AECOM

Iqaluit Sewage Sludge Management Composting Pilot Project Report

Submitted to:
Bruce Rines
Director of Engineering
City of Iqaluit
P.O. Box 460
Iqaluit, Nunavut X0A 0H0

Prepared for:
City of Iqaluit
P.O. Box 460
Iqaluit, Nunavut X0A 0H0

Prepared by:
AECOM Canada Ltd.
17203-103rd Avenue
Edmonton, Alberta T5S 1J4

March 31, 2009

AECOM Project No. 106787-03

AECOM

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Edmonton, AB T5S 1J4

March 31, 2009

AECOM Project No. 106787-03

Author: Cortney McCracken, EIT

Title: Water/Wastewater Engineer

Date: January 12, 2009

Reviewer: Ken Johnson, P.Eng.

Title: Project Manager

Date: January 12, 2009

AECOM

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March 31, 2009

Project Number: 106787-03

Mr. Bruce Rines
Director of Engineering
City of Iqaluit
P.O. Box 460
Iqaluit, Nunavut X0A 0H0

Dear Mr. Rines:

Re: Final - Iqaluit Sewage Sludge Management Composting Pilot Study Report

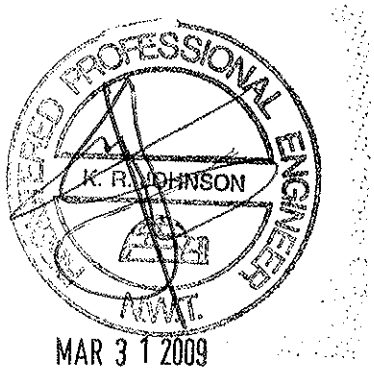
We are pleased to provide you with two (2) copies of the final report for the Iqaluit Sewage Sludge Management Composting Pilot Study. An electronic copy will also be sent by email.

If you have any questions regarding the above please contact the undersigned at 780-453-0910.

Sincerely,
AECOM Canada Ltd.

Ken Johnson, P.Eng.
Project Manager

KRJ:vad
Encls.



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1.0 INTRODUCTION

The City of Iqaluit, Nunavut is in the process of upgrading to a conventional activated sludge wastewater treatment system for its municipal sewage. The first phase of the project (primary treatment) was commissioned in May 2006, and the second phase (secondary treatment) is planned for the next five (5) to ten (10) years. The design, construction, and operation of this facility present challenges that are unique to Iqaluit's harsh arctic environment. One of these challenges is how to dispose of the sewage sludge produced by the sewage treatment facility.

Sewage sludge, produced as a waste product during modern sewage treatment, has specific handling, treatment and disposal requirements. Sludge has high levels of pathogens and high nutrient characteristics, so sludge must usually be treated before disposal in order to protect public health and the receiving environment. Most municipalities in Canada are aware of the need to treat sewage sludge before disposal.

However, sewage sludge treatment in the Canadian north is not well established. Municipal sewage sludge in the north is hidden as an inherent part of a sewage lagoon. Sludge essentially becomes part of the lagoon as it settles to the lagoon bottom, and only requires removal every 10 (ten) to 15 (fifteen) years. With such infrequent sludge disposal, it is easy to ignore municipal sewage sludge entirely. In addition, sludge management techniques used in more southern climates are not necessarily effective in the Northwest Territories and Nunavut because of the challenging environmental and social conditions.

The City of Iqaluit recognized the need for a sewage sludge management plan and retained AECOM Canada Ltd. to complete the plan. AECOM began by identifying available sludge management technologies, and then applied screening criteria to produce a short list of technologies for detailed evaluation. These technologies were reviewed for their applicability in a northern context, and it was recommended that freeze-thaw dewatering and composting was the most appropriate choice for Iqaluit.

With freeze-thaw dewatering and composting selected as the sludge treatment processes, the City applied for funding to begin a pilot project in order to determine how effective the technology would actually be for Iqaluit's sewage sludge. The Federation of Canadian Municipalities approved the City's grant application for equipment and testing. A pilot dewatering and composting facility was constructed next to the landfill in 2006.

AECOM was asked by the City of Iqaluit to determine the effectiveness of the sludge management pilot project. AECOM proposed to do this by analyzing samples of the compost and comparing these samples to the raw sludge. To this end, composted sludge samples were taken from the pilot sludge management area in October 2008, along with raw sewage sludge samples from the site. Samples of Iqaluit's raw sewage sludge were also taken in March, May and June of 2006. This report summarizes the results of the sampling.

2.0 SLUDGE COMPOSTING PROCESS

The sludge management facility is located next to the municipal landfill. Raw sludge is piled at the east end of the site, and four (4) composting piles (windrows) are established on concrete slabs towards the west end of the site. The area is fenced, with two gated entrances: one direct access through a gate from the road on the west side of the site, and an access road from the main gate at the landfill entrance. See **Appendix A** for the site layout.

Freezing and thawing is used to dewater the raw sewage sludge. During spring and fall months, the sludge freezes and thaws, which separates the solid sludge particles from the water. When complete thawing occurs from May to June, some of the separated water drains away. This freeze-thaw process produces a dryer sludge material available for composting.

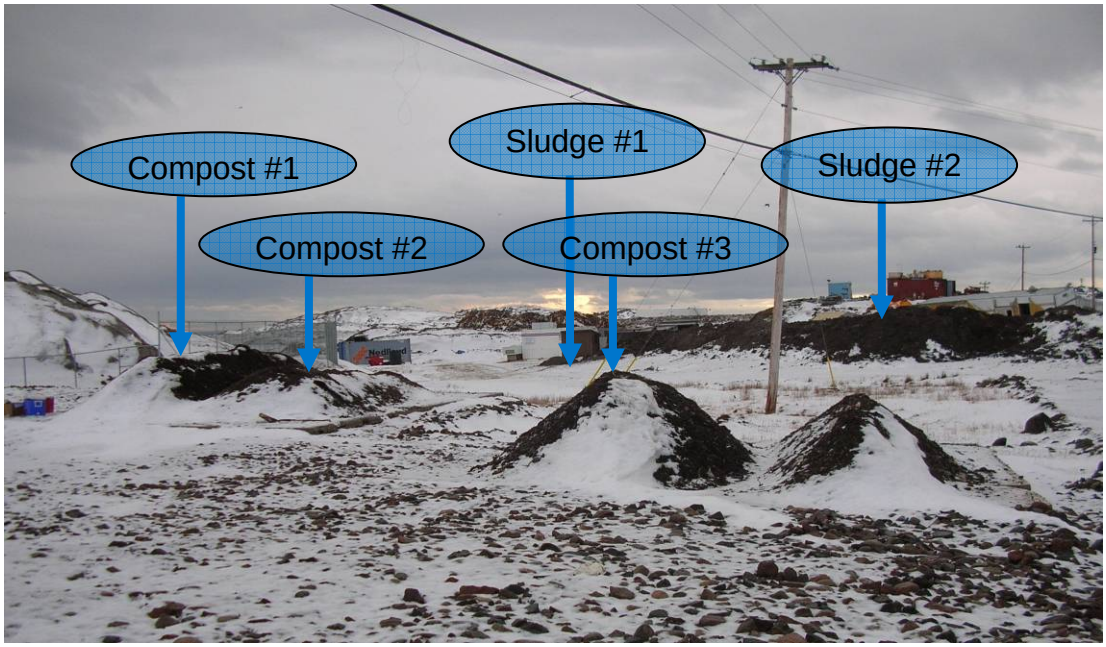
To begin the composting process, dewatered sludge is mixed with wood chips (produced by shredding) at a ratio of approximately 2:1 wood:sludge, and piled in rows. The compost should be turned regularly to encourage aerobic conditions inside the pile. Over the summer months, composting will occur, and a "maturing" phase can occur over the following winter months.

3.0 SAMPLING RESULTS

3.1 2008 Samples

On October 28, 2008 samples of raw sludge and composted material were collected from the City's sludge management facility. See **Figures 1** and **2** below for the sampling locations. The samples were stored in coolers and delivered to Bodycote (Norwest Labs) in Edmonton for analysis on October 30.

Figure 1: 2008 Sample Locations



The sample results were received by AECOM on November 11, 2008. **Table 1** shows the results for the 2008 compost and sludge samples. See **Appendix C** for copies of the Bodycote testing results.

Appendix D contains brief descriptions of the analyzed parameters. Some of the important parameters are discussed in Section 4.

Figure 2: Iqaluit Pilot Sludge Management Site Overview

Table 1: October 2008 Sample Results

Parameter	Unit	Compost #1	Compost #2	Compost #3	Sludge #1	Sludge #2
Aggregate Organic Constituents						
Organic Matter	% weight	10.8	8.3	8.6	84.2	9[1]
Water	%	32.1				
Solids	%	67.4				
Oil (dry wt.)	%	0.68				
Oil (wet wt.)	%	0.46				
Classification						
Nitrogen (TKN)	%	0.35	0.29	0.32	0.35	0.28
Metals						
Mercury	mg/kg	0.12				
Aluminum	mg/kg	6190				
Antimony	mg/kg	3.1				
Arsenic	mg/kg	5.1				
Barium	mg/kg	69				
Beryllium	mg/kg	0.2				
Bismuth	mg/kg	3.3				
Cadmium	mg/kg	1.11				
Chromium	mg/kg	27.7				
Calcium	mg/kg	17700				
Cobalt	mg/kg	5.1				
Copper	mg/kg	283				
Iron	mg/kg	18800				
Lead	mg/kg	87.9				
Magnesium	mg/kg	3400				
Manganese	mg/kg	282				
Molybdenum	mg/kg	4				
Nickel	mg/kg	19				
Phosphorus	mg/kg	1620	1410	1470	2090	1340
Selenium	mg/kg	0.6				
Silicon	mg/kg	680				
Silver	mg/kg	1.4				
Strontium	mg/kg	64				
Thalium	mg/kg	<0.05				
Tin	mg/kg	6				
Titanium	mg/kg	213				
Vanadium	mg/kg	15.5				
Zinc	mg/kg	357				
Microbiological Analysis						
Total Coliforms	MPN/g	<3	7	43	>1,100,000	23000
Fecal Coliforms	MPN/g	<3	7	7	1,100,000	23000

[1] The low organic matter result for Sludge Sample #2 may be an anomaly.

Parameter	Unit	Compost #1	Compost #2	Compost #3	Sludge #1	Sludge #2
Physical and Aggregate Properties						
Solids (wet wt.)	%	55.7	56.2	60.9	19.6	44.8
Soil Acidity						
pH		7.4				
EC (sat.paste equiv)		5.66				
EC (soil:water)		2.75				
Water Soluble Parameters						
BOD (extractable)	mg/kg	3400				104000

3.2 2006 Samples

AECOM staff took samples of raw sludge from Iqaluit (the WWTP or the sludge management site) in March 2006, May 2006, and again in June 2006. Two (2) letter reports on the sampling were produced, dated April 25, 2006 and July 11, 2006.

In summary these reports stated that:

1. Untreated Iqaluit sludge has a high concentration of total solids (around 20%) compared to typical primary sludge (around 6%).

2. Untreated Iqaluit sludge contains a high concentration of Total Coliforms and Fecal Coliforms, with >1,100,000 MPN/g measured for both parameters in both the March and June samples.

3. Untreated Iqaluit sludge contains a low concentration of metals compared to typical wastewater sludge.

The sludge sample taken in March 2006 was analyzed for many different parameters, including various trace metals. The results can be compared to those of the Compost #1 sample taken in 2008, as shown in **Table 2** below.

Table 2: Comparison of Compost and Sludge on All Parameters

Parameter	Unit	Compost (2008)	Sludge (2006)
Aggregate Organic Constituents			
Organic Matter	% weight	10.8	NT
Water	%	32.1	80.2
Solids	%	67.4	17.6
Oil (dry wt.)	%	0.68	11
Oil (wet wt.)	%	0.46	2.16
Classification			
Nitrogen (TKN)	%	0.35	1.08
Metals			
Mercury	mg/kg	0.12	0.08
Aluminum	mg/kg	6190	NT
Antimony	mg/kg	3.1	0.4
Arsenic	mg/kg	5.1	0.4

Parameter	Unit	Compost (2008)	Sludge (2006)
Barium	mg/kg	69	24
Beryllium	mg/kg	0.2	0.2
Bismuth	mg/kg	3.3	NT
Cadmium	mg/kg	1.11	0.17
Chromium	mg/kg	27.7	2.7
Calcium	mg/kg	17700	NT
Cobalt	mg/kg	5.1	0.2
Copper	mg/kg	283	170
Iron	mg/kg	18800	NT
Lead	mg/kg	87.9	3.9
Magnesium	mg/kg	3400	NT
Manganese	mg/kg	282	NT
Molybdenum	mg/kg	4	2
Nickel	mg/kg	19	2.2
Phosphorus	mg/kg	1620	1420
Selenium	mg/kg	0.6	0.9
Silicon	mg/kg	680	NT
Silver	mg/kg	1.4	1
Strontium	mg/kg	64	NT
Thalium	mg/kg	<0.05	0.1
Tin	mg/kg	6	2
Titanium	mg/kg	213	NT
Vanadium	mg/kg	15.5	1
Zinc	mg/kg	357	200
Microbiological Analysis			
Total Coliforms	MPN/g	<3	>1,100,000
Fecal Coliforms	MPN/g	<3	>1,100,000
Escherichia coli	MPN/g		1,100,000
Physical and Aggregate Properties			
Solids (wet wt.) / Total Solids	%	55.7	19.5
Soil Acidity			
pH		7.4	5.6
Water Soluble Parameters			
BOD (extractable)	mg/kg	3400	39500

*NT: Not Tested

4.0 DISCUSSION

4.1 Microbiological Content

The composting process is reducing the number of total and fecal coliforms to a great extent. As shown in **Table 3**, the Most Probable Number of both total and fecal coliforms is very high in Iqaluit's raw sewage sludge; lower in a sample of sludge that has undergone a freeze-thaw dewatering cycle; and very low in the composting material. Both the 2008 and 2006 sample results were used to generate the averages in **Table 3**.

Table 3: Total and Fecal Coliforms in Iqaluit Sludge and Compost

	Units	Average Raw Sludge	Dewatered Sludge	Average Compost
Total Coliforms	MPN/g	> 852,500	23,000	18
Fecal Coliforms	MPN/g	> 852,500	23,000	6

The US Environmental Protection Agency (US EPA) classifies sewage sludge as either Class A or Class B with respect to pathogen content. Either of these classes of treated sludge can be land applied. The EPA regulation states that a composted sludge is considered Class A if the compost temperature is maintained at 55˚C or higher for fifteen (15) days or longer, and the aerated pile is turned a minimum of five times during this period. Compost is considered Class B if the temperature of the compost is raised to 40˚C or higher for five (5) days or longer, and the temperature exceeds 55˚C for at least four (4) hours during this period. The operating temperature of Iqaluit's compost piles during the summer is unknown.

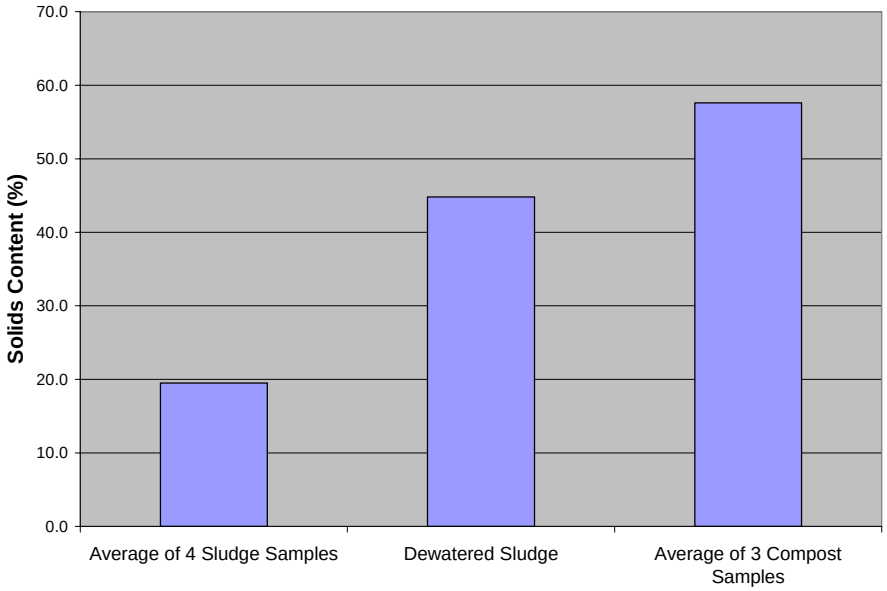
Iqaluit's treated sludge (compost) is either Class A or Class B with respect to pathogens. One of the alternative ways for a treated sludge to be classified as Class B is if the average fecal coliform count of seven samples is less than 2,000,000 Most Probable Number per gram of total solids (dry weight basis). Iqaluit's compost is well below this limit for fecal coliforms, so the compost is at least Class B. There are also several alternatives for a treated sludge to classify as Class A, such as having low test counts for certain pathogens. This has not been examined in detail for Iqaluit's compost.

4.2 Solids Content

The freeze-thaw dewatering process, combined with the composting treatment stage, appears to be effective at increasing the solids content of the sludge material. Raw sewage sludge from Iqaluit's WWTP is about 20% solids. As noted in the April 2006 letter report, this is higher than typical for primary sludge which is generally about 6% solids. After the sludge undergoes freeze-thaw dewatering and is mixed with dry wood chip material, the average solids content of the composting material is 58%.

One of the October 2008 sludge samples appears to have advanced in the freeze-thaw dewatering cycle, since the solids content is 44.8% while four other sludge samples have solids contents of 18, 19.5, 19.6 and 20.9% respectively. This could indicate that the freeze-thaw process is successfully dewatering the sludge. However, no firm conclusions can be made about the effectiveness of the freeze-thaw process due to the limited number of samples.

Figure 3: Solids Content

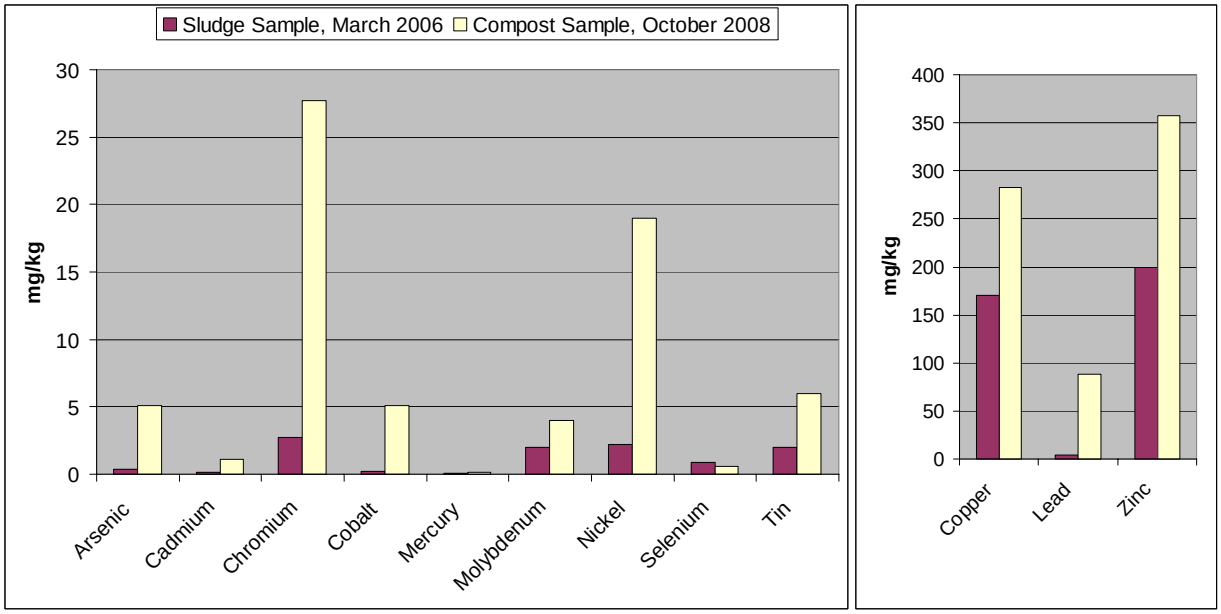


4.3 Metals Content

In the April 25, 2006 letter report on Iqaluit's raw sewage sludge, it was noted that the Iqaluit March 2006 sludge sample had low concentrations for several key metals. The following charts compare the metals concentrations in Iqaluit sludge and compost. The metals concentrations measured in the October 2008 compost sample were somewhat higher than concentrations in the March 2006 raw sludge sample.

A rational explanation for this increase may be the source of the wood waste, which is shredded wood products and contains metal associated with nails and fixtures.

Figure 4: Metals in Sewage Sludge



The metals shown above have an impact on how a treated sludge (biosolid) may be used or disposed of. Except for tin, these twelve (12) metals are considered "of principle concern" in biosolids used for land application by the Ontario Ministry of Environment (1996). Ten (10) of them are regulated by the US Environmental Protection Agency (EPA) for sewage sludge to be used in land application.

USEPA pollutant limits for sewage sludge are shown in **Table 4** below. Treated sludge must be below the Ceiling Concentration limits for any land application. For application on agricultural land, forest, a public contact site, or a reclamation site, the sludge must meet a more stringent Monthly Average Concentration, or else the application of sludge must be limited by a maximum cumulative pollutant loading rate in kilograms per hectare.

Table 4: US EPA Pollutant Limits for Land Applied Sewage Sludge

		Land Application[2]		Surface Disposal[3]
Pollutant	**Units**	**Ceiling Concentration**	**Monthly Average Concentration**	**Maximum Concentration**
Arsenic	mg/kg	75	41	73
Cadmium	mg/kg	85	39	
Chromium	mg/kg			600
Mercury	mg/kg	57	17	
Molybdenum	mg/kg	75		
Nickel	mg/kg	420	420	420
Selenium	mg/kg	100	100	
Copper	mg/kg	4300	1500	
Lead	mg/kg	840	300	
Zinc	mg/kg	7500	2800	

Iqaluit's sludge (treated and untreated) is well within the US EPA limits as shown in **Table 4**. Therefore, based on trace heavy metals content, the compost is suitable for land application.

5.0 CONCLUSIONS

Based on the sampling to date, the freeze-thaw dewatering and composting processes are effectively treating Iqaluit's sewage sludge. Compost samples showed a dramatic reduction in total and fecal coliforms compared to the raw sludge samples. As well, the solids content of compost samples and one partially treated sludge sample was much higher than that of the raw sewage sludge. The processes do not appear to have any significant impact on some contaminants, including metals, but this result is expected.

It is worth noting that the metals concentrations in Iqaluit's sewage sludge and compost are below the US EPA limits on sludge for surface disposal and land application. Iqaluit's treated compost has very low pathogen counts, and likely could be classified as Class B sewage sludge or even Class A. This means that the treated compost is suitable for land disposal and some types of land application.

[2] Land application is defined as the spreading of sewage sludge onto land to condition soil or fertilize vegetation.
[3] Surface disposal is defined as placing sewage sludge on an area of land for final disposal.

6.0 RECOMMENDATIONS

AECOM recommends that the City of Iqaluit continue to use freeze-thaw dewatering and composting to treat the sludge from its Wastewater Treatment Plant. These processes are successfully reducing the microbiological content and increasing the solids content of the sewage sludge. In addition, the technology is cost-effective and requires a modest amount of work to operate and maintain, particularly when compared to other technologies.

Based on a cursory examination of US EPA sewage sludge use and disposal regulations, Iqaluit's treated sewage sludge (compost) is suitable for use as a cover material at the landfill.

7.0 REFERENCES

Mukesh Mathrani, Earth Tech, *Iqaluit WWTP Sludge Analysis.* July 11, 2006.

Michelle Yu, Earth Tech, *Iqaluit WWTP Sludge Analysis.* April 25, 2006.

Ministry of Environment and Ministry of Agriculture, Food and Rural Affairs, Government of Ontario, *Guidelines for the Utilization of Biosolids and Other Wastes on Agricultural Land.* March, 1996.

United States Environmental Protection Agency (US EPA), *Electronic Code of Federal Regulations Title 40: Part 503 – Standards for the Use of Disposal of Sewage Sludge.* Accessed December 2, 2008. http://ecfr.gpoaccess.gov

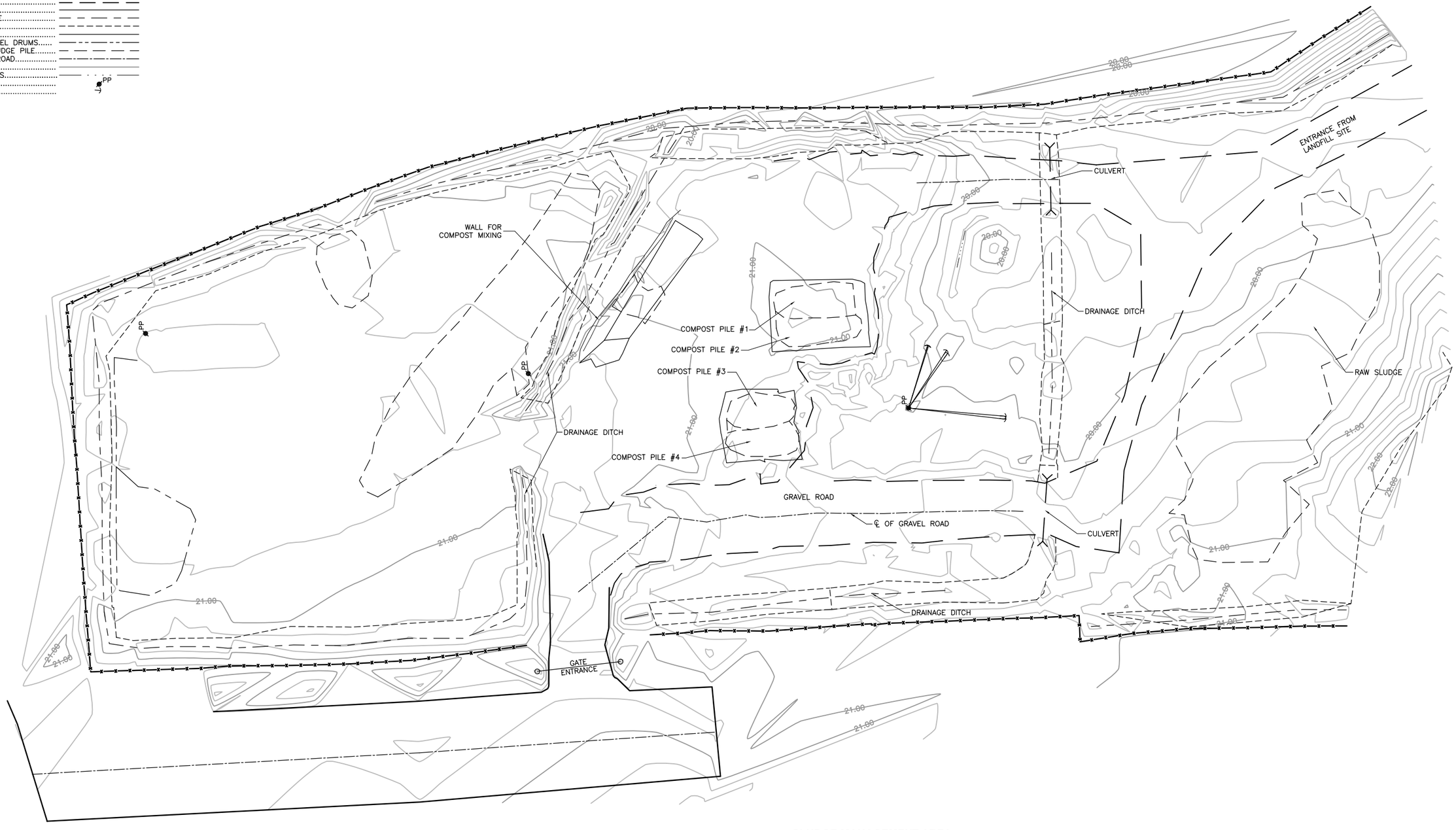
Appendices

Appendix A

Sludge Management Site Layout

LEGEND:

FENCE LINE
EDGE OF ROAD
EDGE OF GRAVEL
CONCRETE PAD
DITCH CENTER LINE
TOP OF SLOPE
GUIDE WIRE
PERIMETER OF STEEL DRUMS
PERIMETER OF SLUDGE PILE
CENTER LINE OF ROAD
CONTOUR
CENTERLINE SWALES
POWER POLE
GUIDE WIRE TIE



SLUDGE MANAGEMENT AREA

SCALE 1:200

0 2 6 10m

PROFESSIONAL SEALS

I/R	YY/MM/DD	ISSUE/REVISION DESCRIPTION	DRN	CHK	DES	ENG	IDR	APP
B	09/03/31	ISSUED FOR FINAL REPORT	MDS	KRJ	CLM	KRJ	KRJ	KRJ
A	09/01/16	ISSUED FOR REVIEW	MDS	KJ	CLM	CLM	KJ	KJ

AECOM

CITY OF IQALUIT
IQALUIT SLUDGE MANAGEMENT
SLUDGE MANAGEMENT AREA
-

PROJECT NUMBER	DRAWING NUMBER	ISSUE/REVISION
106787	106787-C001	B

Appendix B

Sludge Management Site Photographs

Compost on Concrete Slabs

Compost

Access from Main Landfill Entrance

Gated Access Direct from Road

Appendix C

Sample Testing Results

Appendix C-1

2008 Sample Results

Report Transmission Cover Page

Bill To:	Earth Tech Canada Inc.	Project:	
Report To:	Earth Tech Canada Inc.	ID:	
	17203 - 103 Avenue	Name:	
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut
	T5S 1J4	LSD:	
Attn:	Cortney McCracken	P.O.:	
Sampled By:	Cortney McCracken	Acct code:	
Company:			

Lot ID:	**652276**
Approval Status:	Approved
Invoice Frequency:	by Lot
COD Status:	
Control Number:	A104955
Date Received:	Oct 30, 2008
Date Reported:	Nov 7, 2008
Report Number:	1169559

Contact	Company	Address
Cortney McCracken	Earth Tech Canada Inc.	17203 - 103 Avenue Edmonton, AB T5S 1J4 Phone: (780) 732-9467 Fax: (780) 488-2121 Email: cortney.mccracken@aecom.com

	Copies	Delivery	Format
M	1	Post	
	1	Email - Single Report	PDF

_____ PAGES IN THIS TRANSMISSION

Notes To Clients:

Reports associated with this Lot

Id/Format/Report Date	Id/Format/Report Date	Id/Format/Report Date

Bodycote TESTING GROUP

Analytical Report

Bill To:	Earth Tech Canada Inc.	Project:	
Report To:	Earth Tech Canada Inc.	ID:	
	17203 - 103 Avenue	Name:	
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut
	T5S 1J4	LSD:	
Attn:	Cortney McCracken	P.O.:	
Sampled By:	Cortney McCracken	Acct code:	
Company:			

Lot ID:	**652276**
Control Number:	A104955
Date Received:	Oct 30, 2008
Date Reported:	Nov 7, 2008
Report Number:	1169559

Reference Number	652276-1
Sample Date	
Sample Time	
Sample Location	
Sample Description	Compost Pile #1
Matrix	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Soil Acidity						
pH	1:2 Soil:Water	pH	7.4			
Electrical Conductivity	Sat. Paste equiv based on 1:2	dS/m at 25 C	5.66			0.02
Electrical Conductivity	1:2 Soil:Water	dS/m at 25 C	2.75			0.01

Bodycote TESTING GROUP

Analytical Report

Bill To:	Earth Tech Canada Inc.	Project:		Lot ID:	**652276**
Report To:	Earth Tech Canada Inc.	ID:		Control Number:	A104955
	17203 - 103 Avenue	Name:		Date Received:	Oct 30, 2008
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut	Date Reported:	Nov 7, 2008
	T5S 1J4	LSD:		Report Number:	1169559
Attn:	Cortney McCracken	P.O.:			
Sampled By:	Cortney McCracken	Acct code:			
Company:					

		Reference Number	652276-1	652276-2	652276-3	
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	Compost Pile #1	Compost Pile #2	Compost Pile #3	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Aggregate Organic Constituents						
Organic Matter		% by weight	10.8	8.3	8.6	0.1
Oil	Dean Stark, dry wt.	%	0.68			0.05
Oil	Dean Stark, wet wt.	%	0.46			0.05
Water		%	32.1			0.1
Solids		%	67.4			0.1
Classification						
Total Nitrogen	TKN	%	0.35	0.29	0.32	0.02
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	mg/kg	0.12			0.01
Aluminum	Strong Acid Extractable	mg/kg	6190			20
Antimony	Strong Acid Extractable	mg/kg	3.1			0.2
Arsenic	Strong Acid Extractable	mg/kg	5.1			0.2
Barium	Strong Acid Extractable	mg/kg	69			1
Beryllium	Strong Acid Extractable	mg/kg	0.2			0.1
Bismuth	Strong Acid Extractable	mg/kg	3.3			0.5
Cadmium	Strong Acid Extractable	mg/kg	1.11			0.01
Chromium	Strong Acid Extractable	mg/kg	27.7			0.5
Calcium	Strong Acid Extractable	mg/kg	17700			200
Cobalt	Strong Acid Extractable	mg/kg	5.1			0.1
Copper	Strong Acid Extractable	mg/kg	283			1
Iron	Strong Acid Extractable	mg/kg	18800			100
Lead	Strong Acid Extractable	mg/kg	87.9			0.1
Magnesium	Strong Acid Extractable	mg/kg	3400			100
Manganese	Strong Acid Extractable	mg/kg	282			10
Molybdenum	Strong Acid Extractable	mg/kg	4			1
Nickel	Strong Acid Extractable	mg/kg	19.0			0.5
Phosphorus	Strong Acid Extractable	mg/kg	1620	1410	1470	30
Selenium	Strong Acid Extractable	mg/kg	0.6			0.3
Silicon	Strong Acid Extractable	mg/kg	680			50
Silver	Strong Acid Extractable	mg/kg	1.4			0.1
Strontium	Strong Acid Extractable	mg/kg	64			1
Thallium	Strong Acid Extractable	mg/kg	<0.05			0.05
Tin	Strong Acid Extractable	mg/kg	6			1
Titanium	Strong Acid Extractable	mg/kg	213			0.5
Vanadium	Strong Acid Extractable	mg/kg	15.5			0.1
Zinc	Strong Acid Extractable	mg/kg	357			1

Bodycote TESTING GROUP

Analytical Report

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Report To:	Earth Tech Canada Inc.	ID:	
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Date Reported:	Nov 7, 2008
Report Number:	1169559

		Reference Number	652276-1	652276-2	652276-3	
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	Compost Pile #1	Compost Pile #2	Compost Pile #3	
		Matrix	Soil	Soil	Soil	
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Microbiological Analysis						
Total Coliforms	MPN	MPN/g	<3	7	43	3
Fecal Coliforms	MPN	MPN/g	<3	7	7	
Physical and Aggregate Properties						
% solids	Wet Weight	%	55.7	56.2	60.9	0.1

Bodycote TESTING GROUP

Analytical Report

Bill To:	Earth Tech Canada Inc.	Project:		Lot ID:	**652276**
Report To:	Earth Tech Canada Inc.	ID:		Control Number:	A104955
	17203 - 103 Avenue	Name:		Date Received:	Oct 30, 2008
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut	Date Reported:	Nov 7, 2008
	T5S 1J4	LSD:		Report Number:	1169559
Attn:	Cortney McCracken	P.O.:			
Sampled By:	Cortney McCracken	Acct code:			
Company:					

		Reference Number	652276-1	652276-5		
		Sample Date				
		Sample Time				
		Sample Location				
		Sample Description	Compost Pile #1	Sludge (South)		
		Matrix	Soil	Soil		
Analyte		**Units**	**Results**	**Results**	**Results**	Nominal Detection Limit
Water Soluble Parameters						
Biochemical Oxygen Demand	Extractable	mg/kg	3400	104000		20

Bodycote TESTING GROUP

Analytical Report

Bill To:	Earth Tech Canada Inc.	Project:	
Report To:	Earth Tech Canada Inc.	ID:	
	17203 - 103 Avenue	Name:	
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut
	T5S 1J4	LSD:	
Attn:	Cortney McCracken	P.O.:	
Sampled By:	Cortney McCracken	Acct code:	
Company:			

Lot ID:	**652276**
Control Number:	A104955
Date Received:	Oct 30, 2008
Date Reported:	Nov 7, 2008
Report Number:	1169559

Reference Number		652276-4	652276-5
Sample Date			
Sample Time			
Sample Location			
Sample Description		Sludge (North)	Sludge (South)
Matrix		Soil	Soil

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Aggregate Organic Constituents						
Organic Matter		% by weight	84.2	9.0		0.1
Classification						
Total Nitrogen	TKN	%	0.35	0.28		0.02
Metals Strong Acid Digestion						
Phosphorus	Strong Acid Extractable	mg/kg	2090	1340		30
Microbiological Analysis						
Total Coliforms	MPN	MPN/g	>1100000	23000		3
Fecal Coliforms	MPN	MPN/g	1100000	23000		
Physical and Aggregate Properties						
% solids	Wet Weight	%	19.6	44.8		0.1

Approved by:

Anthony Neumann, MSc
Laboratory Operations Manager

Bodycote TESTING GROUP

Quality Control

Bill To:	Earth Tech Canada Inc.	Project:	
Report To:	Earth Tech Canada Inc.	ID:	
	17203 - 103 Avenue	Name:	
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut
	T5S 1J4	LSD:	
Attn:	Cortney McCracken	P.O.:	
Sampled By:	Cortney McCracken	Acct code:	
Company:			

Lot ID:	**652276**
Control Number:	A104955
Date Received:	Oct 30, 2008
Date Reported:	Nov 7, 2008
Report Number:	1169559

Aggregate Organic Constituents

Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Oil	%	0.10	0.08	20	0.10	yes
Water	%	27.6	26.4	20	3.0	yes
Solids	%	72.3	73.5	20	3.0	yes
Date Acquired:	October 30, 2008					

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Organic Matter	% by weight	7.9	6.7	9.7	yes
Date Acquired:	November 01, 2008				
Oil	%	2.18	1.96	2.44	yes
Water	%	1.6	1.3	3.1	yes
Solids	%	96.3	92.7	98.7	yes
Date Acquired:	October 30, 2008				

Classification

Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Total Nitrogen	%	0.05	0.05	10	0.02	yes
Date Acquired:	October 31, 2008					

Metals Strong Acid Digestion

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Mercury	mg/kg	<0.01	-0.07	0.09	yes
Aluminum	mg/kg	<20	-4	5	yes
Antimony	mg/kg	<0.2	-0.2	0.2	yes
Arsenic	mg/kg	<0.2	-0.1	0.2	yes
Barium	mg/kg	<1	-0	1	yes
Beryllium	mg/kg	<0.1	-0.1	0.1	yes
Bismuth	mg/kg	<0.5	-0.4	0.5	yes
Cadmium	mg/kg	<0.01	-0.01	0.01	yes
Chromium	mg/kg	<0.5	-0.4	0.5	yes
Calcium	mg/kg	<200	-0	0	yes
Cobalt	mg/kg	<0.1	-0.1	0.1	yes
Copper	mg/kg	<1	-1	1	yes
Iron	mg/kg	<100	-15	15	yes
Lead	mg/kg	<0.1	-0.1	0.1	yes
Magnesium	mg/kg	<100	-0	0	yes
Manganese	mg/kg	<10	-0	0	yes
Molybdenum	mg/kg	<1	-1	1	yes
Nickel	mg/kg	<0.5	-0.5	0.5	yes
Phosphorus	mg/kg	<30	-0	0	yes
Selenium	mg/kg	<0.3	-0.2	0.2	yes

Bodycote TESTING GROUP

Quality Control

Bill To:	Earth Tech Canada Inc.	Project:		Lot ID:	**652276**
Report To:	Earth Tech Canada Inc.	ID:		Control Number:	A104955
	17203 - 103 Avenue	Name:		Date Received:	Oct 30, 2008
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut	Date Reported:	Nov 7, 2008
	T5S 1J4	LSD:		Report Number:	1169559
Attn:	Cortney McCracken	P.O.:			
Sampled By:	Cortney McCracken	Acct code:			
Company:					

Metals Strong Acid Digestion - Continued

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
Silicon	mg/kg	<50	-0	0	yes
Silver	mg/kg	<0.1	-0.1	0.1	yes
Strontium	mg/kg	<1	-1	1	yes
Thallium	mg/kg	<0.05	-0.04	0.05	yes
Tin	mg/kg	4	1	6	yes
Titanium	mg/kg	<0.5	-0.1	0.5	yes
Vanadium	mg/kg	<0.1	-0.1	0.1	yes
Zinc	mg/kg	<1	-1	1	yes

Date Acquired: October 31, 2008

Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Mercury	mg/kg	1.90	1.74	10	0.03	yes
Barium	mg/kg	4450	4490	20	2	yes

Date Acquired: October 31, 2008

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Mercury	mg/kg	0.31	0.24	0.34	yes
Aluminum	mg/kg	16900	8849	23459	yes
Antimony	mg/kg	0.8	0.2	1.1	yes
Arsenic	mg/kg	84.3	61.4	120.8	yes
Barium	mg/kg	260	188	336	yes
Beryllium	mg/kg	1	0.6	1.2	yes
Bismuth	mg/kg	1.6	0.1	3.5	yes
Cadmium	mg/kg	1.85	1.28	2.90	yes
Chromium	mg/kg	45.7	29.8	61.0	yes
Calcium	mg/kg	124000	103212	151212	yes
Cobalt	mg/kg	13.9	9.8	18.6	yes
Copper	mg/kg	178	147	262	yes
Iron	mg/kg	25200	17736	33498	yes
Lead	mg/kg	118	84.9	161.7	yes
Magnesium	mg/kg	12300	9353	17687	yes
Manganese	mg/kg	542	381	719	yes
Molybdenum	mg/kg	4	2	4	yes
Nickel	mg/kg	59.0	42.9	87.3	yes
Phosphorus	mg/kg	810	401	1007	yes
Selenium	mg/kg	0.7	0.5	1.1	yes
Silicon	mg/kg	1560	-227	1933	yes
Silver	mg/kg	0.9	0.6	1.5	yes
Strontium	mg/kg	236	170	324	yes
Thallium	mg/kg	0.39	0.26	0.50	yes
Tin	mg/kg	4	1	7	yes
Titanium	mg/kg	1220	877.0	1603.0	yes
Vanadium	mg/kg	50.7	32.6	63.4	yes

Bodycote TESTING GROUP

Quality Control

Bill To:	Earth Tech Canada Inc.	Project:	
Report To:	Earth Tech Canada Inc.	ID:	
	17203 - 103 Avenue	Name:	
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut
	T5S 1J4	LSD:	
Attn:	Cortney McCracken	P.O.:	
Sampled By:	Cortney McCracken	Acct code:	
Company:			

Lot ID:	**652276**
Control Number:	A104955
Date Received:	Oct 30, 2008
Date Reported:	Nov 7, 2008
Report Number:	1169559

Metals Strong Acid Digestion - Continued

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
Zinc	mg/kg	467	331	715	yes

Date Acquired: October 31, 2008

Physical and Aggregate Properties

Replicates	Units	Replicate 1	Replicate 2	% RSD Criteria	Absolute Criteria	Passed QC
Moisture	%	43.7	41.2	10		yes

Date Acquired: October 31, 2008

Soil Acidity

Blanks	Units	Measured	Lower Limit	Upper Limit	Passed QC
pH	pH	6.2	5.6	7.4	yes
Electrical Conductivity	dS/m at 25 C	<0.01	-0.00	0.01	yes

Date Acquired: October 31, 2008

Control Sample	Units	Measured	Lower Limit	Upper Limit	Passed QC
pH	pH	6.3	6.1	6.7	yes
Electrical Conductivity	dS/m at 25 C	0.45	0.29	0.65	yes

Date Acquired: October 31, 2008

Bodycote TESTING GROUP

Methodology and Notes

Bill To:	Earth Tech Canada Inc.	Project:	
Report To:	Earth Tech Canada Inc.	ID:	
	17203 - 103 Avenue	Name:	
	Edmonton, AB, Canada	Location:	Iqaluit, Nunavut
	T5S 1J4	LSD:	
Attn:	Cortney McCracken	P.O.:	
Sampled By:	Cortney McCracken	Acct code:	
Company:			

Lot ID:	**652276**
Control Number:	A104955
Date Received:	Oct 30, 2008
Date Reported:	Nov 7, 2008
Report Number:	1169559

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Coliforms- MPN (Enviro)	APHA		Fecal Coliform Procedure, 9221 E	30-Oct-08	BTG Calgary
Coliforms- MPN (Enviro)	APHA		Standard Total Coliform Fermentation Technique, 9221 B	30-Oct-08	BTG Calgary
Mercury (Hot Block) in Soil	US EPA	*	Determination of Hg in Sediment by Cold Vapor Atomic Absorption Spec, 245.5	31-Oct-08	BTG Edmonton
Metals ICP-MS (Hot Block) in soil	SW-846	*	Acid Digestion of Sediments, Sludges, and Soils, EPA 3050B	31-Oct-08	BTG Edmonton
Oil in soil by Dean-Stark	Dean-Stark	*	Determination of the Bitumen, Water and Solids in Oil Sand, ACOSA	30-Oct-08	BTG Edmonton
Organic Matter by Ignition	McKeague	*	Loss on Ignition (LOI), 3.8	01-Nov-08	BTG Edmonton
pH and Conductivity in general soil 1:2	McKeague	*	1:2 Soil:Water Ratio, 4.12	31-Oct-08	BTG Edmonton
TKN in Soil	Ext. Lab		Analysis Completed by External Laboratory,	31-Oct-08	BTG Winnipeg

** Bodycote method(s) based on reference method*

References

APHA	Standard Methods for the Examination of Water and Wastewater
Dean-Stark	ACOSA Reference Method
Ext. Lab	External Laboratory
McKeague	Manual on Soil Sampling and Methods of Analysis
SW-846	Test Methods for Evaluating Solid Waste
US EPA	US Environmental Protection Agency Test Methods

Comments:

Appendix C-2

Sample Results from Previous Years

NORWEST LABS

Control Number E 262008

4744SS

Environmental Sample Information Sheet

NOTE: Proper completion of this form is required in order to proceed with analysis

See reverse for your nearest Norwest location and proper sampling protocol

Billing Address: x	**Copy of Report To:**	**Copy of invoice:** ☐
Company: Earth Tech Canada Inc.	Company: Earth Tech Canada Inc.	Mail invoice to this address for approval ☐
Address: 17203 - 103 Avenue, Edmonton, AB T5S 1J4	Address: 17203 - 103 Avenue, Edmonton, AB T5S 1J4	
QA/QC Report ☐	SAME AS BILLING.	
Attention: ~~Environmental Group~~ Mukesh Mathrani	Attention: Environmental Group	Report Result: Fax ☐ Mail ☐ Courier ☐ e-mail ☐ e-service ☐
Phone: (780) 488-6800 453-0808 (Direct)	Phone: (780) 488-6800	
Fax: (780) 488-2121	Fax: (780) 488-2121	
Cell:	Cell:	
e-mail: ~~gwpollett@earthtech.ca~~ mukesh.mathrani	e-mail: gwpollett@earthtech.ca	
Report Result: Fax ☐ Mail ☐ Courier ☐ e-mail ✓ e-Service ☐		

Information to be included on Report and Invoice

Project ID: 93107
Project Name: IQA - LDI - 2006
Project Location: Various
Legal Location: —
PO#: —
Proj. Acct. Code: —
Agreement ID: 40857

RUSH

Please contact the laboratory to confirm rush dates and times before submitting samples.

Upon filling out this section, client accepts that surcharges will be attached to this analysis

Requirement: all analyses **or** as indicated ☐ **or** ☐

Date Required: _____

Signature: _____

Norwest Authorization: _____

Sample Custody (Please Print)

Sampled by: M. Mathrani

Company ET Signature M.

I authorize Norwest Labs to proceed with the work indicated on this form:

Date: 2006 06 29

Initial: MM

Received by: ☐ Coolers

Waybill # Date ☐ Boxes

Company Time ☐ Samples

Received By: Date: June 29/06

Company: Time: 8:37 am

Special Instructions / Comments

☐ Check here if Norwest is required to report results directly to a regulatory body (Please include contact information)

3 ok

	Sample Identification	Location	Depth IN CM M	Date / Time Sampled	Matrix	Sampling Method	Number of Containers	ROUTINE	WSO/BOD	NUTRIENTS	WW3	METALS/TW22	HG
							↓	Enter tests above (✓ relevant samples below)					
1	As Noted on Bottles' Labels		SURFACE	June 28	Water	Grab	2	✓	✓	✓		✓	✓
2	〃		〃	〃	〃	〃	3				✓		
3	SLUDGE		—										
4			—										
5			—										
6			—										
7			—										
8			—										
9			—										
10			—										
11			—										
12			—										
13			—										
14			—										
15			—										

NOTE: All hazardous samples must be labeled according to WHMIS guidelines.

Page ____ of ____ ##

NWL008 (06/05)

Report Transmission Cover Page

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: **(780) 438-5522**
Fax: **(780) 438-0396**

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: M. Mathrani
Company: ET

Project
ID: 93107
Name: IQA-LDI-2006
Location: Various
LSD:
P.O.:
Acct. Code:

NWL Lot ID: **474455**
Control Number: E 262008
Date Received: Jun 29, 2006
Date Reported: Jul 10, 2006
Report Number: 871132

Contact	Company	Address	
Don Roy	Earth Tech Canada Inc.	17203 - 103 Avenue	
Web		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 453-0709	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: don.roy@earthtech.ca	
Gordon Woollett	Earth Tech Canada Inc.	17203 - 103 Avenue	
Web x		Edmonton, AB T5S 1J4	
Email Notification		Phone: (780) 453-0710	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: gordon.woollett@earthtech.ca	
1 Post			
Greg Wright	Earth Tech Canada Inc.	17203-103 Ave	
Web		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 488-6800	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: greg.wright@earthtech.ca	
Matthew McElwaine	Earth Tech Canada Inc.	17203 - 103 Avenue	
Web		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 453-0821	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: matthew.mcelwaine@earthtech.ca	
Tami Dolen	Earth Tech Canada Inc.	17203-103 Ave	
Web x		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 488-6800	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: tami.dolen@earthtech.ca	

NOTE: **P** indicates a preliminary report is required
NOTE: **A** indicates report is delivered using automated delivery

_____ # OF PAGES IN THIS TRANSMISSION

Report Transmission Notes

Agreement Notes

Lot Notes

Please send a copy of this report to Mukesh Mathrani, (453-0808 direct) mukeshi.mathrani@earthtech.ca AP June 29/06

Sample Notes:

Notes to Clients

Lot Notes:

Sample Notes:

1915852 Sample was gravity filtered to remove particulates for pH and alkalinity analysis.

1915852 Some total metal results were less than dissolved metal results for sample 474455-1. The results were verified and are within the method uncertainty. July 5/06

Batch Notes:

Report Transmission Cover Page

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: **(780) 438-5522**
Fax: **(780) 438-0396**

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: M. Mathrani
Company: ET

Project
ID: 93107
Name: IQA-LDI-2006
Location: Various
LSD:
P.O.:
Acct. Code:

NWL Lot ID: **474455**
Control Number: E 262008
Date Received: Jun 29, 2006
Date Reported: Jul 10, 2006
Report Number: 871132

Method Notes:

Method Result Notes:

Reports associated with this Lot

Id/Format/Reported Date	Id/Format/Reported Date	Id/Format/Reported Date
871132 Env2QC 3 Smp & DL		

Comment:
See Methodology and Notes page of Analytical Report for all comments pertaining to this report.

If this report transmission is not satisfactory, please send report requirements to the address at the top of this page.

Analytical Report

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: M. Mathrani
Company: ET

Project ID: 93107
Name: IQA-LDI-2006
Location: Various
LSD:
P.O.:
Acct. Code:

NWL Lot ID: **474455**
Control Number: E 262008
Date Received: Jun 29, 2006
Date Reported: Jul 10, 2006
Report Number: 871132

NWL Number	474455-1
Sample Date	Jun 28, 2006
Sample Description	IQA-SWDF
Matrix	Water

Analyte		Units	Results	Results	Results	Detection Limit
Inorganic Nonmetallic Parameters						
Kjeldahl Nitrogen	Total	mg/L	20.7			0.06
Phosphorus	Total	mg/L	0.8			0.05
Metals Total						
Calcium	Total	mg/L	203			0.2
Iron	Total	mg/L	12.8			0.1
Magnesium	Total	mg/L	49.0			0.1
Manganese	Total	mg/L	1.02			0.005
Potassium	Total	mg/L	61.7			0.4
Silicon	Total	mg/L	9.42			0.05
Sodium	Total	mg/L	207			0.4
Sulfur	Total	mg/L	105			0.3
Mercury	Total	mg/L	0.0001			0.0001
Aluminum	Total	mg/L	5.01			0.005
Antimony	Total	mg/L	0.0238			0.0002
Arsenic	Total	mg/L	0.018			0.0002
Barium	Total	mg/L	0.12			0.001
Beryllium	Total	mg/L	<0.0002			0.0001
Bismuth	Total	mg/L	<0.001			0.0005
Boron	Total	mg/L	1.06			0.002
Cadmium	Total	mg/L	0.00236			0.00001
Chromium	Total	mg/L	0.0241			0.0005
Cobalt	Total	mg/L	0.0024			0.0001
Copper	Total	mg/L	0.294			0.001
Lead	Total	mg/L	0.0993			0.0001
Lithium	Total	mg/L	0.02			0.001
Molybdenum	Total	mg/L	<0.002			0.001
Nickel	Total	mg/L	0.0226			0.0005
Selenium	Total	mg/L	0.0009			0.0002
Silver	Total	mg/L	0.0006			0.0001
Strontium	Total	mg/L	1.01			0.001
Thallium	Total	mg/L	<0.0001			0.00005
Tin	Total	mg/L	0.02			0.001
Titanium	Total	mg/L	0.382			0.0005
Uranium	Total	mg/L	<0.001			0.0005
Vanadium	Total	mg/L	0.010			0.0001

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Analytical Report

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: M. Mathrani
Company: ET

Project ID: 93107
Name: IQA-LDI-2006
Location: Various
LSD:
P.O.:
Acct. Code:

NWL Lot ID: **474455**
Control Number: E 262008
Date Received: Jun 29, 2006
Date Reported: Jul 10, 2006
Report Number: 871132

NWL Number	474455-1
Sample Date	Jun 28, 2006
Sample Description	IQA-SWDF
Matrix	Water

Analyte		Units	Results	Results	Results	Detection Limit
Metals Total - Continued						
Zinc	Total	mg/L	0.763			0.001
Zirconium	Total	mg/L	0.005			0.001
Routine Water						
pH			7.52			
Electrical Conductivity		µS/cm at 25 C	2050			1
Calcium	Dissolved	mg/L	180			0.2
Magnesium	Dissolved	mg/L	52			0.1
Sodium	Dissolved	mg/L	198			0.4
Potassium	Dissolved	mg/L	59			0.4
Iron	Dissolved	mg/L	0.70			0.01
Manganese	Dissolved	mg/L	0.78			0.005
Chloride	Dissolved	mg/L	249			0.4
Nitrate - N		mg/L	<0.05			0.01
Nitrite - N		mg/L	<0.02			0.005
Nitrate and Nitrite - N		mg/L	<0.07			0.02
Sulfate (SO4)	Dissolved	mg/L	307			0.9
Hydroxide		mg/L	<5			5
Carbonate		mg/L	<6			6
Bicarbonate		mg/L	578			5
P-Alkalinity	as CaCO3	mg/L	<5			5
T-Alkalinity	as CaCO3	mg/L	474			5
Total Dissolved Solids	Calculated	mg/L	1330			1
Hardness	Dissolved as CaCO3	mg/L	660			
Ionic Balance	Dissolved	%	100			

NORWEST LABS

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Analytical Report

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: M. Mathrani
Company: ET

Project ID: 93107
Name: IQA-LDI-2006
Location: Various
LSD:
P.O.:
Acct. Code:

NWL Lot ID: **474455**
Control Number: E 262008
Date Received: Jun 29, 2006
Date Reported: Jul 10, 2006
Report Number: 871132

			NWL Number	474455-1	474455-3		
			Sample Date	Jun 28, 2006	Jun 28, 2006		
			Sample Description	IQA-SWDF	Sludge		
			Matrix	Water	Soil		
Analyte		**Units**		**Results**	**Results**	**Results**	**Detection Limit**
Aggregate Organic Constituents							
Biochemical Oxygen Demand	5 Day	mg/L		269	-		4
Organic Matter		% by weight		-	83.2		0.1
Physical and Aggregate Properties							
Temperature of observed pH		°C		18.5	-		
Solids	Total Suspended	mg/L		868	-		1
% solids	Wet Weight	%		-	20.9		0.1

			NWL Number	474455-2	474455-3		
			Sample Date	Jun 28, 2006	Jun 28, 2006		
			Sample Description	IQA-SWDF	Sludge		
			Matrix	Water	Soil		
Analyte		**Units**		**Results**	**Results**	**Results**	**Detection Limit**
Microbiological Analysis							
Total Coliforms	MPN	MPN/g		-	>1100000		3
Fecal Coliforms	Membrane Filtration	CFU/100 mL		<1	-		
Fecal Coliforms	MPN	MPN/g		-	>1100000		

			NWL Number	474455-3			
			Sample Date	Jun 28, 2006			
			Sample Description	Sludge			
			Matrix	Soil			
Analyte		**Units**		**Results**	**Results**	**Results**	**Detection Limit**
Classification							
Total Nitrogen	TKN	%		1.29			0.01
Metals Strong Acid Digestion							
Phosphorus	Strong Acid Extractable	ug/g		2780			30
Water Soluble Parameters							
Biochemical Oxygen Demand	Extractable	mg/kg		19500			20
Chemical Oxygen Demand		ug/g		7100			25

Approved by:

Darren Crichton, BSc, PChem
Operations Chemist

NORWEST LABS 467089

Control Number E 241020

Environmental Sample Information Sheet

NOTE: Proper completion of this form is required in order to proceed with analysis
See reverse for your nearest Norwest location and proper sampling protocol

Billing Address: x	**Copy of Report To:**	**Copy of invoice:** ☐
Company: Earth Tech Canada Inc.	Company: Earth Tech Canada Inc.	Mail invoice to this address for approval x ☐
Address: 17203-103 Ave, Edmonton, AB T5S 1J4	Address: 17203-103 Ave, Edmonton, AB T5S 1J4	
QA/QC Report ☐		
Attention: Greg Wright	Attention: Greg Wright	
Phone: (780) 488-6800	Phone: (780) 488-6800	
Fax: (780) 488-2121	Fax: (780) 488-2121	
Cell:	Cell:	
e-mail: greg.wright@earthtech.ca	e-mail: greg.wright@earthtech.ca	
Report Result:	**Report Result:**	
Fax ☐	Fax ☐	
Mail ☒	Mail ☒	
Courier ☐	Courier ☐	
e-mail ☒	e-mail ☒	
e-Service ☐	e-service ☐	

Information to be included on Report and Invoice

Project ID:
Project Name: Phase III Arctic ESA
Project Location: 93107
Legal Location:
PO#:
Proj. Acct. Code:
Agreement ID: 62449

RUSH Please contact the laboratory to confirm rush dates and times before submitting samples.

Upon filling out this section, client accepts that surcharges will be attached to this analysis

Required on: all analyses **or** as indicated ☐ or ☐

Date Required: _____
Signature: _____
Norwest Authorization: _____

Sample Custody (Please Print)

Relinquished by:
Company Signature

I authorize Norwest Labs to proceed with the work indicated on this form:
Date: May 4, 2006
Initial: MM

Received by: ☐ Coolers
Waybill # Date ☐ Boxes
Company Time ☐ Samples

Special Instructions / Comments ☐ Check here if Norwest is required to report results directly to a regulatory body (Please include contact information)

COD-5, BOD5, MWGTS, CL43, CL40, 551, CPDI, MTP

Received By: Date:
Company: Time:

	Sample Identification	Location	Depth IN CM M	Date / Time Sampled	Matrix	Sampling Method	Number of Containers	[redacted]	COD	[redacted]	WSO	TSV	TN	TP	FC	TC	Moisture Content
							↓	Enter tests above (✔ relevant samples below)									
1	sewage sludge	IQALUIT Landfill Site	—	May 3, 2006		Grab	2		✔		✔	✔	✔	✔	✔	✔	✔
2			—														
3			—														
4			—														
5			—														
6			—														
7			—														
8			—														
9			—														
10			—														
11			—														
12			—														
13			—														
14			—														
15			—														

NOTE: All hazardous samples must be labelled according to WHMIS guidelines.
Accredited by the Standards Council of Canada for specific tests

Courier ✔ May 3/06

NWL008 (08/03)

Report Transmission Cover Page

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: **(780) 438-5522**
Fax: **(780) 438-0396**

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203-103 Ave
Edmonton, AB, Canada
T5S 1J4
Attn: Greg Wright
Sampled By:
Company:

Project ID:
Name: Phase III Arctic ESA
Location:
LSD:
P.O.: 93107
Acct. Code:

NWL Lot ID: **467089**
Control Number: E 241020
Date Received: May 29, 2006
Date Reported: Jun 06, 2006
Report Number: 859383

Contact	Company	Address
Gordon Woollett	Earth Tech Canada Inc.	17203 - 103 Avenue Edmonton, AB T5S 1J4 Phone: (780) 453-0710 Fax: (780) 488-2121 Email: gordon.woollett@earthtech.ca

Web x
Email Notification

	Copies	Delivery Strategy	Format

Contact	Company	Address
Greg Wright	Earth Tech Canada Inc.	17203-103 Ave Edmonton, AB T5S 1J4 Phone: (780) 488-6800 Fax: (780) 488-2121 Email: greg.wright@earthtech.ca

Web x
Email Notification x

	Copies	Delivery Strategy	Format
	1	Post	
A	1	Email - Single Report	PDF

NOTE: **P** indicates a preliminary report is required
NOTE: **A** indicates report is delivered using automated delivery

_____ # OF PAGES IN THIS TRANSMISSION

Report Transmission Notes
Agreement Notes
Lot Notes
Sample Notes:

Notes to Clients
Lot Notes:
Sample Notes:
Batch Notes:
Method Notes:
Method Result Notes:

Reports associated with this Lot

Id/Format/Reported Date	Id/Format/Reported Date	Id/Format/Reported Date
859383 Env2 3 Smp & DL		

Comment:
See Methodology and Notes page of Analytical Report for all comments pertaining to this report.

If this report transmission is not satisfactory, please send report requirements to the address at the top of this page.

Analytical Report

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203-103 Ave
Edmonton, AB, Canada
T5S 1J4
Attn: Greg Wright
Sampled By:
Company:

Project ID:
Name: Phase III Arctic ESA
Location:
LSD:
P.O.: 93107
Acct. Code:

NWL Lot ID: **467089**
Control Number: E 241020
Date Received: May 29, 2006
Date Reported: Jun 06, 2006
Report Number: 859383

NWL Number	467089-1
Sample Date	May 03, 2006
Sample Description	IQALUIT Landfill Site / Sewage Sludge
Matrix	Waste - industrial

Analyte		Units	Results	Results	Results	Detection Limit
Aggregate Organic Constituents						
Organic Matter		% by weight	85.6			0.1
Classification						
Total Nitrogen	TKN	%	1.22			0.01
Metals Strong Acid Digestion						
Phosphorus	Strong Acid Extractable	ug/g	1720			30
Microbiological Analysis						
Total Coliforms	MPN	MPN/g	>110000			3
Fecal Coliforms	MPN	MPN/g	>110000			
Physical and Aggregate Properties						
% solids	Wet Weight	%	18.0			0.1
Water Soluble Parameters						
Biochemical Oxygen Demand	Extractable	mg/kg	30400			20
Chemical Oxygen Demand		ug/g	23200			25

Approved by:

Darren Crichton, BSc, PChem
Operations Chemist

NORWEST LABS

450064

Control Number E 262011

Environmental Sample Information Sheet

NOTE: Proper completion of this form is required in order to proceed with analysis

See reverse for your nearest Norwest location and proper sampling protocol

Billing Address:	**Copy of Report To:**	**Copy of invoice:** ☐
Company: Earth Tech Canada Inc.	Company: Earth Tech Canada Inc.	Mail invoice to this address for approval ☐
Address: 17203 - 103 Avenue, Edmonton, AB T5S 1J4	Address: 17203 - 103 Avenue, Edmonton, AB T5S 1J4	
QA/QC Report ☒		
Attention: Environmental Group	Attention: Environmental Group	
Phone: (780) 488-6800	Phone: (780) 488-6800	
Fax: (780) 488-2121	Fax: (780) 488-2121	
Cell:	Cell:	
e-mail: gwoollett@earthtech.ca	e-mail: gwoollett@earthtech.ca	
Report Result:	**Report Result:**	
Fax ☐	Fax ☐	
Mail ☐	Mail ☐	
Courier ☐	Courier ☐	
e-mail ☐	e-mail ☐	
e-Service ☒	e-service ☐	

Information to be included on Report and Invoice

Project ID: 86905
Project Name: Iqaluit Sludge Management
Project Location: WWTP
Legal Location: IQALUIT WWTP
PO#:
Proj. Acct. Code:
Agreement ID: **40857**

RUSH

Please contact the laboratory to confirm rush dates and times before submitting samples.

Upon filling out this section, client accepts that surcharges will be attached to this analysis

Required on: all analyses **or** as indicated ☐ or ☐

Date Required: _____
Signature: _____
Norwest Authorization: _____

Sample Custody (Please Print)

Sampled by: Ken Johnson
Company ET Signature KJ
I authorize Norwest Labs to proceed with the work indicated on this form:
Date: March 13, 2006
Initial: KJ

Received by: ☐ Coolers
Waybill # Date ☐ Boxes
Company Time ☐ Samples

Special Instructions / Comments

☐ Check here if Norwest is required to report results directly to a regulatory body (Please include contact information)

Please refer to the attached "Memo".
Please give me a call if you have any questions.
Mukesh Mathrani @ (780) 453-0808.

Received By: Date:
Company: Time:

	Sample Identification	Location	Depth IN CM M	Date / Time Sampled	Matrix	Sampling Method	Number of Containers ↓	TW35	DW16	O/G	H8	Enter tests above (✓ relevant samples below)
1	Wastewater sludge	WWTP	—	March 10, 2006	sludge	Grab	2					
2			—									
3			—									
4			—									
5			—									
6			—									
7			—									
8			—									
9			—									
10			—									
11			—									
12			—									
13			—									
14			—									
15			—									

NOTE: All hazardous samples must be labeled according to WHMIS guidelines.

Page ____ of ____ ##

NWL008 (05/05)

NORWEST LABS

Report Transmission Cover Page

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: Ken Johnson
Company: ET

Project ID: 86905
Name: Iqaluit WWTP Sludge Management
Location: WWTP, IQALUIT WWTP
LSD:
P.O.:
Acct. Code:

NWL Lot ID: **450064**
Control Number: E 262011
Date Received: Mar 16, 2006
Date Reported: Mar 27, 2006
Report Number: 829789

Contact	Company	Address	
Don Roy	Earth Tech Canada Inc.	17203 - 103 Avenue	
Web		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 453-0709	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: don.roy@earthtech.ca	
Gordon Woollett	Earth Tech Canada Inc.	17203 - 103 Avenue	
Web x		Edmonton, AB T5S 1J4	
Email Notification		Phone: (780) 453-0710	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: gordon.woollett@earthtech.ca	
1 Post			
Greg Wright	Earth Tech Canada Inc.	17203-103 Ave	
Web		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 488-6800	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: greg.wright@earthtech.ca	
Matthew McElwaine	Earth Tech Canada Inc.	17203 - 103 Avenue	
Web		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 453-0821	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: matthew.mcelwaine@earthtech.ca	
Stephen Yuen	Earth Tech Canada Inc.	17203 - 103 Avenue	
Web x		Edmonton, AB T5S 1J4	
Email Notification		Phone: (780) 453-0710	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: stephen.yuen@earthtech.ca	
Tami Dolen	Earth Tech Canada Inc.	17203-103 Ave	
Web x		Edmonton, AB T5S 1J4	
Email Notification x		Phone: (780) 488-6800	Fax: (780) 488-2121
Copies Delivery Strategy Format		Email: tami.dolen@earthtech.ca	

NOTE: **P** indicates a preliminary report is required
NOTE: **A** indicates report is delivered using automated delivery

_____ # OF PAGES IN THIS TRANSMISSION

Report Transmission Notes

Agreement Notes

Lot Notes

Sample Notes:

Notes to Clients

Lot Notes:

Analysis was completed on a sample that exceeded the recommended holding time for BOD analysis.

NORWEST LABS

Report Transmission Cover Page

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: Ken Johnson
Company: ET

Project
ID: 86905
Name: Iqaluit WWTP Sludge Management
Location: WWTP, IQALUIT WWTP
LSD:
P.O.:
Acct. Code:

NWL Lot ID: **450064**
Control Number: E 262011
Date Received: Mar 16, 2006
Date Reported: Mar 27, 2006
Report Number: 829789

Sample Notes:

Batch Notes:

Method Notes:

Method Result Notes:

Reports associated with this Lot

Id/Format/Reported Date	Id/Format/Reported Date	Id/Format/Reported Date
828047 Env2 3 Smp & DL 24-Mar-06	829789 Env2 3 Smp & DL	

Comment:
See Methodology and Notes page of Analytical Report for all comments pertaining to this report.

If this report transmission is not satisfactory, please send report requirements to the address at the top of this page.

NORWEST LABS

Analytical Report

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: Ken Johnson
Company: ET

Project ID: 86905
Name: Iqaluit WWTP Sludge Management
Location: WWTP, IQALUIT WWTP
LSD:
P.O.:
Acct. Code:

NWL Lot ID: 450064
Control Number: E 262011
Date Received: Mar 16, 2006
Date Reported: Mar 27, 2006
Report Number: 829789

NWL Number	450064-1
Sample Date	Mar 10, 2006
Sample Description	WWTP / Wastewater Sludge
Matrix	Waste - industrial

Analyte		Units	Results	Results	Results	Detection Limit
Aggregate Organic Constituents						
Oil	Dean Stark, dry wt.	%	11.00			0.05
Oil	Dean Stark, wet wt.	%	2.16			0.05
Water		%	80.2			0.1
Solids		%	17.6			0.1
Classification						
Nitrogen	Total	%	1.08			0.02
Hot Water Soluble						
Boron	Water Soluble	ug/g	1			0.1
Metals Strong Acid Digestion						
Mercury	Strong Acid Extractable	ug/g	0.08			0.01
Antimony	Strong Acid Extractable	ug/g	<0.4			0.2
Arsenic	Strong Acid Extractable	ug/g	<0.4			0.2
Barium	Strong Acid Extractable	ug/g	24			1
Beryllium	Strong Acid Extractable	ug/g	<0.2			0.1
Cadmium	Strong Acid Extractable	ug/g	0.17			0.01
Chromium	Strong Acid Extractable	ug/g	2.7			0.5
Cobalt	Strong Acid Extractable	ug/g	<0.2			0.1
Copper	Strong Acid Extractable	ug/g	170			1
Lead	Strong Acid Extractable	ug/g	3.9			0.1
Molybdenum	Strong Acid Extractable	ug/g	<2			1
Nickel	Strong Acid Extractable	ug/g	2.2			0.5
Phosphorus	Strong Acid Extractable	ug/g	1420			15
Selenium	Strong Acid Extractable	ug/g	0.9			0.3
Silver	Strong Acid Extractable	ug/g	1			0.1
Thallium	Strong Acid Extractable	ug/g	<0.1			0.05
Tin	Strong Acid Extractable	ug/g	<2			1
Vanadium	Strong Acid Extractable	ug/g	1			0.1
Zinc	Strong Acid Extractable	ug/g	200			1
Microbiological Analysis						
Total Coliforms	MPN	MPN/g	>1100000			3
Fecal Coliforms	MPN	MPN/g	>1100000			
Escherichia coli	MPN	MPN/g	1100000			
Physical and Aggregate Properties						
Total Solids	As Received	% by weight	19.50			0.01
Total Solids, Fixed	As Received	% by weight	0.62			0.01

NORWEST LABS

Analytical Report

Norwest Labs
7217 Roper Road NW
Edmonton, AB. T6B 3J4
Phone: (780) 438-5522
Fax: (780) 438-0396

Bill to: Earth Tech Canada Inc.
Report to: Earth Tech Canada Inc.
17203 - 103 Avenue
Edmonton, AB, Canada
T5S 1J4
Attn: Environmental Group
Sampled By: Ken Johnson
Company: ET

Project ID: 86905
Name: Iqaluit WWTP Sludge Management
Location: WWTP, IQALUIT WWTP
LSD:
P.O.:
Acct. Code:

NWL Lot ID: 450064
Control Number: E 262011
Date Received: Mar 16, 2006
Date Reported: Mar 27, 2006
Report Number: 829789

NWL Number	450064-1
Sample Date	Mar 10, 2006
Sample Description	WWTP / Wastewater Sludge
Matrix	Waste - industrial

Analyte		Units	Results	Results	Results	Detection Limit
Physical and Aggregate Properties - Continued						
Total Solids, Volatile	As Received	% by weight	18.90			0.01
Soil Acidity						
pH	1:2 Soil:CaCl2 sol.	pH	5.6			
Water Soluble Parameters						
Biochemical Oxygen Demand	Extractable	mg/kg	39500			20

Approved by:

Darren Crichton, BSc, PChem
Operations Chemist

Appendix D

Descriptions of Sampling Parameters

Parameter	Description
Organic matter	The weight loss on ignition test method was used to determine organic matter for Iqaluit sludge/compost samples. This method correlates the weight loss from a dry soil sample when exposed to high temperatures with oxidizable organic carbon.
Solids / Water	Two different tests were done on Iqaluit samples to determine solids content. The water and solids results reported under Aggregate Organic Constituents were found using Dean Stark analysis, which is mainly used to determine the sample's oil content. The solids content reported under Physical and Aggregate Properties is determined based on the sample moisture content. This method analyzes the difference in weight between the wet sample and the sample after oven-drying for at least four hours.
Oil	Oil content was determined for some samples using Dean Stark analysis. This analysis uses toluene reflux (a reaction in a distilling apparatus) to separate the oil, water and solid components of the sample.
Nitrogen	Total Kjeldahl Nitrogen is the sum of organic nitrogen and ammonia. Organic nitrogen includes natural matter such as proteins, urea, and many synthetic organic materials. Ammonia is mainly produced through reactions involving organic nitrogen-containing compounds and urea.
Metals	Trace metals concentrations were determined in the lab by strong acid digestion (nitric acid). This method provides 'total' metal concentrations for most practical intents, although some structural soil elements such as aluminum and potassium are only partially extracted.
Total Coliforms	Total Coliforms include all coliform bacteria, which are used as an indicator of microbiological quality in water and wastewater. The Most Probable Number (MPN) of total coliforms was determined for Iqaluit sludge/compost using a multiple-tube fermentation procedure. The MPN is the statistically probable number of coliform bacteria (in a 100-mL sample) that would give the results found in the laboratory.
Fecal Coliforms / E.coli	Fecal Coliforms are coliform bacteria that are found only in the feces of warm-blooded mammals. These can be separated from non-fecal coliforms using elevated-temperature tests. Most Probable Number analysis was used for Iqaluit sludge and compost testing (see Total Coliforms).
Biochemical Oxygen Demand (BOD)	Five-day BOD (BOD_5) describes the nitrogenous and carbonaceous oxygen demand of organisms present in the sample over a 5 day incubation period. BOD is the difference between the final and initial Dissolved Oxygen (DO) levels in the sample. This parameter gives a general indication of the quality of wastewaters.

Parameter	Description
Chemical Oxygen Demand (COD)	COD analysis is a relatively quick test where the sample is oxidized with a strong chemical oxidant. The COD is a measurement of the oxygen required for this chemical oxidation. COD gives an indication of the amount of organic matter in the sample.

References:
American Public Health Association, *Standard Methods For the Examination of Water and Wastewater, 17th Edition*. Port City Press, Baltimore, Maryland.1989.
Agvise Laboratories, *Soil Organic Matter*, http://www.agviselabs.com/tech_art/om.php
Bodycote Testing Group, *Dean Stark Analysis in Soil and Sludge.*
Bodycote Testing Group, *Moisture Content.*

About AECOM
AECOM (NYSE: ACM) is a global provider of professional technical and management support services to a broad range of markets, including transportation, facilities, environmental and energy. With more than 40,000 employees around the world, AECOM is a leader in all of the key markets that it serves. AECOM provides a blend of global reach, local knowledge, innovation, and technical excellence in delivering solutions that enhance and sustain the world's built, natural, and social environments.

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