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NUNATTA ENVIRONMENTAL SERVICES INC.

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PROTECTING OUR ARCTIC ENVIRONMENT

Station Parameters Report

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

Water Licence Number - NWB4NUN0511-Type "B"

Prepared for:

Nunavut Water Board
P.O. Box 119
Gjoa Haven, NU
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Prepared by:

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Dated: November, 2011
Parameters set out by waterboard for Landfarm.

Table of Contents

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

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)	

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 list of items to report on these items are referred to as stations. (MW 1-MW 6 and NUN1-NUN 9)

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

These wells were installed in 2004 and ended up 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

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 which is present in the wells yet 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 checked into November with not enough water present to sample. Plans for 2012 include installation of 2 new monitoring wells on the east side of the property. One in the approximate location of the previous MW08-04 and one at the opposite end of the new cell 4 along the east fence. (Map #1, page 13)

1.0 NUN 1:

Discharge from Active Carbon Treatment Facility

2010. We discharged water and took post discharge samples. These were when we were pumping out a cell full of melt water June 1th Laboratory Order number **1023110** and again on June 21 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.

2.0 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

3.0 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.

4.0 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 cell 4 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 then water is pumped to fill these holes. The surrounding earth slowly absorbs the water most 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 if monitored corectly. Water is added to these pits every couple days.

4.1 Water Pump Out 2010

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**	

4.2 Water Pump Out 2011

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
August	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**	

5.0 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 at end of 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 un frozen water content from 8% to 10 % then microbial activity would be sustained by as much as 100% longer after freeze up and if introducing organic matter such as manure, wood chips or Biochar would add this 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.

Summer of 2011 we were to start trial studies here at the landfarm in Iqaluit but due to budget cuts at the University this project did not happen and everything thing has been pushed ahead into 2012. Cold temperatures account for a considerable amount of the year at this geographic location and this information would be useful to all landfarm owners in Nunavut.

This project is planned to be run over 3 years using soils from on this landfarm. This information will be valuable to other landfarms in cold climates. 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.

Mines has express interest in the outcome of this experiment as they often maintain landfarms with little or no degradation and they would like be interested in a process to reduce soil content and to save having to build more containment cells.

6.0 NUN 6

Cell 1

This cell is the receiving cell. All new product is dumped here, 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 concentrated soil with other lesser soil. The soils are screened to remove stones and construction debris. (wood, steel, wire, concrete) Soil is piled up to 4 meters to accommodate trucks dumping new material and this allows mixing of soil and later in summer month permits digging of holes to dump excess water pumped from cell 4. Water is pumped into these holes to increase water content in soil and the soil wicks the moisture off to the atmosphere and this reduces water level in cell **4 before freeze up and makes room for melt water in the spring.**

7.0 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 will be screened again to remove remaining soil. This soil will be placed in another holding 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

8.0 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 allow thawed soils to be scraped down exposing frozen core to warm temperatures and 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 left the land farm. Continuous dumping of fresh hydrocarbons onto this flat cultivated soil in Cell 3. When summer activities were at there peak it was easier to dump soil where ever possible and the flat level surface of cell three attracted truck drivers. For this reason soils exhibited high readings of Hydrocarbons.

A specific plan has been laid out for the soil to follow in order to ensure this does hinder 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 and used as a melting place for fuel or oil contaminated snow.

This year we moved all our water separating equipment into a location inside this cell. That way when working with these products should anything spill it will not be outside the containment cell. This equipment was removed late fall and part of the cell was filled with screened out soil from cell 1. This will give us more room to store barrels and to set up an efficient water separation /filtering system and still remain within the confines of the impermeable liner.

By adding soil to cell 4 we made a bigger area for trucks to back into and dump snow and this will also give us a bigger area on which to build the contaminated water separation facility.

Separation facility will consist of 2 X 5000L holding tanks and will reduce the need for so many barrels on site. Contaminated water will be transported from spill site to landfarm in 2500L tanks on a heavy duty tri axel trailer. The water can be discharged into these holding tanks freeing up trailer and allowing faster and safer handling of large water volumes. Separation equipment is set up above these tanks and water will be drawn into equipment and gravity fed out into storage drums (contaminates) or released into cell 4 (water)

In time this cell will be used as a finishing cell much like cell 3 where soil will be fertilized and aerated frequently. This will allow landfarm to increase it output to double what one cell will

produce. For the present time this cell will have room for surplus water storage until melt water can be filtered or stored in a more efficient manner.

9.0 Nun 9:

Rock Reject Stockpile

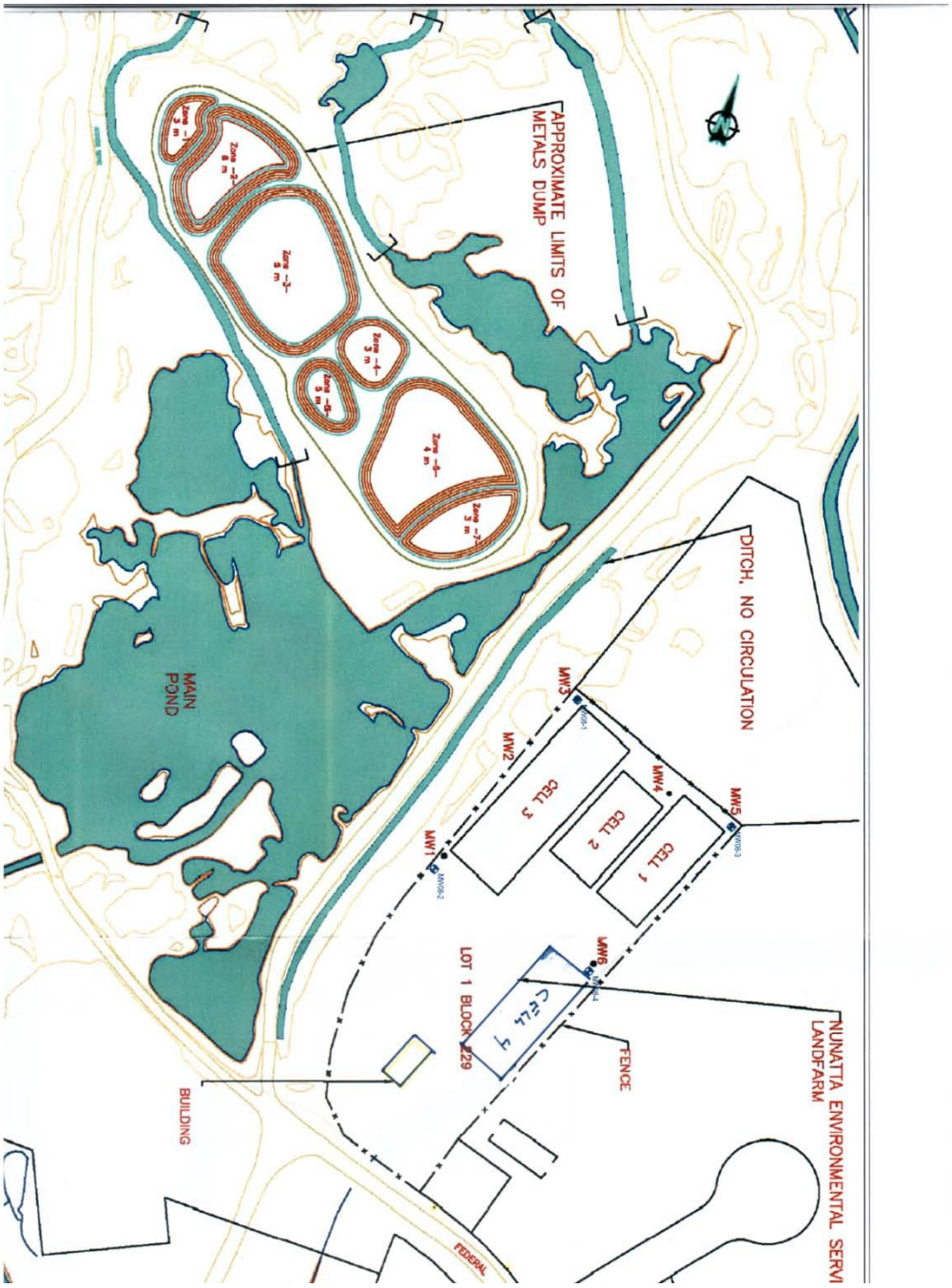
Rocks have not been addressed prior to 2009. They were left in the soil piles and only picked out and placed along the sides of the berms while soil was being cultivated in cell 3.

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.

This plant has a belt stacker to soils are delivered into cone shaped stacks which offer more surface area and better aeration than soils handled by loader which can become compacted. Stones are placed in cell 2 to weather off hydrocarbons. Stones will be tested and when CCME standards are met, authorities will be notified rocks and stones will be released from landfarm to go to gravel crushers to make clear stone products. Gravel crushers are very keen to get clean rock products. Blasting rock is their only other option.

To Date no stones have been removed from the landfarm.

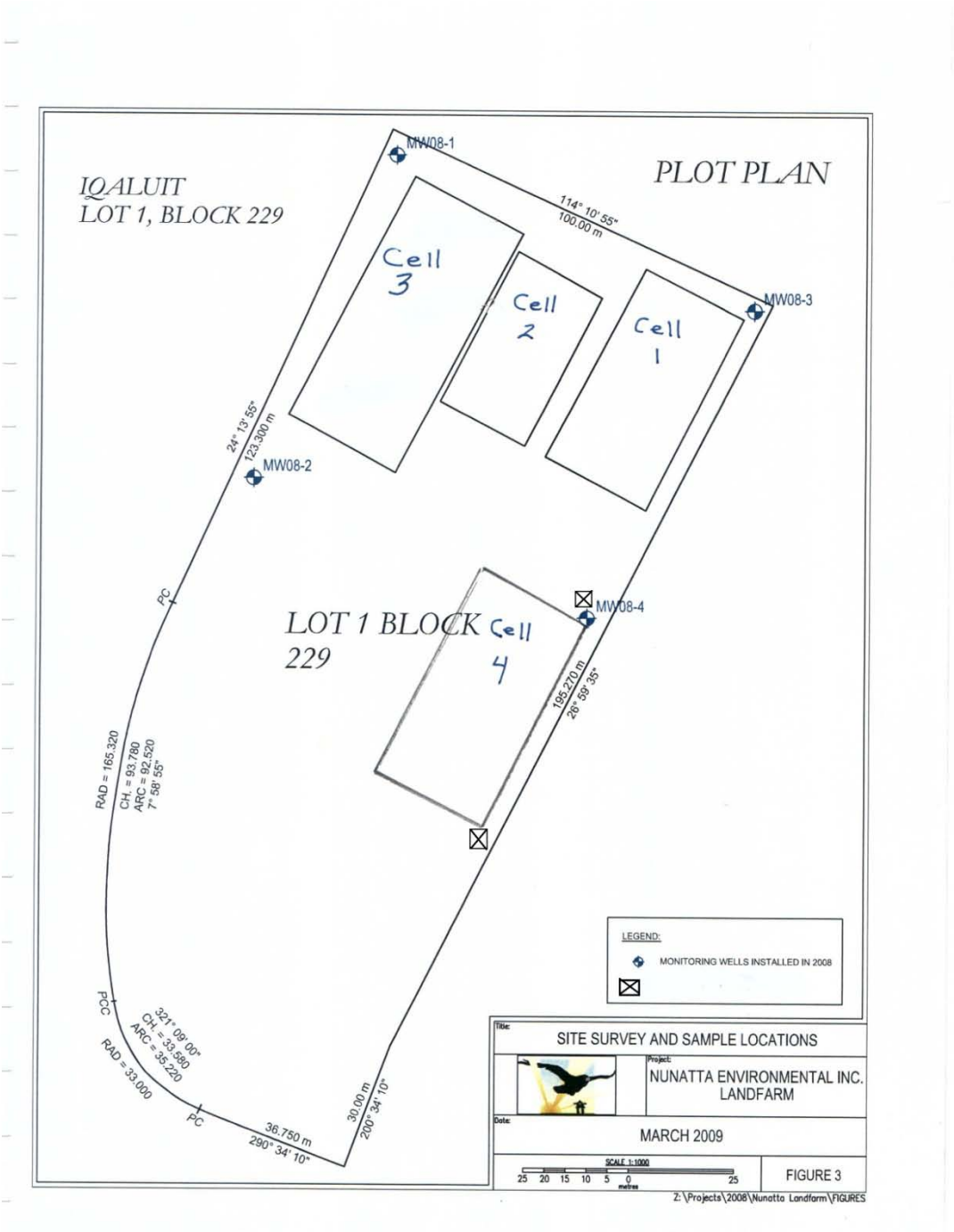
Landfarm Location.



Cells constructed in 2004 shown in Red

Cells constructed in 2008 shown in Blue (larger map next page)

Landfarm cell 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.

List of lab reports

Reference Appendex I for report files

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

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.