were put in late season and samples were available from 2 of the four wells MW08-03 and MW08-04.(Map # 2)Sample results included in Franz report.
In 2009 Nunatta Environmental began the construction of cell 4 and monitoring well MW08-04 was removed to permit construction equipment to make ready the land and build the new cell walls. The last sample taken from MW08-04 was July 14 of 2009 Lab report **0929063**. Report indicates levels within CCME standards.
Since MW08-04 was the well which contained enough water for yearly testing. Removing it has rendered us unable to provide test results for this side of the land farm. In summer of 2012 plans are to install 2 new wells on east side of property. As shown in Map #3
On September 20 2010 a sample was taken from the MW08-03 well (referred to in report as well #1 in the report due to its close proximity to cell 1). The results from this test indicate all is below CCME standards.
This summer 2011 it was very wet but the temperatures were cool and the ground did not thaw enough to allow ample water for sampling. Water is present in the wells but not enough quantity to fill the sample jars to capacity for testing purposes.
Testing requires the wells be purged first but again this is not possible. This includes MW08-01 MW08-02 and MW08-03. These wells have been right checked into November with not enough water present to take sample.
Plans for 2012 include installation of 2 new monitoring wells on the east side of the property. One new test well installed in approximately the same location as the old test well, referred to as MW08-04 and a second one on the south east end of the new cell 4 along the boundary fence. (Map #3) This new well will bear designation of MW08-05.
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NUN 1:

Discharge from Active Carbon Treatment Facility

2010. We discharged cell water and took pre and post discharge samples. These were when we were pumping out of cell #3 it contained melt water which was in contact with contaminated soil. The date for this was June 1st. Laboratory Order number **1023110.** Pumping and Sampling was done again on June 21st, Laboratory Order number **1026067**. These results are attached to end of this document.
In 2011 water to be discharged from tanks tested below CCME standards so samples were not taken but water was passed through a new unused active carbon filter any way. No reason to take sample water met CCME standards without activated carbon filtering.

NUN 2:

Discharge from Cell 1

Since 2010 Water from cell 1 was discharged into cell 4. No water was discharged from cell into environment. As this cell is the receiving cell for incoming soils it is expected have highest concentrations of Hydrocarbons so it is not put into holding tanks but is put into cell #4

NUN 3:

Discharge from cell 2

Cell 2 is the smallest cell and it typically is kept full of rocks, this keeps snow from collecting and keeps melt water to a minimum.

As cell 2 shares a common wall with cell 3 and the low point allows water from cell 3 to flow into the south west corner of cell 2 a lot of water is collected in this corner and pumped into the storage tanks. As soon as tanks are full the balance goes into cell 4. This cell is the rock storage cell where stones are placed to weather off. The rocks fall into a rounded shape and snow does not have a place to lodge so it blows clear.

NUN 4:

Discharge from Cell 3

This cell is the finishing cell for remediated soil. Concentrations of hydrocarbons are lowest in this cell. This cell is located on the west side of the land farm and winds blow snow into this cell more than the other cells. This cell accumulates a lot of melt water.

Samples of the discharge water and water contained in the cell. Lab report Sample Order **1023110** shows water from the cell and a sample of the water discharged from the carbon filter referred to as post pumped water. Results show the water was below CCME standards for discharge.

Water test results shown in Sample Order **1023110** indicate the water in cell 3 could have been discharged without use of active carbon filtering. Discharge from cell 3 was 2724 L per hour and pumping lasted 48 hours releasing 130,750 L. Or 130 cubic meters

Water sample taken at the end of 48 hours show no breach. Results: Sample Order **1026067**

Later that month we put water from cell 4 (which tested high in Volatiles) through activated carbon filters and sampled it, results prove active carbon filter removed hydrocarbons down to acceptable CCME levels.

Since 2010 all water is pumped into tanks or cell 4 until the rush of melt water is over then water is filtered (polished) and tested. Should release be required inspectors are notified in advance. Other wise water is kept contained until end of season and discharged prior to freeze up.

Nun 4 (a)
Cell number 4

This cell was constructed with the intention of it to hold excessive water from other cells until rush of melt water is over. Cells and dirt piles are in the path of blowing snow so this cell does not collect much of snow.

It has had ice form across its whole width and winds blow most snow out of cell. Contaminated snow is dumped into this cell to melt and water brought in from excavation sites is also dumped into this cell.

Water from this cell is discharged into other cells over the summer months. In order to handle large volumes of water it was necessary to dig deep holes into the piles of earth in cell #1 our storage cell and then water is pumped into these holes and the surrounding earth slowly absorbs the water. Much of this water is wicked off into the atmosphere or contained by the soil as none appears to run out into containment area along cell walls. Water is added to these pits every couple days.

Summer of 2010 water was pumped out of cell 4 into soil piles in cell 1 and 2 totalling 145,500 L or 145 cubic meters

Date	from	to	Litres	Cu/M	notes
September	Cell 4	cell 2	20,000	20	Pump out of cell 4 into soil piles
	Cell 4	Cell 2	20,000	20	Dug big pools in top of soil piles
	Cell 4	cell 1	20,000	20	with excavator down to frost layer
October	Cell 4	cell 2	20,000	20	and filled with water as often as
	Cell 4	Cell 1	25,000	25	soil would hold water.
	Cell 4	cell 1	20,000	20	want to lower cell 4 for winter
	Cell 4	Cell 1	20,000	20	to have capacity for spring of 2011
		Total	145,000	**145**	

In 2011 water was pumped out of cell 4 into cell 1 soils 135,000 L or 135 cubic metres. This was late season and this was done to lower volume of water in cell 4 to make room for spring melt water.

Date	from	to	Litres	Cu/M	notes

Aug.	pump out extra	Cell #4	Cell #1	30,000	30	Dug hole in cell #1 filled with water
	pump extra	Cell #4	Cell #1	20,000	20	Filled hole again with water
Sept.	pump extra	Cell #4	Cell #1	20,000	20	Filled hole again with water
	pump extra	Cell #4	Cell #1	25,000	25	Filled hole again with water
	pump extra	Cell #4	Cell #1	20,000	20	Filled hole again with water
	pump extra	Cell #4	Cell #1	20,000	20	Filled hole again with water
			total	135,000	**135**	

NUN 5:

Most Soil brought into landfarm are either from diesel fuel/home heating oil spills that Nunatta has been contracted to clean up or they are from a known source such as water delivery truck loosing hydraulic oil or fuel delivery company overfilling a tank. Spills we are working on are tested in order to assist us delineate the size of the contaminated area so what enters the landfarm is well documented.

The soil at the landfarm is sampled in spring and again in the fall. The spring test is to help us determine the correct amount of fertilizer we require to balance the soil to achieve optimum degradation. The using a formula supplied to us by Steven Siciliano of the University of Saskatchewan. Biography included at the end of this report. It was determined by sample testing a ratio of 100:9:1 for C:N:P: would be the best ratio for soil in our landfarm

The fall sample allows us to see how effective the degradation process was over the summer months.

To confirm soil needs and microbial activities in summer of 2010 we took soil samples every 2 weeks and kept them at the Arctic College Lab at -20 C until they were packaged and shipped to the University of Saskatchewan Labs for analysis. There Professor Siciliano and his team analysed the samples and came up with suggestions for accelerating the break down of hydrocarbons at the landfarm. Plans are to study microbial activity with different variables to see if it is possible to extended microbial activity after freeze up. Ideas such as increasing unfrozen water content which would increase microbial activity would be sustained by as much as 100% longer after freeze up and if introducing organic matter such as manure, wood chips and bone meal Biochar (burned in absence of oxygen) would increase additional 2-3% of liquid water. If it does work as hoped it would increased microbial activity would extend the degradation period by a couple of months over the entire year.

Plans are in place to begin a 3 year test program in conjunction with University of Saskatchewan/Yukon college/Arctic College and Nunatta Environmental starting summer of 2012. This project is planned to be run for 3 years using soils from the Nunatta landfarm. The information gathered will provide us with an accelerated procedure of breaking down hydrocarbons and hopefully some heavy metals. This information will aid other landfarms

operating in cold climates to be more efficient. Cold temperatures account for a considerable amount of the year at this geographic location Too often soil additives used in the warm climates to accelerate remediation do not work up here and some even become carcinogenetic when exposed to deep cold.

NUN 6
Cell 1

This cell is the receiving cell. All fresh contaminated soil is dumped into this cell, the soil is piled up and large rocks removed or set aside. This soil is turned with excavator to melt frost and to stir heavy concentrations into other soils to blend. When time permits, soils are screened to remove stones and construction debris. (Wood, steel, wire, concrete) Soil is put into a pile often up to 4 meters high. This is to leave an area inside the cell for trucks to continue to dump. By making soil piles tall it allows us to dig into them to make pools for excess water pumped from other cells or tanks. Water is pumped into these pools wicks away into the atmosphere, adds moisture to soil but mostly it reduces water levels in other cells and this makes room for spring melt waters

NUN 7
Cell 2

Rock/stone containment cell. Stones removed from incoming soils are put in this cell to weather off hydrocarbons. These stones are screened again to separate anything larger than 2 inches and when they meet CCME standards they will be delivered to a gravel crushing plant to be used in road building products. Stones, smaller than 2 inches, are screened again to remove remaining soil. This soil will be placed in another cell to finish remediation. Soil in this cell is sampled as an indicator to soil health and to guide in deciding where to place the soil removed from the rocks.

NUN 8
Cell 3

This is the finishing cell where weathered soils are kept and will undergo extensive aeration. Fertilizers are added to the soil when it is piled in this cell. The soil is stored here in tall windrows most of the year. The tall windrows allows thawed soils to be scraped down exposing the still frozen core to warm temperatures this will speeds up the breakdown of hydrocarbons. This is repeated until all soil is thawed and then it is put through the rotary screening plant and restacked into long windrows.

Samples taken in the spring are used to determine the correct amount of fertilizers to be added for that season.

Samples taken in the fall are used to determine what the rate of degradation was achieved over the summer thaw and to set in motion plans for next summers soil activities.
In the past no soil has been removed from the land farm. Repeated dumping of fresh hydrocarbons into this cell kept weathered/remediated soils from meeting CCME standards.

A specific plan for contaminated soil to follow through the land farm has been established in order to ensure this kind of activity does not slow the progress of the landfarm as it has in the past.

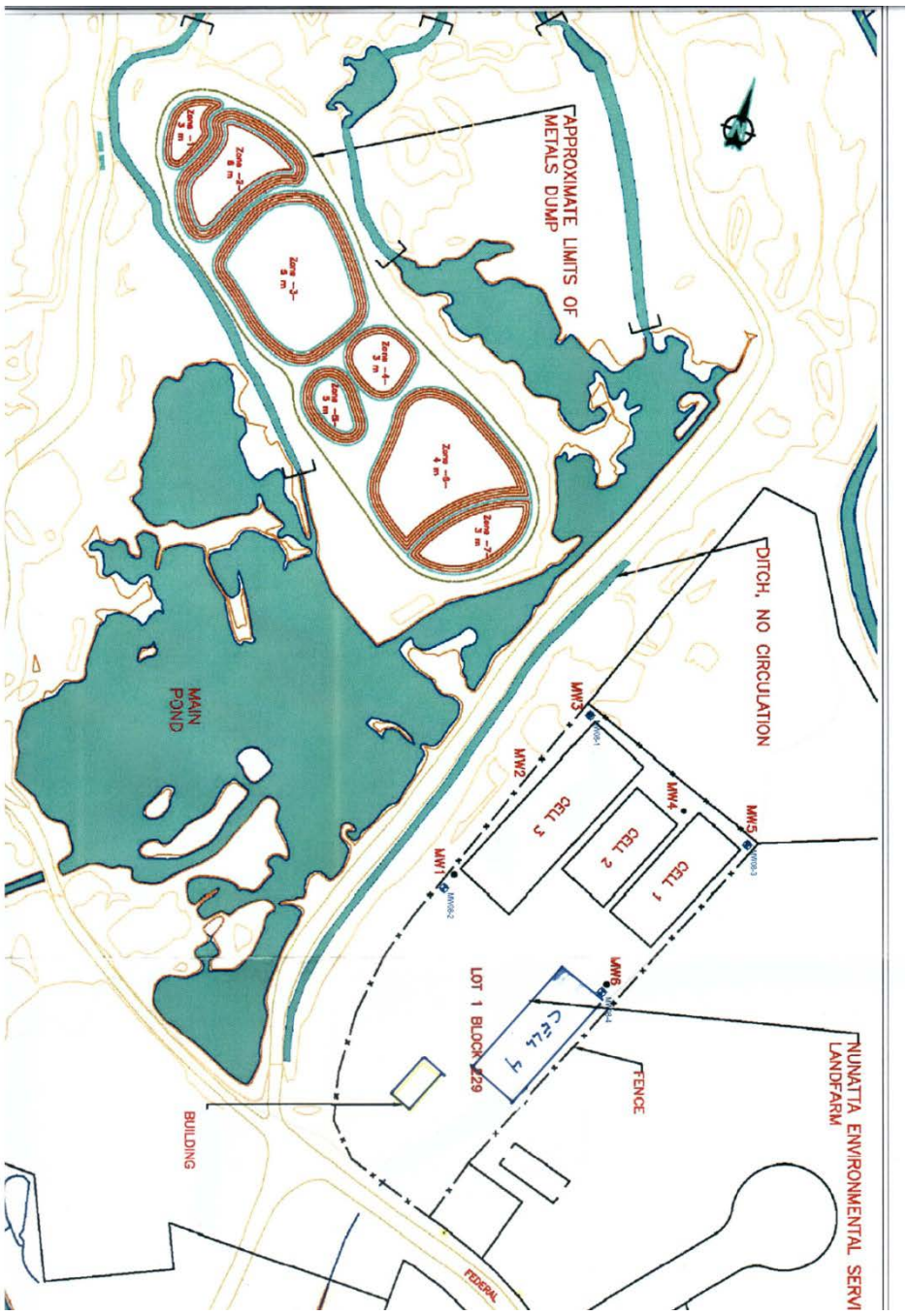
NUN8 A:
Cell number 4

This is the newest cell at the landfarm.
It has been used to contain spring melt water from other cells and is used as the holding cell for fuel or oil contaminated snow.
This year we moved more soil into this cell to create a large flat surface on which to locate our water separating equipment. By doing this we will be able to store and separate all our drums and reduce the risk of contamination reaching the environment. In the future when overcrowding has been reduced this cell will be a finishing cell like cell 3. This will allow the landfarm to increase its output to double what one cell will produce. For the present time this cell will be used for surplus water storage until melt water can be filtered or stored in a more efficient manner.

Nun 9:
Rock Reject Stockpile

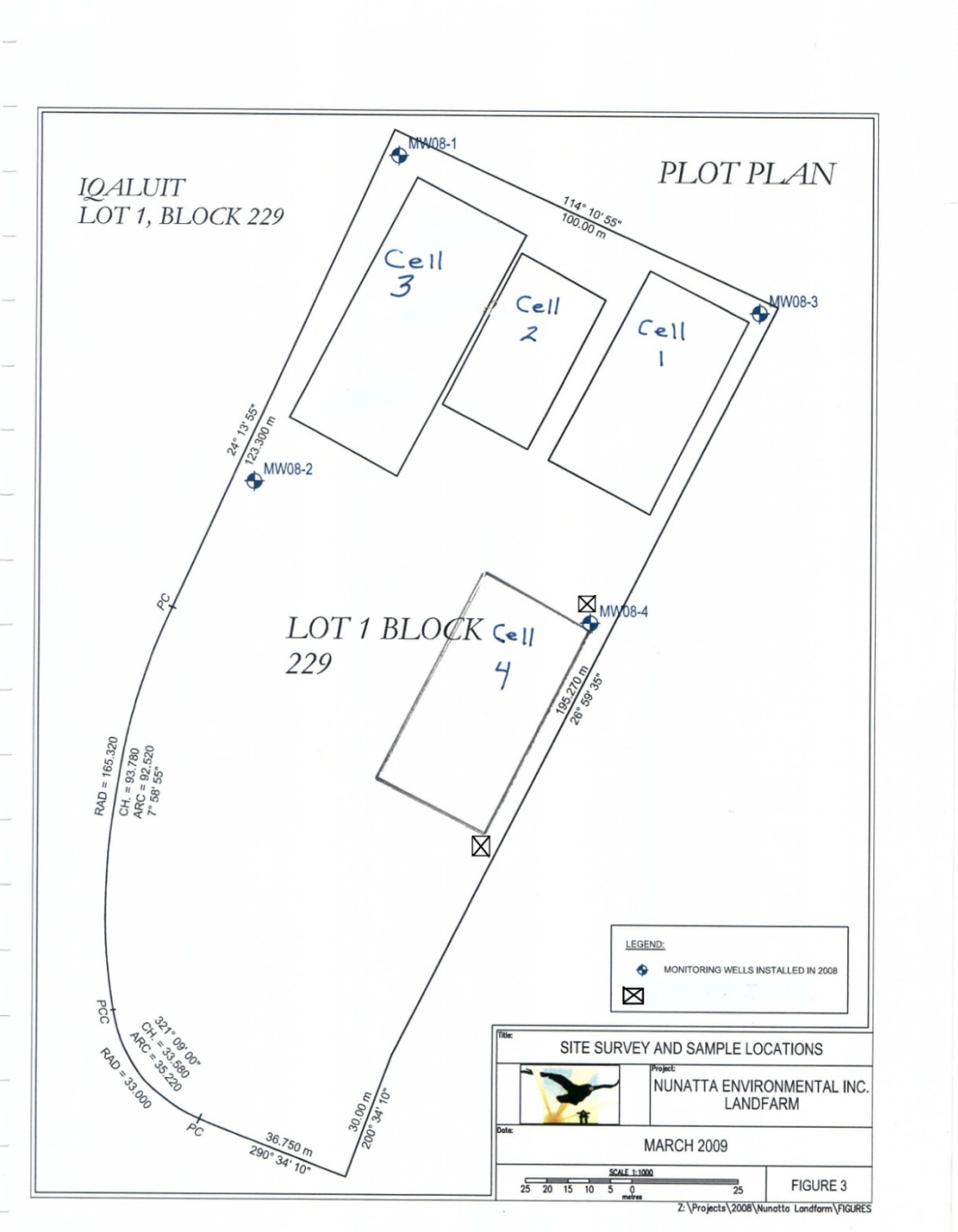
Rocks in the soil have not been addressed prior to 2009. They were left in the soil piles and only picked out and placed along the sides of the berms while soil was being cultivated.
In 2009 a large shaker was purchased and a lot of soil was put through this screening plant removing stones larger than 2 inches. Up to 30 % of the total mass was stones 2 inches or bigger. In 2010 a new Rotary screening plant was purchased it has a smooth action which mixes soils and breaks up lumps and has a screen sized to 3/4 inch by adjusting speed of rotation of the drum it is possible to screen down to about 5/8 of an inch. This removes an additional 20-25% of bulk, this reduced soil pile size dramatically.
Stones are placed in cell 2 to weather off hydrocarbons. Stones will be tested each year when CCME standards are met, authorities will be notified and rocks and stones will be released from landfarm. Local Construction Companies have expressed interest these products. Because the stones are free of sand and soil it allows the gravel crushers to make clear stone products.
To Date no stones have been removed from the landfarm.

Landfarm Location.



Test wells installed in 2004 shown in Red
Test wells installed in 2008 shown in Blue

Landfarm cells and monitoring wells



Black boxes with X at ends of cell 4 are locations for monitoring wells
To be installed in summer of 2012

Biography:
Professor Steven Sisciliano,
University of Saskatchewan, Canada

Position: Professor
Email: steven.siciliano@usask.ca
Website: http://soiltox.com/
Department: Soil Science
Expertise: Arctic Soils, microbial ecology, toxicology
Bio:

Education: B.Sc. Biochemistry (Concordia), Ph.D. Toxicology (Saskatchewan)

Research:

We have four key initiatives in the Poles devoted to exploring how soil and human health are linked.

• Exploring how soil ecosystems communicate with one another.
• Understanding how the amount of liquid water in frozen affects pollutants and biogeochemistry.
• Working with the citizens of the City of Iqaluit in the Lower Base Region to investigate what sort of and how many pollutants are in the soil around their homes.
• Archiving polar soil samples for future generations.

Not all of our research projects involve traveling across the globe! We are also active in studies involving soil and water quality and greenhouse gases in Saskatchewan and across the prairies.

Selected Publications:

Siciliano SD, AN Schafer, MAM Forgeron, I Snape. 2008. Hydrocarbon contamination increases the liquid water content of frozen Antarctic soils. Environmental Science and Technology 42:8324-8329.

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NUNATTA ENVIRONMENTAL SERVICES INC.

List of lab reports

Soil reports for Landfarm

2008

November Analysis Order 0845175

Covers cell # 3 soils..... HM, TPH, PAH, Btex

And test pits for water well MW08-1. MW08-03 and MW08-04

2009

September Analysis Order 0938209

Covers cell # 1, 2, 3, Soils..... HM, TPH, PAH, Btex

2010

June Analysis Order 1023109

Covers cells 1, 2 Soils .....HM, TPH, PAH, Btex

August Analysis Order 1035041

Covers soils rotary screened cell 3.... N, P, K, Organism count HM, TPH, PAH, PCB, Btex

August Analysis Order 1035089

Covers soils in cell 3 in different piles.. HM, TPH, PAH, Btex

November Analysis Order 1049097

Covers soils in Cells 1, 2, 3, N, P, K, and Organism count, HM, TPH, PAH, PCB, Btex

Analysis Order 1035089

Covers cell 3 and different piles with in that cell

2011

July Analysis Order 1127164

Covers cell 1, 2, 3, 4 Soils N, P, K, Organism count HM, TPH, PAH, PCB, Btex

October Analysis Order 1142097

Covers Cells 1, 2, 3, 4 Soils. N, P, K, Organism count HM, TPH, PAH, PCB, Btex

Water reports for Landfarm

2009

July Analysis Order 0929063
Covers Monitoring well MW08-04

2010

June Analysis Order 1023110
Covers water in cell 4, water in cell 3 (referred to as 1 berm) and post pump water from discharge vessel.

June Analysis Order 1026067
Covers water from cell 4 and water from filtering vessel (Post WTR cell #4) refers to testing carbon filter after 48 hours of pumping from cell #3. Shows filter was performing its duties.

Sept Analysis Order 103084
Covers tanks 1(black), 3(red), cell #4, and Test well MW08-03 (referred to as well #1, due to its close proximity to cell #1.)
This was to permit pumping out, prior to winter freeze up and to test monitoring well water. Sample #2 was missing from package.

Sept Analysis Order 1039165
Covers tank 1(black), 2(green), 3(red), and cell 4 not enough water to retest well MW08-03
Retest of samples sent to Lab earlier when sample turned up missing.

2011

August Analysis Order # 1132189
Covers Tank 1(Black), 2(green), and cell #4, Tank 3(red) was not filled this year.

Laboratory Accreditation

Canadian Association for Laboratory Accreditation Inc.

CALA

Certificate of Accreditation

Paracel Laboratories Ltd.
Unit 300
2319 St. Laurent Blvd
Ottawa, Ontario

This laboratory is accredited in accordance with the recognised International Standard ISO/IEC 17025:2005. This accreditation demonstrates technical competence for a defined scope and the operation of a laboratory quality management system (refer joint ISO-ILAC-IAF Communiqué dated 18 June 2005).

Accreditation No:	A 1262
Issued on:	September 9, 2009
Accreditation Date:	January 3, 2005
Expiry Date:	September 9, 2012

Chief Executive Officer

ilac-MRA CALA

This certificate is the property of the Canadian Association for Laboratory Accreditation Inc. and must be returned on request; reproduction must follow guidelines in place at date of issue. For the specific tests to which this accreditation applies, please refer to the laboratory's scope of accreditation at www.cala.ca

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NUNATTA ENVIRONMENTAL SERVICES INC.

CALA
Canadian Association for Laboratory Accreditation Inc.

CALA Directory of Laboratories

Membership Number: 1262
Laboratory Name: Paracel Laboratories Ltd.
Parent Institution:
Address: Unit 300 2319 St. Laurent Blvd Ottawa ON K1G 4J8
Contact: Mr. Dale Robertson
Phone: (613) 731-9577
Fax: (613) 731-9064
Email: drobertson@paracellabs.com

Standard: Conforms with requirements of ISO/IEC 17025
Clients Served: All Interested Parties
Revised On: July 7, 2011
Valid To: September 9, 2012

Scope of Accreditation

Air (Inorganic)
Asbestos - Air (Occupational Health) (Ottawa West Laboratory) (066)
PM-003; modified from NIOSH 7400
PCM FIBRE COUNTING
Asbestos-Mr. Blair Schildknecht
Asbestos-Ms. Marcia Bertrand

Air (Inorganic)
Metals - Air (Occupational Health) (036)
PI-020; modified from NIOSH 7300
ICP/MS - DIGESTION
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Silver
Zinc

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NUNATTA ENVIRONMENTAL SERVICES INC.

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PI-020; modified from NIOSH 7300
ICP/MS - DIGESTION
Arsenic
Beryllium
Cadmium
Chromium
Copper
Lead
Silver
Zinc

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Solids (Mycology)
Fungi (Contact Plate) - Solids (Ottawa West Laboratory) (047)
PM-001; modified from AIHA GUIDELINES
CULTURE
Fungal Speciation

Solids (Mycology)
Fungi (Tape Lift) - Solids (Ottawa West Laboratory) (043)
PM-002; modified from ASTM D7391
MICROSCOPIC
Fungal Propagule - Genus

Solids (Organic)
Semi-Volatile Organic Compounds (SVOC) - Solids (074)
PO-003 SVOC; modified from SW-846 8270
GC/MS - EXTRACTION
1-methylnaphthalene
1,2,4-Trichlorobenzene
2-Chloronaphthylene
2-Chlorophenol
2-methylnaphthalene
2-nitrophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-Tetrachlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitorphenol
2,4-Dinitrotoluene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-dinitrotoluene
3,3-dichlorobenzidine
4-Chloro-3-Methylphenol
4-Chloroaniline
4-chlorophenyl phenyl ether
4-nitrophenol
Acenaphthene
Acenaphthylene
Anthracene
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Benzylbutylphthalate
Biphenyl
Bis(2-chloroethoxy)methane

Bis(2-chloroisoproply)ether
Bis(2-ethylhexyl)phthalate
Chrysene
Di-n-butyl phthalate
Di-n-octyl phthalate
Dibenzo (a,h) anthracene
diethyl phthalate
Dimethyl phthalate
Fluoranthene
Fluorene
hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno (1,2,3 - cd) pyrene
Indole
m/p-Cresol (3/4-Methylphenol)
N-Nitroso-di-n-propylamine
N-Nitrosodiphenylamine
Naphthalene
Nitrobenzene
o-Cresol (2-methylphenol)
Pentachlorophenol
Phenanthrene
Phenol
Pyrene
Quinoline

Solids (Organic)
Total PCBs - Soil (029)
PO-002 ; modified from EPA SW 8080A
GC/ECD - EXTRACTION
Total PCB

Solids (Organic)
Total Petroleum Hydrocarbons (TPH) - Soil (020)
PO-007 ; CCME PHC TIER 1 METHOD, REV. 5
GC/FID - EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50
TPH (C10-C24)

F1: C6-C10
TPH (C5-C10)

Solids (Organic)
TPH Heavy Oil - Soil (025)
PO-009 ; modified from MOE E33
GRAVIMETRIC - EXTRACTION
F4: Gravimetric
Total Petroleum Hydrocarbons (heavy oil)

Solids (Organic)
Volatile Organic Compounds (VOC) - Soil (017)
PO-001 ; modified from EPA SV
846 8240, 624
GC/MS - PURGE AND TRAP
1,1-Dichloroethane
1,1-dichloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,1,2,2-Tetrachloroethane
1,2-Dibromethane
1,2-dichlorobenzene
1,2-dichloroethane
1,2-Dichloropropane
1,3-Dichlorobenzene
1,3,5-Trimethylbenzene
1,4-dichlorobenzene
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
Chloromethane
cis-1,2-Dichloroethylene
cis-1,3-Dichloropropene
Dichlorodifluoromethane
Dichloromethane
Ethylbenzene
Hexane
m/p-xylene

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trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Trichlorofluoromethane
Vinyl Chloride

Swab
Fungi - Swab (Ottawa West Laboratory) (048)
PM-001; modified from AIHA GUIDELINES
CULTURE
Fungal Speciation

Water (Inorganic)
Alkalinity - Water (001) OSDWA †
PI-003; modified from EPA 310.1
TITRIMETRIC
Alkalinity (pH 4.5)

Water (Inorganic)
Ammonia - Water (062) OSDWA †
PI-004; modified from EPA 351.2
AUTO COLOR
Ammonia

Water (Inorganic)
Anions - Water (034) OSDWA †
PI-016 ; modified from EPA 300.1
ION CHROMATOGRAPHY
Bromide
Chloride
Fluoride
Nitrate
Nitrite
Phosphate
Sulfate

Water (Inorganic)
Biochemical Oxygen Demand (BOD) - Water (055)
PI-014; modified from SM 5210 B
D.O. METER
BOD (5 day)

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Water (Inorganic)
Carbon - Water (056) OSDWA †
PI-011; modified from MOE E3247 B
IR - COMBUSTION
Organic Carbon

Water (Inorganic)
Chemical Oxygen Demand (COD) - Water (054)
PI-009; modified from SM 5220 D
REFLUX - COLORIMETRIC
COD

Water (Inorganic)
Chlorine - Water (053) OSDWA †
PI-005; modified from SM 4500-Cl G
COLORIMETRIC
Free Chlorine

Water (Inorganic)
Colour - Water (042) OSDWA †
PI-019; modified from HACH 8025
SPECTROPHOTOMETRIC
Apparent Colour
True Colour

Water (Inorganic)
Conductivity - Water (003) OSDWA †
PI-006 ; modified from EPA 120.1
CONDUCTIVITY METER
Conductivity (25°C)

Water (Inorganic)
Cyanide - Water (052) OSDWA †
PI-008; modified from MOE E3015
AUTO COLOR - DISTILLATION
Cyanide (SAD)
Free Cyanide

Water (Inorganic)
Dissolved and Extractable Metals - Water (004) OSDWA †
PI-020 ; modified from EPA 200.8
ICP/MS

Antimony
Arsenic
Barium
Beryllium
Bismuth
Boron
Cadmium
Calcium
Chromium
Cobalt
Copper
Iron
Lead
Magnesium
Manganese
Molybdenum
Nickel
Potassium
Selenium
Silver
Sodium
Strontium
Thallium
Tin
Titanium
Tungsten
Uranium
Uranium
Vanadium
Zinc

Water (Inorganic)
Fluoride - Leachate (005)
PI-007 ; modified from EPA 340.2
SELECTIVE ION ELECTRODE
Fluoride

Water (Inorganic)
Hexavalent Chromium - Water (033) OSDWA †
PI-013; modified from MOE E3056A.1
COLORIMETRIC
Hexavalent Chromium

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Water (Inorganic)
Oil and Grease - Water (032)
PO-004; modified from EPA 9070A, EPA 3510 SILICA GEL CLEANUP
GRAVIMETRIC - EXTRACTION
F4G
Oil and Grease, Mineral
Total Oil and Grease

Water (Inorganic)
pH - Water (013) OSDWA †
PI-010 ; modified from EPA 150.1
pH METER
pH

Water (Inorganic)
Phenols - Water (064) OSDWA †
PI-002; modified from EPA 420.2
AUTO COLOR - DISTILLATION
Total Phenolics

Water (Inorganic)
Solids - Water (040) OSDWA †
PI-012; modified from SM 2450 C/D
GRAVIMETRIC
Total Dissolved Solids
Total Suspended Solids

Water (Inorganic)
Sulphide - Water (041) OSDWA †
PI-019; modified from SM 4500-S2D
COLORIMETRIC (METHYLENE BLUE)
Sulphide

Water (Inorganic)
Total Kjeldahl Nitrogen (TKN) - Water (061) OSDWA †
PI-004; modified from EPA 351.2
AUTO COLOR - DIGESTION
Total Kjeldahl Nitrogen

Water (Inorganic)
Total Mercury - Water (014) OSDWA †
PI-015 ; modified from EPA 7245.1
COLD VAPOUR AA - DIGESTION
Mercury

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Water (Inorganic)
Total Metals - Water (065)
PI-020; modified from EPA 200.8
ICP/MS - DIGESTION
Aluminum
Barium
Boron
Chromium
Cobalt
Copper
Iron
Lead
Manganese
Molybdenum
Nickel
Strontium
Thallium
Titanium
Vanadium
Zinc

Water (Inorganic)
Total Phosphorus - Water (060) OSDWA †
PI-011; modified from EPA 365.1
AUTO COLOR - DIGESTION
Total Phosphorus

Water (Inorganic)
Turbidity - Water (051) OSDWA †
PI-017; modified from HACH 2100 P
NEPHELOMETRY
Turbidity

Water (Microbiology)
Coliforms - Water (057) OSDWA †
PW-001; modified from MOE E3407
MEMBRANE FILTRATION (DC-AGAR)
Background Counts
Escherichia coli (E. coli)
Total Coliforms

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Water (Microbiology)
Fecal (Thermotolerant) Coliforms - Water (058) OSDWA †
PW-002; modified from SM 9222 D
MEMBRANE FILTRATION (mFC)
Fecal (Thermotolerant) Coliforms

Water (Microbiology)
Heterotrophic Plate Count (HPC) - Water (059) OSDWA †
PW-003; modified from SM 9215 C
SPREAD PLATE (PCA)
Heterotrophic Plate Count (HPC)

Water (Organic)
Petroleum Hydrocarbons (PHC) - Water (038) OSDWA †
PO-006; prep: modified from MOE E3421; qunat: CCME PHC Tier I
GC/FID - PURGE AND TRAP
F1: C6-C10

Water (Organic)
Petroleum Hydrocarbons (PHC) - Water (039) OSDWA †
PO-007; prep: modified from MOE E3421; qunat: CCME PHC Tier I
GC/FID - EXTRACTION
F2: C10-C16
F3: C16-C34
F4: C34-C50

Water (Organic)
Semi-Volatile Organic Compounds (SVOC) - Water (075)
PO-003 SVOC; modified from SW-846 8270
GC/MS - EXTRACTION
1-methylnaphthalene
1,2,4-Trichlorobenzene
2-Chloronaphthylene
2-Chlorophenol
2-methylnaphthalene
2-nitrophenol
2,3,4,5-Tetrachlorophenol
2,3,4,6-Tetrachlorophenol
2,4-Dichlorophenol
2,4-Dimethylphenol
2,4-Dinitorphenol
2,4-Dinitrotoluene
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol
2,6-dinitrotoluene
4-Chloro-3-Methylphenol
4-Chloroaniline

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4-chlorophenyl phenyl ether
4-nitrophenol
7H-dibenzo(c,g)carbazole
Acenaphthene
Acenaphthylene
Acridine
Anthracene
banzo(j)fluoranthene
Benzo (a) anthracene
Benzo (a) pyrene
Benzo (b) fluoranthene
benzo(e)pyrene
Benzo (g,h,i) perylene
Benzo (k) fluoranthene
Benzylbutylphthalate
Biphenyl
Bis(2-chloroethoxy)methane
Bis(2-chloroethyl)ether
Bis(2-chloroisoproply)ether
Bis(2-ethylhexyl)phthalate
Chrysene
Di-n-butyl phthalate
Di-n-octyl phthalate
Dibenzo (a,h) anthracene
dibenzo(a,i)pyrene
dibenzo(a,j)acridine
diethyl phthalate
Dimethyl phthalate
Fluoranthene
Fluorene
hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno (1,2,3 - cd) pyrene
Indole
m/p-Cresol (3/4-Methylphenol)
N-Nitrosodphenylamine
Naphthalene
Nitrobenzene
o-Cresol (2-methylphenol)
Pentachlorophenol
Perylene
Phenanthrene
Phenol
Pyrene
Quinoline

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Water (Organic)
Tannin & Lignin - Water (073)
PI-018 TANNIN AND LIGNIN; SM 5550
COLORIMETRIC
Tannin & Lignin

Water (Organic)
Total PCBs - Water (035)
PO-002
GC/ECD - EXTRACTION
Total PCB

OSDWA †
; modified from EPA 8080A

Water (Organic)
Total Petroleum Hydrocarbons (TPH) - Water (030)
PO-006
GC/FID - PURGE AND TRAP
Total Petroleum Hydrocarbons (C5-C10)

; modified from MOE E3421, E3

Water (Organic)
Total Petroleum Hydrocarbons (TPH) - Water (031)
PO-007
GC/FID - EXTRACTION
Total Petroleum Hydrocarbons (C10 -C24)

; modified from MOE E3421

Water (Organic)
Volatile Organic Compounds (VOC) - Water (007)
PO-001
GC/MS - PURGE AND TRAP
1,1-Dichloroethane
1,1-dichloroethylene
1,1,1-Trichloroethane
1,1,2-Trichloroethane
1,2-dichlorobenzene
1,2-dichloroethane
1,2-Dichloropropane
1,3-Dichlorobenzene
1,4-dichlorobenzene
Benzene
Bromodichloromethane
Bromoform
Bromomethane
Carbon Tetrachloride
Chlorobenzene
Chlorodibromomethane
Chloroethane
Chloroform
cis-1,3-Dichloropropene

OSDWA †
; modified from EPA 624

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Dichlorodifluoromethane
Dichloromethane
Ethylbenzene
Hexane
m/p-xylene
o-xylene
Styrene
Tetrachloroethylene
Toluene
trans-1,2-Dichloroethylene
trans-1,3-Dichloropropene
Trichloroethylene
Vinyl Chloride

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