Summer Village of Sandy Beach

Lagoon Water Release

Operational Plan

Report No. 1803471 February 2019

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APPENDICES

1 Background

Morrison Hershfield is retained by Summer Village of Sandy Beach to assist in evaluation and rehabilitation of the existing lagoon system. We reviewed the background information and completed the site inspections of the facility. The lagoon capacity has been significantly exceeded and we are recommending emergency release from lagoons to prevent catastrophic failure.

The existing sewage lagoon system was constructed in 1990/91 and consists of three cells including a primary cell and two evaporation cells. During our site inspections and review, we noted the following:

- The designed free board in the lagoon cells was approximately 900 mm while currently the freeboard is about 100 mm.
- Currently the liquid depth in the cells is approximately 2.4 m compared with the design of 1.5 m.
- The interconnecting flow control chambers between the various cells are flooded.
- There are significant erosion issues along the cell embankments and berms. Sand bags have been placed at many locations to control the erosion and prevent liquid spill from the lagoons.
- The owner reduced the inflows to the lagoons in 2016 and completely stopped the inflows in fall 2017.

The lagoons were designed to hold a liquid volume of about 43,000 m^3, while currently the liquid in the lagoons is estimated to be about 69,000 m^3.

Site photographs depicting the issues are provided in Appendix-A. The existing lagoons are excessively overloaded and have maintenance issues. This poses significant risks as failure of the berms would cause sudden and uncontrolled spill from the lagoons. To prevent catastrophic failure of the berms and to be able to complete repairs, we recommend immediate release of the excess volume of liquid in the cells.

2 Sampling and Analytical Testing

Samples were obtained from Cell# 3 and the analytical testing results are as follows:

Parameter	Unit	Value
$cBOD_5$	mg/L	14
TSS	mg/L	49
NH_3-N	mg/L	0.084
pH		10.3
E.Coli	CFU/100 mL	<10
EC	µS/cm	1860
Calcium	mg/L	10.2
Magnesium	mg/L	4.2
Sodium	mg/L	381
SAR		25
pH		10.3
E.Coli	CFU/100 mL	<10

The sample location and analytical test results are provided in Appendix-B.

3 Proposed Release Volume

It is proposed to release approximately 35,000 m^3 of liquid from the lagoons. This will remove the 26,000 m^3 of liquid in excess of the design capacity of the lagoons and an additional 9,000 m^3 so that critical repairs and maintenance could be completed. After an initial release of the about 26,000 m^3, the damaged berms and piping structures / manholes will be exposed to allow reassessment of the damages and reconfirmation of the need for any further releases.

4 Release Area

It is proposed to release the liquid to the wooded area to the South West of the lagoons. The proposed locations, flow paths and property ownerships are provided in Appendix-C. All area are owned by the Summer Village of Sandy Beach. Based on the available open source contour mapping information, it is anticipated that the released water will have a minimum of over 500 m overland flow in the wooded area before reaching the lake water body. In the wooded area,

there is a lower depression having a contour of +/- 702 m and an area of about 1 ha, which will likely hold the released the water which will available for evapotranspiration over the summer months.

5 Soil Sampling

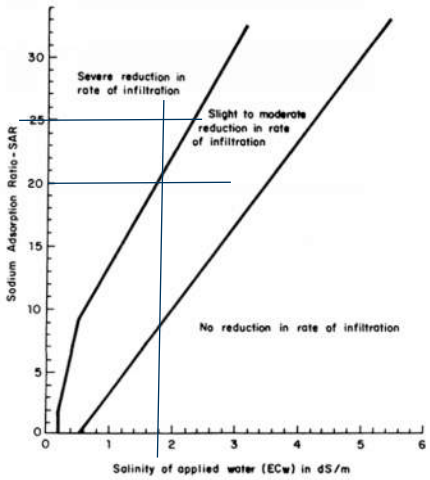
Soil sampling and analytical testing was completed by Parkland Geo and their report is provided in Appendix-D. Ten (10) auger holes to a depth of 2.5-3.2 m were advanced along the potential flow path in the wooded area. The sub-soil conditions mostly encountered Topsoil, Sand, Silty Clays, Clay Till, and Clay Shale.

6 Environmental Impacts

To assess potential environmental impacts of the proposed release, the lagoon water quality was compared with Alberta Treated Effluent Quality Standards for Wastewater Irrigation (Table 3.3 Standards and Guidelines for Municipal Waterworks, Wastewater and Storm Drainage Systems, Part 3, Wastewaters Systems Standards for Performance and Design). The lagoon water quality complies with all the water quality standards with the exception of Sodium Absorption Ratio (SAR).

6.1 Impact of High SAR Water in the Release Area

Sustained application of high SAR water results in reduction in the rate of infiltration of water, which subsequently results in loss of vegetative cover. Generally, a onetime release and application of high SAR water is not often considered a potential problem, as the background calcium and magnesium present in the soils would adjust the SAR of water upon application.



The relative rate of water infiltration as affected by salinity and sodium adsorption ration is provided in the figure (Source: Food and Agriculture Organization http://www.fao.org/3/T0234E/T0234E04.htm).

The salinity or Electrical Conductivity of Water is 1.86 dS/m. At SAR of 25, the water will cause sever reduction in rate of infiltration; which can have a detrimental impact on the vegetation as the water wouldn't be available to the root zone for evapotranspiration by plants; however it will evaporate quickly as it would stay on top of grund surface. This may also have beneficial impact on groundwater as the water wouldn't infiltrate into the soils.

It would be desirable if the SAR value is reduced to around 20, as that would reduce the soil impacts. The SAR reduction can be achieved by adding powdered Gypsum to the lagoons while they are frozen. During the spring inversion, the powdered gypsum on ice surface will mix with water and will reduce the SAR of the water.

Currently the lagoon water has Calcium Concentration of 0.51 meq/L and raising it to 1 meq/L will reduce the SAR to 20. The amount of 100% gypsum needed to supply 1 meq/L of calcium is equal to 86 Kg per 1000 m^3 of water. The normal agricultural gypsum powder commonly available locally is generally 70% pure; and addition of about five (5) tonnes (5000 Kg) will add enough calcium to reduce the SAR to under 20.

6.2 Impact on Groundwater

Of the ten (10) auger holes, ground water seepage was encountered in three (3) boreholes at depth of over 2 m depth. This suggests that the released liquid from the lagoons will have to infiltrate at least 2 m to connect with the groundwater and would have to pass through clay layer in excess of 0.7 m. Of the three wells with groundwater, one well had clay layer of 0.7 m while the other wells had clay layer of more than 1 m.

Given the depth of groundwater and the thick clay layer separating the water bearing strata from the surface water, it is believed that sufficient barrier exists to prevent and minimize any impacts on ground water.

6.3 Erosion and Flooding Impacts

Key concerns would be due to any potential erosion, flooding or excessive ponding of water in the natural environment. Given the natural vegetation within the wooded area and the controlled release of the water from the lagoons, any erosion, flooding or ponding will be minimized. The operator responsible for the release will monitor the forest and inspect the flow paths at least once a day during the release period.

The liquid will be slowly released from cell# 3 of the lagoons via siphoning and pumping at approximately 1000 m^3/day. The flow volume released will be calculated by daily recording the flow depths in the manhole for the interconnecting piping between Cell 1 and Cell 3. The release points are provided in Appendix-C. The liquid will be released over a period of approximately 60 days after the snow is melted; and, is tentatively planned from May 1 to June 30, 2019. The release will be suspended during any sustained wet weather event.

The released water to the wooded areas will be monitored by the municipality's licensed operator; and will prevent any runoff to the lake. Should any runoff is suspected, Alberta Environment will be notified.

7 Public and Social Impacts

There are no known groundwater wells or residential dwellings in the wooded area where the release is proposed. There are some ATV trails in the wooded areas that are used by the locals. The local municipality will provide written notices to all the area residents to inform them of the release from the lagoons and to stay away from any wet areas or any ponded water.

8 Operational Plan

8.1 Gypsum Addition to Lagoons

Approximately 5000 KG of powdered gypsum will be evenly spread over the frozen surface of Cell 1 and Cell 2 utilizing an inflatable boat/raft. It is desired that the gypsum is spared during March while the lagoon surface is frozen. The gypsum may be wetted to prevent it from dusting.

8.2 Communication Plan

Communication advisories residents providing information about the activities and also potential environmental and health impacts will be delivered to local residents by the Municipality; and notices will also be affixed on main ATV entrances into the wooded areas. Public complaints and concerns will be received by the municipality who would follow up and respond back to the community members. The following communication will made to the residents:

- Prior to Lagoon Discharge (April 2019): In order to notify public and local residents the Summer Village will send out letters to all village residents. In addition the information will also be included in the Summer Village Newsletter and on the village website. The information will include contact information, emergency information and the date of the proposed discharge. During discharge signs will be placed along the roads notifying visitors or locals of the discharge activity and emergency contact info. The information supplied will contact information for submission of any complaints from residents in the area. The local residents or visitors to Sandy Beach may also communicate directly with the Village of Sandy Beach or social media networks.
- After completion of the Lagoon Discharge (July 2019): On completion of the discharge and dry out of any ponding, the Summer Village will notify all the residents and remove all the signs etc.

8.3 Flow Control and Monitoring

The flow will be released at a slow rate of approximately 1000 m^3/day or about 11-12 L/s, which will spread in an area of approximately 150,000 m^2, resulting in an application rate of about 6-7 mm of water applied to the area per day. Given the low application rate, runoff is not anticipated.

However, the operator will daily monitor and track the water flow by walking the water path and will maintain a log book to record any abnormal events including but not limited to:

- Any abnormal ponding
- Any surface runoff approaching the road or the properties; prevent any runoff offsite by damming and stopping the release.
- Report any offsite runoff to the release team and Alberta Environment (Contact name and number).

9 Key Contacts and Release Supervision

The flow will be released by the licenced operator employed by the municipality. The various flow paths will be monitored on daily basis and adjustments will be made to prevent any flooding and public concerns. The key contacts are:

Trevor Garnder- Operator
Tel: 780-967-5552
Cell: 780-967-5552
Email: supersuckervac@gmail.com

Rudolph Liebenberg
CAO, Summer Village of Sandy Beach
Tel: 780-967-2873
Cell: 780-718-1894
Email: svsandyb@xplornet.ca

Chad Newton
Project Manager, Morrison Hershfield
Tel: 780-783-5200
Cell:780-909-2423
Email: cnewton@morrisonhershfield.com

Abdul Khan, P.Eng.
Process Engineer, Morrison Hershfield
Tel: 780-483-5200
Cell: 587-985-1820
Email: akhan@morrisonhershfield.com

10 Emergency Response Plan (ERP)

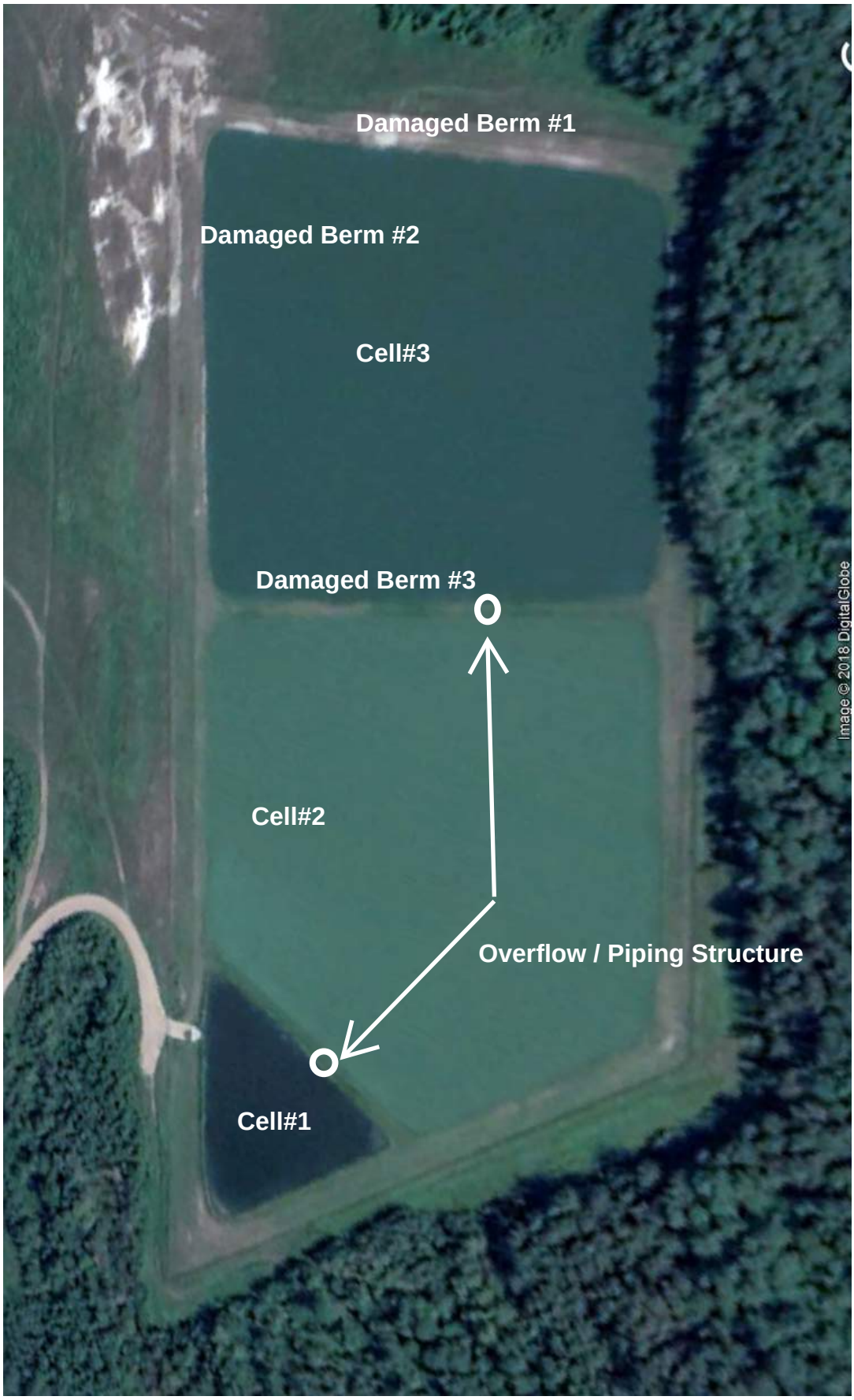
The table below shows types of emergencies that may occur and actions to take including first points of contact during this one-time release of wastewater from the lagoon.

Type of Emergency	Actions	Contact
Wastewater Ponding at Discharge Location	• Stop all pumping activity from lagoon until infiltration rate improves in soil.	• Consultant - Morrison Hershfield Limited (Chad Newton @ 780-483-5200)
Runoff from the Release Area	• Contain the spill from spreading outside the area of discharge and estimate quantity spilled.	• Sandy Beach Office: Ph: 780-967-2873 or Cell: 780-718-1894

Type of Emergency	Actions	Contact
	• Call a Hydrovac Truck ASAP to minimize additional spilling • Contact Town Authorities and Consultant including affected downstream residents along Lake Shore Dr. and nearby communities such as the Alexander Indian Reserve. • Contact Alberta Environment	• Alberta Environment: Ph: 800-222-6514 or 780-422-4505 • Consultant - Morrison Hershfield Limited (Chad Newton @ 780-483-5200)
Trespassing Area of Discharge	• Notify the Village authorities to locate trespasser to have them removed from area.	• Sandy Beach Office: Ph: 780-967-2873 or Cell: 780-718-1894
Discharge Reached Lakeshore Dr. or Lakes Nearby	• Inform all residents to ensure nobody is inside lake waters • Ensure nobody has trespassed discharge area boundary. • Report to Fisheries and Oceans Canada • Report to Alberta Environment	• Alberta Environment: Ph: 1-800-222 – 6514 or 780-422-4505 • Fisheries and Oceans: 1-855-852-8320 (Edmonton Office) • Notify local residents through media or contact information available
Vandalism	• Call local police or RCMP	• Police: 911 • RCMP: 780-939-4520

Appendix A: Site Photographs

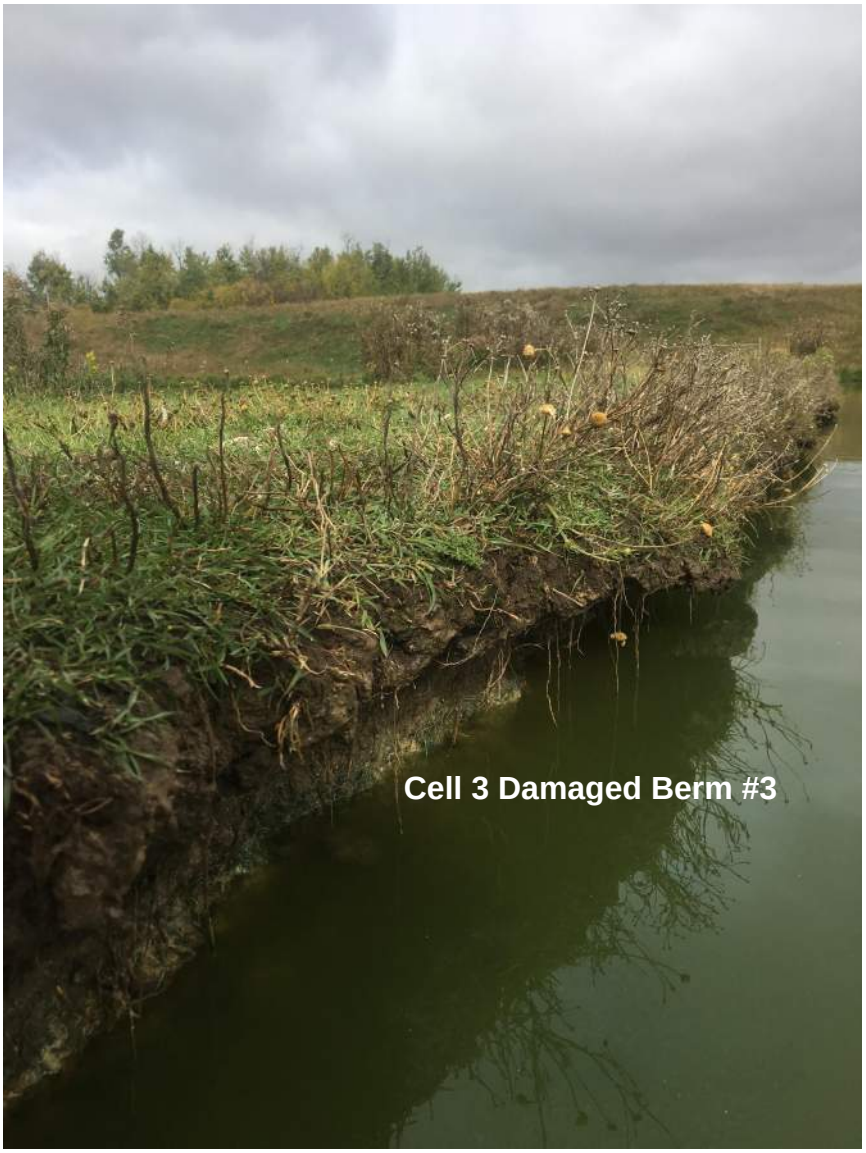
Sandy Beach Lagoon



Sandy Beach Lagoon

Sandy Beach Lagoon

Sandy Beach Lagoon



Appendix B: Lagoon Water Quality

Exova
7217 Roper Road NW
Edmonton, Alberta
T6B 3J4, Canada

T: +1 (780) 438-5522
F: +1 (780) 434-8586
E: Edmonton@exova.com
W: www.exova.com

Report Transmission Cover Page

Bill To:	Summer Village of Sandy Beach	Project ID:		Lot ID:	**1272494**
	Box 63	Project Name:		Control Number:	C113476
	RR 1 Site 1	Project Location:		Date Received:	May 23, 2018
	Onoway, AB, Canada	LSD:		Date Reported:	Jun 5, 2018
	T0E 1V0	P.O.:		Report Number:	2289104
Attn:	Bob Arial	Proj. Acct. code:			
Sampled By:					
Company:					

Contact	Company	Address
Bob Arial	**Summer Village of Sandy Beach**	Box 63, RR 1 Site 1 Onoway, AB T0E 1V0 Phone: (780) 967-2873 Fax: (780) 967-2813 Email: svsandyb@xplornet.ca

Delivery	Format	Deliverables
Email - Single Report	PDF	Invoice

Contact	Company	Address
Kevin Liu	**Morrison Hershfield Limited**	300, 6807 Railway Ave SE Calgary, AB T2H 2V6 Phone: (587) 893-8886 Fax: (403) 246-4220 Email: kliu@morrisonhershfield.com

Delivery	Format	Deliverables
Email - Merge Reports	PDF	COC / Test Report

Notes To Clients:

- May 25, 2018 - Sample 1272494-1; 6104313: Due to the nature of sample, only 10ml of sample could be filtered for coliform testing. As a result the detection limit is <10 cfu/100ml

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Analytical Report

Bill To:	Summer Village of Sandy Beach	Project ID:		Lot ID:	**1272494**
	Box 63	Project Name:		Control Number:	C113476
	RR 1 Site 1	Project Location:		Date Received:	May 23, 2018
	Onoway, AB, Canada	LSD:		Date Reported:	Jun 5, 2018
	T0E 1V0	P.O.:		Report Number:	2289104
Attn:	Bob Arial	Proj. Acct. code:			
Sampled By:					
Company:					

Reference Number	1272494-1
Sample Date	May 22, 2018
Sample Time	11:00
Sample Location	
Sample Description	Sandy Beach Lagoon / 21.5°C (Just sampled)
Matrix	Water

Analyte		Units	Results	Results	Results	Nominal Detection Limit
Aggregate Organic Constituents						
Biochemical Oxygen Demand	Inhibited	mg/L	14			4
Chemical Oxygen Demand		mg/L	265			5
Inorganic Nonmetallic Parameters						
Ammonia - N		mg/L	0.084			0.025
Ammonium/Ammonia Preservation			Yes			
Microbiological Analysis						
Total Coliforms	Membrane Filtration	CFU/100 mL	<10			1
Fecal Coliforms	Membrane Filtration	CFU/100 mL	<10			1
Physical and Aggregate Properties						
Solids	Total Suspended	mg/L	49			2
Routine Water						
pH			10.3			
Temperature of observed pH		°C	20.8			
Electrical Conductivity	at 25 °C	µS/cm	1860			1

Approved by:

Anthony Neumann, MSc
Laboratory Operations Manager

Data have been validated by Analytical Quality Control and Exova's Integrated Data Validation System (IDVS).
Generation and distribution of the report, and approval by the digitized signature above, are performed through a secure and controlled automatic process.

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Methodology and Notes

Bill To:	Summer Village of Sandy Beach	Project ID:		Lot ID:	**1272494**
	Box 63	Project Name:		Control Number:	C113476
	RR 1 Site 1	Project Location:		Date Received:	May 23, 2018
	Onoway, AB, Canada	LSD:		Date Reported:	Jun 5, 2018
	T0E 1V0	P.O.:		Report Number:	2289104
Attn:	Bob Arial	Proj. Acct. code:			
Sampled By:					
Company:					

Method of Analysis

Method Name	Reference		Method	Date Analysis Started	Location
Alkalinity, pH, and EC in water	APHA	*	Conductivity, 2510 B	May 25, 2018	Exova Edmonton
Alkalinity, pH, and EC in water	APHA	*	pH - Electrometric Method, 4500-H+ B	May 25, 2018	Exova Edmonton
Ammonium-N in Water	APHA	*	Automated Phenate Method, 4500-NH3 G	May 25, 2018	Exova Edmonton
BOD (Carbonaceous) in water	APHA	*	5 Day, 5210 B	May 24, 2018	Exova Edmonton
Chemical Oxygen Demand in water	APHA	*	Closed Reflux, Colorimetric Method, 5220 D	May 24, 2018	Exova Edmonton
Chemical Oxygen Demand in water	US EPA	*	US EPA method, 8000	May 24, 2018	Exova Edmonton
Coliforms - Membrane Filtration	APHA		Fecal Coliform Membrane Filter Procedure, 9222 D	May 24, 2018	Exova Calgary
Coliforms - Membrane Filtration	APHA		Standard Total Coliform Membrane Filter Procedure, 9222 B	May 24, 2018	Exova Calgary
Solids Suspended (Total, Fixed and Volatile)	APHA	*	Total Suspended Solids Dried at 103-105'C, 2540 D	May 28, 2018	Exova Edmonton

** Reference Method Modified*

References

APHA	Standard Methods for the Examination of Water and Wastewater
US EPA	US Environmental Protection Agency Test Methods

Comments:

- May 25, 2018 - Sample 1272494-1; 6104313: Due to the nature of sample, only 10ml of sample could be filtered for coliform testing. As a result the detection limit is <10 cfu/100ml

Appendix C: Release Area Map

SAMPLING LOCATIONS

Sample ID	Northing	Easting
S1	5966723.1	695387.1
S2	5966687.1	695278.6
S3	5966620.6	695205.8
S4	5966568.8	695121.8
S5	5966501.5	695043.3
S6	5966492.8	694944.5
S7	5966493.3	694845.8
S8	5966488.8	694746.8
S9	5966599.7	694879.1
S10	5966557.6	695253.6

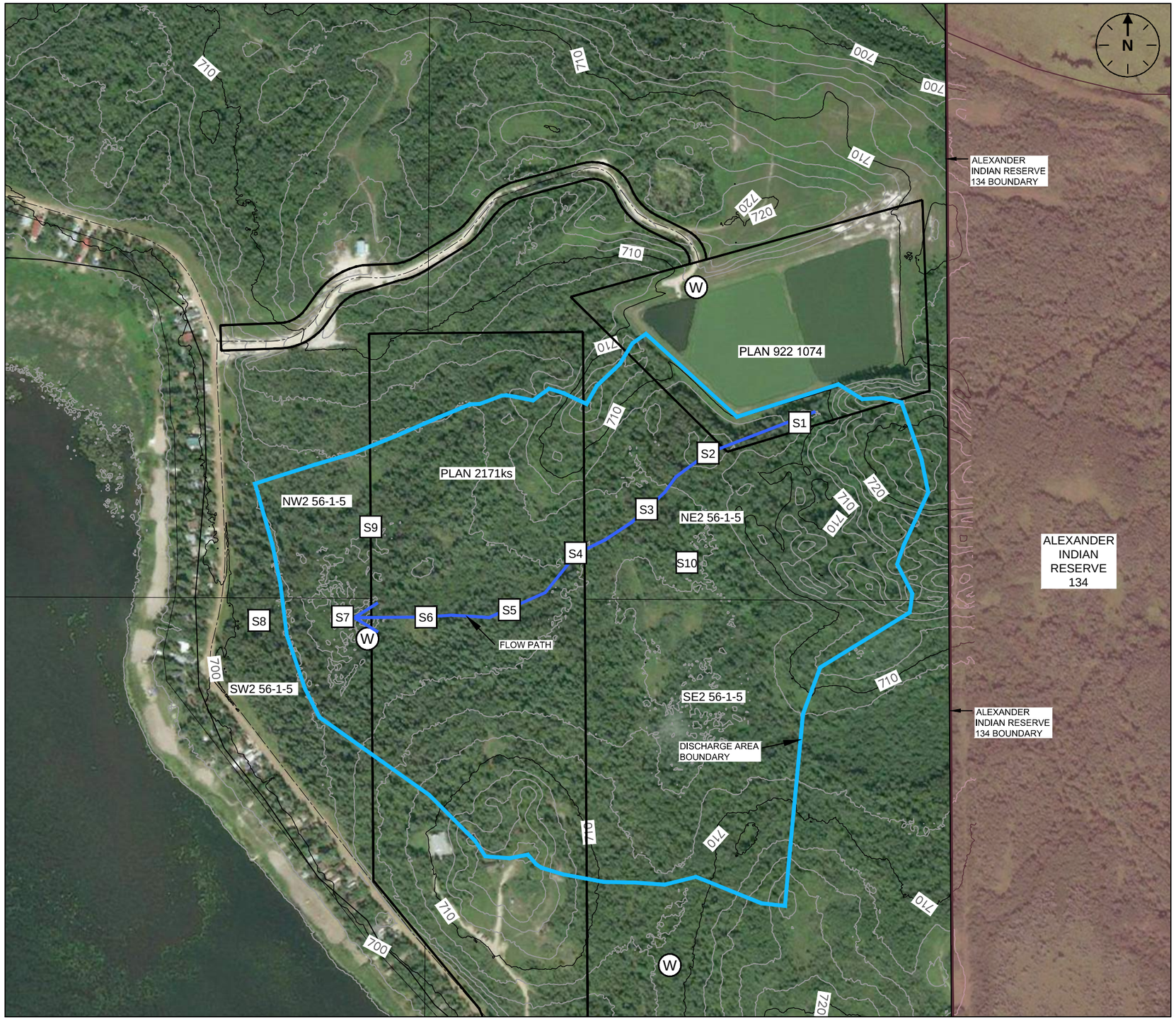
NOTES:
DRAWING IMAGERY SOURCE: BING MAPS
DRAWING CONTOURS: AltaLIS LIDAR (2010)
LEGAL LINES FROM SPIN PLANS: 9221074 & 2172ks

(W) WATER WELL LOCATION
SOURCE: ABADATA (TO BE CONFIRMED)

S1 PROPOSED SAMPLE LOCATION

DISCHARGE AREA BOUNDARY

FLOW PATH



MORRISON HERSHFIELD

SUMMER VILLAGE OF SANDY BEACH

0m 50 100 150 200

SANDY BEACH ENGINEERING STUDY
SAMPLING LOCATION PLAN

SCALE 1:5000

Nov 19, 2018
VERSION 0.2

Appendix D: ParklandGeo Report

Parkland Geo-Environmental Ltd.
189 Pembina Road
Sherwood Park, AB, T8H 2W8
www.parklandgeo.com
T: 780 416 1755
F: 780 416 1752

December 21, 2018
Project No. ED2091

Via e-mail: cnewton@morrisonhershfield.com
Original will remain on file

Morrison Hershfield Limited
Suite 300, 1630 - 91 Street SW
Edmonton, Alberta
T6X 0W8

ATTN: Mr. Chad Newton, MBA, PMP, Principal
Senior Project Manager

RE: Emergency Discharge - Soil Sampling
Summer Village of Sandy Beach
Baseline Soil Testing Results

Dear Mr. Newton:

1.0 INTRODUCTION

Parkland Geo-Environmental Ltd. (ParklandGEO) was commissioned by Morrison Hershfield Limited to conduct a limited Phase 2 ESA within NE and SE-02-56-01-W5M at the Village of Sandy Beach, Alberta. The sampling and classification of the soil is required by Alberta Environment prior to the emergency discharge of water from holding ponds to allow for needed repair of the berms.

The scope of work for the environmental investigation was outlined in ParklandGEO proposal PRO-ED-200-R1 dated August 9, 2018. Authorization to proceed was provided by Mr. Chad Newton of Morrison Hershfield Ltd. via email on November 19, 2018.

2.0 SITE DESCRIPTION

The site was located at the Village of Sandy Beach, Alberta, within NE and SE-02-56-01-W5M as shown on the Sampling Location Plan provided by Morrison Hershfield (Figure 1). At the time of the investigation the site was snow covered treed land bordered by Lakeshore Dr to the west, Alexander Indian Reserve to the east, the lagoon to the north, and a summer camp to the south. The planned discharge flow path began from the south end of the lagoon (Borehole 18-01) and flowed southwest toward Lakeshore Dr (Borehole 18-08). Hiking and ATV trails were located throughout the property.

3.0 FIELD INVESTIGATION PROGRAM

On November 30 and December 5 2018, ten hand auger holes were advanced to depths ranging between 2.5 and 3.2 m below grade at the approximate locations shown in Figure 1. All holes were completed by a hand auger and were backfilled with cuttings with the surface repaired to match aesthetically with the surroundings.

The soil sampling method was as follows:

- Disturbed soil samples were collected from 0-15 cm and 15-30 cm depths, then at every 1.0 m interval thereafter, and at each stratigraphic change;

- Soils encountered were visually examined during drilling and logged according to the Modified Unified Soil Classification System. All soil samples were returned to ParklandGEO's Sherwood Park laboratory for further examination. The laboratory program consisted of moisture contents and grain size analysis.

- The 0-15 and 15-30 cm soil samples were submitted to AGAT Laboratories for salinity analysis.

- Borehole locations were recorded with a handheld Garmin GPS upon completion.

4.0 ASSESSMENT CRITERIA

The Alberta Tier 1 Soil and Groundwater Remediation Guidelines present generic criteria, such that a contaminant that exceeds the Guidelines would either require remediation, risk management or development of site-specific guidelines. In addition, they assume the presence of all exposure pathways and receptors within a particular land use. The Alberta Tier 2 Soil and Groundwater Remediation Guidelines use more detailed, site specific information obtained through investigation which considers only the applicable exposure pathways and receptors.

Selection of the applicable guidelines is governed by the land use, soil grain size and exposure pathway applicability. The pathway assessments for this site is presented on Table 1.

Selection of applicable land use is based on the most conservative allowable land use. For the Subject Property, natural area land use guidelines were applied. Based on the grain size testing the soils were fine and coarse grained (Table 2).

The applicable regulatory guidelines for soil and groundwater applied to this site are:

- *Alberta Tier 1 Soil and Groundwater Remediation Guidelines* (February, 2016).

5.0 RESULTS

5.1 SUBSOIL STRATIGRAPHY

Soils encountered while drilling generally consisted of topsoil overlaying sand or clay, which was underlain by clay till, coal or bedrock that extended beyond the depths of drilling. Definitions of the terminology and symbols used on the logs are provided on the accompanying explanations sheets in Appendix B. The following is a brief explanation of the soil conditions encountered.

5.1.1 TOPSOIL

A layer of topsoil was encountered at the surface of all boreholes and extended to depths ranging from 0.1 to 1.1 mbg. Topsoil was also found in Borehole 18-08 from 0.8 to 1.3 mbg. The topsoil generally contained little clay, silt, organics, was low plastic, damp and black. Moisture contents ranged from 55 to 227 percent.

5.1.2 SAND

Sand was encountered below the topsoil in Boreholes 18-01, 18-03, 18-07 and 18-08 and extended to depths ranging from 0.5 to 1.7 mbg. Sand was also found underlying the clay layer in Boreholes 18-01, 18–04, 18-05, 18-09 and 18-10 and extended to depths ranging from 0.9 to 3.1 mbg. The sand was generally fine to coarse grained, consisted of little silt, trace clay, organics, occasional rust staining, was cohesionless, massive, damp, and brown to grey. Grain Size Analysis in Borehole 18-01 at 1.0 m found the layer to be coarse grained containing 78 percent sand, 13 percent silt, and 10 percent clay. Moisture contents ranged between 9 and 29 percent.

5.1.3 SILTY CLAY

Silty clay was encountered below the topsoil in Boreholes 18-02, 18-04, 18-05, 18-06, 18-09 and 18-10 and extended to depths ranging from 0.7 to 3.1 mbg. Silty Clay was also found underlying sand in Boreholes 18-01, 18-03, 18-05, 18-07 and 18-08. The clay and silt generally contained trace sand, organics, was medium plastic, damp to moist, and grey to brown. The clay was observed to be high plastic in Boreholes 18-06, 18-07, and 18-09. Grain Size Analysis in Borehole 18-06 at 2.0 m found the layer to be fine grained containing 52 percent clay, 44 percent silt, and 4 percent sand. Moisture contents ranged from 22 to 81 percent.

5.1.4 CLAY TILL

Clay till was encountered in Boreholes 18-03, 18-04, 18-08 and 18-10 below the topsoil, silty clay or sand layers and extended to depths ranging from 2.1 mbg to beyond the depth of drilling. The clay till generally contained little to some silt, little sand, trace gravel, coal chips, occasional rust staining and was medium plastic, massive, damp to moist and brown. Moisture contents ranged between 18 to 39 percent.

5.1.5 WEATHERED CLAY SHALE

Weathered clay shale bedrock was encountered in Boreholes 18-03, 18-05, 18-07, and 18-09 below the sand, clay, or clay till layers and extended beyond the depth of drilling. The clay shale consisted of little silt, sand, trace gravel, was firm to stiff, medium plastic, massive, damp and dark grey to brown. Moisture contents ranged from 29 to 79 percent.

5.1.6 COAL

A layer of coal was encountered below the clay till in Borehole 18-08 and extended beyond the depth of investigation. The coal contained some clay, silt, was stiff, wet and black. Moisture contents ranged from 31 to 54 percent.

5.1.7 GROUNDWATER

Groundwater seepage was encountered in Boreholes 18-01, 18-04 and 18-09 at 2.4, 2.3 and 2.2 mbg, respectively. All other boreholes were dry upon completion.

5.2 ANALYTICAL RESULTS - SALINITY

ParklandGEO submitted twenty soil samples for salinity analyses. The salinity analyses results are summarized in Table 3 and compared to the topsoil or subsoil guidelines as applicable.

All samples had electrical conductivity (EC) ratings of “Good”. All samples had a sodium absorption ratio (SAR) rating of “Fair” or “Good”. Samples from Boreholes 18-01, 18-03, 18-04, 18-05 (15-30 cm sample), 18-09 and 18-10 all had pH levels that were within the lower range of the Guidelines. Samples from Boreholes 18-02, 18-05 (0-15 cm sample), 18-06, 18-07 and 18-08 had pH levels that were below the Guidelines.

6.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the limited Phase 2 ESA program which consisted of sampling the surficial deposits through the proposed discharge flow path the soil was found to have EC ratings of “Good”, SAR ratings that ranged from “Fair” to “Good”, and pH levels that were either below or towards the lower range of the acceptable Guidelines.

Based on the work scope performed and the results obtained, ParklandGEO recommends additional sampling at the same locations after the lagoon is released to assess for any impacts of the release.

7.0 LIMITATIONS AND CLOSURE

The American Society for Testing and Materials Standard of Practice notes that no environmental site assessment can wholly eliminate uncertainty regarding the potential for recognized environmental conditions in connection with a property. Performance of a standardized environmental site assessment protocol is intended to reduce, but not eliminate, uncertainty regarding the potential for recognized environmental conditions in connection with the subject property, given reasonable limits of time and cost.

This report has been prepared for the exclusive use of **MORRISON HERSHFIELD LIMITED** and their approved agents. Any use which a third party makes of this report, or any reliance on or decisions to be made based on it, are the responsibility of such third parties. **PARKLAND GEO-ENVIRONMENTAL LTD.**, and The ParklandGEO Consulting Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report. No other warranty, expressed or implied, is made.

We trust that this report meets with your current requirements. If there are any questions, please contact the undersigned at 780.416.1755.

Respectfully Submitted,

PARKLAND GEO-ENVIRONMENTAL LTD.
APEGA Permit to Practice No. P - 8867

Reviewed By:

December 21, 2018

Kyle Coons, E.I.T.
Geotechnical Engineer

Daniel Yost, P.Eng.
Principal, Geo-Environmental Engineering

Attached: Appendix A - Figures
Appendix B - Tables
Appendix C - Borehole Logs and Explanation Sheets
Appendix D - Analytical Results
Report Limitations

APPENDIX A

SAMPLING LOCATION PLAN
PROVIDED BY MORRISON HERSHFIELD

SAMPLING LOCATIONS

Sample ID	Northing	Easting
S1	5966723.1	695387.1
S2	5966687.1	695278.6
S3	5966620.6	695205.8
S4	5966568.8	695121.8
S5	5966501.5	695043.3
S6	5966492.8	694944.5
S7	5966493.3	694845.8
S8	5966488.8	694746.8
S9	5966599.7	694879.1
S10	5966557.6	695253.6

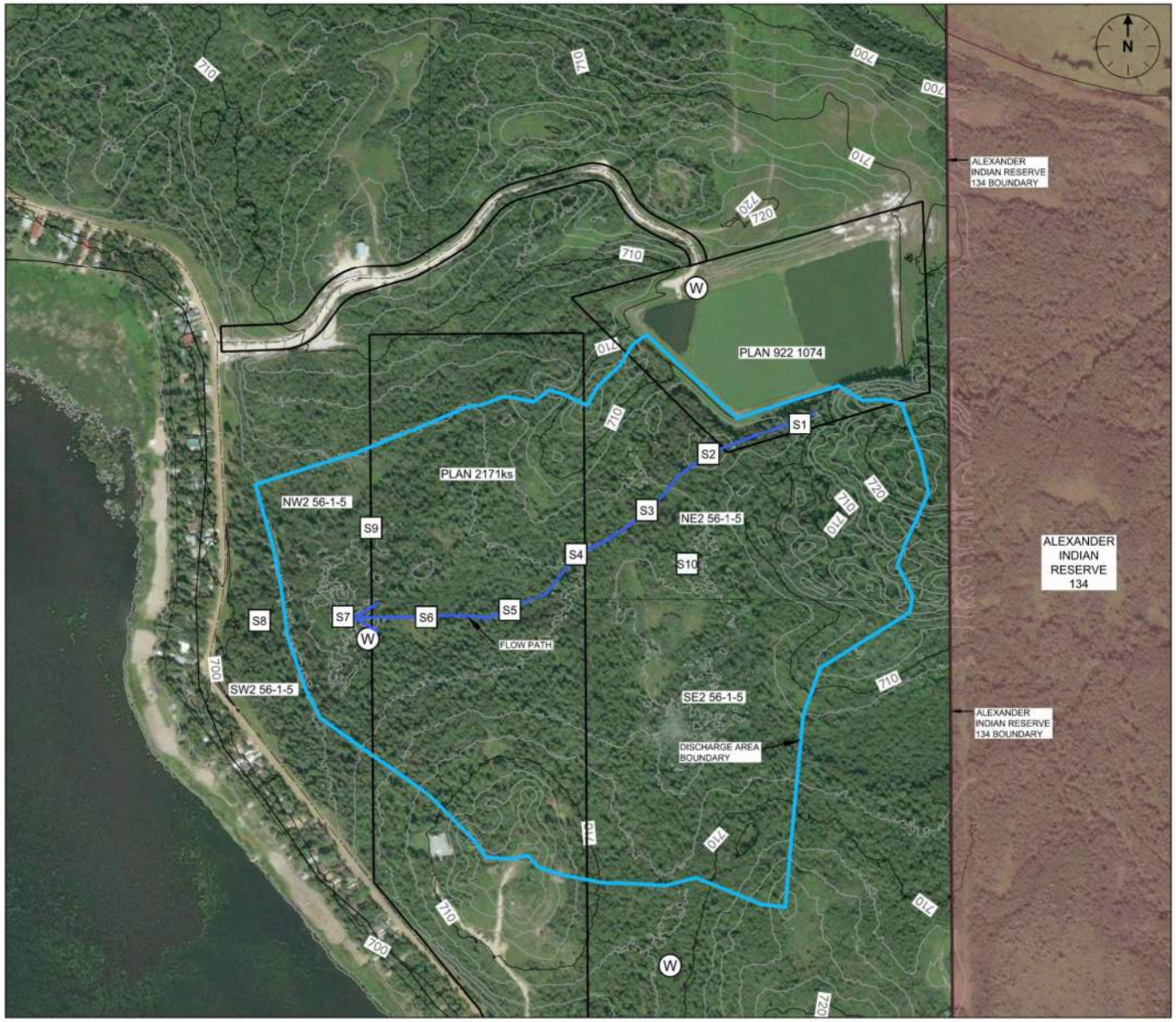
NOTES:
DRAWING IMAGERY SOURCE: BING MAPS
DRAWING CONTOURS: AltaLIS LIDAR (2010)
LEGAL LINES FROM SPIN PLANS: 9221074 & 2172ks

(W) WATER WELL LOCATION
SOURCE: ABADATA (TO BE CONFIRMED)

S1 PROPOSED SAMPLE LOCATION

DISCHARGE AREA BOUNDARY

FLOW PATH



MORRISON HERSHFIELD

SUMMER VILLAGE OF SANDY BEACH

0m 50 100 150 200

SANDY BEACH ENGINEERING STUDY
SAMPLING LOCATION PLAN

SCALE 1:5000

Nov 19, 2018
VERSION 0.2

APPENDIX B

TABLE 1: LAND USE AND PATHWAY ASSESSMENT

TABLE 2: SOIL ANALYSES - GRAIN SIZE

TABLE 3: SOIL ANALYSES - SALINITY

TABLE: 1
TITLE: LAND-USE AND PATHWAY ASSESSMENT

PROJECT#: ED2091
CLIENT: Morrison Hershfield
PROJECT: Sandy Beach Soil Sampling
SITE: Sandy Beach
LOCATION:

1. Tier 1/2 Applicability

Condition	Applicable	Comments
Source of volatile contaminants present within 30 cm of a building foundation	NO	
Land/water use not captured by Generic Tier 1 land uses	NO	
Exposure Pathway is present that is not considered at Tier 1 for the land use	NO	
Human receptors spend more time at site than average or receiver higher levels of exposure	NO	
Ecological receptors with high sensitivity	NO	
Unusual structural features (ie. earthen floor, unusually low air exchange rates)	NO	
Groundwater flow to stagnant waterbodies	NO	
Groundwater within 10 m of a surface water body	NO	
Very coarse textured materials enhancing groundwater or vapour transport	NO	
Fractured bedrock	NO	
Source length of groundwater contamination greater than 10 m	NO	
Inorganic contaminants in organic soil	NO	

Note: If any of the above conditions are applicable, Tier 1 Guidelines cannot be used; a Tier 2 approach must be used. If none of the above conditions are applicable, a Tier 1 or Tier 2 approach may be used.

2. Applicable Land Use

Land Use	Applicable	Comments
Natural Area (away from human habitation; primary concern is the protection of ecological receptors)	YES	
Agricultural (primary land use is growing crops or tending livestock)	NO	
Residential (primary activity is residential or residential activity, includes urban parks, campgrounds)	NO	
Commercial (primary activity is commercial, and there is free access to all members of the public)	NO	
Industrial (primary activity is production / manufacturing - public access is restricted)	NO	

3. Applicable Soil Type

Soil Type	Applicable	Comments
Fine-Grained	YES	
Coarse-Grained	YES	

4. Applicable Surface Water Use

Water Use	Applicable	Comments
Drinking Water	YES	
Aquatic Life	YES	
Irrigation	YES	
Livestock Water	YES	
Wildlife Water	YES	

5. Pathway Exclusion

Pathway	Applicable	Comments
Human Exposure Pathways		
Direct Soil Contact	YES	
Vapour Inhalation (basement)	YES	
Vapour Inhalation (slab-on-grade)	YES	
Protection of Domestic Use Aquifer*	YES	
Off-Site Migration by Wind or Water Erosion	YES	
Ecological Exposure Pathways		
Direct Soil Contact	YES	
Nutrient/Energy Cycling	YES	
Livestock Ingestion	YES	
Wildlife Ingestion	YES	
Freshwater Aquatic Life*	YES	
Livestock Watering*	YES	
Wildlife Watering*	YES	
Irrigation Watering*	YES	
Off-Site Migration by Wind or Water Erosion	YES	
Other Pathways		
Management Limit	YES	

* Pathway can be excluded at Tier 2 approach.

Refer to Each Table for the Most Stringent Guideline for the Applicable Legislation, Land-Use and Soil Type

TABLE: 2
TITLE: SOIL ANALYSES - GRAIN SIZE

PROJECT#: ED2091
CLIENT: Morrison Hershfield
PROJECT: Sandy Beach Soil Sampling
SITE: Sandy Beach
LOCATION:

REFERENCE: UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

Sample ID	Depth (m)	>0.075 mm (%)	Classification
18-01	1.00	77.6	COARSE-GRAINED
18-06	2.00	4.4	FINE-GRAINED

TABLE: 3
TITLE: **SOIL ANALYSES - SALINITY**

PROJECT#: ED2091
CLIENT: Morrison Hershfield
PROJECT: Sandy Beach Soil Sampling
SITE: Sandy Beach
LOCATION:

CRITERIA: ALBERTA TIER 1/2 SOIL AND GROUNDWATER REMEDIATION GUIDELINES, FEBRUARY 201(
TABLE 4, ALBERTA TIER 1 SALT REMEDIATION GUIDELINES

Topsoil Guidelines apply to surface A, L, F, H and O horizons or the equivalent surface soil where these horizons are not present.
Subsoil Guidelines apply to B and C horizons and the upper portion of the parent material
For Commercial/Industrial Sites, Topsoil EC = 4 dS/m, Topsoil SAR = 12, Subsoil EC = 4 dS/m, Subsoil SAR = 12
Material characterized by SAR of 12 to 20 may be rated as "Poor" if the the texture is sandy loam or coarser and saturation % is less than 10(

SAR and pH are unitless. All other concentrations in mg/kg unless otherwise noted.
NO = Does not meet QA/QC

EC = Electrical Conductivity
SAR = Sodium Adsorption Ratio
TGR = Total Gypsum Ratio

TOPSOIL	EC	Rating	SAR	pH	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulphate	Sat. %	TGR (t/ha)
	<2	Good	<4	6-8.5	No Guidline							
	2-4	Fair	4-8									
	4-8	Poor	8-12									
	>8	Unsuitable	>12									

																QA/QC		
Sample ID	Depth (m)	Sample Date	EC (mS/cm)	Rating	SAR	Rating	pH	Ca	Cl^-	Mg	K	Na	SO_4^{2-}	Sat. %	TGR (t/ha)	Hold Times Met	Acceptable Limits Met	Notes
18-01	0 - 0.15	30-Nov-2018	0.68	Good	7.60	Fair	6.19	27	25	5	17	164	65	86	0.05	YES	YES	
18-02	0 - 0.15	30-Nov-2018	0.42	Good	0.34	Good	5.64	60	17	18	32	3	55	141	<0.01	YES	YES	
18-03	0 - 0.15	30-Nov-2018	0.48	Good	2.26	Good	6.85	46	19	9	15	64	43	171	<0.01	YES	YES	
18-04	0 - 0.15	30-Nov-2018	0.53	Good	2.73	Good	6.58	44	22	9	12	76	42	171	<0.01	YES	YES	
15-05	0 - 0.15	5-Dec-2018	0.34	Good	1.36	Good	5.55	37	15	8	3	35	73	119	<0.01	YES	YES	
18-06	0 - 0.15	5-Dec-2018	0.52	Good	4.55	Fair	4.93	29	14	5	<2	101	134	103	<0.01	YES	YES	
18-07	0 - 0.15	5-Dec-2018	0.38	Good	1.50	Good	4.64	37	8	7	3	38	135	588	<0.01	YES	YES	
18-07	0.15 - 0.30	5-Dec-2018	0.26	Good	1.43	Good	4.81	25	6	5	<2	30	91	727	<0.01	YES	YES	
18-08	0 - 0.15	5-Dec-2018	0.49	Good	0.34	Good	5.98	93	12	20	17	12	70	81	<0.01	YES	YES	
18-09	0 - 0.15	5-Dec-2018	0.46	Good	1.13	Good	7.16	60	5	8	<2	35	77	110	<0.01	YES	YES	
18-10	0 - 0.15	30-Nov-2018	0.48	Good	0.61	Good	6.01	69	10	17	8	22	57	114	<0.01	YES	YES	

SUBSOIL	EC	Rating	SAR	pH	Calcium	Chloride	Magnesium	Potassium	Sodium	Sulphate	Sat. %	TGR (t/ha)
	<3	Good	<4	6-8.5	No Guidline							
	3-5	Fair	4-8									
	5-10	Poor	8-12									
	>10	Unsuitable	>12									

																QA/QC		
Sample ID	Depth (m)	Sample Date	EC (mS/cm)	Rating	SAR	Rating	pH	Ca	Cl^-	Mg	K	Na	SO_4^{2-}	Sat. %	TGR (t/ha)	Hold Times Met	Acceptable Limits Met	Notes
18-01	0.15 - 0.30	30-Nov-2018	0.53	Good	6.43	Fair	6.36	25	17	3	6	128	50	46	<0.01	YES	YES	
18-02	0.15 - 0.30	30-Nov-2018	0.21	Good	1.34	Good	4.54	18	14	5	4	25	35	46	<0.01	YES	YES	
18-03	0.15 - 0.30	30-Nov-2018	0.57	Good	4.49	Fair	7.1	33	20	7	4	109	56	48	<0.01	YES	YES	
18-04	0.15 - 0.30	30-Nov-2018	0.38	Good	4.16	Fair	6.92	18	9	4	<2	75	40	66	<0.01	YES	YES	
18-05	0.15 - 0.30	5-Dec-2018	0.26	Good	2.40	Good	6.08	20	8	4	<2	45	42	48	<0.01	YES	YES	
18-06	0.15 - 0.30	5-Dec-2018	0.66	Good	5.20	Fair	5.95	35	8	7	<2	129	136	91	<0.01	YES	YES	
18-08	0.15 - 0.30	5-Dec-2018	0.18	Good	0.61	Good	5.78	28	6	7	3	14	29	40	<0.01	YES	YES	
18-09	0.15 - 0.30	5-Dec-2018	0.50	Good	1.89	Good	6.82	47	8	9	<2	54	79	76	<0.01	YES	YES	
18-10	0.15 - 0.30	30-Nov-2018	0.20	Good	1.15	Good	6.32	22	6	5	<2	23	22	54	<0.01	YES	YES	

APPENDIX C

BOREHOLE LOGS

EXPLANATION SHEETS

Parkland GEO

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S1

BOREHOLE NO.: 18-01

PROJECT NO.: ED2091

Depth (m)	Description	Elev.	Sample Depth	Sample Type	Pocket Pen Cu (kPa) 25 75 125 175	Comments	Moisture Content and Atterburg Limits (%) (Wp |-----X-----| Wl) 25 50 75
	GROUND SURFACE	0.00					
0	***Topsoil*** Forest litter, little clay, silt, organics, low plastic, black	-0.15	1G1	G			
			1G2	G			
	Sand Fine to medium grain, little silt, trace clay, cohesionless, trace organics, damp, dark grey - trace rust, no organics, dry to damp, light brown						
1			1G3	G		Grain Size Analysis at 1.0 m: Sand = 77.6% Silt = 12.6% Clay = 9.8% Gravel = 0% Coarse Grained	9
		-1.70					
	Clay And silt, trace sand, medium to high plastic, mottled, trace rust staining, coal chips, organics, damp, grey and brown. -little sand, wet		1G4	G		Groundwater at approximately 2.4 m	29
2		-2.75					
	Sand Some silt, little clay						
3		-3.10	1G5	G			28
	END OF BOREHOLE Open Water at 2.7 m						

LOGGED BY: KC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: November 30, 2018

GROUND ELEVATION:
NORTHING: 5966721 m
EASTING: 695383 m

BOREHOLE NO.: 18-02

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S2

PROJECT NO.: ED2091

SUBSURFACE PROFILE				SAMPLE		Pocket Pen	Comments	Moisture Content and Atterburg Limits (%)
Depth (m)	Symbol	Description	Elev.	Depth	Type	Cu (kPa) 25 75 125 175		(Wp |-----X-----| Wl) 25 50 75
0		GROUND SURFACE	0.00					
		Topsoil Forest litter, little clay, silt, organics, low plastic, black	-0.10	2G1	G			
				2G2	G			
		Clay And silt, trace sand, low plastic, massive, trace organics, dry, grey						
		- some clay at 0.4 m						
1		- no organics, damp		2G3	G			30
2				2G4	G			31
3			-3.10	2G5	G			36
		END OF BOREHOLE						
		Open Dry						

LOGGED BY: KC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: November 30, 2018

GROUND ELEVATION:
NORTHING: 5966695 m
EASTING: 695284 m

Parkland GEO

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S3

BOREHOLE NO.: 18-03

PROJECT NO.: ED2091

SUBSURFACE PROFILE

Depth (m)	Symbol	Description	Elev.
		GROUND SURFACE	0.00
0		***Topsoil*** Forest litter, little clay, silt, organics, low plastic, black	-0.15
		Sand Fine to medium grain, some silt, little clay, cohesionless, massive, trace rust staining, organics, damp, grey and brown	
1		- little silt	-1.10
		Clay Some silt, little sand, medium plastic, mottled, moist, grey	-1.40
		Clay Till Some silt, little sand, trace gravel, medium plastic, massive, trace coal chips, moist to wet	
2			-2.10
		Weathered Clay Shale Little sand, little silt, trace gravel, firm to stiff, medium plastic, massive, damp, dark grey to brown	-2.50
		END OF BOREHOLE Open Dry	
3			

SAMPLE

Depth	Type
3G1	G
3G2	G
3G3	G
3G4	G
3G5	G
3G6	G

Pocket Pen
Cu (kPa)
25 75 125 175

Comments

Auger Refusal at 2.5 m

Moisture Content and Atterburg Limits (%)
(Wp |-----X-----| Wl)
25 50 75

9
24
23
31

LOGGED BY: KC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: November 30, 2018

GROUND ELEVATION:
NORTHING: 5966621 m
EASTING: 695206 m

BOREHOLE NO.: 18-04

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S4

PROJECT NO.: ED2091

SUBSURFACE PROFILE

Depth (m)	Symbol	Description	Elev.
		GROUND SURFACE	0.00
0		***Topsoil*** Forest litter, little clay, silt, organics, low plastic, black	-0.15
		Clay And silt, trace sand, gravel, medium plastic, massive, trace organics, damp to moist, black	
1			-1.30
		Sand Fine to medium grain, little silt, trace clay, cohesionless, trace organics, damp, dark grey	
		- grey	
2		- moist to wet	-2.40
		Clay Till Little silt, sand, trace gravel, medium plastic, massive, trace coal chips, rust staining, damp to moist	
3			-3.10
		END OF BOREHOLE	
		Open Dry	

SAMPLE

Depth	Type
4G1	G
4G2	G
4G3	G
4G4	G
4G5	G
4G6	G

Pocket Pen
Cu (kPa)
25 75 125 175

Comments
Groundwater at approximately 2.3 m

Moisture Content and Atterburg Limits (%)
(Wp |-----X-----| Wl)
25 50 75
42
29
16
18

LOGGED BY: KC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: November 30, 2018

GROUND ELEVATION:
NORTHING: 5966569 m
EASTING: 695122 m

BOREHOLE NO.: 18-05

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S5

PROJECT NO.: ED2091

SUBSURFACE PROFILE

Depth (m)	Description	Elev.
	GROUND SURFACE	0.00
0	***Topsoil*** Forest litter, little clay, silt, organics, low plastic, black	-0.20
	Clay Some silt, trace sand, firm, low to medium plastic, massive, damp to moist, brown and grey	-0.70
	Sand Fine and medium grain sand, little silt, trace clay, compact, cohesionless, massive, damp, brown	-0.90
1	***Clay*** Little sand, silt, trace gravel, firm to stiff, massive	
	- some sand	-1.60
	Weathered Clay Shale Little sand, little silt, trace gravel, firm to stiff, medium plastic, massive, damp, dark grey to brown	
2	- stiff	
3		-3.10
	END OF BOREHOLE	
	Open Dry	

SAMPLE

Depth	Type
5G1	G
5G2	G
5G3	G
5G4	G

Pocket Pen
Cu (kPa)
25 75 125 175

Comments

Moisture Content and Atterburg Limits (%)
(Wp |-----X-----| Wl)
25 50 75

28
39

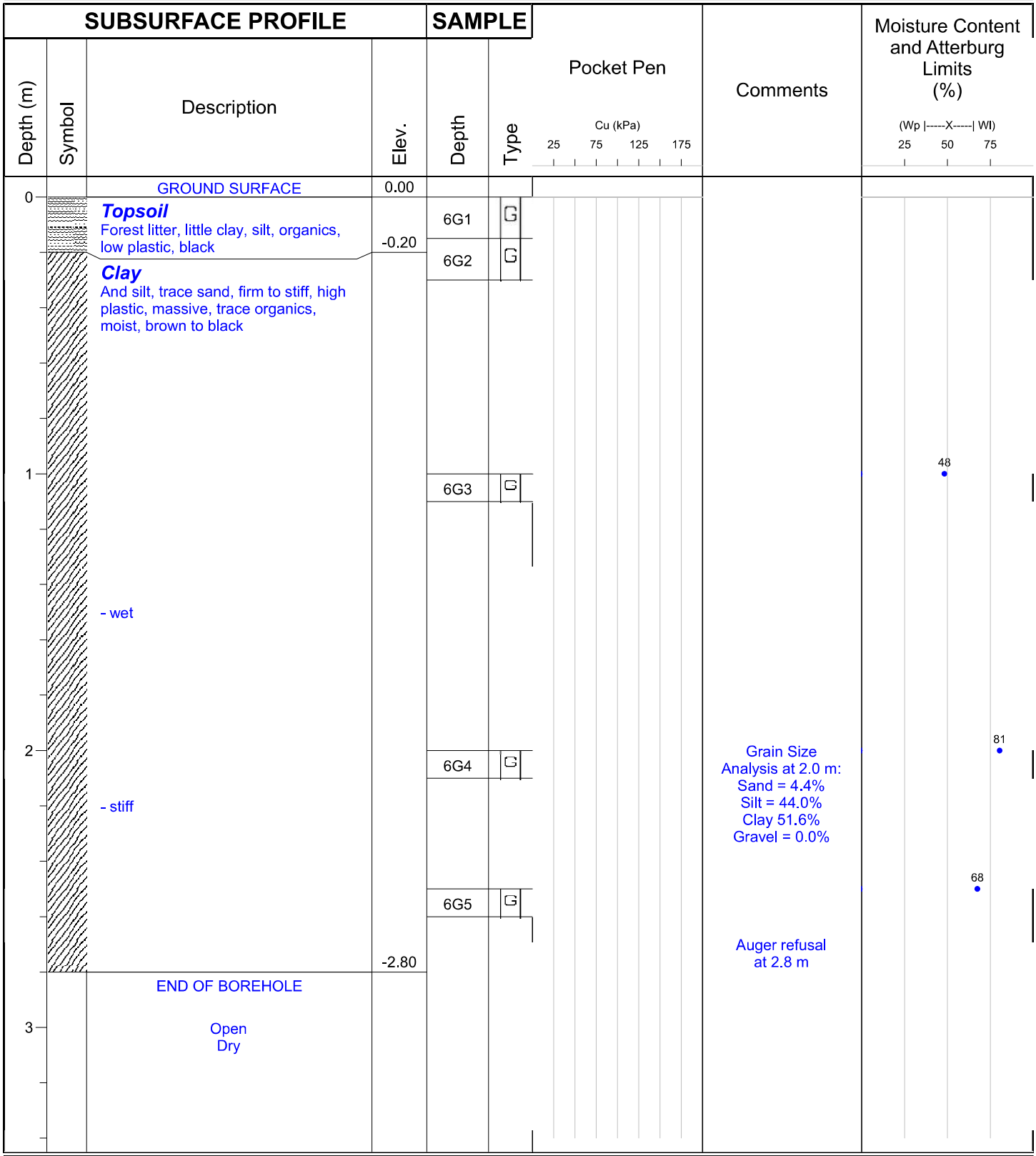
LOGGED BY: DC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: December 5, 2018

GROUND ELEVATION:
NORTHING: 5966502 m
EASTING: 695043 m

BOREHOLE NO.: 18-06

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S6

PROJECT NO.: ED2091



LOGGED BY: DC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: December 5, 2018

GROUND ELEVATION:
NORTHING: 5966493 m
EASTING: 694945 m

Parkland GEO

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S7

BOREHOLE NO.: 18-07

PROJECT NO.: ED2091

Depth (m)	Symbol	Description	Elev.	Sample Depth	Sample Type	Pocket Pen Cu (kPa) 25 75 125 175	Comments	Moisture Content and Atterburg Limits (%) (Wp |-----X-----| Wl) 25 50 75
		GROUND SURFACE	0.00					
0		***Topsoil*** Forest litter, peat, soft, cohesionless, massive, trace organics, damp, brown to black		7G1	G			
				7G2	G			
		- little clay, damp to moist						>100
1			-1.10	7G3	G			
		Sand Trace clay, silt, compact, cohesionless, massive, trace organics, moist, grey - wet at 1.3 m	-1.50					
		Clay Little silt, firm, high plastic, massive, moist to wet, grey	-2.00					79
2		***Weathered Clay Shale*** Little sand, little silt, trace gravel, firm to stiff, medium plastic, massive, damp, dark grey to brown		7G4	G			
			-2.60				Auger refusal at 2.6 m due to slough	
		END OF BOREHOLE Open to 2.2 m Dry						
3								

LOGGED BY: DC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: December 5, 2018

GROUND ELEVATION:
NORTHING: 5966493 m
EASTING: 694846 m

Parkland GEO

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S8

BOREHOLE NO.: 18-08

PROJECT NO.: ED2091

SUBSURFACE PROFILE

Depth (m)	Symbol	Description	Elev.
		GROUND SURFACE	0.00
0		***Topsoil*** Forest litter, peat, soft, trace organics, damp, black	-0.10
		Sand Trace silt, compact, cohesionless, massive	-0.50
		Clay Little silt, firm, medium plastic, massive, trace organics	-0.80
		Topsoil Little silt, trace clay, firm, low plastic, massive, trace organics, damp, black	
1		- some silt	-1.30
		Clay Till Some silt, little sand, firm, low to medium plastic, massive, trace coal chips, rust staining, damp to moist, brown	
		- little silt at 1.5 m	
		- Some silt, damp	
2			
		- dry to damp	-2.80
		Coal Some clay, silt, stiff, wet, black	
3			-3.10
		END OF BOREHOLE	
		Open Water at 2.8 m	

SAMPLE

Depth	Type
8G1	G
8G2	G
8G3	G
8G4	G
8G5	G
8G6	G
8G7	G
8G8	G

Pocket Pen — Cu (kPa): 25, 75, 125, 175

Comments

Moisture Content and Atterburg Limits (%) — (Wp |-----X-----| Wl): 25, 50, 75

35
55
39
29
31
54

LOGGED BY: DC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: December 5, 2018

GROUND ELEVATION:
NORTHING: 5966489 m
EASTING: 694747 m

BOREHOLE NO.: 18-09

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S9

PROJECT NO.: ED2091

SUBSURFACE PROFILE

SAMPLE

Depth (m)	Description	Elev.	Depth	Type
	GROUND SURFACE	0.00		
0	***Topsoil*** Forest litter, peat, little clay, little silt, firm, massive, trace organics, damp, black	-0.15	9G1	G
			9G2	G
	Clay Some topsoil, little silt, firm, medium plastic, massive, trace organics, damp to moist, black			
			9G3	G
	- high plastic			
1	- brown to grey	-1.20		
	Sand Fine to medium grain, some clay, trace silt, compact, non to low plastic, trace rust staining, damp to moist, - coal seam 0.1 m thick		9G4	G
	- moist			
2	- little clay, moist to wet, occasional 5 to 20 mm thick sandy clay layers			
	- wet		9G5	G
		-2.50		
	Weathered Clay Shale Little sand, little silt, trace gravel, firm to stiff, medium plastic, massive, damp, dark grey to brown		9G6	G
3		-3.20		
	END OF BOREHOLE Open Water at 2.6 m			

Pocket Pen
Cu (kPa)
25 75 125 175

Comments
Groundwater at approximately 2.2 m

Moisture Content and Atterburg Limits (%)
(Wp |-----X-----| Wl)
25 50 75
42
22
29
28

LOGGED BY: DC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: December 5, 2018

GROUND ELEVATION:
NORTHING: 5966600 m
EASTING: 694879 m

BOREHOLE NO.: 18-10

CLIENT: Morrison Hershfield Ltd.
SITE: Sandy Beach Lagoon
BH LOCATION: S10

PROJECT NO.: ED2091

Depth (m)	Symbol	Description	Elev.	Sample Depth	Sample Type	Pocket Pen Cu (kPa)	Comments	Moisture Content and Atterburg Limits (%)
		GROUND SURFACE	0.00					
0		***Topsoil*** Forest litter, peat, little clay, little silt, firm, massive, trace organics, damp, black	-0.20	10G1	G			
				10G2	G			
		Clay And silt, trace sand, medium plastic, mottled, trace rust staining, coal chips, organics, damp, grey and brown						22
				10G3	G			
1		- some sand	-1.10					
		Sand Some silt, little clay, cohesionless, massive, trace rust staining, damp, brown and grey		10G4	G			13
			-1.80					
		Clay Till Little silt, little sand, trace gravel, medium plastic, massive, trace coal chips, rust staining, damp to moist, dark grey						
2				10G5	G			34
			-2.70					
		END OF BOREHOLE						
		Open Dry						
3								

Pocket Pen Cu (kPa): 25, 75, 125, 175

Moisture Content and Atterburg Limits (%): (Wp |-----X-----| Wl) 25, 50, 75

LOGGED BY: KC
CONTRACTOR: N/A
RIG/METHOD: Hand Auger
DATE: December 5, 2018

GROUND ELEVATION:
NORTHING: 5966558 m
EASTING: 695254 m

THE PARKLANDGEO CONSULTING GROUP
EXPLANATION OF TERMS AND SYMBOLS

The terms and symbols used on the borehole logs to summarize the results of the field investigation and subsequent laboratory testing are described on the following pages.

The borehole logs are a graphical representation summarizing the soil profile as determined during site specific field investigation. The materials, boundaries, and conditions have been established only at the borehole location at the time of drilling. The soil conditions shown on the borehole logs are not necessarily representative of the subsurface conditions elsewhere across the site. The transitions in soil profile can have gradual rather than distinct boundaries.

1. **PRINCIPAL SOIL TYPE** – The major soil type by weight of material or by behaviour.

Material	Grain Size
Boulders	Larger than 300 mm
Cobbles	75 mm to 300 mm
Coarse Gravel	19 mm to 75 mm
Fine Gravel	5 mm to 19 mm
Coarse Sand	2 mm to 5 mm
Medium Sand	0.425 mm to 2 mm
Fine Sand	0.075 mm to 0.425 mm
Silt	0.020 to 0.075 mm
Clay	Smaller than 0.020 mm

2. **DESCRIPTION OF MINOR SOIL TYPE** – Minor soil types are identified by weight of minor component.

Descriptor	Percent
and	35 to 50
some	20 to 35
little	10 to 20
trace	1 to 10

3. **CONSISTENCY OF FINE GRAINED SOILS** – The following terms are used relative to undrained shear strength and Standard Penetration Test (SPT), , N value, for blows per 300 mm penetration (ASTM D1586).

Description	Undrained Shear Strength, C_u (kPa)	SPT N Value
Very Soft	Less than 12	Less than 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 150	15 to 30
Hard	Over 150	Over 30

4. **RELATIVE DENSITY OF COARSE GRAINED SOIL** – The following terms are used relative to Standard Penetration Test (SPT),, N value for blows per 300 mm penetration (ASTM D1586).

Description	SPT N Value
Very Loose	Less than 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	Over 50

5. **TYPICAL SEDIMENTARY BEDROCK TYPES AND CLASSIFICATION** – The following terms are based on visual inspection and field/laboratory identification tests.

Characteristic	Sandstone	Mudrocks			
		Siltstone	Mudstone	Clayshale	Claystone
Composition	>50% Sand $CaCO_3$ or silica binder. Use weak acid to test for $CaCO_3$.	>50% Silt	33% to 66% Silt & 33% to 66% Clay	>50% Clay & <33% Silt	
Bedding	Banding possible Non- Fissile Wackes – dirty sandstone matrix (>15% clay)	Non-Fissile & Non-laminated	Non-Fissile & Non-laminated	Fissile	Non-Fissile

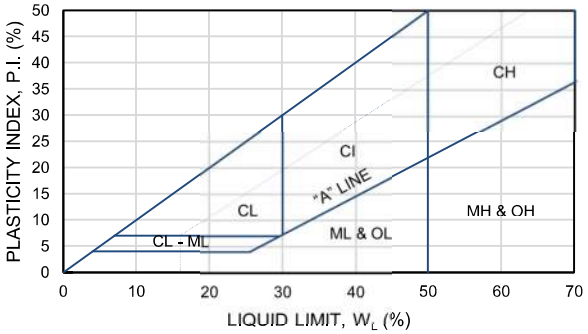
Definitions

Fissile Breaks apart on bedding planes, not fractures.
Shale Only used to describe a fissile clay mudrock.
Slate Hard Mudstone exposed to high pressure and temperature.
Limestone Sedimentary rock (i.e. particles) formed from calcium carbonate minerals from skeletal fragments of marine organisms such as coral. Particles generally too small to see with eye.

THE PARKLANDGEO CONSULTING GROUP
EXPLANATION OF TERMS AND SYMBOLS

MODIFIED UNIFIED CLASSIFICATION SYSTEM FOR SOILS

MAJOR DIVISION			GROUP SYMBOL	GRAPH SYMBOL	TYPICAL DESCRIPTION	LABORATORY CLASSIFICATION CRITERIA	
COARSE GRAINED SOILS (MORE THAN HALF BY WEIGHT LARGER THAN NO. 200 SIEVE)	GRAVELS MORE THAN HALF COARSE GRAINS LARGER THAN NO. 4 SIEVE	CLEAN GRAVELS (LITTLE OR NO FINES)	GW		WELL GRADED GRAVELS, GRAVEL-SAND MIXTURE, LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} \geq 4$ AND $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			GP		POORLY GRADED GRAVELS, GRAVEL-SAND MIXTURES, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY GRAVELS (WITH SOME FINES)	GM		SILTY GRAVELS, GRAVEL-SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			GC		CLAYEY GRAVELS, GRAVEL-SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE AND P.I. GREATER THAN 7
	SANDS MORE THAN HALF FINE GRAINS SMALLER THAN NO. 4 SIEVE	CLEAN SANDS (LITTLE OR NO FINES)	SW		WELL GRADED SANDS, GRAVELLY SANDS WITH LITTLE OR NO FINES	$C_U = \frac{D_{60}}{D_{10}} \geq 4$ AND $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}} = 1$ to 3	
			SP		POORLY GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES	NOT MEETING ABOVE REQUIREMENTS	
		DIRTY SANDS (WITH SOME FINES)	SM		SILTY SANDS, SAND-SILT MIXTURES	CONTENT OF FINES EXCEEDS 12%	ATTERBERG LIMITS BELOW "A" LINE OR P.I. LESS THAN 4
			SC		CLAYEY SANDS, SAND-CLAY MIXTURES		ATTERBERG LIMITS ABOVE "A" LINE AND P.I. GREATER THAN 7
FINE-GRAINED SOILS (MORE THAN HALF BY WEIGHT PASSES NO. 200 SIEVE)	SILTS BELOW "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L < 50%	ML		INORGANIC SILTS & VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY	CLASSIFICATION IS BASED UPON PLASTICITY CHART (SEE BELOW)	
		W_L > 50%	MH		INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS, FINE SANDY OR SILTY SOILS		
	CLAYS ABOVE "A" LINE NEGLIGIBLE ORGANIC CONTENT	W_L < 30%	CL		INORGANIC CLAYS OF LOW PLASTICITY, GRAVELLY, SANDY, OR SILTY SOILS		
		30% < W_L < 50%	CI		INORGANIC CLAYS OF MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS		
		W_L > 50%	CH		INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS		
	ORGANIC SILTS & CLAYS BELOW "A" LINE	W_L < 50%	OL		ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW AND MEDIUM PLASTICITY		
		W_L > 50%	OH		ORGANIC CLAYS OF HIGH PLASTICITY, ORGANIC SILTS		
HIGHLY ORGANIC SOILS			Pt		PEAT AND OTHER HIGHLY ORGANIC SOILS	STRONG COLOR OR ODOR, AND OFTEN FIBROUS TEXTURE	



NOTES ON SOIL CLASSIFICATION AND DESCRIPTION:

1. Soil are classified and described according to their engineering properties and behaviour.
2. Boundary classification for soil with characteristics of two groups are given combined group symbols (e.g. GW-GC is a well graded gravel sand mixture with clay binder between 5 and 12%).
3. Soil classification is in accordance with the Unified Soil Classification System (ASTM D2487) with the exception that an inorganic clay of medium plasticity (CI) is recognized.
4. The use of modifying adjectives may be employed to define the estimated percentage range of minor components.

APPENDIX D

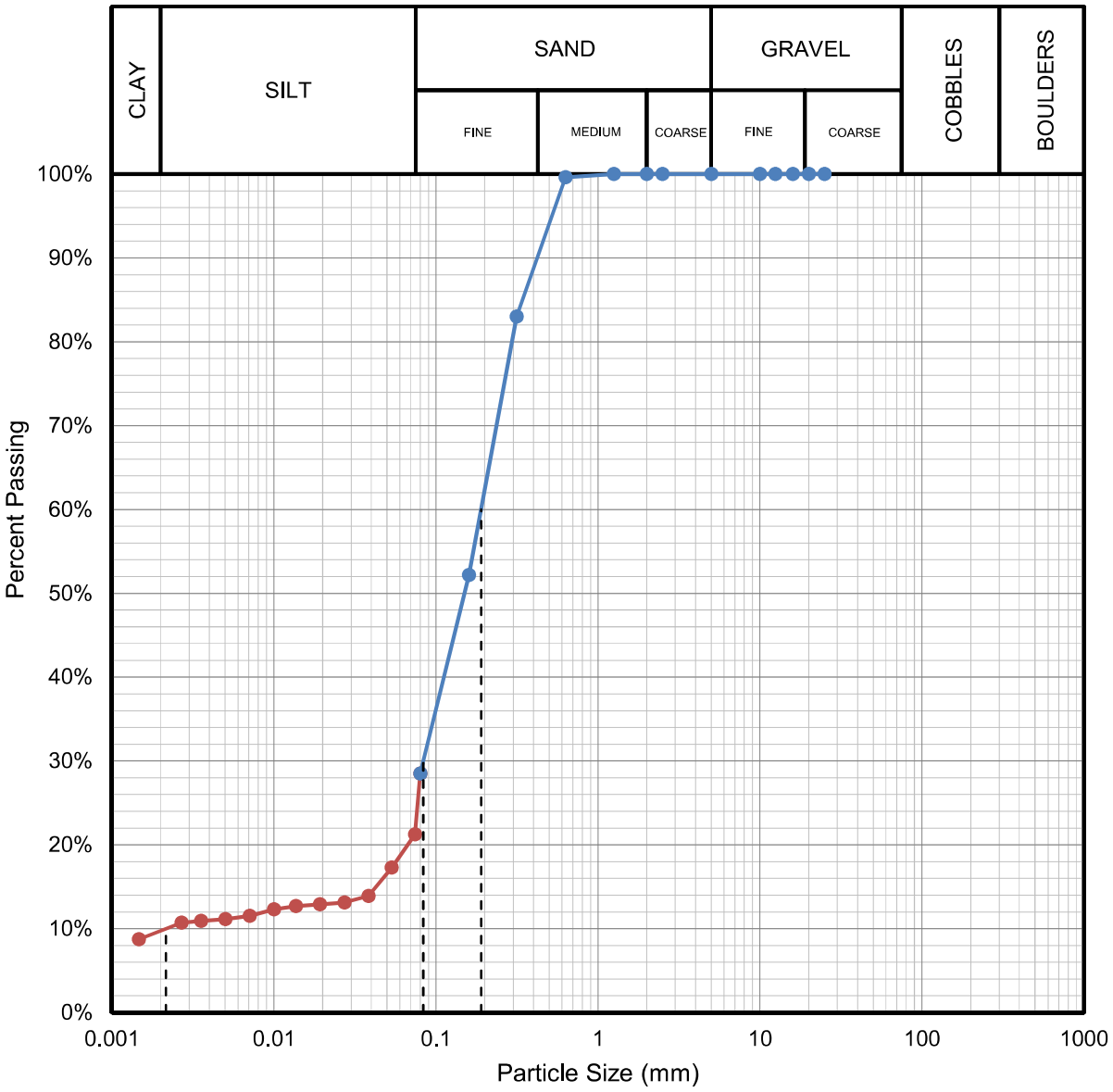
ANALYTICAL RESULTS

PARTICLE-SIZE ANALYSIS

ASTM D422

PROJECT: Sandy Beach Lagoon Release
PROJECT#: ED2091
CLIENT: Morrison Hershfield Ltd.
SOIL DESCRIPTION: sand, little silt, trace clay

SAMPLE DATE: November 30, 2018
TEST DATE: December 18, 2018
SAMPLE ID: 18-01
DEPTH: 1.0 m



SUMMARY OF RESULTS		
	Gravel	0.0%
	Sand	77.6%
	Silt	12.6%
	Clay	9.8%

GRAIN SIZE		
	D_{10}	0.0022 mm
	D_{30}	0.0836 mm
	D_{60}	0.1902 mm

COEFFICIENTS		
	Coefficient of Uniformity, C_U	88.2
	Coefficient of Curvature, C_C	17.0

TECH: OH
CHECKED: KC

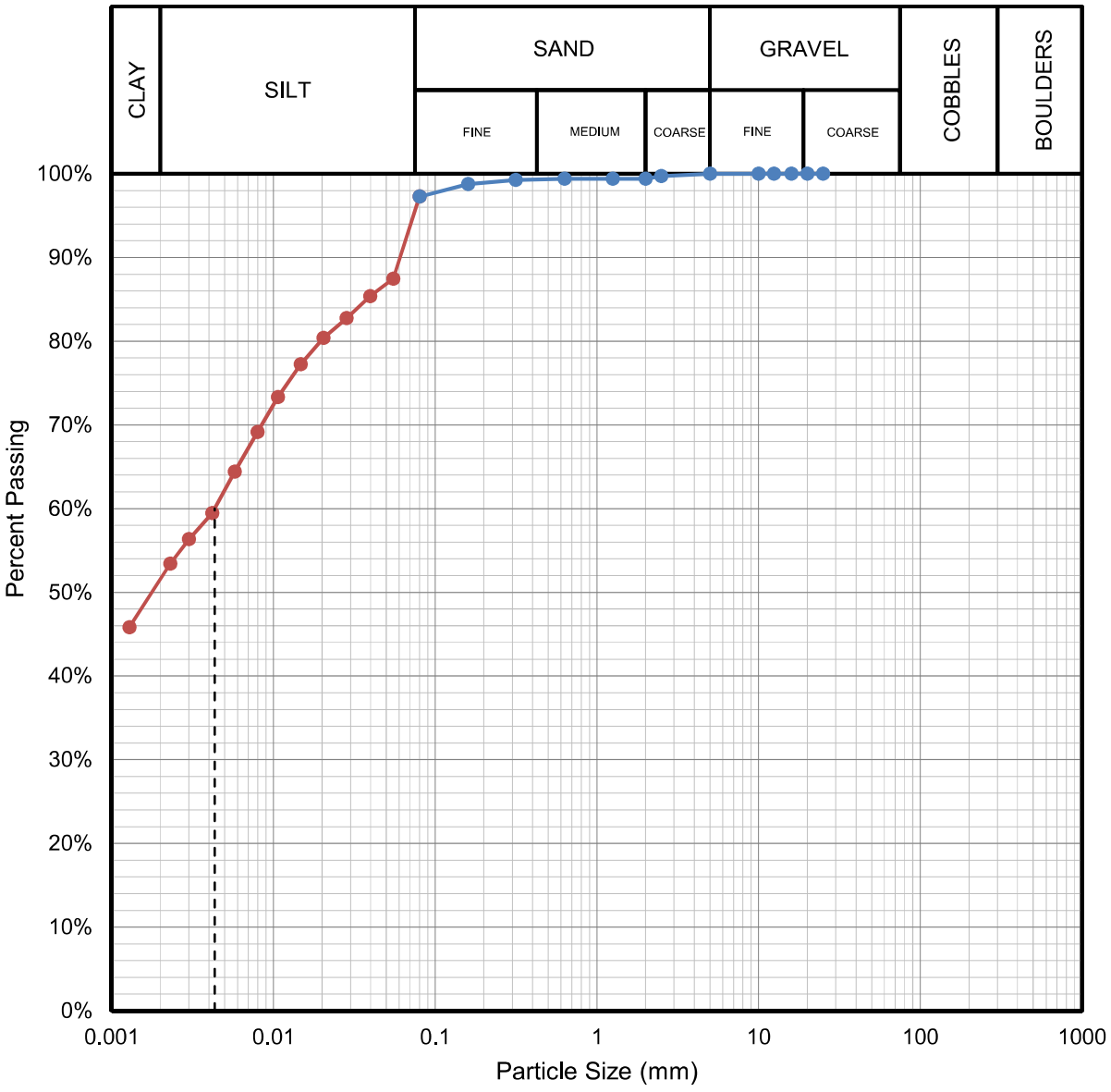
V14.5 U20170131
P:\Projects 2050-2099\ED2091 MH Sandy Beach Lagoon Release Sampling ENV\Laboratory\ED2091 Hydro 18-01 @ 2.0 m

PARTICLE-SIZE ANALYSIS

ASTM D422

PROJECT: Sandy Beach Lagoon Release
PROJECT#: ED2091
CLIENT: Morrison Hershfield Ltd.
SOIL DESCRIPTION: clay, and silt, trace sand

SAMPLE DATE: December 5, 2018
TEST DATE: December 18, 2018
SAMPLE ID: 18-06
DEPTH: 2.0 m



SUMMARY OF RESULTS		
	Gravel	0.0%
	Sand	4.4%
	Silt	44.0%
	Clay	51.6%

GRAIN SIZE		
	D_{10}	---
	D_{30}	---
	D_{60}	0.0043 mm

COEFFICIENTS		
	Coefficient of Uniformity, C_U	---
	Coefficient of Curvature, C_C	---

TECH: OH
CHECKED: KC

V14.5 U20170131
P:\Projects 2050-2099\ED2091 MH Sandy Beach Lagoon Release Sampling ENV\Laboratory\ED2091 Hydro 18-06 @ 2.0 m

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CLIENT NAME: **PARKLAND GEO**
189 PEMBINA ROAD
SHERWOOD PARK, AB T8H2W8
(780) 416-1755

ATTENTION TO: **Daniel Yost**

PROJECT: **ED2091**

AGAT WORK ORDER: **18E418228**

SOIL ANALYSIS REVIEWED BY: **Melinda Guay, Technical Reviewer**

DATE REPORTED: **Dec 17, 2018**

PAGES (INCLUDING COVER): **9**

VERSION*: **1**

Should you require any information regarding this analysis please contact your client services representative at (780) 395-2525

*NOTES

All samples will be disposed of within 30 days following analysis. Please contact the lab if you require additional sample storage time.

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Certificate of Analysis

AGAT WORK ORDER: 18E418228

PROJECT: ED2091

CLIENT NAME: PARKLAND GEO

ATTENTION TO: Daniel Yost

SAMPLING SITE:

SAMPLED BY:

Soil Analysis - Salinity (AB Tier 1 - pH Calcium Chloride)

DATE RECEIVED: 2018-12-06

DATE REPORTED: 2018-12-17

SAMPLE DESCRIPTION:				18-01 0-15cm	18-01 15-30cm	18-02 0-15cm	18-02 15-30cm	18-03 0-15cm	18-03 15-30cm	18-04 0-15cm	18-04 15-30cm
SAMPLE TYPE:				Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
DATE SAMPLED:				2018-11-30	2018-11-30	2018-11-30	2018-11-30	2018-11-30	2018-11-30	2018-11-30	2018-11-30
Parameter	Unit	G / S	RDL	9767988	9767994	9767995	9767996	9767997	9767998	9767999	9768000
pH (CaCl2 Extraction)	pH Units		N/A	6.19	6.36	5.64	4.54	6.85	7.10	6.58	6.92
Electrical Conductivity (Sat. Paste)	dS/m		0.05	0.68	0.53	0.42	0.21	0.48	0.57	0.53	0.38
Sodium Adsorption Ratio	N/A		0.34	7.60	6.43	<0.34	1.34	2.26	4.49	2.73	4.16
Saturation Percentage	%		1	86	46	141	46	171	48	171	66
Chloride, Soluble	mg/L		5	25	17	17	14	19	20	22	9
Calcium, Soluble	mg/L		1	27	25	60	18	46	33	44	18
Potassium, Soluble	mg/L		2	17	6	32	4	15	4	12	<2
Magnesium, Soluble	mg/L		1	5	3	18	5	9	7	9	4
Sodium, Soluble	mg/L		2	164	128	3	25	64	109	76	75
Sulfate, Soluble	mg/L		2	65	50	55	35	43	56	42	40
Theoretical Gypsum Requirement	tonnes/ha		0.01	0.05	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium, Soluble (meq/L)	meq/L		0.05	1.35	1.25	2.99	0.90	2.30	1.65	2.20	0.90
Calcium, Soluble (mg/kg)	mg/kg		1	23	12	85	8	79	16	75	12
Chloride, Soluble (meq/L)	meq/L		0.06	0.71	0.48	0.48	0.39	0.54	0.56	0.62	0.25
Chloride, Soluble (mg/kg)	mg/kg		2	22	8	24	6	32	10	38	6
Magnesium, Soluble (meq/L)	meq/L		0.08	0.41	0.25	1.48	0.41	0.74	0.58	0.74	0.33
Magnesium, Soluble (mg/kg)	mg/kg		1	4	1	25	2	15	3	15	3
Potassium, Soluble (meq/L)	meq/L		0.05	0.43	0.15	0.82	0.10	0.38	0.10	0.31	<0.05
Potassium, Soluble (mg/kg)	mg/kg		2	15	3	45	<2	26	<2	21	<2
Sodium, Soluble (meq/L)	meq/L		0.09	7.13	5.57	0.13	1.09	2.78	4.74	3.31	3.26
Sodium, Soluble (mg/kg)	mg/kg		2	141	59	4	12	109	52	130	50
Sulfur (as Sulfate), Soluble (meq/L)	meq/L		0.04	1.35	1.04	1.15	0.73	0.90	1.17	0.87	0.83
Sulfur (as Sulfate), Soluble (mg/kg)	mg/kg		2	56	23	78	16	74	27	72	26

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Certificate of Analysis

AGAT WORK ORDER: 18E418228

PROJECT: ED2091

CLIENT NAME: PARKLAND GEO

ATTENTION TO: Daniel Yost

SAMPLING SITE:

SAMPLED BY:

Soil Analysis - Salinity (AB Tier 1 - pH Calcium Chloride)

DATE RECEIVED: 2018-12-06

DATE REPORTED: 2018-12-17

		SAMPLE DESCRIPTION:		18-05 0-15cm	18-05 15-30cm	18-06 0-15cm	18-06 15-30cm	18-07 0-15cm	18-07 15-30cm	18-08 0-15cm	18-08 15-30cm
		SAMPLE TYPE:		Soil	Soil	Soil	Soil	Soil	Soil	Soil	Soil
		DATE SAMPLED:		2018-11-30	2018-12-05	2018-12-05	2018-12-05	2018-12-05	2018-12-05	2018-12-05	2018-12-05
Parameter	Unit	G / S	RDL	9768004	9768008	9768009	9768010	9768011	9768012	9768013	9768015
pH (CaCl2 Extraction)	pH Units		N/A	5.55	6.08	4.93	5.95	4.64	4.81	5.98	5.78
Electrical Conductivity (Sat. Paste)	dS/m		0.05	0.34	0.26	0.52	0.66	0.38	0.26	0.49	0.18
Sodium Adsorption Ratio	N/A		0.34	1.36	2.40	4.55	5.20	1.50	1.43	<0.34	0.61
Saturation Percentage	%		1	119	48	103	91	588	727	81	40
Chloride, Soluble	mg/L		5	15	8	14	8	8	6	12	6
Calcium, Soluble	mg/L		1	37	20	29	35	37	25	93	28
Potassium, Soluble	mg/L		2	3	<2	<2	<2	3	<2	17	3
Magnesium, Soluble	mg/L		1	8	4	5	7	7	5	20	7
Sodium, Soluble	mg/L		2	35	45	101	129	38	30	12	14
Sulfate, Soluble	mg/L		2	73	42	134	136	135	91	70	29
Theoretical Gypsum Requirement	tonnes/ha		0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium, Soluble (meq/L)	meq/L		0.05	1.85	1.00	1.45	1.75	1.85	1.25	4.64	1.40
Calcium, Soluble (mg/kg)	mg/kg		1	44	10	30	32	218	182	75	11
Chloride, Soluble (meq/L)	meq/L		0.06	0.42	0.23	0.39	0.23	0.23	0.17	0.34	0.17
Chloride, Soluble (mg/kg)	mg/kg		2	18	4	14	7	47	44	10	2
Magnesium, Soluble (meq/L)	meq/L		0.08	0.66	0.33	0.41	0.58	0.58	0.41	1.65	0.58
Magnesium, Soluble (mg/kg)	mg/kg		1	10	2	5	6	41	36	16	3
Potassium, Soluble (meq/L)	meq/L		0.05	0.08	<0.05	<0.05	<0.05	0.08	<0.05	0.43	0.08
Potassium, Soluble (mg/kg)	mg/kg		2	4	<2	<2	<2	18	<2	14	<2
Sodium, Soluble (meq/L)	meq/L		0.09	1.52	1.96	4.39	5.61	1.65	1.30	0.52	0.61
Sodium, Soluble (mg/kg)	mg/kg		2	42	22	104	117	223	218	10	6
Sulfur (as Sulfate), Soluble (meq/L)	meq/L		0.04	1.52	0.87	2.79	2.83	2.81	1.89	1.46	0.60
Sulfur (as Sulfate), Soluble (mg/kg)	mg/kg		2	87	20	138	124	794	662	57	12

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Certificate of Analysis

AGAT WORK ORDER: 18E418228

PROJECT: ED2091

CLIENT NAME: PARKLAND GEO

ATTENTION TO: Daniel Yost

SAMPLING SITE:

SAMPLED BY:

Soil Analysis - Salinity (AB Tier 1 - pH Calcium Chloride)

DATE RECEIVED: 2018-12-06

DATE REPORTED: 2018-12-17

SAMPLE DESCRIPTION:				18-09 0-15cm	18-09 15-30cm	18-10 0-15cm	18-10 15-30cm
SAMPLE TYPE:				Soil	Soil	Soil	Soil
DATE SAMPLED:				2018-12-05	2018-12-05	2018-11-30	2018-11-30
Parameter	Unit	G / S	RDL	9768016	9768017	9768018	9768020
pH (CaCl2 Extraction)	pH Units		N/A	7.16	6.82	6.01	6.32
Electrical Conductivity (Sat. Paste)	dS/m		0.05	0.46	0.50	0.48	0.20
Sodium Adsorption Ratio	N/A		0.34	1.13	1.89	0.61	1.15
Saturation Percentage	%		1	110	76	114	54
Chloride, Soluble	mg/L		5	5	8	10	6
Calcium, Soluble	mg/L		1	60	47	69	22
Potassium, Soluble	mg/L		2	<2	<2	8	<2
Magnesium, Soluble	mg/L		1	8	9	17	5
Sodium, Soluble	mg/L		2	35	54	22	23
Sulfate, Soluble	mg/L		2	77	79	57	22
Theoretical Gypsum Requirement	tonnes/ha		0.01	<0.01	<0.01	<0.01	<0.01
Calcium, Soluble (meq/L)	meq/L		0.05	2.99	2.35	3.44	1.10
Calcium, Soluble (mg/kg)	mg/kg		1	66	36	79	12
Chloride, Soluble (meq/L)	meq/L		0.06	0.14	0.23	0.28	0.17
Chloride, Soluble (mg/kg)	mg/kg		2	6	6	11	3
Magnesium, Soluble (meq/L)	meq/L		0.08	0.66	0.74	1.40	0.41
Magnesium, Soluble (mg/kg)	mg/kg		1	9	7	19	3
Potassium, Soluble (meq/L)	meq/L		0.05	<0.05	<0.05	0.20	<0.05
Potassium, Soluble (mg/kg)	mg/kg		2	<2	<2	9	<2
Sodium, Soluble (meq/L)	meq/L		0.09	1.52	2.35	0.96	1.00
Sodium, Soluble (mg/kg)	mg/kg		2	39	41	25	12
Sulfur (as Sulfate), Soluble (meq/L)	meq/L		0.04	1.60	1.64	1.19	0.46
Sulfur (as Sulfate), Soluble (mg/kg)	mg/kg		2	85	60	65	12

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

9767988-9768020 If sodium results in mg/L are less than detection, SAR is non-calculable and is reported as 0.
Sodium Adsorption Ratio is a calculated parameter. The calculated value is the ratio of the sodium concentration in mmol/L over the square rooted sum of the calcium and magnesium concentrations in mmol/L.
Theoretical Gypsum Requirement is a calculated parameter. The calculation is from “A Comparison of Methods for Gypsum Requirement of Brine-Contaminated Soils”, Canadian Journal of Soil Science, 1998.

Analysis performed at AGAT Edmonton (unless marked by *)

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Quality Assurance

CLIENT NAME: PARKLAND GEO

AGAT WORK ORDER: 18E418228

PROJECT: ED2091

ATTENTION TO: Daniel Yost

SAMPLING SITE:

SAMPLED BY:

Soil Analysis

RPT Date: Dec 17, 2018			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Soil Analysis - Salinity (AB Tier 1 - pH Calcium Chloride)															
pH (CaCl2 Extraction)	347	9767994	6.36	6.35	0.2%	N/A	100%	90%	110%						
Electrical Conductivity (Sat. Paste)	347	9767994	0.53	0.49	8.0%	< 0.05	97%	90%	110%						
Saturation Percentage	347	9767994	46	48	4.3%	< 1	100%	80%	120%						
Chloride, Soluble	2408	9767944	17	21	NA	< 5	98%	80%	120%				111%	80%	120%
Calcium, Soluble	348	9767994	25	25	0.0%	< 1	103%	80%	120%				118%	80%	120%
Potassium, Soluble	348	9767994	6	6	NA	< 2	101%	80%	120%				116%	80%	120%
Magnesium, Soluble	348	9767994	3	3	NA	< 1	106%	80%	120%				119%	80%	120%
Sodium, Soluble	348	9767994	128	123	4.0%	< 2	105%	80%	120%				94%	80%	120%
Sulfate, Soluble	348	9767994	50	47	6.2%	< 2	95%	80%	120%				119%	80%	120%

Comments: If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated
If Matrix spike value is NA, the spiked analyte concentration was lower than that of the matrix contribution.

Certified By:

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Method Summary

CLIENT NAME: PARKLAND GEO

AGAT WORK ORDER: 18E418228

PROJECT: ED2091

ATTENTION TO: Daniel Yost

SAMPLING SITE:

SAMPLED BY:

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Soil Analysis			
pH (CaCl2 Extraction)	INOR-171-6207	SHEPPARD 2007; HENDERSHOT 2008	PH METER
Electrical Conductivity (Sat. Paste)	INOR-171-6208	SHEPPARD 2007; MILLER 2007	CONDUCTIVITY METER
Sodium Adsorption Ratio	INOR-171-6201 & INOR-171-6002	McKeague 3.26	CALCULATION
Saturation Percentage	INOR-171-6002	MILLER 2007; SHEPPARD 2007	GRAVIMETRIC
Chloride, Soluble	INOR-171-6212	CARTER & GREGORICH 2007, SM 3120B	COLORIMETER
Calcium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Potassium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Magnesium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Sodium, Soluble	INOR-171-6201	CARTER & GREGORICH 2007, SM 3120B	ICP/OES
Sulfate, Soluble	INOR-171-6201 & INOR-171-6002	SHEPPARD 2007; EATON 2005; MILLER 2007, SM 3120B	ICP/OES
Theoretical Gypsum Requirement	INOR-171-6201 & INOR-171-6002	USDA HDBK 60, 22D	CALCULATION