

Nunami Stantec
P.O. Box 188
RANKIN INLET, Nunavut
X0C 0G0



September 19, 2018

City of Iqaluit
Building 901 (City Hall) Nunavut Drive
Iqaluit, NU X0A 0H0

Attention: Matthew Hamp, Department of Engineering and Sustainability

Dear Matthew,

**Reference: Iqaluit Wastewater Treatment System
Existing Sewage Lagoon Performance Review**

BACKGROUND

Nunami Stantec, in cooperation with the City of Iqaluit, previously prepared the potential timeline and developed an action plan to temporarily divert flow to the existing lagoon to allow the improvements to be implemented to the existing Wastewater Treatment Plant (WWTP). See letter of June 6, 2018. The diversion is necessary as the current Headworks within the WWTP will require a complete shutdown for up to 4 months to replace the existing components with new and improved equipment in order to provide additional capacity to meet the growing needs of the City. A technical review of the lagoon action plan was performed by CIRNAC, in which their comments and recommendations were implemented into the updated action plan (See letter of August 10th, 2018).

A future use of the lagoon was identified more than a decade ago as a provisional treatment process in the event that the wastewater treatment facility needed to be bypassed. This objective remains with a specific requirement for the current project to provide a treatment process during the needed diversion to build the new plant. The intent is also to incorporate the lagoon, as previously intended, as a provisional treatment process in the overall treatment system.

As per the action plan, a test diversion to the lagoon was undertaken and the results of that testing and the sludge survey performed, and the anticipated level of treatment is summarized in this letter.

LAGOON ACTION PLAN UPDATE

The previously prepared Action Plan is updated as follows:

Event	Planned Date	Actual Date
Prepare and Approve Lagoon Action Plan	June 2018	June 2018
Performance Test (two weeks)	July 2018	August 2018
Perform Sludge Survey	August 2018	September 2018
Quantify Anticipated Treatment Results	August 2018	September 2018
Inform Stakeholders	September 2018	September 2018

Event	Planned Date	Actual Date
Install Public Access Deterrents	September 2018	
Divert Flow to Lagoon	October 2018	
Monitor Lagoon	October 2018 to January 2019	
Divert to Newly Commissioned WWTP (Primary Treatment)	January 2019	
Prepare Desludge Documents for Pricing	February 2019	
Obtain Pricing & Award	March 2019	
Shipping of Geotubes	July 2019	
Commence Dewatering of Sludge	August 2019	
Complete Dewatering of Sludge	September 2019	
Decant Lagoon & Evaluate Condition	September 2019	
Prepare Lagoon Operations Manual	October 2019	
Lagoon in Operation for Plant Upset Conditions	October 2019	
WWTP Commissioned (Secondary Treatment)	November 2019	
Geotube Freeze Thaw Dewatering	Winter 2019/2020	
Excavate and Transport Dewatered Solids to Landfill for use as an organic cover material	August 2020	

LAGOON COMPONENTS

Lagoon Characteristics

The available piping systems to the lagoon incorporate a combination septage dump station and diversion chamber which allows both the septage and gravity flow from the City's system to be directed to the lagoon on a provisional basis.

Based on the survey performed, the normal operating volume of the lagoon is estimated to be 25,000 m³.

The outlet from the lagoon, based on 1991 as-builts, consists of piped discharge controlled by a valve chamber; the elevation of the discharge is 5.6 metres, which is approximately 2 metres above the bottom of the lagoon. The lagoon is not lined and several features such as a French drain, and an overflow spillway, were incorporated into the design of the lagoon to maintain the geotechnical stability of the system. The discharge point of the outlet directs the flow to the same channel that the current WWTP outfall discharges to.

The lagoon provided successful treatment of sewage for decades, and it is anticipated that it will continue to function as a treatment facility and provide a reasonable level of treatment for the four-month shutdown.

Current Sludge Volume

It is understood that the most recent desludging of the sewage lagoon occurred in 1991. The lagoon remained in full operation until 2006 at which time the mechanical primary treatment system was commissioned at the current WWTP. Since 2006, the lagoon has been utilized for short periods during process upsets at the WWTP.

The sludge survey has been performed and the results are:

- Volume Pond – 20,436 m³
- Volume Sludge – 1,597 m³
- Volumetric Sludge Percentage – 7.8%

LAGOON PERFORMANCE

The testing was undertaken over a 2-week period in July and August. Both the influent and effluent were tested.

Performance Test Results

The results of the recent testing are as follows:

Date	Sample	BOD (mg/L)	TSS (mg/L)
Sewage Lagoon			
July 27, 2018	Influent	134	124
	Effluent	24	58

August 2, 2018	Influent	59	148
	Effluent	33	64
August 7, 2018	Influent	173	176
	Effluent	60	72

SUMMARY - average BOD removal was 64%, while average TSS removal was 57%.

Above presented data shows an average calculated effluent TSS:BOD rate of 1.9, which indicates good lagoon treatment performance. TSS:BOD rates close to 1 indicate poor treatment or short-circuiting, with untreated wastewater mixing with the effluent while rates less than 1 indicate old sludge solubilization and release of soluble BOD. Rates above 2 are due to algal overgrowth and high loss of sludge particles with the effluent.

And in comparison, the most recent results of testing of the Wastewater Treatment Plant are as follows:

Date	Sample	BOD (mg/L)	TSS (mg/L)
Wastewater Treatment Plant			
November 30, 2017	Influent	146	300
	Effluent	151	164
January 24, 2018	Influent	237	244
	Effluent	202	208
March 8, 2018	Influent	223	188
	Effluent	182	168
March 15, 2018	Influent	322	284
	Effluent	300	324

SUMMARY - average BOD removal was 9%, while average TSS removal was 15%.

As seen, the Wastewater Treatment Plant which consists of primary treatment only, has been performing poorly. The sewage lagoon has by far outperformed the WWTP and a much higher level of performance can be anticipated during the diversion.

Theoretical Lagoon Performance

Even though the TSS removal during the winter months when the diversion to the lagoon will be accomplished is expected to be higher than the TSS removal obtained during testing over the summer months, for worst case scenario conditions the TSS average removal of 57% is used to estimate the solids that will stay in the lagoon during a four-month wastewater diversion period. The estimation follows:

Current WWTP Flow to be Diverted to the Lagoon:	3,326 m ³ /day
Influent Wastewater TSS:	149 ppm or g/ m ³ (using the TSS average obtained during summer testing)
Total Influent Solids to lagoon:	497 kg/day
Total Expected Days of Flow Diversion to Lagoon:	120 days
Total Quantity of Solids to be Diverted to Lagoon:	59,602 kg
Estimated TSS Removal Expected:	57% (same obtained during summer testing for worst case scenario)
Solids Expected to Settle in Lagoon for 120 Days:	33,973 kg
Typical Sludge Density:	1,100 kg/m ³
Volume of Solids to Settle in Lagoon for 120 Days:	31 m ³
Total Lagoon Volume from Survey:	20,436 m ³
Current Volume of Solids in Lagoon from Survey:	1,597 m ³
Current Volumetric Solids Percentage in Lagoon:	7.8%
Total Solids Volume in Lagoon after 120 Days:	1,628 m ³
Volumetric Solids Percentage in Lagoon after 120 Days:	8.0%

The estimation shows that the volumetric solids increase in the lagoon over a period of 4 months would be only 0.2% which wouldn't present any issues for the lagoon operation.

The top water elevation registered in the lagoon survey is 5.9 meter. Therefore, the lagoon will be able to receive approximately 0.6 more meters of water depth to reach the maximum water elevation of 6.5 meters registered on the lagoon design drawings. Considering a total lagoon storage volume of approximately 25,000 m³ at maximum water level in the lagoon, the hydraulic retention time could be estimated as follows:

Estimated Total Lagoon Storage Volume:	25,000 m ³
Total Solids Volume in Lagoon after 120 Days:	1,628 m ³
Total Water Volume in Lagoon after 120 Days:	23,372 m ³
Current WWTP Flow to be Diverted to the Lagoon:	3,326 m ³ /day
Lagoon Hydraulic Retention Time (HRT):	7 days.

This HRT is congruent with calculations developed during previous years for the lagoon. Therefore, effluent BOD during the winter months wouldn't be expected to be above 160 mg/L (Refer to performance Evaluation of Primary Sewage Lagoon in Iqaluit, N.W.T. by Ken Johnson and John Cucheran). A BOD effluent at that level, will provide a BOD removal of approximately 30% based on a BOD influent of 232 mg/L as measured from the testing developed during the summer months, which is much better than the current BOD removal obtained by the WWTP of 9%.

SUMMARY

Based on the recent test diversion to the lagoon and the current performance of the wastewater treatment plant, it is anticipated that the lagoon will provide a much higher level of treatment both at the beginning and end of the diversion.

Please note again that the wastewater treatment plant cannot be upgraded without the interrupting flow to the plant for the 4-month period. The headworks is receiving a complete upgrade with increased robustness, capacity, and redundancy. In addition, the Contractor Kudlik Construction, anticipates that a shutdown of nearer to 2-months will be required, however, we have based our analysis on a 4 months period in the event that a longer contingency period is required.

We recommend that the diversion proceed and trust this meets your current requirements.

Should you have any questions, please contact the undersigned.

Sincerely,

Nunami Stantec



Glenn Prosko, P.Eng.
Senior Project Manager
Phone: (780) 969-3258
Glenn.Prosko@stantec.com

Attachment: Lagoon test summary results
Sludge Survey Report

cc. Eslam Maher, Colliers

Appendix A

Lagoon Sample Results

C.O.C.: ---

REPORT No. B18-22323

Report To:

City of Iqaluit

PO Box 460,
Iqaluit NU X0A 0H0

Attention: Maria Karveli

Caduceon Environmental Laboratories

2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 30-Jul-18

JOB/PROJECT NO.: 110126045 - Iqaluit WWTP

DATE REPORTED: 08-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

			Client I.D.		Test F - Influent	Test F - Discharge		
			Sample I.D.		B18-22323-1	B18-22323-2		
			Date Collected		27-Jul-18	27-Jul-18		
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
BOD	mg/L	3	SM 5210B	30-Jul-18/O	134	24		
Total Suspended Solids	mg/L	3	SM 2540D	01-Aug-18/O	124	58		
Conductivity @25°C	µmho/cm	1	SM 2510B	30-Jul-18/O	329	225		
pH @25°C	pH Units		SM 4500H	30-Jul-18/O	7.28	7.69		
Nitrite (N)	mg/L	0.1	SM4110C	01-Aug-18/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	01-Aug-18/O	< 0.1	< 0.1		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	01-Aug-18/O	15.2	8.46		
o-Phosphate (P)	mg/L	0.01	MOEE 3366	01-Aug-18/O	1.09	0.79		
Phosphorus-Total	mg/L	0.01	E3199A.1	31-Jul-18/K	3.13	1.60		
Aluminum	mg/L	0.01	SM 3120	31-Jul-18/O	0.18	0.13		
Antimony	mg/L	0.0005	EPA 200.8	30-Jul-18/O	< 0.0005	< 0.0005		
Arsenic	mg/L	0.0005	EPA 200.8	30-Jul-18/O	0.0006	< 0.0005		
Barium	mg/L	0.001	SM 3120	31-Jul-18/O	0.017	0.015		
Beryllium	mg/L	0.002	SM 3120	31-Jul-18/O	< 0.002	< 0.002		
Cadmium	mg/L	0.000070	EPA 200.8	30-Jul-18/O	0.000198	0.000090		
Chromium	mg/L	0.002	SM 3120	31-Jul-18/O	< 0.002	< 0.002		
Cobalt	mg/L	0.005	SM 3120	31-Jul-18/O	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	31-Jul-18/O	0.220	0.046		
Iron	mg/L	0.005	SM 3120	31-Jul-18/O	0.416	1.56		
Lead	mg/L	0.0001	EPA 200.8	30-Jul-18/O	0.0023	0.0011		
Lithium	mg/L	0.01	SM 3120	31-Jul-18/O	< 0.01	< 0.01		
Manganese	mg/L	0.001	SM 3120	31-Jul-18/O	0.066	0.111		
Mercury	mg/L	0.00002	SM 3112 B	02-Aug-18/O	0.00003	< 0.00002		
Molybdenum	mg/L	0.01	SM 3120	31-Jul-18/O	< 0.01	< 0.01		
Nickel	mg/L	0.01	SM 3120	31-Jul-18/O	< 0.01	< 0.01		
Selenium	mg/L	0.005	EPA 200.8	30-Jul-18/O	< 0.005	< 0.005		
Silver	mg/L	0.0001	EPA 200.8	30-Jul-18/O	< 0.0001	< 0.0001		

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.



R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an *

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

C.O.C.: ---

REPORT No. B18-22323

Report To:

City of Iqaluit

PO Box 460,
Iqaluit NU X0A 0H0

Attention: Maria Karveli

Caduceon Environmental Laboratories

2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 30-Jul-18

JOB/PROJECT NO.: 110126045 - Iqaluit WWTP

DATE REPORTED: 08-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

			Client I.D.	Test F - Influent	Test F - Discharge		
			Sample I.D.	B18-22323-1	B18-22323-2		
			Date Collected	27-Jul-18	27-Jul-18		
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed			
Strontium	mg/L	0.001	SM 3120	31-Jul-18/O	0.066	0.056	
Thallium	mg/L	0.0003	EPA 200.8	30-Jul-18/O	< 0.0003	< 0.0003	
Tin	mg/L	0.05	SM 3120	31-Jul-18/O	< 0.05	< 0.05	
Titanium	mg/L	0.005	SM 3120	31-Jul-18/O	0.005	< 0.005	
Uranium	mg/L	0.0003	EPA 200.8	30-Jul-18/O	< 0.0003	< 0.0003	
Vanadium	mg/L	0.005	SM 3120	31-Jul-18/O	< 0.005	< 0.005	
Zinc	mg/L	0.005	SM 3120	31-Jul-18/O	0.411	0.037	
Total Coliform	cfu/100mL	1	MOE E3371	30-Jul-18/O	5300000	20000	
Fecal Coliform	cfu/100mL	1	MOE E3371	30-Jul-18/O	860000	30	

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.



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Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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C.O.C.: ---

REPORT No. B18-23373

Report To:

City of Iqaluit

PO Box 460,
Iqaluit NU X0A 0H0

Attention: Maria Karveli

Caduceon Environmental Laboratories

2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 07-Aug-18

JOB/PROJECT NO.: Test F

DATE REPORTED: 14-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

			Client I.D.		Test F Influent	Test F Discharge		
			Sample I.D.		B18-23373-1	B18-23373-2		
			Date Collected		02-Aug-18	02-Aug-18		
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
BOD	mg/L	3	SM 5210B	09-Aug-18/O	59	33		
Total Suspended Solids	mg/L	3	SM 2540D	09-Aug-18/O	148	64		
Conductivity @25°C	µmho/cm	1	SM 2510B	08-Aug-18/O	358	307		
pH @25°C	pH Units		SM 4500H	08-Aug-18/O	7.00	7.43		
Nitrite (N)	mg/L	0.1	SM4110C	08-Aug-18/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	08-Aug-18/O	< 0.1	< 0.1		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	09-Aug-18/O	19.4	12.9		
o-Phosphate (P)	mg/L	0.01	MOEE 3366	09-Aug-18/O	1.25	0.83		
Phosphorus-Total	mg/L	0.01	E3199A.1	10-Aug-18/K	3.78	2.15		
Aluminum	mg/L	0.01	SM 3120	09-Aug-18/O	0.27	0.11		
Antimony	mg/L	0.0001	EPA 200.8	08-Aug-18/O	0.0010	0.0005		
Arsenic	mg/L	0.0001	EPA 200.8	08-Aug-18/O	< 0.0005	< 0.0005		
Barium	mg/L	0.001	SM 3120	09-Aug-18/O	0.024	0.017		
Beryllium	mg/L	0.002	SM 3120	09-Aug-18/O	< 0.002	< 0.002		
Cadmium	mg/L	0.00015	EPA 200.8	08-Aug-18/O	0.000161	0.000085		
Chromium	mg/L	0.002	SM 3120	09-Aug-18/O	< 0.002	< 0.002		
Cobalt	mg/L	0.005	SM 3120	09-Aug-18/O	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	09-Aug-18/O	0.258	0.093		
Iron	mg/L	0.005	SM 3120	09-Aug-18/O	0.591	1.22		
Lead	mg/L	0.00002	EPA 200.8	08-Aug-18/O	0.00273	0.00086		
Lithium	mg/L	0.01	SM 3120	09-Aug-18/O	< 0.01	< 0.01		
Manganese	mg/L	0.001	SM 3120	09-Aug-18/O	0.077	0.113		
Mercury	mg/L	0.00002	SM 3112 B	13-Aug-18/O	0.00003	< 0.00002		
Molybdenum	mg/L	0.01	SM 3120	09-Aug-18/O	< 0.01	< 0.01		
Nickel	mg/L	0.01	SM 3120	09-Aug-18/O	< 0.01	< 0.01		
Selenium	mg/L	0.001	EPA 200.8	08-Aug-18/O	< 0.005	< 0.005		
Silver	mg/L	0.0001	EPA 200.8	08-Aug-18/O	< 0.0001	< 0.0001		

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.



R.L. = Reporting Limit

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Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie

Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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C.O.C.: ---

REPORT No. B18-23373

Report To:

City of Iqaluit

PO Box 460,
Iqaluit NU X0A 0H0

Attention: Maria Karveli

Caduceon Environmental Laboratories

2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 07-Aug-18

JOB/PROJECT NO.: Test F

DATE REPORTED: 14-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

			Client I.D.	Test F Influent	Test F Discharge		
			Sample I.D.	B18-23373-1	B18-23373-2		
			Date Collected	02-Aug-18	02-Aug-18		
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed			
Strontium	mg/L	0.001	SM 3120	09-Aug-18/O	0.069	0.074	
Thallium	mg/L	0.00005	EPA 200.8	08-Aug-18/O	< 0.0003	< 0.0003	
Tin	mg/L	0.05	SM 3120	09-Aug-18/O	< 0.05	< 0.05	
Titanium	mg/L	0.005	SM 3120	09-Aug-18/O	< 0.005	< 0.005	
Uranium	mg/L	0.00005	EPA 200.8	08-Aug-18/O	< 0.0003	< 0.0003	
Vanadium	mg/L	0.005	SM 3120	09-Aug-18/O	< 0.005	< 0.005	
Zinc	mg/L	0.005	SM 3120	09-Aug-18/O	0.795	0.056	
Total Coliform	cfu/100mL	1	MOE E3371	08-Aug-18/O	1860000	940000	
Fecal Coliform	cfu/100mL	1	MOE E3371	08-Aug-18/O	1020000	41000	

NOTE: Total & Fecal Coliform passed acceptable holding times upon arrival at Lab.



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Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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C.O.C.: ---

REPORT No. B18-23562

Report To:

City of Iqaluit

PO Box 460,

Iqaluit NU X0A 0H0

Attention: Maria Karveli

Caduceon Environmental Laboratories

2378 Holly Lane

Ottawa Ontario K1V 7P1

Tel: 613-526-0123

Fax: 613-526-1244

DATE RECEIVED: 09-Aug-18

JOB/PROJECT NO.: Test F

DATE REPORTED: 16-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

Test Samples were improperly
labeled.

Left column is effluent sample
Right column is influent sample

Client I.D.	Test F Influent	Test F Discharge		
Sample I.D.	B18-23562-1	B18-23562-2		
Date Collected	07-Aug-18	07-Aug-18		

Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
BOD	mg/L	3	SM 5210B	10-Aug-18/O	60	173		
Total Suspended Solids	mg/L	3	SM 2540D	10-Aug-18/O	72	176		
Conductivity @25°C	µmho/cm	1	SM 2510B	09-Aug-18/O	320	421		
pH @25°C	pH Units		SM 4500H	09-Aug-18/O	8.02	7.10		
Nitrite (N)	mg/L	0.1	SM4110C	09-Aug-18/O	< 0.1	< 0.1		
Nitrate (N)	mg/L	0.1	SM4110C	09-Aug-18/O	< 0.1	0.1		
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	09-Aug-18/O	11.8	21.0		
o-Phosphate (P)	mg/L	0.01	MOEE 3366	09-Aug-18/O	0.76	1.89		
Phosphorus-Total	mg/L	0.01	E3199A.1	13-Aug-18/K	2.36	3.77		
Aluminum	mg/L	0.01	SM 3120	13-Aug-18/O	0.09	0.24		
Antimony	mg/L	0.0001	EPA 200.8	09-Aug-18/O	< 0.0005	< 0.0005		
Arsenic	mg/L	0.0001	EPA 200.8	09-Aug-18/O	< 0.0005	< 0.0005		
Barium	mg/L	0.001	SM 3120	13-Aug-18/O	0.014	0.019		
Beryllium	mg/L	0.002	SM 3120	13-Aug-18/O	< 0.002	< 0.002		
Cadmium	mg/L	0.00015	EPA 200.8	09-Aug-18/O	0.000129	0.000234		
Chromium	mg/L	0.002	SM 3120	13-Aug-18/O	< 0.002	< 0.002		
Cobalt	mg/L	0.005	SM 3120	13-Aug-18/O	< 0.005	< 0.005		
Copper	mg/L	0.002	SM 3120	13-Aug-18/O	0.107	0.225		
Iron	mg/L	0.005	SM 3120	13-Aug-18/O	0.855	0.896		
Lead	mg/L	0.00002	EPA 200.8	09-Aug-18/O	0.00121	0.00335		
Lithium	mg/L	0.01	SM 3120	13-Aug-18/O	< 0.01	< 0.01		
Manganese	mg/L	0.001	SM 3120	13-Aug-18/O	0.101	0.130		
Mercury	mg/L	0.00002	SM 3112 B	14-Aug-18/O	< 0.00002	0.00012		
Molybdenum	mg/L	0.01	SM 3120	13-Aug-18/O	< 0.01	< 0.01		
Nickel	mg/L	0.01	SM 3120	13-Aug-18/O	< 0.01	< 0.01		
Selenium	mg/L	0.001	EPA 200.8	09-Aug-18/O	< 0.005	< 0.005		
Silver	mg/L	0.0001	EPA 200.8	09-Aug-18/O	< 0.0001	0.0001		



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Lab Manager - Ottawa District

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Iqaluit NU X0A 0H0

Attention: Maria Karveli

Caduceon Environmental Laboratories

2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 09-Aug-18

JOB/PROJECT NO.: Test F

DATE REPORTED: 16-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

			Client I.D.	Test F Influent	Test F Discharge		
			Sample I.D.	B18-23562-1	B18-23562-2		
			Date Collected	07-Aug-18	07-Aug-18		
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed			
Strontium	mg/L	0.001	SM 3120	13-Aug-18/O	0.065	0.066	
Thallium	mg/L	0.00005	EPA 200.8	09-Aug-18/O	< 0.0003	< 0.0003	
Tin	mg/L	0.05	SM 3120	13-Aug-18/O	< 0.05	< 0.05	
Titanium	mg/L	0.005	SM 3120	13-Aug-18/O	< 0.005	0.005	
Uranium	mg/L	0.00005	EPA 200.8	09-Aug-18/O	0.00036	0.00045	
Vanadium	mg/L	0.005	SM 3120	13-Aug-18/O	< 0.005	< 0.005	
Zinc	mg/L	0.005	SM 3120	13-Aug-18/O	0.050	0.123	
Total Coliform	cfu/100mL	1	MOE E3371	09-Aug-18/O	28000000 ¹	12000000	
Fecal Coliform	cfu/100mL	1	MOE E3371	09-Aug-18/O	3100000	1900000	

¹ duplicate = 20000000 cfu/100 ml

R.L. = Reporting Limit

Test methods may be modified from specified reference method unless indicated by an *

Site Analyzed=K-Kingston,W-Windsor,O-Ottawa,R-Richmond Hill,B-Barrie



Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

The analytical results reported herein refer to the samples as received. Reproduction of this analytical report in full or in part is prohibited without prior consent from Caduceon Environmental Laboratories.

C.O.C.: G72049

REPORT No. B18-24879

Report To:

City of Iqaluit

PO Box 460,
Iqaluit NU X0A 0H0

Attention: Maria Karveli

Caduceon Environmental Laboratories

2378 Holly Lane
Ottawa Ontario K1V 7P1
Tel: 613-526-0123
Fax: 613-526-1244

DATE RECEIVED: 21-Aug-18

JOB/PROJECT NO.: Test F

DATE REPORTED: 30-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

			Client I.D.		Sewer Lagoon Decant			
			Sample I.D.		B18-24879-1			
			Date Collected		18-Aug-18			
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
BOD	mg/L	3	SM 5210B	22-Aug-18/O	41			
Total Suspended Solids	mg/L	3	SM 2540D	22-Aug-18/O	69			
Conductivity @25°C	µmho/cm	1	SM 2510B	21-Aug-18/O	351			
pH @25°C	pH Units		SM 4500H	21-Aug-18/O	7.35			
Nitrite (N)	mg/L	0.1	SM4110C	21-Aug-18/O	< 0.1			
Nitrate (N)	mg/L	0.1	SM4110C	21-Aug-18/O	< 0.1			
Ammonia (N)-Total	mg/L	0.01	MOEE 3364	22-Aug-18/O	15.7			
o-Phosphate (P)	mg/L	0.01	MOEE 3366	22-Aug-18/O	0.95			
Phosphorus-Total	mg/L	0.01	E3199A.1	24-Aug-18/K	4.12			
Aluminum	mg/L	0.01	SM 3120	28-Aug-18/O	0.08			
Antimony	mg/L	0.0001	EPA 200.8	22-Aug-18/O	< 0.0005			
Arsenic	mg/L	0.0001	EPA 200.8	22-Aug-18/O	< 0.0005			
Barium	mg/L	0.001	SM 3120	28-Aug-18/O	0.017			
Beryllium	mg/L	0.002	SM 3120	28-Aug-18/O	< 0.002			
Cadmium	mg/L	0.000015	EPA 200.8	22-Aug-18/O	0.000387			
Chromium	mg/L	0.002	SM 3120	28-Aug-18/O	0.011			
Cobalt	mg/L	0.005	SM 3120	28-Aug-18/O	< 0.005			
Copper	mg/L	0.002	SM 3120	28-Aug-18/O	0.109			
Iron	mg/L	0.005	SM 3120	28-Aug-18/O	0.654			
Lead	mg/L	0.00002	EPA 200.8	22-Aug-18/O	0.00236			
Lithium	mg/L	0.01	SM 3120	28-Aug-18/O	< 0.01			
Manganese	mg/L	0.001	SM 3120	28-Aug-18/O	0.136			
Mercury	mg/L	0.00002	SM 3112 B	24-Aug-18/O	< 0.00002			
Molybdenum	mg/L	0.01	SM 3120	28-Aug-18/O	< 0.01			
Nickel	mg/L	0.01	SM 3120	28-Aug-18/O	0.02			
Selenium	mg/L	0.001	EPA 200.8	22-Aug-18/O	< 0.005			

NOTE: Bacteria passed acceptable holding time upon arrival at Lab.



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Attention: Maria Karveli

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DATE RECEIVED: 21-Aug-18

JOB/PROJECT NO.: Test F

DATE REPORTED: 30-Aug-18

P.O. NUMBER:

SAMPLE MATRIX: Waste Water

WATERWORKS NO.

			Client I.D.		Sewer Lagoon Decant			
			Sample I.D.		B18-24879-1			
			Date Collected		18-Aug-18			
Parameter	Units	R.L.	Reference Method	Date/Site Analyzed				
Silver	mg/L	0.0001	EPA 200.8	22-Aug-18/O	< 0.0001			
Strontium	mg/L	0.001	SM 3120	28-Aug-18/O	0.077			
Thallium	mg/L	0.00005	EPA 200.8	22-Aug-18/O	< 0.0003			
Tin	mg/L	0.05	SM 3120	28-Aug-18/O	< 0.05			
Titanium	mg/L	0.005	SM 3120	28-Aug-18/O	< 0.005			
Uranium	mg/L	0.00005	EPA 200.8	22-Aug-18/O	0.00041			
Vanadium	mg/L	0.005	SM 3120	28-Aug-18/O	< 0.005			
Zinc	mg/L	0.005	SM 3120	28-Aug-18/O	0.148			
Total Coliform	cfu/100mL	1	MOE E3371	21-Aug-18/O	560000			
Fecal Coliform	cfu/100mL	1	MOE E3371	21-Aug-18/O	16000			

NOTE: Bacteria passed acceptable holding time upon arrival at Lab.



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Greg Clarkin , BSc., C. Chem
Lab Manager - Ottawa District

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Appendix B

Sludge Survey Report



LAMBOURNE ENVIRONMENTAL Ltd.

51 Belich Crescent, Red Deer County T4S 2K5 Ph. (403) 348-8298

Fax (403) 348-8290

September 18, 2018

Iqaluit, NU
Attn: Sandra Rousseau

Dear Sandra,

On behalf of Lambourne Environmental Ltd. and our colleagues at Hydrasurvey Ltd. I am pleased to present you with the enclosed survey report. I trust that you will find the information provided useful in assessing the current state of the lagoon at Iqaluit.

Lambourne Environmental is a full-service Lagoon Desludging and Disposal company. We have been meeting the lagoon cleaning needs of Western Canada for 25 years. We pride ourselves on planning and executing projects to the satisfaction of all our stakeholders.

Should you have any questions regarding the survey report please contact Andrew Ambrocichuk at 780-328-9102 or myself.

Thank you for the opportunity to serve you. If you have any questions or would like to further discuss the potential desludging and disposal work for this project we would be more than happy to help and come up with a solution.

Yours truly,
Lambourne Environmental Ltd.

David Linsley, B.Sc.
General Manager

SLUDGE SURVEY REPORT

IQALUIT, NU WASTEWATER LAGOON

Location: Iqaluit, NU

Name of Lagoon(s): Iqaluit Wastewater Lagoon

Client: Lambourne Environmental

Client Contact: David Linsley

Report prepared by: A. Ambrocichuk

Surveyors: A. Ambrocichuk, S. Gay, B. Bury

Date(s) of Survey: 06/09/18 – 07/09/18

Map Grid Reference: Datum: WGS84, Projection: UTM, Zone 19N


Revision Number: 1

Report Print Size: 11x17”



Figure 1 Plan overview of Iqaluit, NU Wastewater Lagoon

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Depths are relative to water level at the time of the survey
Survey data collected on September 6-7, 2018
Report any discrepancies in this report to Hydrasurvey Ltd.
Do not modify or use this report for purposes other than which it is intended

	Name	Date	HYDRASURVEY 		
Prepared by:	AA	17-09-2018			
			Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey	
			Project Number	18027	
Unless otherwise specified all dimensions are in meters			Revision	1	
			Sheet	1	

FIGURES, TABLES, APPENDICES SUMMARY

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Prepared by:	AA	17-09-2018			
			Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey	
			Project Number	18027	
Unless otherwise specified all dimensions are in meters			Revision	1	
			Sheet	2	

EXECUTIVE SUMMARY

Hydrasurvey conducted a sludge survey of the Iqaluit Wastewater Lagoon on September 6-7, 2018. The purpose of the survey and this report is to map and quantify sludge build-up in the lagoon.

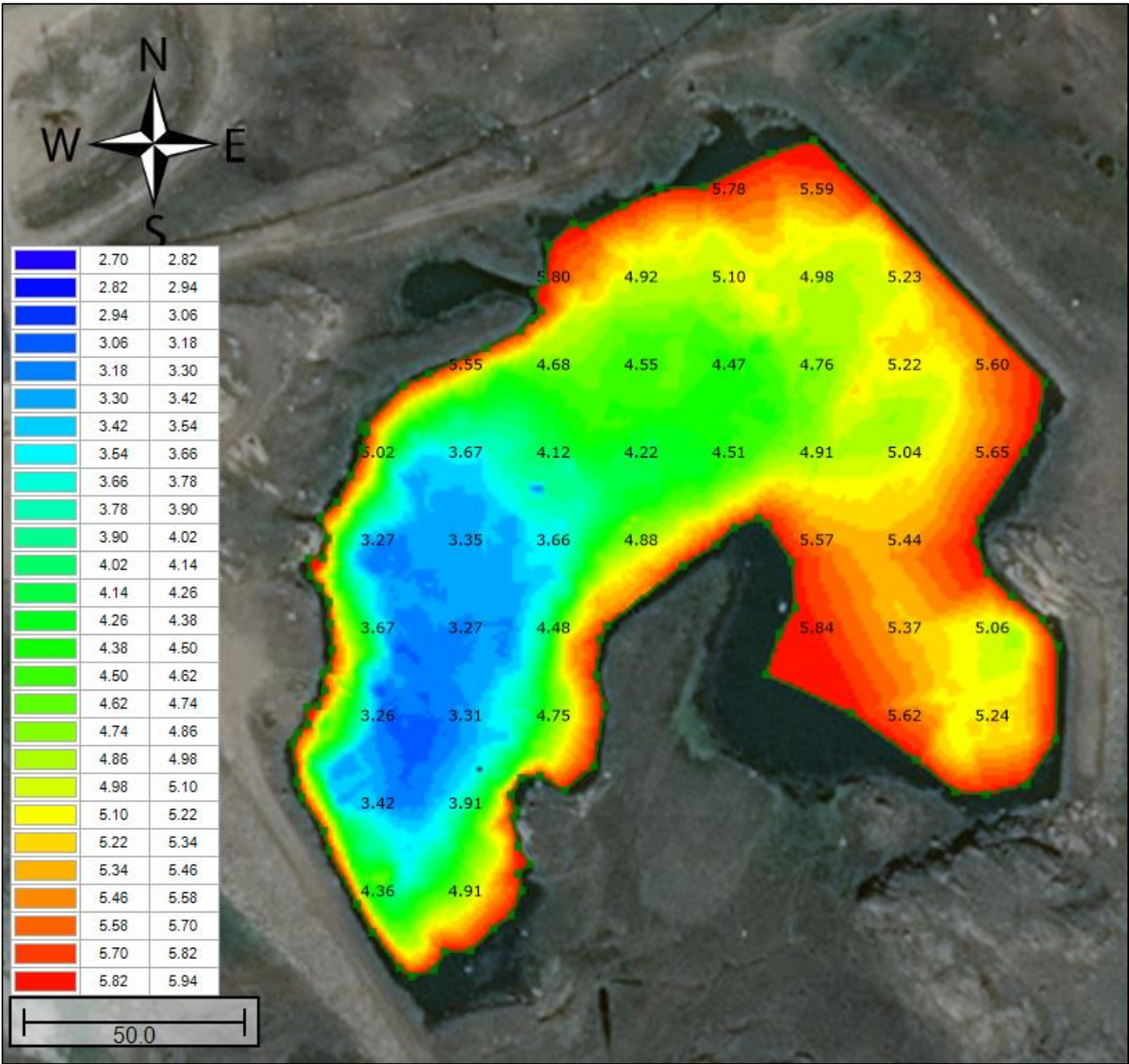

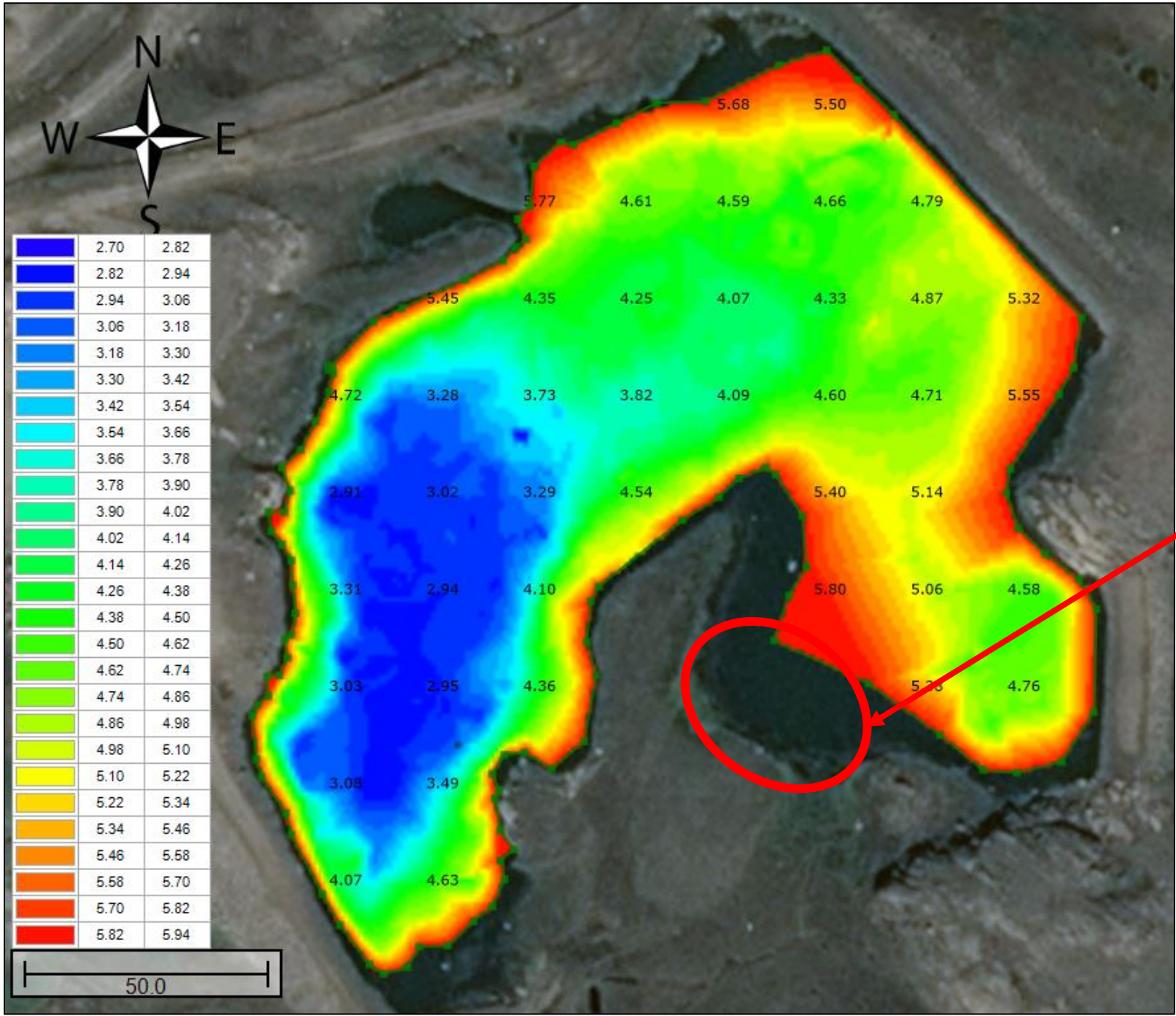


Figure 2 Iqaluit lagoon top of sludge elevations (m)

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Unless otherwise specified all dimensions are in meters			Revision	1	
			Sheet	3	

EXECUTIVE SUMMARY CONTINUED




- Iqaluit lagoon water elevation at the time of survey was 5.9m and appeared to be well below the high waterline, exposing accumulated sludge along the shoreline. The image below shows the sludge beach as identified by the red circle in the CAD drawing to the left. Boat access to determine the depth of this sludge was not possible due to the extremely shallow beach.

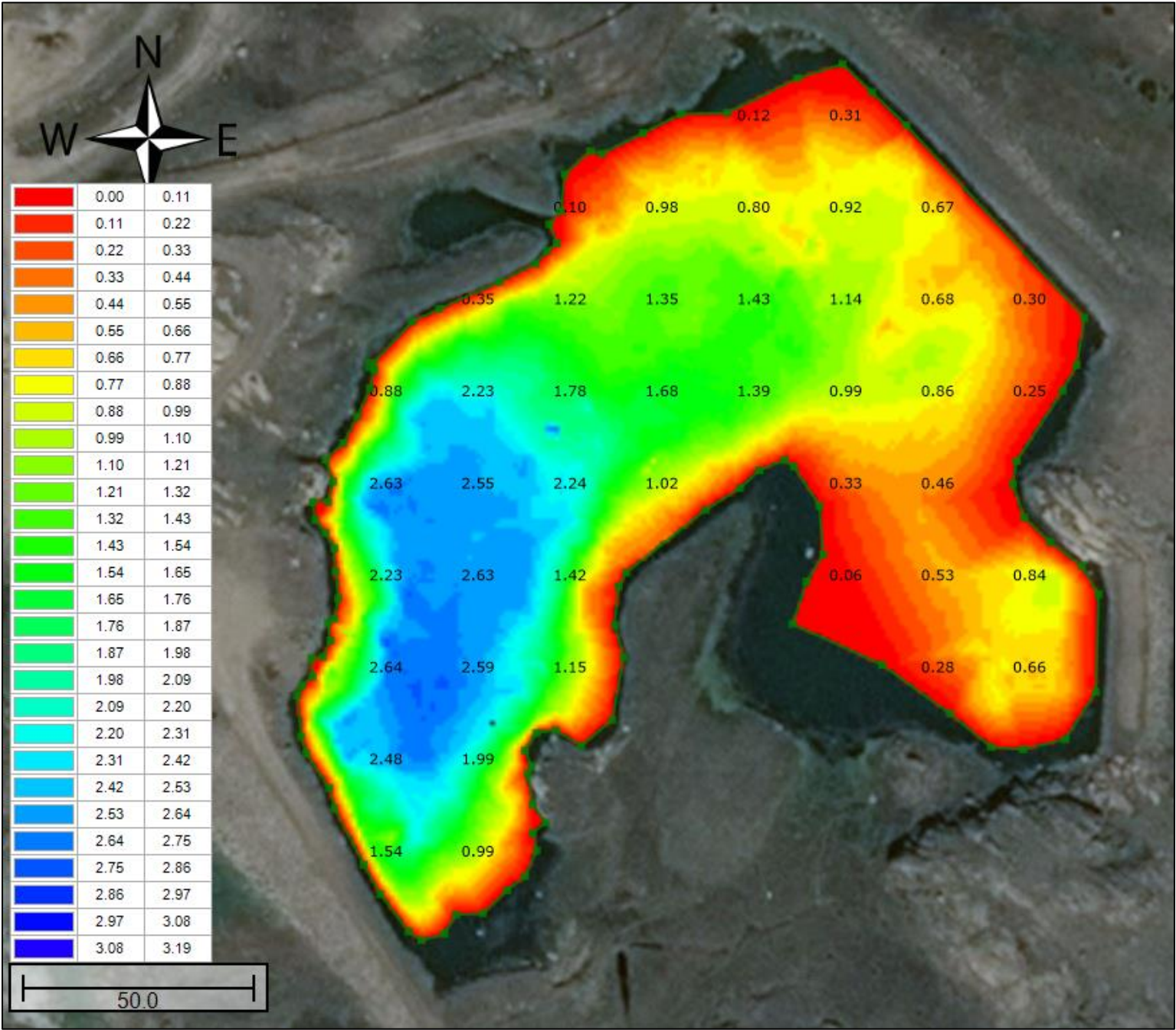


Figure 3 Iqaluit lagoon bottom profile elevations (m)


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EXECUTIVE SUMMARY CONTINUED



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			Project Number	18027	
Unless otherwise specified all dimensions are in meters			Revision	1	
			Sheet	5	

EXECUTIVE SUMMARY CONTINUED

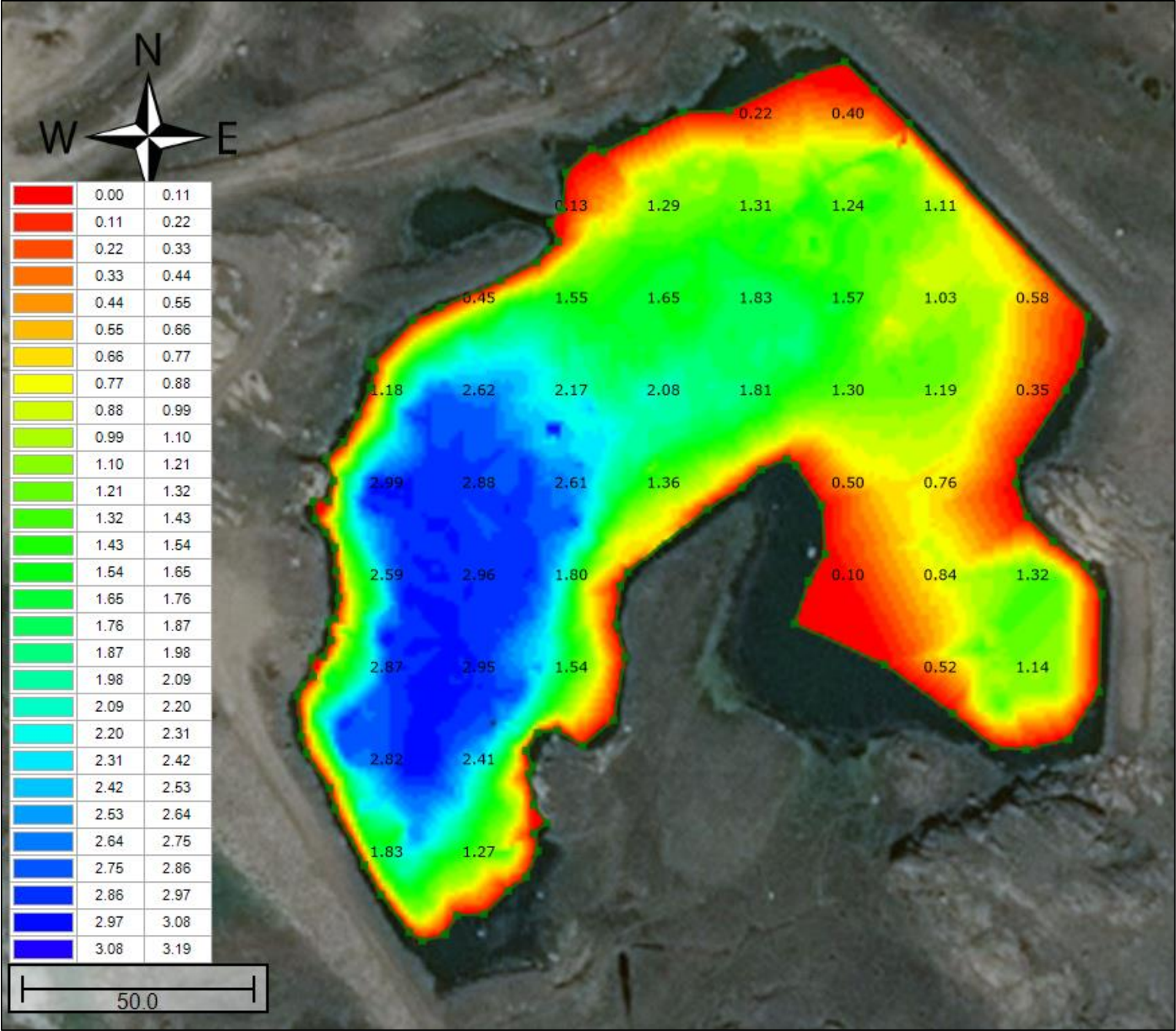

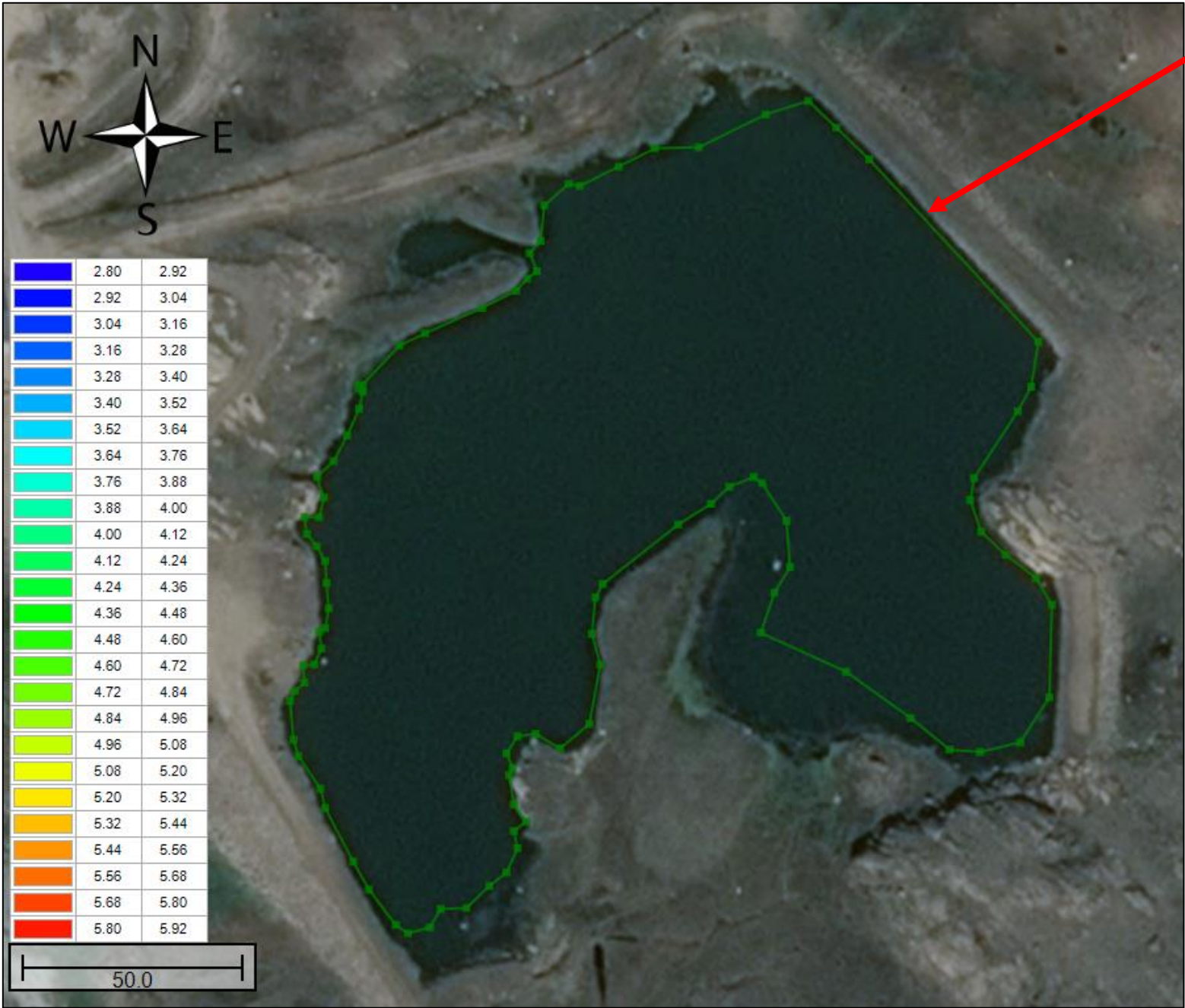


Figure 5 Iqaluit lagoon bottom profile depths (m)

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			Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey	
			Project Number	18027	
Unless otherwise specified all dimensions are in meters			Revision	1	
			Sheet	6	


EXECUTIVE SUMMARY CONTINUED



Green line represents location of shoreline at the time of survey

Figure 6 Iqaluit lagoon shoreline as marked with RTK GNSS at the time of survey (m)

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			Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey	
			Project Number	18027	
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			Sheet	7	

EXECUTIVE SUMMARY CONTINUED

ESTIMATED SLUDGE QUANTITY

Estimated sludge volume is calculated using software that compares the measured and interpolated sludge depths and elevations with the lagoon liner. A sludge sample is taken for lab analysis to determine total solids and total volatile solids and to obtain dry weight.

IQALUIT LAGOON:

TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (WET) = **5,220 m³**
TOTAL ESTIMATED VOLUME OF SLUDGE TO BE REMOVED (DRY) = **1,597 m³**
TOTAL ESTIMATED VOLATILE SOLIDS QUANTITY (DRY) = **316 m³**

Figure 8 Iqaluit lagoon estimated sludge volume

LAGOON HYDRAULIC CAPACITY AT PRESENT SLUDGE LOADING

Hydraulic capacity calculations for each lagoon are performed by comparing the water level at the time of survey to the sludge profile with results shown below.

ESTIMATED HYDRAULIC CAPACITY (WATER LEVEL @ 5.9 m) = **20,436 m³**


Figure 7 Iqaluit lagoon hydraulic capacity

Table 1 Iqaluit Lagoon Stage Volumes at Present Sludge Loading			
Stage	Depth (m)	Volume (m³)	Area (m²)
1	0.0	20436	17605
2	0.5	12624	13502
3	1.0	7116	8231
4	1.5	3715	5230
5	2.0	1565	3515
6	2.5	189	1765

A NOTE ON VOLUME CALCULATIONS

Estimates of sludge quantity and pond hydraulic capacity are provided in this report. It is important to note that reported sludge volumes are based on pond depths measured by the sub-bottom profiler or infrared sludge interface detector and verified using manual checks. Sludge volumes are calculated using software that creates interpolations between the sounding lines measured in the field. As such the volume of sludge calculated in this report will vary from what is actually found in the field. The volumes shown in this report should be used as guidelines for planning maintenance desludging or dredging and should not be assumed to be exactly accurate. By choosing to use the sludge volume estimates provided in this report the user agrees to indemnify and hold Hydrasurvey harmless of any additional charges resulting from underestimated or overestimated sludge volumes.

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			Project Title	Iqaluit, NU Wastewater Lagoon Sludge Survey	
			Project Number	18027	
Unless otherwise specified all dimensions are in meters			Revision	1	
			Sheet	8	

SLUDGE SURVEY DETAILED FINDINGS – TOP OF SLUDGE 3D IMAGE

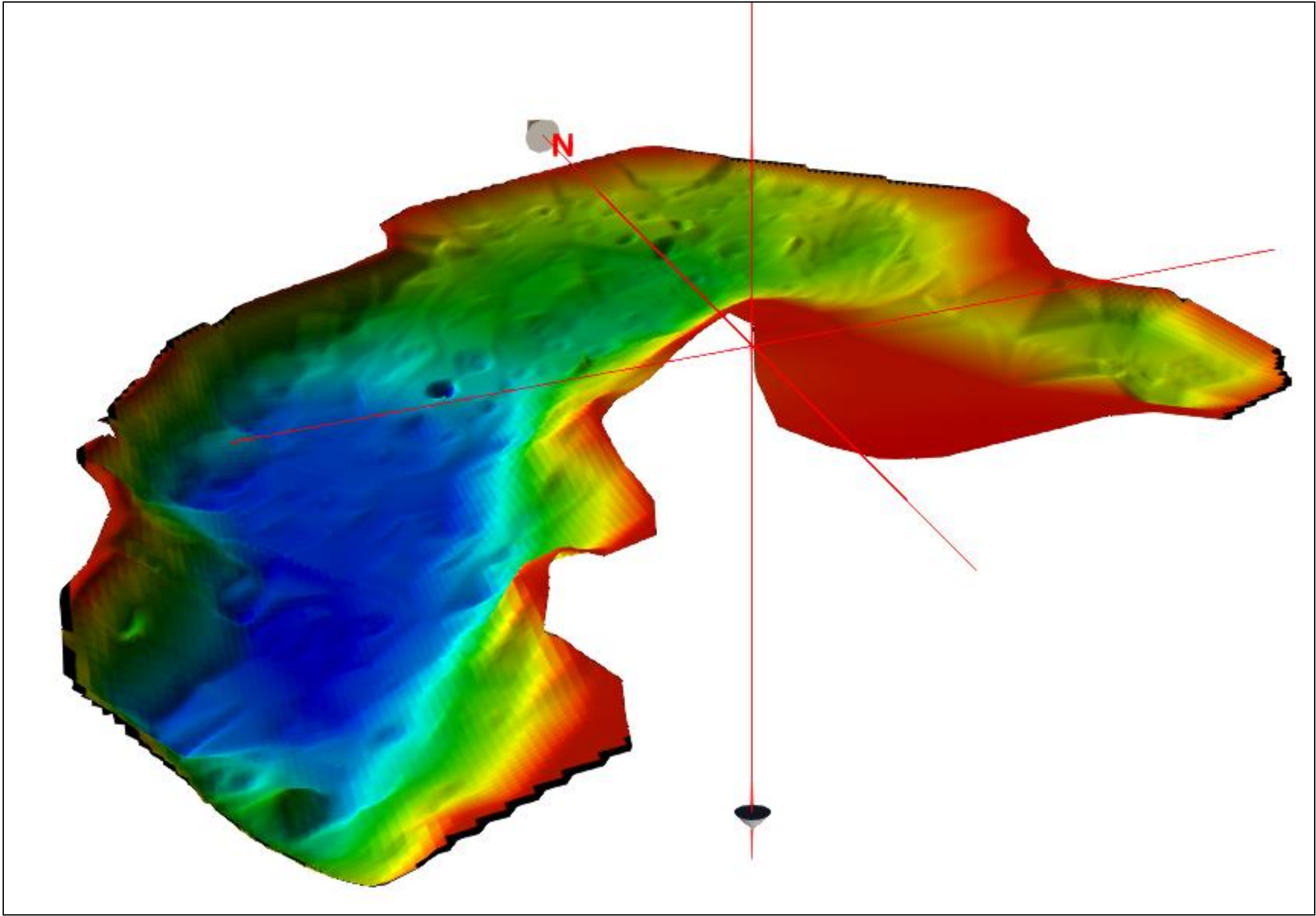



Figure 9 Iqaluit Lagoon 3D isometric image of top of sludge looking north east

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			Sheet	9	

SLUDGE SURVEY DETAILED FINDINGS – SURVEY IMAGES



Figure 12 The north east corner of the Iqaluit Lagoon at the influent location was full of sludge. A portion of this area was not accessible by boat due to the extremely shallow beach that has formed. This influent area was in constant operation during the survey.




Figure 10 The low waterline exposed a large beach at the south west corner of the Iqaluit lagoon



Figure 11 Exposed riprap and shoreline along the east dyke of the lagoon

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Unless otherwise specified all dimensions are in meters			Revision	1	
			Sheet	10	

SLUDGE SURVEY DETAILED FINDINGS – ECHOGRAM SAMPLE

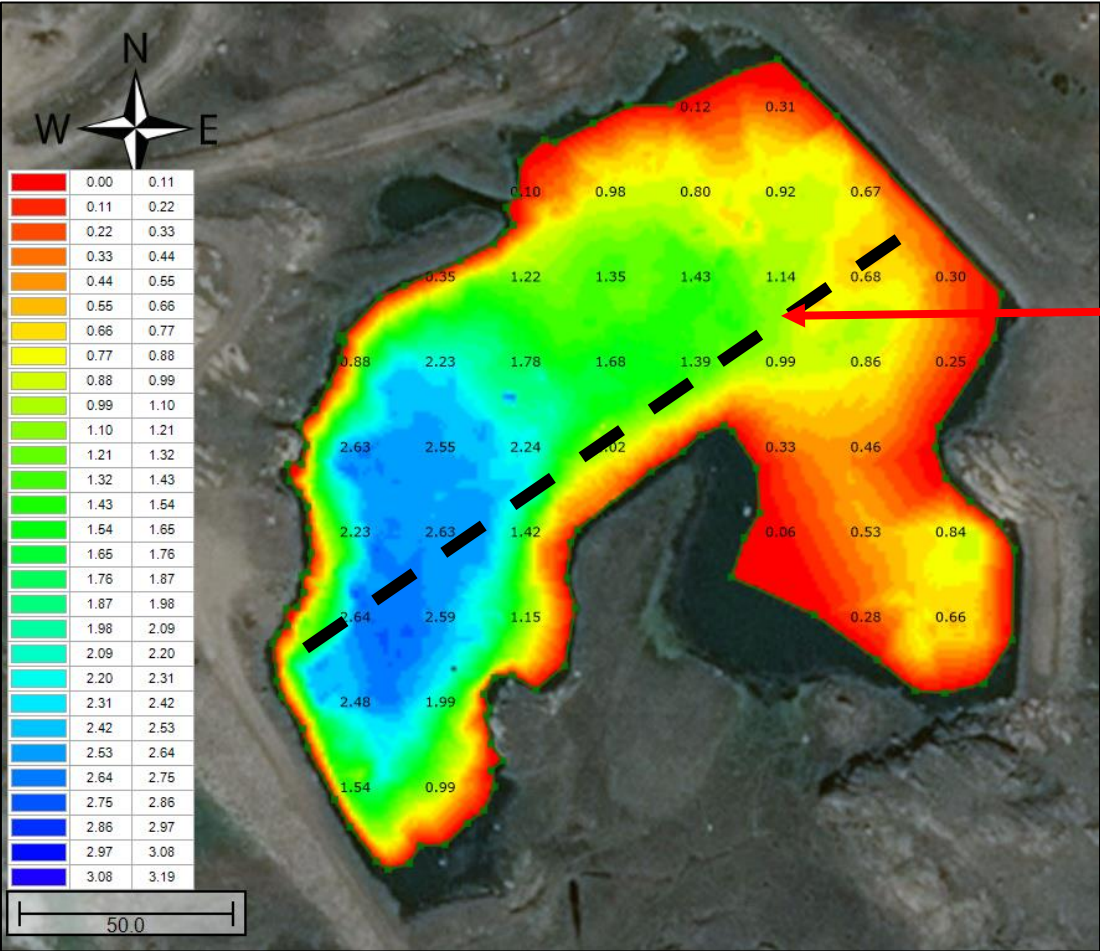


Figure 13 Depths to top of sludge (m) with reference survey line marked

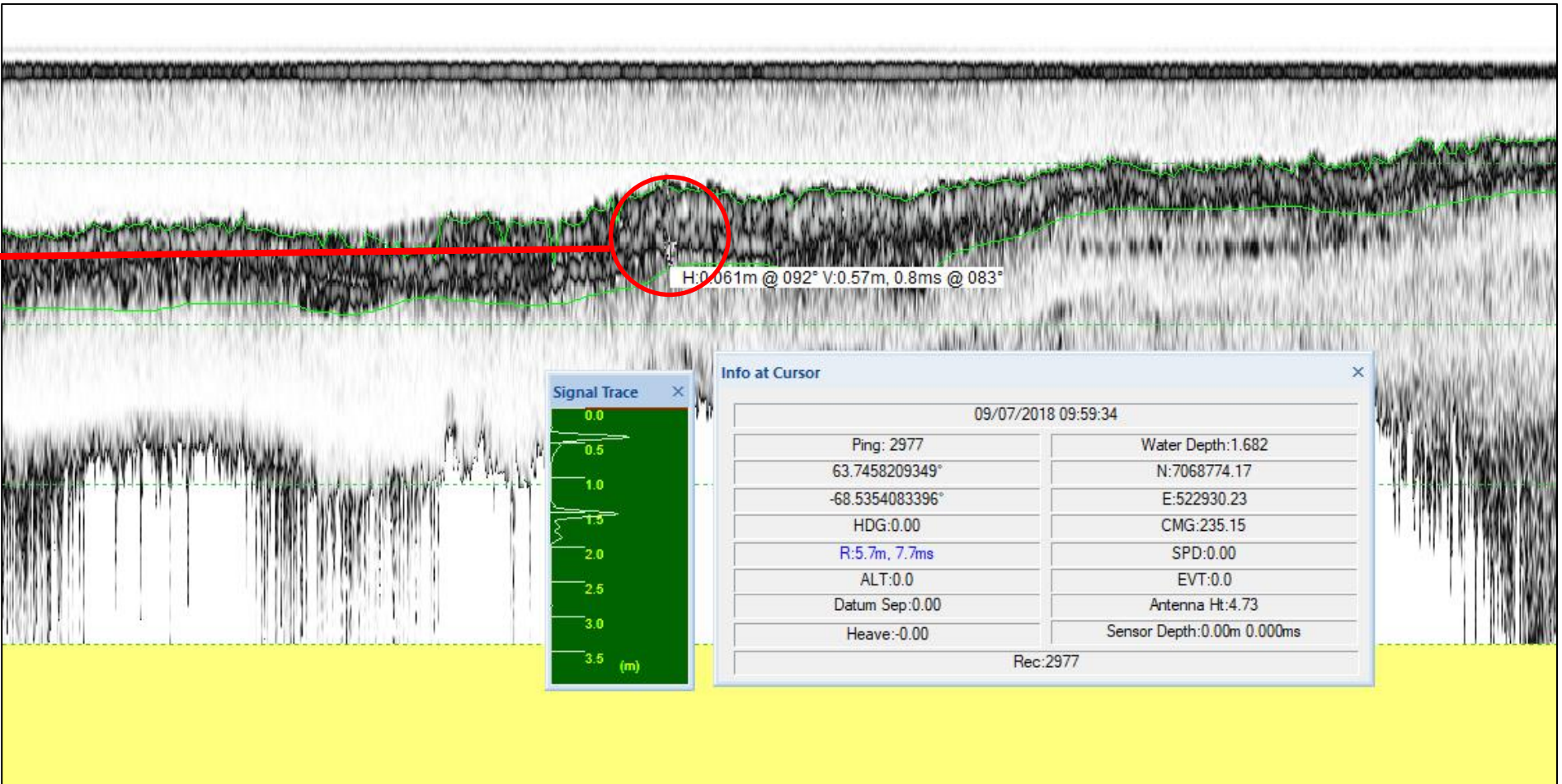



Figure 14 Echogram showing accumulated sludge on bottom

- The sub-bottom profiler echogram image above represents the cross section (elevation) view of the black line in the figure to the left. The red circle shows the accumulated sludge on top of the lagoon bottom. At this point the sludge is measured at 0.57 m thick.
- Hydrasurvey used the sub-bottom profiler to survey all boat accessible areas of the Iqaluit lagoon.

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			Sheet	11	

SURVEY METHODOLOGY

Hydrasurvey uses sub-bottom profiling technology and RTK GNSS positioning to map both the top of sludge and lagoon bottom. Hydrasurvey uses both an infrared sludge interface detector and a sludge judge to correlate actual field measurements with acoustic reflectors measured using the sub-bottom profiler. In very shallow (< 0.5 m) water depths Hydrasurvey uses an infrared sludge interface detector with RTK GNSS positioning to measure the sludge blanket. Hydrasurvey also collects sludge samples and tests them for total solids and total volatile solids for computation of dry material volumes.

Sludge Survey Equipment:

Vessel: Inshore survey vessel (Commercial grade inflatable) outfitted with survey system mount and electric motor

Positioning: RTK Base and Rover GNSS system

Sonar: Mutli-frequency sub-bottom profiler (High Frequency at 100kHz, Low Frequencies at 15kHz, 12kHz, 10kHz, 8kHz, 6kHz, 5kHz and 4kHz)

Sound Velocity: Portable sound velocity profiler (temperature, depth, conductivity)

Sludge measurement devices: Infrared sludge interface detector, sludge judge and Ekman grab sampler

Survey line spacing	10 m
Survey speed	3 km/hr
Number of manual sludge measurements	6
Number of sludge samples taken	1
Number of sound velocity profiles taken	2
Average sound velocity in the lagoons	1445.65 m/s
Sub-bottom profiler transducer settings	HF: 100kHz, LF: 8kHz
Transducer draft (below waterline)	0.23 m
GPS antenna height (above waterline)	1.43 m
Lagoon water elevation during survey	5.9 m
Number of planned survey lines	37 lines
Approximate total distance of survey lines	4.5 km

Table 2 Sludge Survey Details

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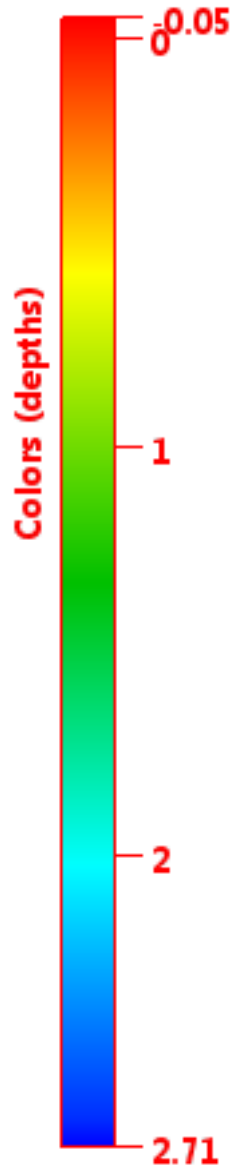
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- Trust this document one time only
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Visit: <https://helpx.adobe.com/acrobat/using/enable-3d-content-pdf.html> for more information.



HYDRASURVEY



3D scene of Iqaluit wastewater lagoon. Note 3D pdfs are in Beta and are to be used for reference purposes only. Do not scale from this drawing.		
Map Projection: UTM WGS84 Z19 (m)	Company: Hydrasurvey Ltd.	Area: Iqaluit Wastewater Lagoon
Date: September 06, 2018	Chief Surveyor: A. Ambrocichuk	Vessel: Hydraboat 1

CERTIFICATE OF ANALYSIS

REPORTED TO Hydrasurvey Ltd.
9715 - 76 Street
Edmonton, AB T6C 2L1

ATTENTION Andrew Ambrocichuk

PO NUMBER

PROJECT Cell 2A

PROJECT INFO

WORK ORDER 8090632

RECEIVED / TEMP 2018-09-10 09:46 / NA

REPORTED 2018-09-17 15:36

Introduction:

CARO Analytical Services is a testing laboratory full of smart, engaged scientists driven to make the world a safer and healthier place. Through our clients' projects we become an essential element for a better world. We employ methods conducted in accordance with recognized professional standards using accepted testing methodologies and quality control efforts. CARO is accredited by the Canadian Association for Laboratories Accreditation (CALA) to ISO 17025:2005 for specific tests listed in the scope of accreditation approved by CALA.

Big Picture Sidekicks



You know that the sample you collected after snowshoeing to site, digging 5 meters, and racing to get it on a plane so you can submit it to the lab for time sensitive results needed to make important and expensive decisions (whew) is VERY important. We know that too.

We've Got Chemistry



It's simple. We figure the more you enjoy working with our fun and engaged team members; the more likely you are to give us continued opportunities to support you.

Ahead of the Curve



Through research, regulation knowledge, and instrumentation, we are your analytical centre for the technical knowledge you need, BEFORE you need it, so you can stay up to date and in the know.

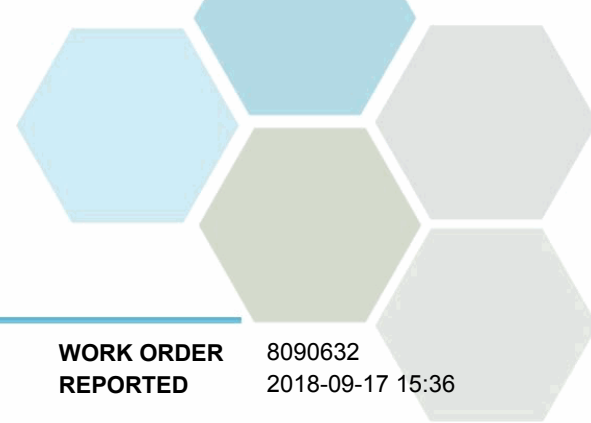
If you have any questions or concerns, please contact me at jshanko@caro.ca

Authorized By:

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TEST RESULTS

REPORTED TO PROJECT Hydrasurvey Ltd.
Cell 2A

WORK ORDER REPORTED 8090632
2018-09-17 15:36

Analyte	Result	RL	Units	Analyzed	Qualifier
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Iqaluit S1 (8090632-01) | Matrix: Solid | Sampled: 2018-09-06

General Parameters

Solids, Total	30.6	0.1	% wet	2018-09-17	
Solids, Volatile	19.8	0.1	% dry	2018-09-17	

APPENDIX 1: SUPPORTING INFORMATION

REPORTED TO PROJECT Hydrasurvey Ltd.
Cell 2A

WORK ORDER REPORTED 8090632
2018-09-17 15:36

Analysis Description	Method Ref.	Technique	Location
Solids, Total in Solid	SM 2540 G (2011)	Gravimetry	Kelowna
Solids, Volatile in Solid	SM 2540 G (2011)	Gravimetry	Kelowna

Glossary of Terms:

RL	Reporting Limit (default)
% dry	Percent (dry weight basis)
% wet	Percent (as received basis)
SM	Standard Methods for the Examination of Water and Wastewater, American Public Health Association

General Comments:

The results in this report apply to the samples analyzed in accordance with the Chain of Custody document. This analytical report must be reproduced in its entirety. CARO is not responsible for any loss or damage resulting directly or indirectly from error or omission in the conduct of testing. Liability is limited to the cost of analysis. Samples will be disposed of 30 days after the test report has been issued unless otherwise agreed to in writing.

APPENDIX 2: QUALITY CONTROL RESULTS

REPORTED TO Hydrasurvey Ltd.
PROJECT Cell 2A

WORK ORDER 8090632
REPORTED 2018-09-17 15:36

The following section displays the quality control (QC) data that is associated with your sample data. Groups of samples are prepared in "batches" and analyzed in conjunction with QC samples that ensure your data is of the highest quality. Common QC types include:

- **Method Blank (Blk):** A blank sample that undergoes sample processing identical to that carried out for the test samples. Method blank results are used to assess contamination from the laboratory environment and reagents.
- **Duplicate (Dup):** An additional or second portion of a randomly selected sample in the analytical run carried through the entire analytical process. Duplicates provide a measure of the analytical method's precision (reproducibility).
- **Blank Spike (BS):** A sample of known concentration which undergoes processing identical to that carried out for test samples, also referred to as a laboratory control sample (LCS). Blank spikes provide a measure of the analytical method's accuracy.
- **Matrix Spike (MS):** A second aliquot of sample is fortified with with a known concentration of target analytes and carried through the entire analytical process. Matrix spikes evaluate potential matrix effects that may affect the analyte recovery.
- **Reference Material (SRM):** A homogenous material of similar matrix to the samples, certified for the parameter(s) listed. Reference Materials ensure that the analytical process is adequate to achieve acceptable recoveries of the parameter(s) tested.

Each QC type is analyzed at a 5-10% frequency, i.e. one blank/duplicate/spike for every 10-20 samples. For all types of QC, the specified recovery (% Rec) and relative percent difference (RPD) limits are derived from long-term method performance averages and/or prescribed by the reference method.

Analyte	Result	RL Units	Spike Level	Source Result	% REC	REC Limit	% RPD	RPD Limit	Qualifier
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General Parameters, Batch B8I0647

Duplicate (B8I0647-DUP1)		Source: 8090632-01		Prepared: 2018-09-17, Analyzed: 2018-09-17					
Solids, Total	29.9	0.1 % wet		30.6			2	7.5	
Solids, Volatile	20.4	0.1 % dry		19.8			3	9	
Reference (B8I0647-SRM1)		Prepared: 2018-09-17, Analyzed: 2018-09-17							
Solids, Total	68.6	0.1 % wet		69.3	99	80-120			