R.M. OF GIMLI
REPORT NUMBER: 181-03988-01

ADDENDUM TO NOTICE OF ALTERATION FOR EAL 2473 R

R.M. OF GIMLI - BIOSOLIDS LAND APPLICATION

JUNE 19, 2020

ADDENDUM TO NOTICE OF ALTERATION FOR EAL 2473 R

BIOSOLIDS LAND APPLICATION

R.M. OF GIMLI

FINAL

PROJECT NO.: 181-09388-01
DATE: JUNE 10, 2020

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June 19, 2020

Manitoba Conservation and Climate
Environmental Stewardship Division
Environmental Approvals Branch
1007 Century Street
Winnipeg, Manitoba R3H 0W4

Attention: Director

Subject: Provision of Addendum to Notice of Alteration to the R.M. of Gimli's EAL No. 2473 R in Support of Biosolids Land Application

WSP Canada Inc., on behalf of the Rural Municipality (R.M.) of Gimli, is providing this report as supplemental information in support of the R.M.'s biosolids land application program as requested in a Notice of Alteration approval letter provided by the Manitoba Conservation and Climate, Environmental Approval Branch (File No. 4522.10, dated December 16, 2019) for the R.M.'s existing Environment Act Licence (Licence) No. 2473 R.

If you have any questions or concerns about this submission, please contact the undersigned at your convenience.

Yours sincerely,

[redacted]
Darren Keam, M.Sc., P.Ag.
Team Lead, Environmental Management

DLS/dk
Encl.
cc:
WSP ref.: 181-03988-01

REVISION HISTORY

FIRST ISSUE

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Prepared by	Reviewed by	Approved By		
Danette Sahulka, Senior Ecologist	Darren Keam, Team Lead	Darren Keam, Team Lead		
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Prepared by	Reviewed by	Approved By		
Danette Sahulka, Senior Ecologist	Darren Keam, Team Lead	Darren Keam, Team Lead		
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June 19, 2020	FINAL REPORT			
Prepared by	Reviewed by	Approved By		
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June 19, 2020
Date

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June 19, 2020
Date

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1 INTRODUCTION

This report provides updated information pertaining to the Rural Municipality (R.M.) of Gimli's biosolids land application program as requested in a Notice of Alteration approval letter provided by the Manitoba Conservation and Climate, Environmental Approvals Branch (**File No. 4522.10, dated December 16, 2019**) for the R.M.'s existing Environment Act Licence (Licence) No. 2473 R.

1.1 CONTACT INFORMATION

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1.2 BACKGROUND

Previously, biosolids land application from the R.M. of Gimli's established wastewater storage cells was occurring on a periodic/sporadic basis under the R.M.'s existing License[2] (the R.M.'s waste treatment plant operates under a separate EAL No. 2587). The R.M. has recently commissioned the construction of a two-cell biosolids storage pond (with future expansion to a third cell) within the Arnes Waste Disposal Ground (WDG) site (located at SW-10-21-3EPM). The storage pond will be utilized to store biosolids produced by the R.M.'s wastewater treatment plant until the materials can be land applied (approximately every 2-3 years for land application). It is anticipated that the existing storage cells will be decommissioned once the new storage pond is constructed at the Arnes WDG; to facilitate the decommissioning, land application of biosolids material will be required from the existing storage cells in the fall of 2020 (refer to Gimli Lagoon Decommissioning Plan, WSP, June 2020).

[2] Environment Act Licence No. 2473 R

In support of construction of the new storage pond, a recent request was made to the Manitoba Conservation and Climate (MCC), Environmental Approvals Branch (EAB) by WSP Canada Inc. (WSP), on behalf the R.M. of Gimli, for a Notice of Alteration (NOA) to the R.M.'s current Licence. Conditional approval of the NOA was provided by the EAB on December 16, 2019 contingent upon the R.M. providing updated information regarding the process going forward for the land application of biosolids from the existing storage cells and future biosolids storage pond.

As such, WSP has completed the following actions to support final approval of the NOA from the EAB:

- Review and summary of existing environmental conditions for the area of land application.
- In-field soil test pit program (four test pits advanced to 150 centimeters [cm]) completed in November 2019 to assess horizonation, soil texture and to collect soil samples for soil nutrients, metals and pH, Sodium Absorption Ratio, electrical conductivity and particle size analysis for those lands listed in the Licence to determine suitability for biosolids land application.
- A review of soil nutrient and heavy metals analysis collected from the test pit program to determine nutrient and metal loading rate potential.
- Review of biosolids quality data previously collected by the R.M. of Gimli and collection of current biosolids samples from existing biosolids to determine quality and potential prescription rates for land application.
- Review of current environmental legislation/regulations and current biosolids land application licensing requirements in relation to the R.M.'s Licence to mitigate deficiencies and improve the R.M.'s biosolids land application program.
- Provision of this report as an addendum to the aforementioned NOA; this report provides supporting information for the biosolids lands application component of the NOA as requested by the EAB.

1.3 LOCATION OF BIOSOLIDS LAND APPLICATION PROGRAM

As per the existing EAL No. 2473 R, the application of biosolids from the existing and future storage ponds will occur onto lands that are owned by the R.M. of Gimli (Status of Title, Appendix B) and located within Sections 12-19-3EPM, 13-19-3EPM, and 7-19-4EPM of the R.M. of Gimli (herein referred to as the "project area") (Table 1.1, and Map 1, Appendix A). The identified sections of land are divided between two Status of Title Certificates (and municipal Roll entries) as identified on survey plan 23108 and 31970.

The Gimli airport runway property (Status of Title 2145706/1, Roll No. 188402) cover approximately 185 hectares (457 acres) of the four sections of land and is excluded from this assessment. The remainder of the project area (Status of Title 1225753, Roll No. 188403), 290 hectares (718 acres) consists of planted grasses that are maintained by the R.M. as well as areas utilized for agricultural crop production. Historically, biosolids have been applied to the agricultural land adjacent to the Gimli Airport on 7-19-4EPM.

Table 1-1 Available Land Descriptions and Title Certificate

Title Number	Plan of Survey	Legal Land Description	Municipal Roll No.
1225753/1	23108 and 31970	All that portion of Parcel B Plan 23108 WLTO taken for water control works plan 27555WLTO in E1/2 of 12 and 13-19-3EPM and W1/2 of 7 and 18-19-4 EPM and in Government Road Allowance (Closed).	188403

Note: Status of Title and Plan of Survey are included in Appendix B.

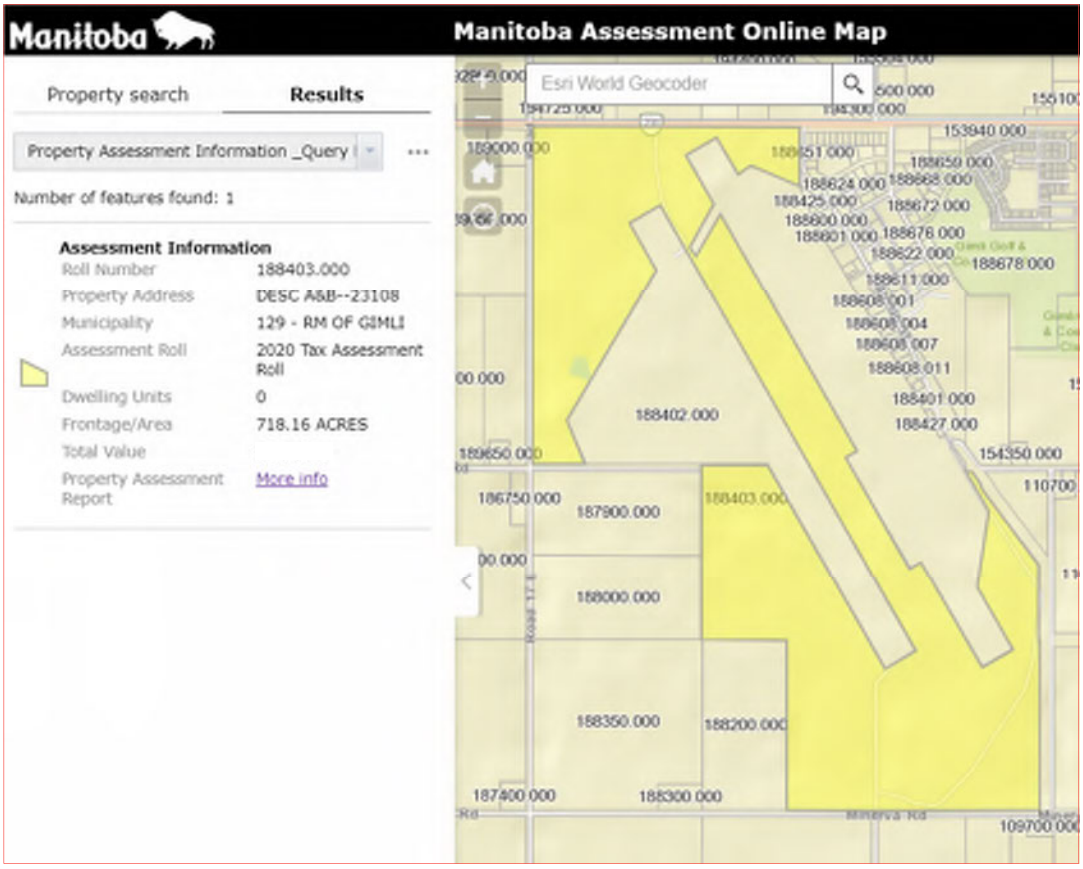


Figure 1-1 Status of Title Parcel 1225753/1, Municipal Roll No. 188403

2 EXISTING BIOPHYSICAL ENVIRONMENT

2.1 LAND USE

Land use adjacent to the project area consists primarily of agricultural crop production (annual and forage crops). The western edge of the Town of Gimli lies within 2 km of the project area and Lake Winnipeg lies further east of the Town, within 3.5 km of the project area. In addition, several tourist/ recreational areas are located along Lake Winnipeg, within 5 km of the project area including the Town of Gimli Beach, Kings Park, Loni Beach and Pelican Beach (refer to Map 1, Appendix A).

2.2 CLIMATE

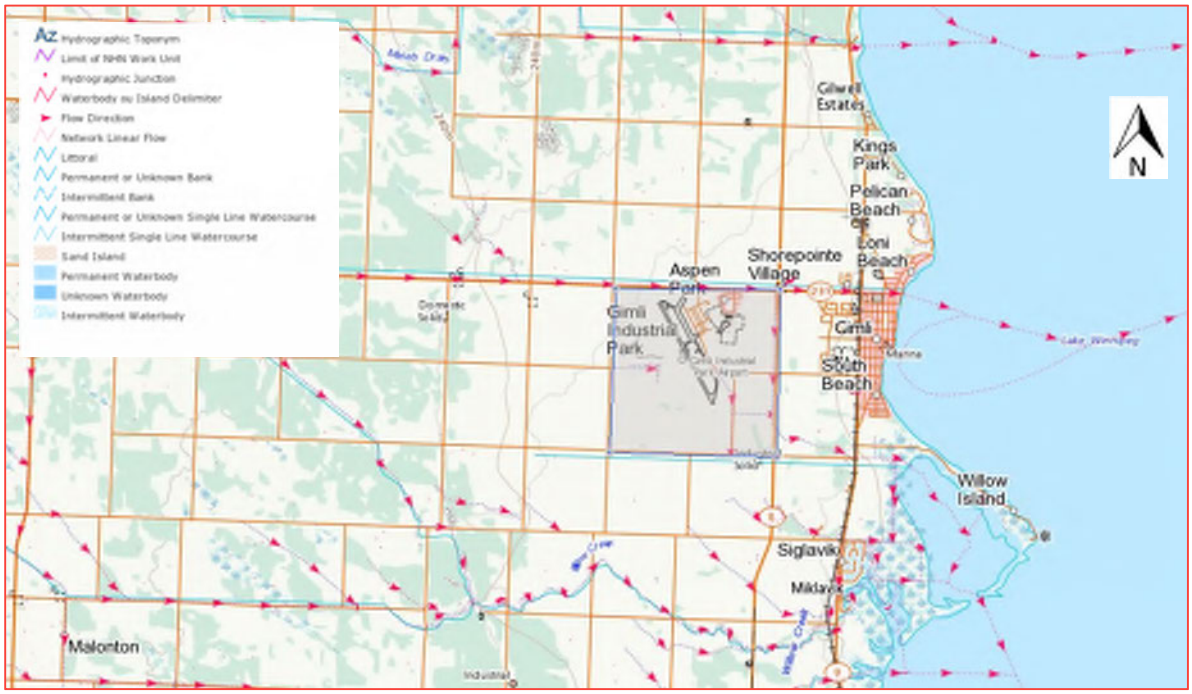
The project area is located within the Gimli Ecodistrict of the Interlake Plain Ecoregion which is covered by the broader Boreal Plains Ecozone (Smith, Veldhuis, Mils, Eilers, Fraser and Lelyk 1998).

The Gimli Ecodistrict lies in a more humid and cooler subdivision of the Subhumid Low Boreal Ecoclimatic Region. The ecodistrict is characterized by short, warm summers and cold winters with a mean average temperature of 1.4ºC (Smith, et al. 1998). The average crop-growing season is 176 days with approximately 1,540 growing degree-days. Mean annual precipitation is 520 millimeters (mm), one quarter of which is in the form of snowfall. The Gimli Ecodistrict has a moderately cold, humid, Cryoboreal to subhumid, cool, Boreal soil climate (Smith, et al. 1998).

2.3 PHYSIOGRAPHY AND DRAINAGE

The project area is situated at an elevation of approximately 244 metres above sea level, along the southwestern shore of the south basin of Lake Winnipeg. The physiography of the area ranges from level to depressional glaciolacustrine lowland to gently undulating, terraced plain with water-worked glacial till, shallow glaciolacustrine deposits and glaciofluvial materials. Along the western side of Lake Winnipeg, the land slopes gently at an elevation change of approximately 0.5 metres (m) per km eastward toward the lake (Smith, et al. 1998).

The R.M. of Gimli lies within the Icelandic/Willow Creek Watershed and is part of the Winnipeg South Drainage diversion of the larger Nelson River drainage system. The nearest surface water body to the project area is Lake Winnipeg, located within 6 km of the project area to the east. According to the Natural Resources Canada, *The Atlas of Canada – Toporama* online mapping tool, regional drainage is eastward towards Lake Winnipeg (refer to Figure 1).



(Image taken from Natural Resources Canada, The Atlas of Canada – Toporama, February 13, 2020. Available online at: https://atlas.gc.ca/toporama/en/index.html).

Figure 2-1 Regional Surface Water Flow Direction for the Gimli Area

2.4 SOILS

Soils in the ecodistrict consist of poorly drained Peaty Gleysols and shallow organic soils within lowland areas while lake terrace areas are dominated by well to imperfectly drained, Dark Gray Chernozems while Gray Luvisols have formed under forest vegetation (Smith, et al. 1998). The soil reconnaissance survey completed for the project area indicated that the area is dominated by soils from the Balmoral Series that consist of Rego Humic Gleysols that have developed on strongly calcareous, moderately fine textured sediments influenced by poor natural drainage. Surface soil texture has been described as ranging from loam to silty clay loam (Manitoba Agriculture, Food and Rural Initiatives 2010).

As no detailed soil survey reports exist for the area to determine soil suitability for biosolids land application, a soil test pit program was undertaken to better assess soils characteristics within the project area. Refer to Section 3.1 for further information.

2.5 SURFICIAL AND BEDROCK GEOLOGY

Till surficial deposits are found within the project area that are comprised of off-shore glaciolacustrine sediments consisting of clay, silt and minor sand deposits that range from 1 to 20 m in thickness, deposited from suspension in offshore, deep water of glacial Lake Agassiz that have been commonly worn and homogenized by icebergs (Matile and Keller, 2004). Surface sand and gravel deposits in the region occur mainly as long narrow beach ridges overtop the till materials. Thickness of surficial deposits rand from zero to 50 metres in the region (Rutulis 1981).

These surficial deposits are underlain by carbonate rock (limestone and dolostone) bedrock of the Selkirk Member, of the Red River Formation of the Ordovician period within the Paleozoic era (Betcher, Grove and Pupp 1995). The carbonate bedrock in the region contains fractures that make it permeable and therefore capable of conveying and storing water. Below the carbonate rock layer lies an interbedded shale and sandstone formation under which lies granite and other hard rocks, (Rutulis 1981). Depth to bedrock within the R.M. of Gimli ranges between 20 to 40 metres below ground level (Rutulis 1981).

2.6 GROUNDWATER AND HYDROLOGICAL DESCRIPTION

Groundwater bearing formations or aquifers at the project area are formed by extensive carbonate rock beds with minor shale beds. This aquifer is almost continuous throughout the area. The depth to the aquifer ranges from less than 36 m to 49 m below grade. The potential yield around this area is approximately in the range of 1 to 100 litres per second. The water quality for the upper part of carbonate aquifer is of good quality (Rutulis and Mamott 1987).

A review of the Manitoba GWDrill (2018) groundwater well logs for the Project Area. Within the three sections of land there were a total of 24 test wells, domestic use wells, production wells and geothermal wells. In general, the description of the stratigraphy is: Brown till (0-8ft) over, Grey Clay (8-29ft over, Grey Till (29 – 132 ft) over, Brown Limestone (132 – 240ft). This general description was based on eight test wells completed for the RM in 2017. The groundwater well search results are included in Appendix C.

The key consideration of these well bore logs is that there is sufficient clay or clay till recorded to depth in this Project Area.

2.7 TERRESTRIAL ENVIRONMENT

The native vegetation of the Gimli Ecodistrict is dominated by stands of trembling aspen; white spruce is also found interspersed with trembling aspen in more northern areas of the ecodistrict. Along river channels Manitoba maple, American elm, green ash and cottonwood tree species dominate. Wet depressional areas host willows, sedges and meadow grasses, while wetter marsh areas are characterized by cattail, reed and sedge species (Smith, et al. 1998).

Vegetation cover associated with the project area consists primarily of planted grasses and forage crops that are mowed/harvested several times during the growing season. The areas immediately surrounding the project area consists primarily of agricultural land used for the production of annual and forage crops.

Although habitat for wildlife species within the project area is limited due to the primarily agricultural nature of the surrounding area and location of much of the project area adjacent to the Gimli airport, habitat for wildlife species is fairly extensive within the region; examples of species that may be found include white-tailed deer, moose, black bear, beave, snowshoe hare, coyote and various waterfowl species.

2.8 SURFACE WATER BODIES AND AQUATIC LIFE

A review of the National Hydrology Network GeoBase Series open maps data viewer (Government of Canada - no date [n.d.]) and the Lower Interlake Area Designation of Drains plan (Government of Manitoba n.d.) indicates the presence of several constructed drains in the area including: a third order drain[3] to the north of the project area along Road 231 that drains to the east to Lake Winnipeg and to the south through a drain along Provincial Trunk Highway (PTH) #8 to a drainage channel that leads to Lake Winnipeg; a second order[3] drain that has its start at the southeast end of the Gimli Industrial Park/airport area near Anson Street and Gimli Park Road that connects to the drainage channel along PTH and also to the second order drain along Minerva Road (Road 109 N) to the south of the project area (refer to Figure1).

The constructed drain/unnamed tributary along Road 231 was assessed in 2013 by Milani for habitat complexity and fish species; Milani described this unnamed tributary as a Class B habitat, having a simple stream complexity with some cobble and lots of submerged vegetation. During the assessment, Milani (2013) also reported the presence of central mudminnow and northern pike fish species being present within this tributary indicating that this drain/tributary provides fish habitat for at least one game fish species (northern pike). There are no other waterbodies or wetlands within the project study area nor in the surrounding area.

Aquatic life is restricted to the unnamed drains in the area and Lake Winnipeg. Examples of species that may occur in these areas include frogs, dragonflies and turtles as well as various waterfowl and shorebird species. A review of the Fisheries and Oceans Canada, aquatic species at risk open viewer map (2019) indicated that the bigmouth buffalo (*Ictiobus cyprinellus),* a fish species listed as "Special Concern" under the *Species at Risk Act* has the potential to occur in the waters of Lake Winnipeg in the Gimli area (3.5 km east of the project area).

2.9 POTENTIAL TERRESTRIAL SPECIES OF CONSERVATION CONCERN

As the land use associated with the project area includes industrial use associated with the Gimli airport and agriculturally cultivated area, species of conservation concern are not anticipated to be present on these lands.

[3] Drains are classified in terms of 'order' and range in size from 1st to 7th order – the higher the number being the largest size of drain. Examples of 1st and 2rd order drains include small swales, depressions or manmade ditches in which water runs only in spring or after heavy rains; this may include ditches along municipal roads. Third order to 7th order streams are larger in size, many have been manmade including municipal and highway road drains, and have significant measurable flows of surface water runoff during spring and after heavy rains. Fifth order and higher streams typically have year-round flows, and are large, 'natural' waterways such as the Assiniboine, Souris and Red River (Geoff Reimer, Manitoba Water Stewardship, n.d.).

3 REGULATORY REQUIREMENTS

Since the initial License was granted in 2003/2003R, several new regulatory requirements and beneficial management practices have come to fruition. As such, in support of the biosolids land application component of the NOA, the following sections provide applicable information and pertinent strategies that the R.M. of Gimli is committed to in order to ensure a sustainable land application program.

At that time of the License was granted, *The Environment Act* and *Livestock Manure and Mortalities Management Regulations* were the prominent Acts governing the land application of biosolids materials. In 2005 *The Water Protection Act* and in 2008 the *Nutrient Management Regulation* under *The Water Act* were enacted that provide additional requirements for land application of manure and biosolids to afford protection of Manitoba's water resources. As such, the R.M. of Gimli will adhere to the following Acts and Regulations as they apply to biosolids land application program:

- *The Environment Act* C.C.S.M. c. E125 (1987)
- *Livestock Manure and Mortalities Management Regulation* 42/98
- *The Water Protection Act* C.C.S.M. c. W65 (2005)
- *Nutrient Management Regulation* 62/2008
- Environmental Regulations for Treatment and Disposal of Biosolids in Manitoba, Mike Van Den Bosch, P.Eng., Municipalities & Industrial Approvals, Manitoba Environment.

4 LAND SUITABILITY

4.1 DOMINANT SOILS WITHIN THE PROJECT AREA

Based on soil reconnaissance level maps (available from the Manitoba Agrimaps interactive mapping program), there are six soil series within the project area that include Plum Ridge, Lakeland, Balmoral, Ledwyn, Peguis and Thalberg. Single soil series or compound map series and the applicable number of hectares are outlined in Table 4.1 and characteristics of the soil series are outlined in Table 2 and shown in Map 2 (Appendix A).

Table 4-1 Soil Series and the Aerial Extent within the PSA

Field #	Field Number/Legal Location	Soil Series	Map Unit (percent area of polygon)	Aerial Extent (ha)
1	13-19-3EPM	Pl	Plum Ridge (100%)	27.3
		BAM	Balmoral, drained (40%)	92.3
			Balmoral, non-eroded or minimal (30%)	69.2
			Balmoral, peaty (30%)	69.2
2	12-19-3EPM	La	Lakeland (100%)	82.4
		BAM	Balmoral, drained (40%)	69.6
			Balmoral, non-eroded or minimal (30%)	52.2
			Balmoral, peaty (30%)	52.2
		Le	Ledwyn (100 %)	3.0
4	7-19-4EPM	BAM	Balmoral, drained (40%)	67.3
			Balmoral, non-eroded or minimal (30%)	50.4
			Balmoral, peaty (30%)	50.4
		Pe/T	Peguis (100 %)	88.3
		Pe	Thalberg (100 %)	4.0

Table 4-2 Description of Soil Series within the PSA

Soil Series	Description	Surface Texture	Drainage
Balmoral (BAM)	Rego Humic Gleysols developed on strongly calcareous, moderately fine textured sediments influenced by poor natural drainage.	Loam to silty clay loam.	Drainage is poor to very poor.
Lakeland (La)	Imperfectly drained Gleyed Rego Black carbonated soils developed on moderately to extremely calcareous, dominantly fine loamy sediments.	Loam to clay loam and occasionally silty clay.	Imperfectly drained.
Ledwyn (Le)	Gleyed Dark Gray Chernozem soils developed on very strongly to extremely calcareous, dominantly moderately fine textured (SCL, CL, SiCL) sediments.	Very fine sandy loam to silty clay loam; the soils commonly become slightly coarser with depth and are often stratified with very fine sand.	Runoff is slow and internal drainage is moderate to moderately rapid, but may be impeded by a high-water table.
Peguis (Pe/T)	Imperfectly drained Gleyed Dark Gray Chernozem soils developed on a moderately to strongly calcareous lacustrine clay strata underlain by extremely calcareous loamy glacial till within a metre of the surface.	Silty clay loam.	Runoff is moderately slow; permeability is moderately slow in the upper clay strata and moderate to moderately slow in the loamy substrata.
Thalberg (Pe)	Imperfectly drained Gleyed Solonetzic Dark Gray Chernozem soils developed on weakly calcareous lacustrine clay.	Silty clay loam.	Runoff is slow and permeability is slow to very slow.
Reference: Smith, R., Veldhuis, H., Mils, G., Eilers, R., Fraser, W., & Lelyk, G. (1998)			

4.2 SOIL TEXTURE

To confirm the soil texture for the land parcels within the project area, a test pit program was undertaken in November 2019. Three test pits were excavated to an approximate depth of 150 cm or greater depending on the soil features. Outlined below are the in-field observations and soil texture results for each.

Table 4-3 Test Pit Observations

Test Pit Location	Observations	Particle Size Analysis
TP01 14U 0637557 5611376 NW13-19-03EPM	Cropland: small grains. No biosolids to date. 0-6": Loamy, gray colour; 6-24": Silt Loam, tan colour; 24-60": Silt Clay Loam, Platy, Mottles, moist with apparent water movement.	0-6": Silt Loam 6-24": Silt Loam 24-60": Silt Clay Loam
TP02 14U 0637789 5610775 NW13-19-03EPM	Permanent grass cover. No biosolids to date. 0-6": Loamy, gray colour; 6-24": Silt Loam, tan colour; 24-60": Silt Clay Loam, Platty, Mottles, moist with apparent water movement.	0-6": Silty Clay Loam/ Clay Loam 6-24": Silt Loam 24-60": Silt Clay Loam
TP03 14U 0638836 5609302 SW07-19-04EPM	Permanent grass cover. Biosolids received in 2014, 205 and 2016 (exact areas unidentified) 0-18": Loamy, black, strong grass growth; 18-32": Silty, tan colour; 32-60": Silt Clay, Platy, Mottles, moist with apparent water movement; 60+" Clay	0-6": Silty Clay Loam 6-24": Silt Loam 24-60": Silt Clay Loam 60-72": Clay

4.3 CANADA LAND INVENTORY – SOIL CAPABILITY FOR AGRICULTURE

The *Nutrient Management Regulation* (NMR) under *The Water Protection Act*, came into effect on March 18, 2008. The MNR outlines nutrient application restrictions based on the Canada Land Inventory Soil Capability Classification for agriculture ratings (Government of Manitoba 2008). The Canada Land Inventory (CLI) is a dry-land agriculture capability inventory for rural Canada. The CLI limitations are based on climate, geology, soil chemical and physical characteristics (salinity and structure), droughtiness, inundation, erosion, stoniness and landscape topography of the soils.

The CLI groups mineral soils into seven classes with the same relative degree of limitation and then delineates subclasses within each class based on type of limitation (Fraser et al. 2001). Classes one to seven are based on increasing degree of limitation, the first three classes are capable of sustained cultivated crop production, class four is marginal for sustained arable cropping and class five is capable of pasture or hay, class six is capable of permanent pasture and class seven has no capability for arable crop or permanent pasture. There are thirteen different subclasses or limitations.

Soils series within the project area range from Class 2, 3, 5 and 6 dryland agricultural capabilities with subclass designations of W and M. The class descriptions are taken directly from Agriculture and Agri-food Canada, 2013:

- Class 1: Soils in this class have no significant limitations for crop selection. Topography of the soils are level to nearly level; they are deep, well to imperfectly drained and have moderate water holding capacity. The soils have an abundance of available nutrients for plant growth, are easily maintained in good tilth and fertility; soil productivity is considered moderately high to high for a wide range of cereal and special crops (field crops).
- Class 2: Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices. Class 2 soils have a good water-holding capacity, the limitations are moderate and productivity is moderately high. Limitations may be one of the following; adverse regional climate, moderate effects of accumulative undesirable characteristics; moderate effects of erosion, poor soil structure or slow permeability, low fertility (correctable with fertilization), gentle to moderate slopes, occasional damaging overflow, and wetness (correctable with drainage).
- Class 3: Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices. The limitations are more severe than for Class 2 soils. They affect one or more of the following practices: timing and ease of tillage, planting and harvesting, choice of crops, and methods of conservation. Under good management they are fair to moderately high in productivity for a wide range of crops.
- Class 4: Soils in this class have severe limitations that restrict the range of crops or require special conservation practices, or both. The limitations seriously affect one or more of the following practices: timing and ease of tillage, planting and harvesting, choice of crops, and methods of conservation. The soils are low to fair in productivity for a fair range of crops but may have high productivity for a specially adapted crop.
- Class 5: Soils in this class have very severe limitations that restrict their capability to producing perennial forage crops, and improvement practices are feasible. The limitations are so severe that soils are not capable of use for sustained production of annual field crops. The soils are capable of producing native or tame species of perennial forage plants and may be improved by use of farm machinery. The improvement practices may include clearing of bush, cultivation, seeding, fertilizing, or water control.
- Class 6: Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible. The soils provide some sustained grazing for farm animals, but the limitations are so severe that improvement by use of farm machinery is impractical, terrain may be unsuitable for use of farm machinery, or the soils may not respond to improvement, or the grazing season may be very short.
- Class 7: Soils in this class have no capability for arable culture or permanent pasture. This class also includes rockland, other non-soil areas, and bodies of water too small to show on the maps.

The subclass descriptions are as follows (Agriculture and Agri-food Canada, 2013):

- ‘M - Moisture limitation: This subclass consists of soils where crops are adversely affected by droughtiness owing to inherent soil characteristics. They are usually soils with low water-holding capacity.
- ‘W’: Excess Water – this subclass includes soils where excess water other than brought about by inundation is a limitation to agricultural use. Excess water may result from inadequate soil drainage, a high-water table, seepage or from runoff from surrounding areas.

Table 4-2 and Map 4 (Appendix A) provide a summary of the soil series found within the PSA and the corresponding dryland agricultural capability limitations.

4.4 NUTRIENT MANAGEMENT ZONES

The MNR also outlines criteria for the application of nutrients (nitrogen and phosphorous) to agricultural land. The purpose of the NMR is to protect water quality for sensitive water bodies and/or groundwater by encouraging responsible nutrient planning through regulating the application of substances containing nitrogen or phosphorous (Manitoba Sustainable Development n.d.). The Water Quality Management Zone nitrogen application limits within Zones N1, N2 and N3 are summarized as a rate of application that results in a residual concentration of nitrate nitrogen within the top 0.6 m of soil at the end of the growing season, at any place within the application area no greater than:

- Zone N1: 157.1 kg/ha (140 lbs/ac)
- Zone N2: 101 kg/ha (90 lbs/ac)
- Zone N3: 33 kg/ha (30 lbs/ac)

The Water Quality Management Zone phosphorous application limits within zones N1 to N3 where soil test phosphorous levels (i.e., Olsen procedure) for any place in the application area is 60 ppm or more except at a rate of application that does not exceed:

- Two times the applicable phosphorous removal rate, if the soil test phosphorous levels are less than 120 ppm; or
- The applicable phosphorous removal rate if the soil test phosphorous levels are 120 ppm or more but less than 180 ppm.

All the land parcels proposed for the program fall within Zone N1 and are subject to the aforementioned nitrogen and phosphorus application restrictions.

Table 4-4 Land Area for Status of Title 23108 Agricultural Capability Limitations and Equivalent Water Quality Management Zone

Legal Land Location	Area (ha)	Agricultural Capability	Water Quality Management Zone
13-19-03EPM	27.0	Class 2	N1
	60.9	Class 3	N1
12-19-03EPM	-	Class 2	N1
	77	Class 3	N1
07-19-04EPM	39	Class 2	N1
	33	Class 3	N1

5 BIOSOLIDS QUALITY

5.1 NUTRIENTS - NITROGEN AND PHOSPHORUS

The sample results for the biosolids nitrogen profile is between 6.2 to 6.92 percent total nitrogen between the 2019 and 2020 sampling events. Total Kjeldahl nitrogen concentration ranges between 5.96 and 6.7% between 2019 and 2020 sampling events; the ammonium-nitrogen (NH4-N) is 0.56 and 0.49% and Nitrate-N concentrations is 34.4 mg/kg. The organic matter content is 57.1%, total organic carbon content is 33.5% and total carbon by combustion is 34.7%. Of the 2020 material, the measured moisture content is 85.4% with a total Solids of 14.6% (Table 5.1, Appendix D). This provides an estimated organic nitrogen content of 64, 290 mg/kg. Generally, this nitrogen profile is consistent with the other cake like biosolids reviewed.

Significant findings reported by Fitzgerald and Racz (1999) and Ross et al (2003) is that the mineralization of organic nitrogen to inorganic, plant available nitrogen (nitrate and ammonium-nitrogen) was approximately 11% of biosolids N in year one and is highly dependent on soil temperature (micro-climate). It was further determined that approximately 67% of biosolids ammonium (17% of the total nitrogen) was lost as ammonia gas to volatilization when biosolids were not incorporated.

When utilizing an organic source as a fertilizer, only a portion of the total nitrogen is immediately available in the organic form and goes through a mineralization process. Mineralization is the conversion of organic nitrogen to ammonium nitrogen. Like hog manure, the anticipated mineralization rate for biosolids in year one is 25 percent, for year two, 12 percent and for year three, six percent.

When calculating the mineralization rate for the biosolids material in the prescription example, the following assumptions were made:

- At a Carbon to Nitrogen (C:N) ratio that exceeds 30:1, N becomes a limiting nutrient for decomposer organisms and this can reduce the rate of decomposition and results in N immobilization. The C:N ratio for the Cell 1 biosolids material is approximately 10:1, thus mineralization was assumed to continue at anticipated rates. Cell 2 is assumed to be similar.
- With a Carbon to Phosphorous (C:P) ratio between 200:1 and 300:1, mineralization and immobilization balance each other to result in no net release of P from the decomposing manure. When C:P is below this range, P is released and when above this range P will be tied up and not released for crop use. The Cell 1 biosolids material C:P ratio was below this range and P was anticipated to be released. Cell 2 is assumed to be similar.
- When animal and municipal wastes have N:P ratios ranging from 1:1 to 1:2 and are applied based on N rates on soils, over time P will accumulate. The Cell 1 biosolids material N:P ratio was 2.5:1, thus it was anticipated that P will not accumulate. Cell 2 is assumed to be similar.

The physical and chemical characterization of the Gimli Biosolids from sample analysis completed in 2014, 2019 and 2020 is provided in Table 5.1 (Appendix D).

5.1.1 *TRACE METALS*

Gimli's biosolids contain varying concentrations of metals as a result of discharges of metals via wastewater to the wastewater treatment system. Concerns regarding metals added to agricultural soil due to land application is justifiable due to the potential deleterious effects on soil quality, movement to surface and groundwater, phytotoxicity to crops, accumulation in crops and animal/human health effects.

A study completed by Fitzgerald and Racz (1999) reported that for loading rates of City of Winnipeg biosolids at 0, 50, 100 and 200 tonnes per hectare (t/ha), biosolids cadmium was not mobile, was not plant available and that very little of the cadmium was taken up by wheat plants. They also reported that for concentrations of other heavy metals (e.g., copper, zinc, nickel and lead), there was no consistent affect on the heavy metal content of wheat grain due to increasing rates of added biosolids. Fitzgerald and Racz (1999) concluded that heavy metals in the biosolids-treated soils was similar to that of wheat produced in the Canadian Prairies and that loading rates as high as 200 t/ha did not affect grain quality.

In Gimli's biosolids material, the metals of principal concern to agriculture include: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. The trace metal concentrations of these elements and others are outlined in Table 5.2 (Appendix D) for biosolids materials sampled in 2014 by the R.M and 2020 by WSP. The mean concentration in mg/kg and kg/tonne are presented.

MCC has established cumulative loading rates for each of these metals. The cumulative weight per hectare of each heavy metal in the soil is calculated by adding the amount of each metal in the biosolids at the prescription rate to the background soil level of the same metal (Table 5.3, Appendix D). The soil metal concentrations will be determined prior to each application event to ensure suitability of land parcels for application.

5.1.1.1 *CUMULATIVE METALS MODEL*

As outlined in Section 5.1.1 many trace elements are regulated under a cumulative weight per hectare of each heavy metal in the soil (Table 8). The cumulative weight is calculated by adding the amount of each heavy metal in the sludge solids applied to the background level of the same metal in the soil, thus ensuring the cumulative concentration of that metal is not exceeding the applied guideline. These cumulative guidelines are based on the CCME soil quality guidelines for the protection of the environment and human health. The mean concentration of the individual heavy metals from the biosolids sample analyzed in 2014 indicates that application of the biosolids would have metal concentrations below the applied CCME guidelines for agriculture soil.

The estimated loading rate of the metals of concern when the biosolids are applied at a rate to provide a two-times crop removal rate for P2O5 are shown in Table 5.3, Appendix D. The anticipated loading rate for biosolids is 11 tonnes per hectare (dry). Table 5.3, Appendix D outlines the number of applications of biosolids required to increase the soil metal content to the maximum levels permitted by the applied guideline. The number of applications of biosolids from the R.M. of Gimli lagoon is limited to about eight events, based on a limitation associated with the concentration of copper accumulation in the soil. While copper is a micro-nutrient required by crops, the uptake and removal of this element in the grain of crops is very minor and of little consequence to mass balance determinations.

Number of Application Events Permitted before meeting applied guideline example calculation for copper.

$$Total\ Amo\quad t\ o\qquad tal\ P\ rmitt\ \ d\ b\quad or\qquad ti\ \ g\ G\ \ id\ \ li\quad\ L\ v\ \ l$$
$$= \left[\left(Soil\qquad tal\ G\ \ id\ \ li\quad \frac{mg}{kg} - Soil\qquad tal\ Co\ \ c\quad\ tratio\ \ \frac{mg}{kg}\right)\quad 1{,}000{,}000\right]$$
$$\times \left[Sampl\quad D\ \ pth\ (m)\ \times Soil\ B\ \ lk\ D\quad\ sity\ \frac{kg}{m3} \times 10{,}000\ \frac{m2}{ha}\right]$$

$$Amo\quad t\ o\qquad tal\ Add\ \ d\ p\ \ r\ Applicatio$$
$$= [Biosolids\qquad tal\ Co\ \ c\quad\ tratio\ \ \frac{mg}{kg} \times \frac{To\qquad s}{H\ \ ctar} \times \left(\frac{1000}{1{,}000{,}000}\right)]$$

$$N\ \ mb\ \ r\ o\quad Applicatio\quad Ev\quad ts$$
$$= (Total\ Amo\quad t\ o\qquad tal\ P\ \ rmitt\ \ d\ b\quad or\qquad ti\ \ g\ G\ \ id\ \ li\quad\ L\ v\ \ l)$$
$$(Amo\quad t\ o\qquad tal\ Add\ \ d\ p\ \ r\ Applicatio$$

Notes:
Copper guideline: 63 mg/kg
Mean Soil Metal Concentration =
Soil Bulk Density: 1,200 kg/m^3
Soil Depth: 0.15 m
Hectare: 10,000 m^2
Soil Mass: 1,000,000 mg/kg
Example Loading Rate (dry): 11 Tonnes/Hectare

$$= \left[\left(63\ \frac{mg}{kg} - 8.34\ \frac{mg}{kg}\right)\quad 1{,}000{,}000\right] \times \left[0.15\ m\ \times 1{,}200\ \frac{kg}{m3}\ x\ 10{,}000\ \frac{m2}{ha}\right]$$
$$\left(1065.5g\ \frac{mg}{kg} \times 11\ \frac{T}{Ha}\quad 1{,}000\right)$$

$$N\ \ mb\ \ r\ o\quad Applicatio\quad Ev\quad ts = 98.388\quad 111.72 = 8.4$$

Therefore, Application Events to meet Cumulative Guideline = approximately 8 events.

5.1.2 SALTS

The biosolids material from the Gimli biosolids sampled in 2019 had an electrical conductivity (E.C.) value of 2.96 decisiemens per metre (dS/m) and a Sodium Absorption Ratio (SAR) of 1.31. The biosolids material may be considered as "slightly-saline" and as such does pose a slight environmental risk for soil salinization, as soil E.C., soluble ions (e.g., sodium, potassium, chloride and sulfate) and SAR may increase directly with rate application. This is anticipated to be a negligible impact for the following management approaches; the application of the biosolids volumes is limited over the years, application is a single event in a fall season and will be rotated across the field from year to year and annual precipitation will move the limited soluble ions out of the rooting zone between application events.

Comparatively, the reported salinity is less than to hog manure as reported by Racz and Fitzgerald (2001), where it was found that the mean E.C of 145 hog manure samples from Manitoba had a value of 16.0 dS/m and a SAR of 5.1. It is reported by Sullivan, Cogger and Bary (2007) that repeated biosolids applications did not result in detrimental salt accumulations in soil even at locations with low precipitation and no irrigation. Further, they reported that annual applications of dewatered cake biosolids (80 percent moisture) made for over 10 years had not increased soil salinity above 1 mmho/cm.

Salinity analysis results for the Gimli biosolids collected in 2019 are provided in Table 5.1, Appendix D.

5.1.3 *EMERGING SUBSTANCES OF CONCERN*

Emerging substances of concern (ESOC), including pharmaceuticals, antibiotics, endocrine-disrupting chemicals (EDCs), hormones and personal care products (PPCPs) continue to be studied in Canada and around the world to assure environmental and public safety (Canadian Council of Ministers of the Environment [CCME] 2012). ESOC continue to emerge due to the development of new detection methods and changes in technologies (McCarthy 2015). In general, most ESOC are found in very low concentrations (nanograms), in wastewater residuals and do not necessarily imply risk to the environment or human health based on detection (CCME 2012). In 2009, the CCME reviewed ESOC concentrations and effects of treatment processes, and identified 22 significant findings, of which seven are reported below:

- Of the 24 pharmaceutical, alkyklphenolic and fragrance compounds found in detectable concentrations in more than 75% of the in-going sludge, only 14 of 71 pharmaceutical, alkyklphenolic and fragrance compounds (20%) were found in more than 75% of the treated biosolids samples likely to be land applied.
- The antibacterial compounds triclosan and triclocarban, the antibiotic ciprofloxacin and the fragrance compound galaxolide (HHCB) were the compounds most frequently detected (9 of 11 sites) above 1,000 nanograms per gram (ng/g) total solids (dry).
- A few pharmaceutical compounds appear to be removed readily by either aerobic or anaerobic biological treatment, including sulfamethoxazole, trimethoprim, caffeine and diltiazem.
- A limited number of pharmaceutical compounds appeared to be difficult to remove in almost all processes examined, when present at detectable concentrations. These included the diuretic furosemide, the anti-epileptic carbamazepine, and the antibiotic ofloxacin.
- Naproxen appears to increase substantially through aerobic composting, possibly due to biotransformation from other compounds, but it appears to be more efficiently removed by anaerobic digestion.
- While many of the ESOC remain associated with the solid phase of the sludges or biosolids, a number of compounds can be lost in any aqueous process sidestream (e.g., dewatering filtrate, leachate, digester supernatant), including furosemide, ibuprofen and 2-hydroxy-ibuprofen, naproxen, acetaminophen, caffeine, carbamazepine, clarithromycin, dehydronifedipine, erythromycin-H_2O, sulfamethoxazole and trimethoprim.
- Less than 1% of the mass of fragrance compounds in feed sludge resides in the process sidestreams or leachates from the treatment processes, while between 1% and 6% of the mass of bisphenol A in the feed sludges was transferred to the process sidestreams or leachates.

The Canadian Municipal Water Consortium (Canadian Water Network) commissioned Dr. Lynda McCarthy with Ryerson University to complete a literature review for information pertaining to ESOC that was entitled: Risks Associated with Application of Municipal Biosolids to Agricultural Lands in a Canadian Context. The literature review was conducted in order to summarize current knowledge on the occurrence, fate and potential risks of ESOC and pathogens present in biosolids after application to agricultural land (in conditions relevant to Canada). Based on

the few existing risk assessments, it is suggested that the presence of ESOC and pathogens poses a low risk to human and environmental health. (Note: It was found that the limited number of risk assessments is due to limited data; toxicity and ecotoxicity data for ESOC is generally not available).

McCarthy's literature review evaluated the fate of biosolids related ESOC and pathogens after land application. It was concluded that determining the fate of ESOC and pathogens after land application is complex, site-specific to ESOC and pathogen characterizations and properties (e.g., water solubility and partition coefficient), environmental variables (e.g., temperature, moisture, pH and organic matter content), and application methods, each factor of which limit the success of understanding the true fate. Generally, studies have concluded that most of the compounds found in biosolids do not reach groundwater after land application and that the concentrations of ESOC and pathogens in tile drainage and surface runoff are much lower than typical concentrations found in wastewater treatment plant effluent.

McCarthy's literature review also concluded that ESOC uptake by plants may be an overestimate due to the proof of concept approach to demonstrating the uptake. The limited number of risk assessments has demonstrated however that the risk to human health from the consumption of plants grown in biosolids-amended soils under relevant conditions was considered minimal risk and that although the presence of ESOC in soil, crops or soil organisms may not be desirable, the sole presence of chemicals does not constitute proof of negative impact to the soil ecosystem.

Currently, there are no federal or provincial requirements to address ESOC in biosolids land application programs. The City of Steinbach will continue to monitor academic literature and engage with provincial regulators to maintain a current understanding of ESOC as information becomes available.

5.2 AGRONOMY

Crops grown on lands receiving biosolids can include cereals oil seeds, and perennial grasses. Application of biosolids will increase soil health (water-holding capacity, tilth) and provide beneficial macro (nitrogen, phosphorus, potassium, sulfur) and micronutrients (boron, copper, zinc, magnesium) to the soil for crop production. The R.M. of Gimli will work with the agricultural producers that rent their land parcels within the PSA and will advise them of the benefits of biosolids application and that the application of commercial fertilizers should only be completed to supplement nutrient levels from the biosolids at agronomically sustainable rates.

Any agricultural producers that rent the land parcels within the PSA will be required to sign a land use agreement with the RM of Gimli that meets certain terms and conditions to ensure compliance with regulatory requirements are met. Listed below are a few of the articles that may be included in an agreement:

- Maintaining an appropriate crop rotation for three years with cereal, oil seed, pulse, soybean and corn crops. No livestock grazing for a period of three years post application growing season.
- Conducting a nutrient management program that accounts for residual nutrients from the biosolids application.
- Direct soil injection of biosolids.
- Permit soil sampling and analysis monitoring for a period of three full years after application.

6 LOGISTICS OF BIOSOLIDS LAND APPLICATION

6.1 GENERAL REQUIREMENTS

It is anticipated that the biosolids material will be stored within the storage pond at the Arnes WDG for a minimum of one year to a maximum of three years (the cells at the storage pond have capacity for storage for up to three years). During a scheduled application date, biosolids materials will be hauled by tandem truck and trailer (as described in the NOA previously submitted to the EAB) to the field area selected for land application within the project area (within Sections 12-19-3EPM, 13-19-3EPM, 7-19-4EPM and 18-19-4EPM of the R.M. of Gimli); the biosolids will then be land applied surface spreading and then incorporation into the soil to a minimum of 15 centimeters (cm) below the soil surface; this will aid in reducing potential losses of nutrient (erosion and volatilization) and odour issues.

Outlined in EAL #2587, prescribes that biosolids will be applied at a rate that does not exceed 15 tonnes per hectare (t/ha) on a dry weight basis and at a rate whereby the plant-available nitrogen added to the land from all sources does not exceed 100 kilograms per hectare (kg/ha) during any year in which the biosolids are applied. As this justifiably accurate, the prescription rate would be based on the mass balance of phosphorus and nitrogen.

Prior to each biosolids land application event (by March 15th of any given year), the R.M. of Gimli will provide the Director of the EAB with a summary letter that provides the location of where the biosolids will be applied, proposed agronomy and prescribed biosolids application rates. The prescription rates for biosolids application will be calculated based on various inputs and assumptions including soil nutrient levels and cumulative weights of heavy metals in soil per hectare as discussed in Sections 7.1 through 7.2 and as outlined in Table 9. An example of the prescription rate calculations worksheet is provided in Appendix D.

Table 6-1 Land Application Nutrient Management Inputs and Assumptions

Categories	Inputs
Information Requirements	– Target crop and anticipated yield - this information is provided by the participating agricultural producer for three years following application. – Target nutrient recommendations to achieve the desired yield - this is based on understanding of crop uptake and removal. Source of this information is typically provided by the Manitoba Soil Fertility Guide. – Soil testing – soil sampling for nutrient and metals profiles is completed (0-15 cm and 15-60 cm). – Biosolids testing – testing of the physical, nutrient and metals profile for the biosolids.
Assumptions	Nitrogen Mineralization rates: – Between 20% and 25% in year one. – Less than 12% in year two and less than 6% in year three. Plant available phosphorus – Between 25% and 50% of total phosphorus.

Categories	Inputs
Methods	Biosolids are surface applied and then incorporated within 48 hours; therefore, volatilization of ammonia loss is 13, 19, 31 and 57% depending upon weather (cool/wet, cool/dry, warm/wet and warm/dry, respectively).
Indicators	– If C:N exceeds 30:1 in the biosolids, then N becomes a limiting nutrient for decomposer organisms, and this can reduce the rate of decomposition and results in N immobilization and loss of plant available nitrogen. – When C:P ratio is between 200:1 and 300:1 in the biosolids, mineralization and immobilization balance each other to result in no net release of P from the decomposing biosolids. When C:P is below this range, P is released. – When animal and municipal wastes with N:P ratios ranging from 1:1 to 1:2 are applied based on N rates on soils, over time P will accumulate.

6.2 APPLICATION RESTRICTIONS AND REQUIRED SETBACK DISTANCES

To minimize risk to human and environmental health and safety from the land application of biosolids and manure, the NMR and the Farm Practices Guidelines for Pig Producers in Manitoba (best management practices [BMPs]) (April 2007) have established soil restrictions and setback distances for land application programs. Table 6-2 provides a summary of requirements outlined in the R.M.'s current Licence. Where restrictions/setbacks are different under the NMR or from current BMPs (listed in Column C of Table 6-2), the R.M. wishes to implement those provisions listed under the NMR or BMPs.

Table 6-3 provides a summary of the soil and setback restrictions applicable to each land parcels within the project area for the Gimli biosolids land application program; these soil and setback restrictions will be adhered to during biosolids application.

Table 6-2 Restrictions and Required Setback Distances for Biosolids Application

Column A	Column B	Column C
Description of Feature	**Requirement as per Current Licence**	**Proposed Change to Restrictions/Setbacks per Requirements under the NMR and BMPs**
General Restrictions		
Land where there is less than 1.5 m of clay or clay till between the soil surface and the water table (aquifer).	Exclusion of such areas from the program.	-
Identifiable boundary of an aquifer which is exposed to the ground surface.	100 m (328 ft)	-
On soils with a pH of less than 6.0.	Exclusion of such areas from the program.	-
On land where the slope is greater than 5%.	Exclusion of such areas from the program.	-
Biosolids application onto frozen soil.	Exclusion of activity from program.	-
Crop restrictions after biosolids land application.	Crops planted on land that have received biosolids are restricted to cereal, forage, oil seed, field peas and lentils for three years post application.	-
Cattle grazing restriction after biosolids land application.	Cattle are not allowed to pasture on land on which biosolids application as occurred for three years post application.	-
Where prior to the application of biosolids, the level of residual nitrate-nitrogen exceeds 100 kilograms per hectare in the upper 60 cm of soil.	Exclusion of application area from program until the residual nitrate-nitrogen levels are reduced below the threshold.	
Where prior to the application of biosolids, the concentration of residual bicarbonate extractable phosphorous as P, exceeds 60 micrograms per gram in the upper 15 cm of soil.	Exclusion of application area from program until bicarbonate extractable phosphorous as P levels are reduced below the threshold.	
Setback Distances on Land Adjacent to Surface Water or a Surface Water Course		
A roadside ditch or an Order 1 or 2 drain.[1]	At least 15 m (49 ft) from first order waterway.	No direct application to ditches and Order 1 and 2 drains.
A groundwater feature.[1]	At least 50 m (164 ft) from any groundwater well.	15 m (49 ft) – vegetated buffer 20 m (66 ft) – non- vegetated buffer
A wetland, bog, marsh or swamp other than a major wetland, bog, marsh or swamp.[1, 2]	*	Distance between the water's edge and the high water mark.[3]

Column A	Column B	Column C
Description of Feature	**Requirement as per Current Licence**	**Proposed Change to Restrictions/Setbacks per Requirements under the NMR and BMPs**
A lake or reservoir designated as vulnerable.[4]	*	30 m (98 ft) - vegetated buffer 35 m (115 ft) – non- vegetated buffer
A lake or reservoir (not including a constructed storm water retention pond) not designated as vulnerable.[4] A river, creek or stream designated as vulnerable.[4]	*	15 m (49 ft) - vegetated buffer 20 m (66 ft) – non- vegetated buffer
A river, creek or stream not designated as vulnerable.[4] An Order 3, 4, 5 or 6 drain.[5] A major wetland, bog, marsh or swamp.[5] A constructed storm water retention pond.	At least 30 m (98 ft) from second order drain or higher.	3 m (10 ft) – vegetated buffer 8 m (26 ft) – non- vegetated buffer
Biosolids Application Setback Distances from Neighbours[2]		
Designated residential areas.	At least 1,000 m (3,280 ft).	400 m (1,312 ft)
Occupied Residence (other than the residence occupied by the owner of the land on which the biosolids are to be applied).	Greater than 300 m (984 ft).	75 m (246 ft)
Property line with residence.[6]	-	10 m (33 ft)
Property line without residence.[6]	-	1.0 m (3.3 ft)

Table 6-3 Summary of Applicable Soil Restrictions and Setback Distances for Gimli Biosolids Land Application Program

Legal Land Location	Restrictions to Biosolids Application[1]
13-19-3EPM	1, 2, 5, 6
12-19-3EPM	1, 2, 4, 5, 6
7-19-4EPM	1, 2, 3, 4, 5, 6

[1]Notes: **Restrictions and Setbacks**

1 - Residual nitrate nitrogen levels cannot exceed 157.1 kg/ha (140 lbs/ac) within the top 0.6 m (2 feet) of soil.

2 - Residual phosphorus levels (as determined by an Olsen-P test) cannot exceed 60 ppm within the top 0.15 m (6 inches) of soil.

3 - 1000 m setback from designated residential area

4 - 75 m setback from occupied residence (other than the residence occupied by the owner of the land on which the biosolids are to be applied)

5 - No direct application to ditches and Order 1 and 2 drains

6 - Setback of 3 m for wetlands with vegetated buffers and 8 m for wetlands with no vegetated buffers

7 POTENTIAL ENVIRONMENTAL EFFECTS AND MITIGATION MEASURES

As part of Gimli's biosolids land application program, mitigation measures will be employed that minimize the impact to the biophysical and socio-economic environments associated with the project area and surrounding area. A summary of the potential effects is provided in Table 7-1 with additional details provided in the following sections.

Table 7-1 Summary of Potential Environmental Effects and Proposed Mitigation Measures

Potential Environmental Effects	Proposed Mitigation Measures
Biophysical Effects	
Soil Quality Effects	
Nutrient Loading	Targeted prescription rates, matching cropping systems to nutrient uptake and removal over three seasons, soil monitoring, uniform application procedures, calibrated equipment.
Metals	Targeted prescription rates, biosolids quality monitoring, soil monitoring, soil chemistry, CCME guidelines.
Salinity and Sodicity	Targeted prescription rates, biosolids quality monitoring, soil monitoring, CCME guidelines, crop rotation.
Water Quality Effects	
Groundwater	Compliance with all Provincial regulations and the establishment of setback distances as outlined in Table 6-2, targeted prescription rates, soil monitoring.
Surface Water	Compliance with all Provincial regulations. Targeted prescription rates, setback distance of 15 m from rivers, creeks and Order 3 or greater drains, direct soil injection of biosolids, cropping systems, soil monitoring.
Natural Areas Effects	
Natural Vegetation, Wildlife and Species of Conservation Concern	Existing land use, timing of application, setback distances, cropping systems.
Socio-economic Effects	
Pathogens	Tillage within 48 hours, climate exposure, setback distances from residences/residential areas as outlined in Table 6-2, restricted access, exposure time between application events and harvest, restricted crop type.
Odour	Good neighbour policies, setback distances, tillage within 48 hours to 15cm, tillage within 48 hours, and monitoring wind direction for optimum conditions.

Potential Environmental Effects	Proposed Mitigation Measures
Metal Accumulation in Crops	Nutrient based application rates, biosolids monitoring, soil monitoring, soil chemistry, CCME guidelines and crop rotation
Emerging Substances of Concern	Climate exposure, microbial degradation, photo-degradation, tillage to a depth of 15cm, direct soil injection of biosolids, setback distances from residences/residential areas as outlined in Table 6-2, restricted access, separation in time between land application event (fall) and crop harvest (the next fall), academic literature monitoring.
Noise, Dust and Malfunctions	Use of dust control measures on gravel roads where possible, hauling during regular work hours, maintain equipment in good working order, regular inspections, spill control/response plan.

7.1 POTENTIAL BIOPHYSICAL EFFECTS

7.1.1 *SOIL EFFECTS AND MITIGATION*

To mitigate potential impacts to the soil/land base within the project area, the R.M. of Gimli will continue to complete a soil sampling program to allow for appropriate biosolids prescription rates and crop and land rotation to be executed for the program to minimize impacts to the soil resource. The soil monitoring program will include:

1. Pre-biosolids application in a given year:

   Collect composite soil samples from each field onto which biosolids will be applied prior to application as per Schedule A of the Licence.

   a. Soil samples from 0-15 cm depth will be analyzed for pH, potassium, nickel, mercury, zinc, sodium bicarbonate extractable phosphorus as P, cadmium, chromium, copper, lead and arsenic. Heavy metal analysis will be carried out in accordance with Schedule B of the Licence.

   b. Soil samples from 0-60 cm will be analyzed for nitrate-nitrogen and total nitrogen.

   c. Monitoring information for each land parcel receiving biosolids will be supplied to the Director of the MSD, EAB by March 15 of the year following biosolids application and will include: description of each land parcel that received biosolids, background levels of soil nutrients, metals and salinity prior to application, dry weight of biosolids applied, cumulative weight of heavy metals for each parcel of land, biosolids prescription rates, laboratory certificates of analysis for biosolids and soil sample results, type of crop grown.

2. Conduct an annual soil sampling program to monitor concentrations of residual soil nutrients, salinity and heavy metals for three-years post application. Monitoring information will be supplied to the Director of the MCC, EAB by March 15 of each year following biosolids application and will include a summary of soil nutrient, salinity and heavy metal results as well as laboratory certificates of analysis for biosolids and soil sample results and type of crop grown.

7.1.1.1 *NUTRIENT LOADING*

Of primary concern associated with the land application of biosolids is the leaching and/or surface runoff of nitrogen and phosphorus into ground or surface water if application rates exceed crop removal rates and soil storing capacity. Nitrogen and phosphorus will be managed based on beneficial farm management practices and following prescription rates based on residual soil nutrient levels and biosolids quality, as well as per applicable regulations. Biosolids will be applied based on nutrient requirements for each land parcel in the project area.

Prescribed nitrogen and phosphorus rates will target uptake and removal ability of pasture (permanent grass cover) lands, small grains, oil seed, pulse and soybean crops and corn. Nutrient management will be compliant with the regulatory requirements outlined in the *Nutrient Management Regulations* of *The Water Protection Act* for both maximum residual nitrogen and phosphorus criteria in nutrient management zone N1.

Post-harvest soil monitoring will be conducted on the land parcels for three-years post application of biosolids to monitor nutrient loading within the soils. Soil sampling and analysis will be completed as follows: sodium bicarbonate extractable-P at 0-15 cm soil depth and nitrate-nitrogen and total nitrogen at 0-60 cm soil depth. Management of land parcels in the project area will be based on the annual soil residual nitrogen and phosphorus levels assessed through the monitoring program.

Mitigation Measures: Targeted prescription rates, matching cropping systems to nutrient uptake and removal over three seasons, soil monitoring, uniform application procedures, calibrated equipment.

7.1.1.2 *METALS*

The soil sampling program of the receiving lands combined with the assessment of biosolids metals concentrations prior to each application will ensure that biosolids are applied based on permitted concentrations for each land parcel as outlined in the CCME guidelines. To prevent overloading of heavy metals into soils, the prescribed application rates will provide cumulative weight criteria for metals that are below the permitted concentrations. Monitoring of biosolids quality and soil monitoring (0-15 cm soil depth) for three years post biosolids application will also be conducted in order to monitor heavy metal loading rates to the land parcels in the project area.

Mitigation Measures: Targeted prescription rates, biosolids monitoring, soil monitoring, CCME guidelines.

7.1.1.3 *SALINITY AND SODICITY*

It is reported by Sullivan et al (2007) that repeated biosolids applications in soil have not resulted in detrimental salt accumulations in soil even at locations with low precipitation and no irrigation. The soil series within the PSA are non-saline.

This is anticipated to be a negligible impact for the following management approaches; the application of the biosolids volumes is limited over the years, application is a single event in a fall season and will be rotated across the field from year to year and annual precipitation will move the limited soluble ions out of the rooting zone between application events. Monitoring of biosolids quality and soil monitoring of the land base as part of the biosolid management plan for three years post application will minimize impacts to the soil resource from the accumulation of salts. Crop rotations will also be established for the program to aid in the reduction of salt accumulation in the soil-rooting zone.

Mitigation Measures: Targeted prescription rates, biosolids monitoring, soil monitoring, CCME guidelines, crop rotation.

7.1.2 *WATER QUALITY EFFECTS AND MITIGATION*

Potential impacts to surface water and aquatic species within the local drainage system includes nutrient loading from surface runoff to the constructed drains in the area including: a third order drain to the north of the project area. However, the impact to surface water and aquatic species is considered to be low as biosolids material will be applied at agronomically appropriate rates and will be incorporated into the soil within 48 hours of application thereby minimizing the potential of overland flow to the drainage system. In addition, appropriate setback distances of 8 m will be established around all Order 3 or higher drains.

However, as most domestic wells in the area draw water from the carbonate aquifer which is overlain by thick clay and/or till deposits that act as barriers to movement of contaminates to the aquifer, impacts to groundwater in the area are considered to be low.

Application of the biosolids materials at agronomically appropriate rates for nitrogen and phosphorous will ensure plant uptake of these nutrients over the growing season, thereby further minimizing the potential of leaching to the groundwater. Direct soil injection of biosolids will minimize the potential of overland flow to groundwater wells. In addition, appropriate setback distances will be established around all residences and domestic wells as outlined in Table 6-2.

Mitigation Measures: Compliance with all Provincial regulations, nutrient based application rates, setback distances, 1.5 m clay underlay, direct soil injection of biosolids, cropping systems, soil monitoring and compliance with regulations and setback distances as per Table 6-2.

7.1.3 VEGETATION AND WILDLIFE EFFECTS AND MITIGATION

As the land parcels within the project area consist primarily of commercial, industrial or other land use (associated with the Gimli airport), mowed pasture and cultivated lands, the impact to native vegetation is anticipated to be negligible.

Potential impacts to wildlife include potential vehicle/wildlife collisions due to transport of biosolids materials to the receiving fields. However, the impact to wildlife/habitat is considered to be low as land within the project area and surrounding local area primarily consists of mowed pasture and cultivated land with minimal natural vegetative cover available as habitat. Equipment traffic associated with the transfer of biosolids from the lagoons to the receiving fields will be below posted speed limits thus reducing the possibility of wildlife collisions. In addition, land application is anticipated to occur in the fall of a given year and as such the potential to impact nesting migratory birds is anticipated to be low.

Therefore, due to the agricultural nature of the area, timing of the biosolids application and establishment of appropriate setback distances as per Table 6-2, impact to native vegetation and wildlife is anticipated to be negligible to minimal.

Mitigation Measures: Existing land use, timing of application, setback distances, cropping systems

7.1.4 GREENHOUSE GAS CONSIDERATIONS

Greenhouse gas (GHG) emissions within the context of this biosolids land application program are carbon dioxide, methane and nitrous oxide. The activities related to GHG contributions are limited to the equipment emissions that will be used to transport, land apply and incorporate the biosolids material and natural decomposition of land applied organic matter in the soil. Land application of biosolids provides significant benefits through the reduction of GHG production that occurs with landfill disposal, carbon sequestration in soil organic matter and reduced use of inorganic commercial fertilizers from petroleum based sources. These three benefits are reported to counter balance the potential emissions due to mechanical needs for the land application program (CCME 2012).

7.2 POTENTIAL SOCIO-ECONOMIC EFFECTS

7.2.1 *PUBLIC SAFETY & HEALTH RISKS AND MITIGATION*

7.2.1.1 *BIOLOGICAL PATHOGENS*

Biological pathogens such as *Escherichia coli* (E. coli) and fecal coliforms as well as nuisance odour associated with land application of biosolids may be considered to pose a public health and safety risk. These human health and safety risks will be managed through the application of the biosolids onto private lands that have restricted public access. In addition, tillage within 48 hours will minimize odour and eliminate human exposure to pathogens. Pathogens from biosolids are often killed by exposure to sunlight ultra violet spectrum, drying conditions, unfavorable pH and other macro and micro environmental conditions. Lands that receive biosolids will also be managed on a crop rotation system for three years that excludes root/vegetable crops and livestock grazing.

In addition, appropriate setback distances including 1,000 m from residential areas, 75 m from occupied residence, 10 m from property lines with a residence and 1 m from property lines without a residence, will be adhered to throughout the program.

Mitigation Measures: Tillage within 48 hours, climate exposure, setback distances, restricted access, separation in time between land application event (fall) and crop harvest (the next fall), restricted crop type

7.2.1.2 *ODOUR MANAGEMENT*

While it is impossible to eliminate odour associated with the biosolids applications, mitigation measures that include the use of best management and good neighbour practices will be employed to minimize odour issues associated with the land applications. Best management practices that will be employed includes tillage of biosolids and public notification via local advertisement to local residents of intended biosolids applicant sites for a give year (e.g. via newspapers, R.M. website). Additionally, the establishment of applicable setback distances from residences as per Table 6-2 will aid in minimizing odour issues.

Mitigation Measures: Good neighbour policy, setback distances, tillage within 48 hours to 15cm depth, and monitoring wind direction for optimum conditions.

7.2.1.3 *METAL ACCUMULATION IN CROPS*

Heavy metal bioaccumulation in agricultural crops consumed by humans poses a minimal human health risk as uptake, removal and accumulation of metals by the harvested portions of crops is minimal. Harb (1999) concluded that the health risk to humans from the consumption of heavy metals in wheat and oats grown on land treated with biosolids is negligible and that there are environmental and economic benefits.

Mitigation Measures: Nutrient based application rates, biosolids monitoring, soil monitoring, soil chemistry, CCME guidelines and crop rotation

7.2.1.4 *EMERGING SUBSTANCES OF CONCERN (ESOC)*

ESOC including pharmaceuticals, antibiotics, EDCs) hormones and PPCPs continue to be studied in Canada and around the world to assure environmental and public safety (CCME 2012). ESOC continue to emerge due to the development of new detection methods (e.g., culture and identification of pathogens) and changes in technologies (McCarthy 2015). In general, most ESOC are found in very low concentrations (nanograms), in wastewater residuals and do not necessarily imply risk to the environment or human health based on detection (CCME 2012).

Mitigation Measures: Climate exposure, microbial degradation, photo-degradation, tillage within 48 hours to 15cm depth, setback distances, separation in time between land application event (fall) and crop harvest (the next fall), and academic literature monitoring

7.2.1.5 *NOISE, DUST AND MALFUNCTIONS*

To minimize the impacts to local residents from dust and noise, wherever possible paved roadways will be utilized during the transport of biosolids to the field sites and transportation will be completed during regular weekly work hours as much as possible.

Mitigation Measures: Good neighbour policy, use of dust control measures on gravel roads, biosolids transport during regular work hours, maintain equipment in good working order, regular equipment inspections, spill control/response plan.

7.3 ECONOMIC BENEFITS

The application of biosolids to agricultural land provides a positive economic benefit to both agricultural producers that may be renting the land and to the R.M. of Gimli. The objective of providing biosolids prescription application rates that match crop requirements for nutrient management is both sustainable and highly economical. As outlined, biosolids provide macronutrients (nitrogen, phosphorous, potassium, and sulfur) and micronutrients (boron, copper, iron, chloride, manganese, molybdenum and zinc) to soils/crops, which provide economic value to the agricultural producer.

To determine the basic economic value of the N and P of the biosolids, the average fertilizer commodity price between May 2019 and April 2020 for Urea (46-0-0) and Triple Super Phosphate (0-45-0) was determined as $0.73/kg N and $0.79/kg P_2O_5, respectively. The following economic value as presented in Table 7-2 is based on the prescribed biosolids land application of 2x Crop removal of P_2O_5 (11 t/ha dry).

Table 7-2 Economic Value for Nitrogen and Phosphorus in Applied Biosolids

Nutrient	Market Price (June 2020)	Hypothetical Application Rate	Value of Applied Biosolids
Available Nitrogen	$0.73/kg	218 kg/ha	$159.14/ha
Total Available P_2O_5	$.79/kg	110 kg/ha	$86.9/ha
Economic Value for Nitrogen and Phosphorus in Biosolids (11 tonnes/ha) sub-total			$246.04/ha

The biosolids material would be provided at no charge to the farm producer and is reducing their fertilizer expenses by approximately $246.04 per hectare (Table 7-2). Based on the anticipated 65 hectares required for the land application this equates to approximately $15,992.60 for just nitrogen and phosphorous fertilizer and does not account for the added benefit of potassium, sulfur and micro-nutrients. Hence the economic benefit to the farm producer is substantial based on the savings the farm producer will incur from crop fertilizer amendments. It should also be noted that the economic benefit to the R.M. is recognized from no land use fees being paid to the farm producer for the application of the biosolids; whereas, if the biosolids were disposed of in the local landfill the tipping fee would represent a significant cost to the R.M.

8 SUMMARY

The objective of the R.M. of Gimli's biosolids land application plan is to complete the land application of biosolids material collected from their wastewater treatment lagoon (and stored at existing cells or in the future at the new storage pond) in an environmentally sustainable and agronomically suitable manner. Pre- and post-application soil monitoring of the land base receiving biosolids will enable the R.M. to make informed decisions regarding nutrient and metal loading to these land parcels to ensure their longevity in the program.

All regulatory requirements, guidelines and good neighbour policies and procedures discussed in this report will be adhered to during the course of the R.M. of Gimli's biosolids land application program. With the employment of appropriate mitigation measures, potential negative effects associated with the R.M.'s biosolids land application program can be minimized. When applied at balanced rates, the land application of biosolids is a sustainable means to reuse nutrients within an agriculture system as the application of biosolid organic material enhances the water holding capacity, structure and tilth of soils thereby providing benefits to land utilized for agricultural production.

The information has been supplied as requested in a Notice of Alteration approval letter provided by the Manitoba Conservation and Climate, Environmental Approval Branch (File No. 4522.10, dated December 16, 2019) for the R.M.'s existing Environment Act Licence No. 2473 R.

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APPENDIX

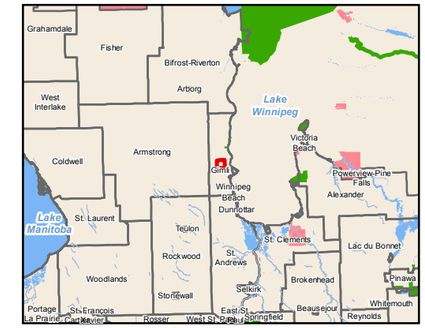
A FIGURES

RM of Gimli Waste Disposal Ground
and Proposed Biosolids Storage Facility

RM of Armstrong

RM of Gimli

Lake Winnipeg



Gimli Storage Sludge Pond and Waste Disposal Site

Legend

- Local Study Area
- Rural Municipality

Coordinate System: NAD 83, UTM Zone 14 N
Data Source: ESRI, MLI, NRCAN, WSP
Date Created: June 24, 2019
Revision Date: June 26, 2019

N

0 0.5 1 2 3 4
Kilometres

MAP 1

Regional Location

wsp

Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

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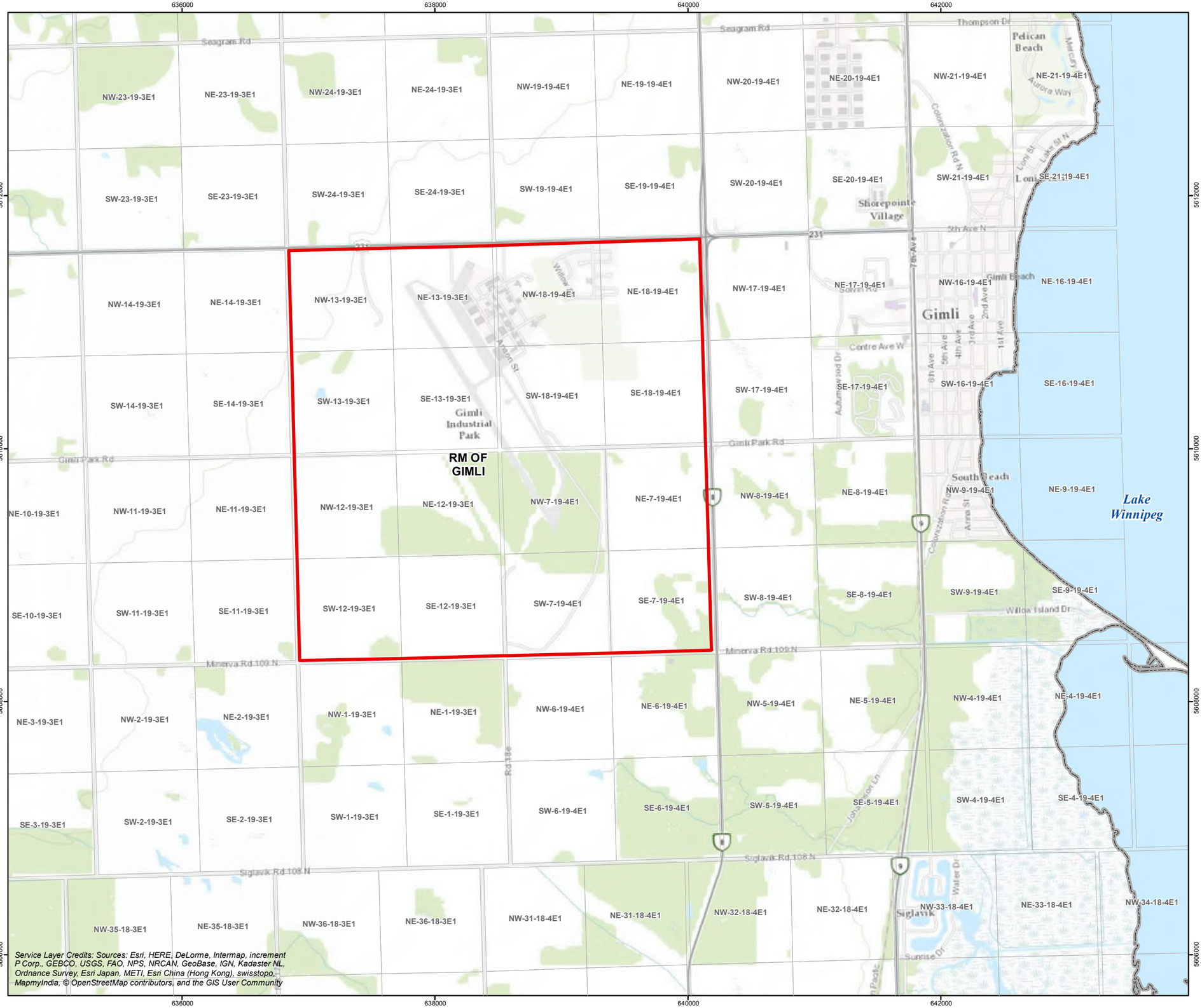

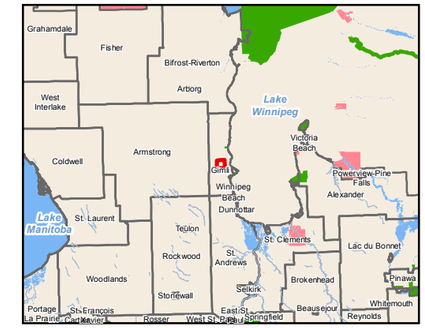

Gimli Storage Sludge Pond and Waste Disposal Site

Legend

- Local Study Area
- Rural Municipality
- Parcel Mapping

Coordinate System: NAD 83, UTM Zone 14 N
Data Source: ESRI, MLI, NRCAN, WSP
Date Created: June 24, 2019
Revision Date: June 26, 2019

N

0 250 500 1,000 1,500 2,000
Metres

MAP 2

Local Study Area

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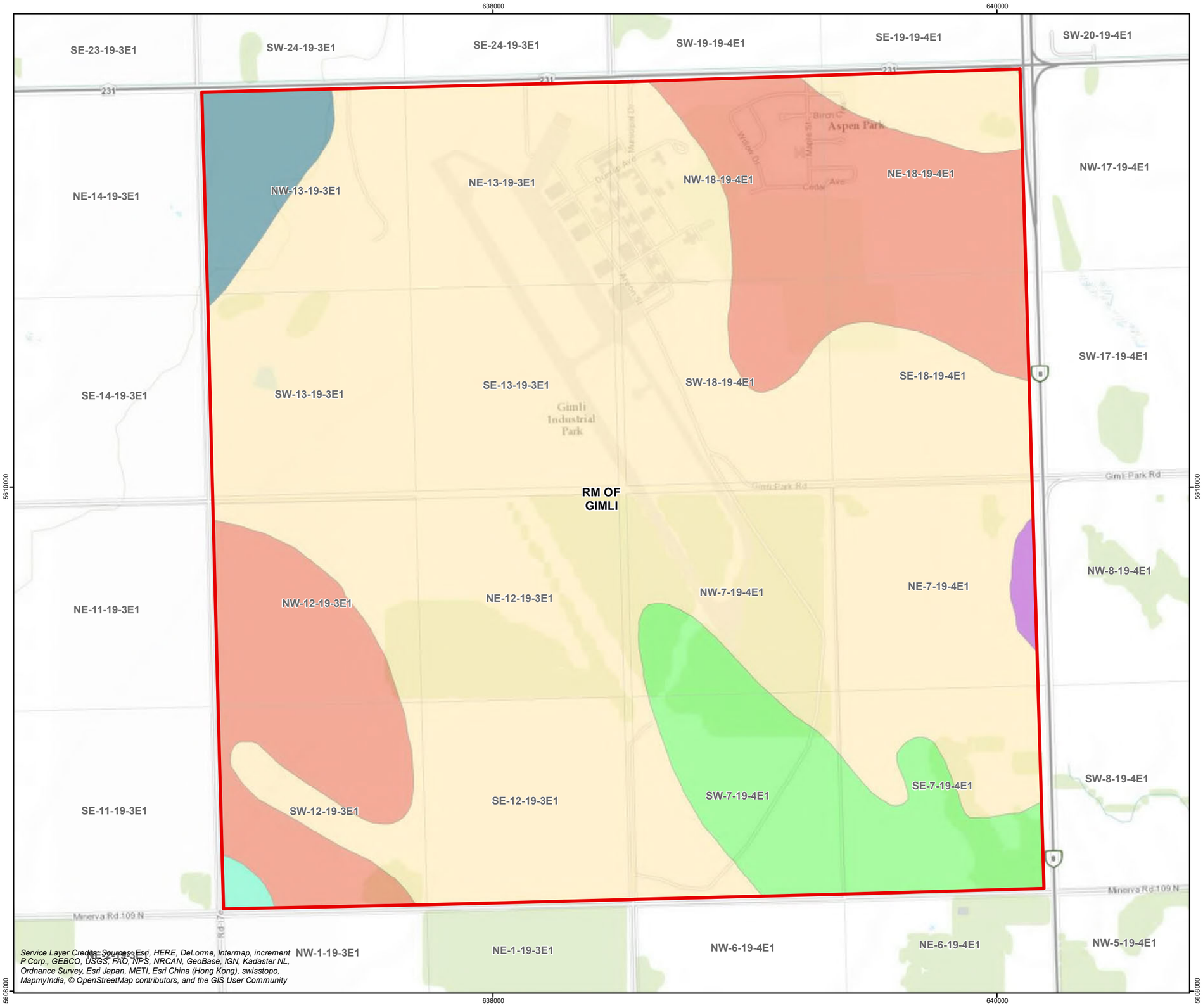
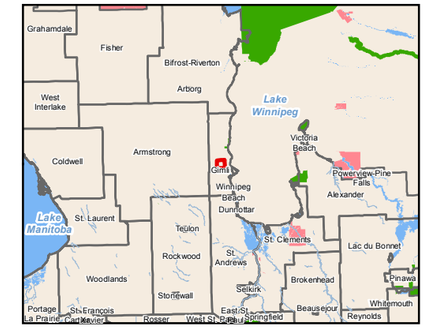




Gimli Storage Sludge Pond and Waste Disposal Site

Legend

- Local Study Area
- Rural Municipality
- Parcel Mapping

Soil Map Unit

- Ba - Balmoral
- La - Lakeland
- Le - Ledwyn
- Pe - Peguis
- Pe/T - Peguis / Thalberg
- Pl - Plum Ridge

Coordinate System: NAD 83, UTM Zone 14 N
Data Source: ESRI, MLI, NRCAN, WSP
Date Created: June 24, 2019
Revision Date: June 26, 2019

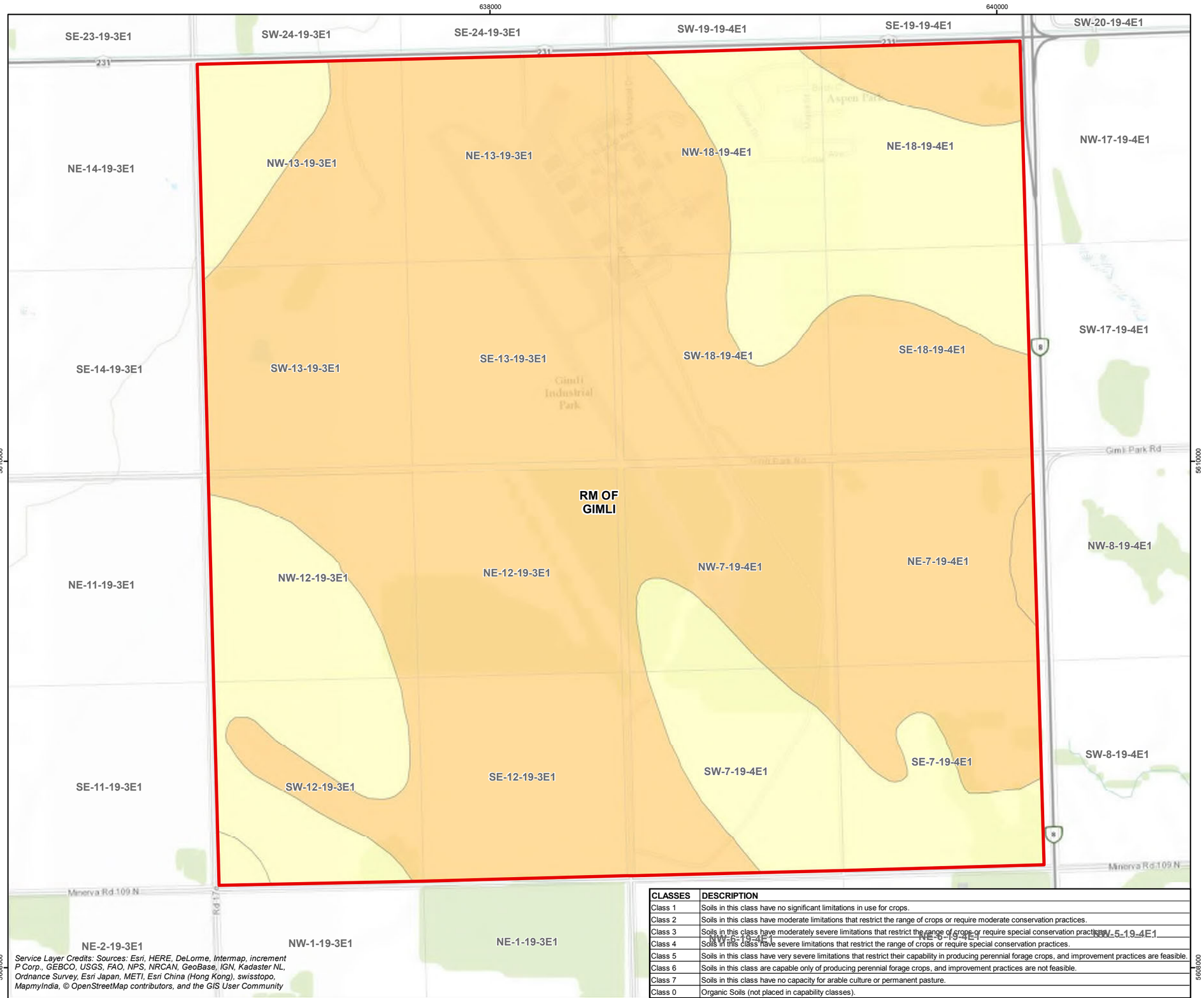
N

0 125 250 500 750 1,000
Metres

MAP 3

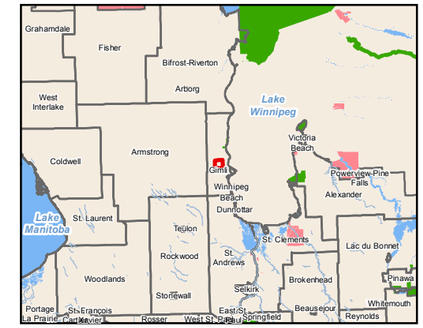
Soil Series within the Local Study Area

U:\Projects\PROJECTS_2018\181-03988-00_RMofGimli_SludgeStoragePonds_WDG\MXD\MAP3_SoilSeries_Bstze_20190626.mxd



Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community

CLASSES	DESCRIPTION
Class 1	Soils in this class have no significant limitations in use for crops.
Class 2	Soils in this class have moderate limitations that restrict the range of crops or require moderate conservation practices.
Class 3	Soils in this class have moderately severe limitations that restrict the range of crops or require special conservation practices.
Class 4	Soils in this class have severe limitations that restrict the range of crops or require special conservation practices.
Class 5	Soils in this class have very severe limitations that restrict their capability in producing perennial forage crops, and improvement practices are feasible.
Class 6	Soils in this class are capable only of producing perennial forage crops, and improvement practices are not feasible.
Class 7	Soils in this class have no capacity for arable culture or permanent pasture.
Class 0	Organic Soils (not placed in capability classes).



Gimli Storage Sludge Pond and Waste Disposal Site

Legend

- Local Study Area
- Rural Municipality
- Parcel Mapping

Agricultural Capability - CLI

- Class 2
- Class 3

Coordinate System: NAD 83, UTM Zone 14 N
Data Source: ESRI, MLI, NRCAN, WSP
Date Created: June 24, 2019
Revision Date: June 26, 2019

N

0 125 250 500 750 1,000
Metres

MAP 4

Soil Dryland Agricultural Capability within the Local Study Area

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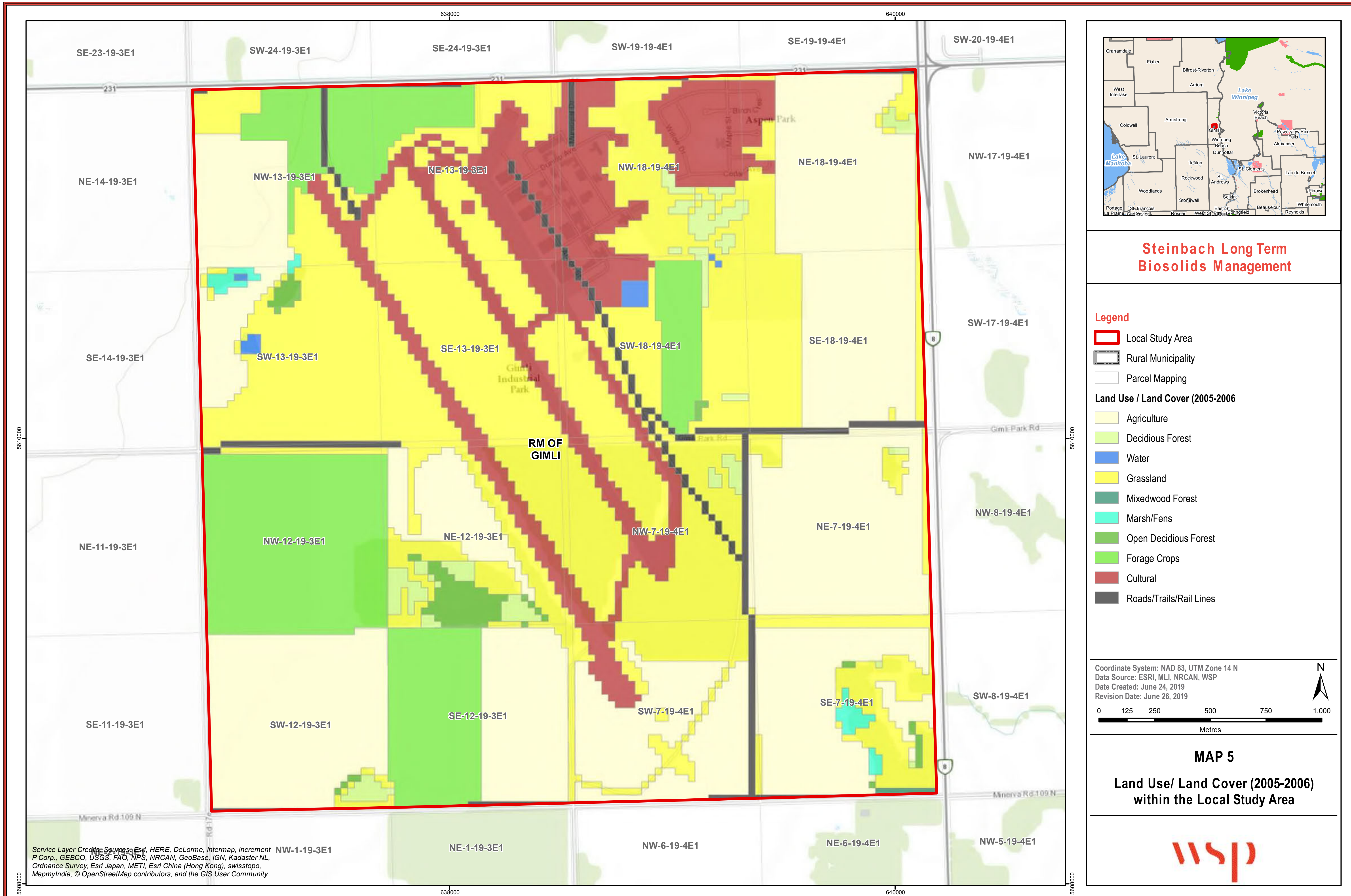
Steinbach Long Term Biosolids Management
Legend
Local Study Area
Rural Municipality
Parcel Mapping
Land Use / Land Cover (2005-2006
Agriculture
Decidious Forest
Water
Grassland
Mixedwood Forest
Marsh/Fens
Open Decidious Forest
Forage Crops
Cultural
Roads/Trails/Rail Lines
Coordinate System: NAD 83, UTM Zone 14 N
Data Source: ESRI, MLI, NRCAN, WSP
Date Created: June 24, 2019
Revision Date: June 26, 2019
0 125 250 500 750 1,000
Metres
N
MAP 5
Land Use/ Land Cover (2005-2006)
within the Local Study Area
wsp
RM OF GIMLI
SE-23-19-3E1
SW-24-19-3E1
SE-24-19-3E1
SW-19-19-4E1
SE-19-19-4E1
SW-20-19-4E1
NE-14-19-3E1
NW-13-19-3E1
NE-13-19-3E1
NW-18-19-4E1
NE-18-19-4E1
NW-17-19-4E1
SE-14-19-3E1
SW-13-19-3E1
SE-13-19-3E1
SW-18-19-4E1
SE-18-19-4E1
SW-17-19-4E1
NE-11-19-3E1
NW-12-19-3E1
NE-12-19-3E1
NW-7-19-4E1
NE-7-19-4E1
NW-8-19-4E1
SE-11-19-3E1
SW-12-19-3E1
SE-12-19-3E1
SW-7-19-4E1
SE-7-19-4E1
SW-8-19-4E1
NW-1-19-3E1
NE-1-19-3E1
NW-6-19-4E1
NE-6-19-4E1
NW-5-19-4E1
Aspen Park
Gimli Industrial Park
Gimli Park Rd
Minerva Rd 109 N
231
8
638000
640000
5610000
5608000
Service Layer Credits: Sources: Esri, HERE, DeLorme, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo, MapmyIndia, © OpenStreetMap contributors, and the GIS User Community
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APPENDIX

B STATUS OF TITLE

STATUS OF TITLE

Title Number **1225753/1**
Title Status **Accepted**
Client File 181-03988-01

The Property Registry
A Service Provider for the Province of Manitoba

1. REGISTERED OWNERS, TENANCY AND LAND DESCRIPTION

HER MAJESTY THE QUEEN IN RIGHT OF THE PROVINCE OF MANITOBA

IS REGISTERED OWNER SUBJECT TO SUCH ENTRIES RECORDED
HEREON IN THE FOLLOWING DESCRIBED LAND:

ALL THAT PORTION OF PARCEL B PLAN 23108 WLTO
TAKEN FOR WATER CONTROL WORKS PLAN 27555 WLTO
IN E1/2 OF 12 AND 13-19-3 EPM AND
IN W1/2 OF 7 AND 18-19-4 EPM AND
IN GOVERNMENT ROAD ALLOWANCE (CLOSED)

The land in this title is, unless the contrary is expressly declared, deemed to be subject to the reservations and restrictions set out in section 58 of *The Real Property Act.*

2. ACTIVE INSTRUMENTS

No active instruments

3. ADDRESSES FOR SERVICE

DEPARTMENT OF JUSTICE (MB.)
DIRECTOR OF LEGAL SERVICES
6TH FLOOR 405 BROADWAY
WPG., MB.
R3C 3L6

4. TITLE NOTES

No title notes

5. LAND TITLES DISTRICT

Winnipeg

6. DUPLICATE TITLE INFORMATION

Duplicate not produced

7. FROM TITLE NUMBERS

1099334/1 Partial

8. REAL PROPERTY APPLICATION / CROWN GRANT NUMBERS

No real property application or grant information

9. ORIGINATING INSTRUMENTS

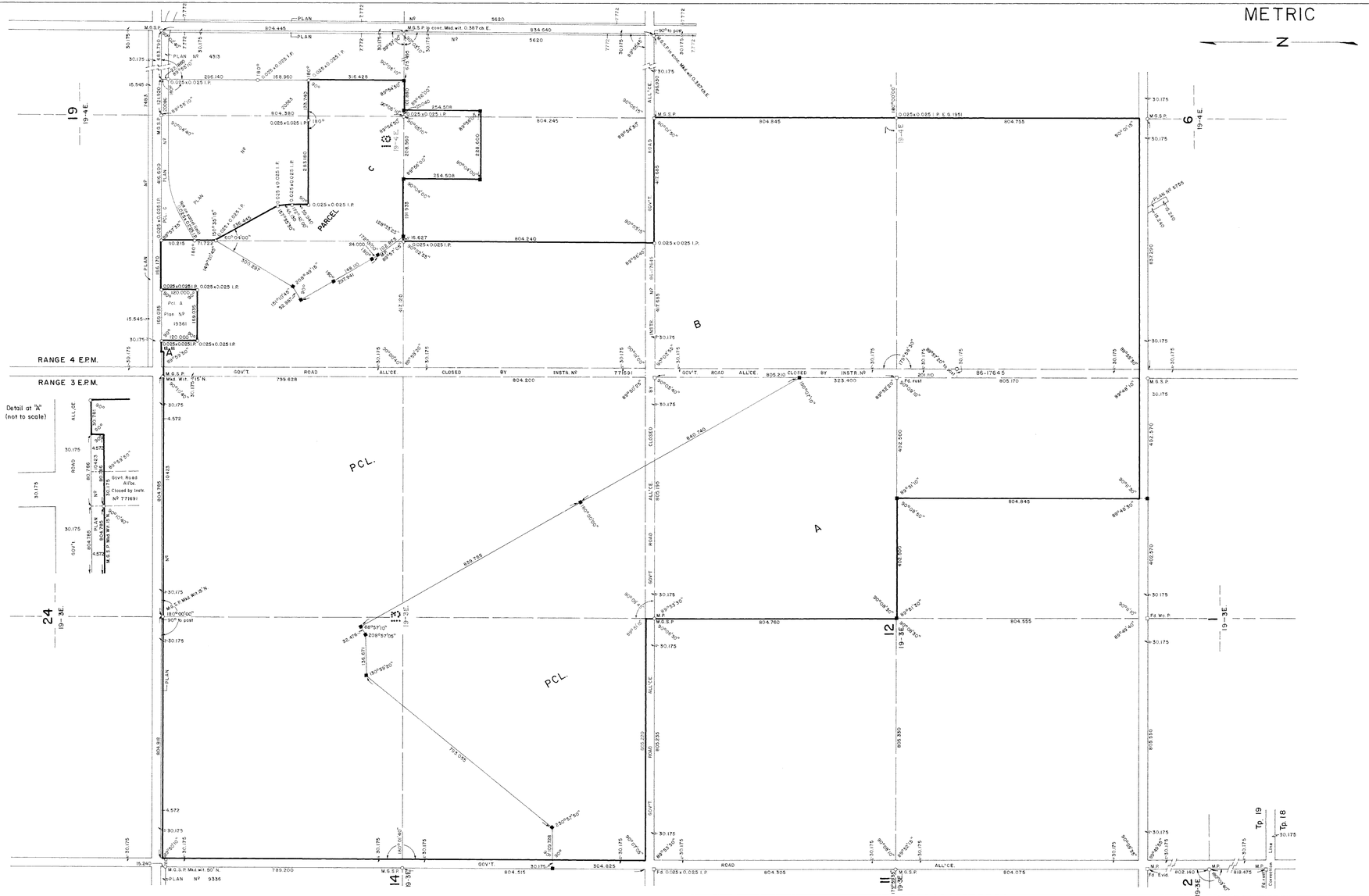
Instrument Type:	**Request To Issue Title - Internal**
Registration Number:	**1486434/1**
Registration Date:	1991-11-22
From/By:	WLTO SURVEY OFFICE
To:	
Amount:	

10. LAND INDEX

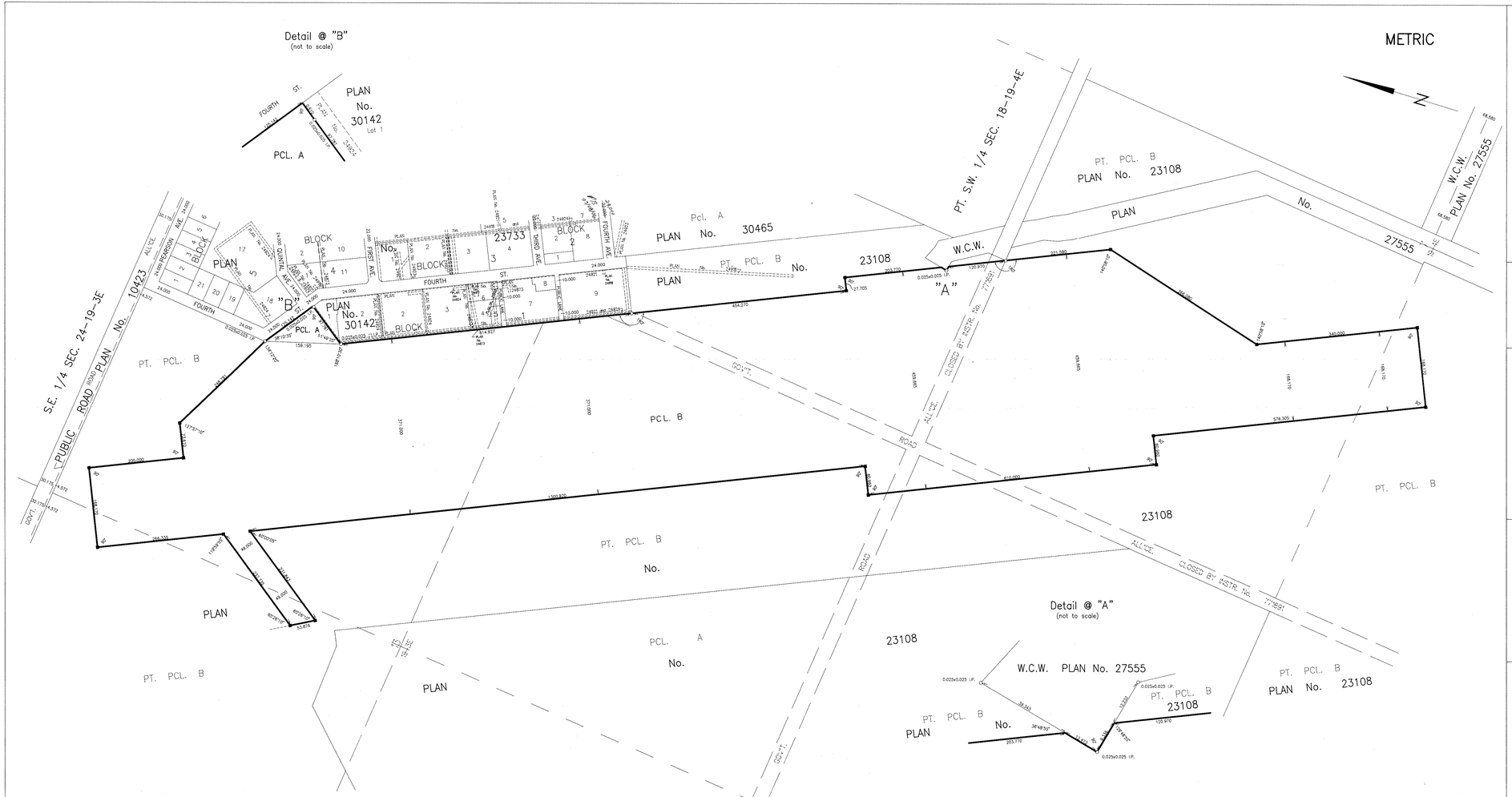
Lot B Plan 23108
WATER CONTROL WORKS PLAN 27555

Plan 27555
WATER CONTROL WORKS IN PCL B PL 23108

CERTIFIED TRUE EXTRACT PRODUCED FROM THE LAND TITLES DATA STORAGE SYSTEM OF TITLE NUMBER 1225753/1


METRIC
N
RANGE 4 E.P.M.
RANGE 3 E.P.M.
Detail at "A" (not to scale)
PLAN OF SURVEY
In E. 1/2 Sec. 12 and Sec. 13, Tp. 19, Rge. 3 E.P.M.
Including all of Plan Nº 5675 in Sec. 13 and
Gov't. Road All'ce.s (now closed) and
In W. 1/2 Sec. 7 and Sec. 18, Tp. 19, Rge. 4E.P.M.
Including all of Plan Nºs 5599 and 5600 in Sec. 7
And Gov't. Road All'ce. (now closed).
R.M. of Gimli
MANITOBA
SCALE : 1: 5000
0 100 200 300 400 500
PARCEL A
PARCEL B
PARCEL C
PCL.
PCL.
GOV'T. ROAD ALL'CE CLOSED BY INSTR. Nº 77691
Govt. Road Allce. Closed by Instr. Nº 77691
Tp. 19
Tp. 18
NOTE
All distances are in metres and decimals of a metre and may be converted to feet by multiplying by 3.28084.
Survey monuments found on the ground are described and shown thus
Iron posts 0.025 x 0.025 x 0.914, marked M.L.S., are placed at all points shown thus
Manitoba Government Survey Posts are placed at all points shown thus
Marker Posts with public warning plates are placed at all points shown thus M.P.
Portions affected by this plan are shown bordered thus
All plans referred to are on record in the Winnipeg Land Titles Office.
AFFIDAVIT
I, Dewey Michael Roger Hoplock, of the City of Winnipeg, Manitoba Land Surveyor, make oath and say that I did personally superintend the survey represented by this plan, that the survey was made between November 13,1985 and January 17,1986, and that the survey and plan are correct and true to the best of my knowledge and belief.
Sworn to before me at Winnipeg this 6th day of February A.D. 1986
A Barrister Authorized to practise under the Land Surveyors Act
APPROVALS
Approved and Confirmed this 27 day of March A.D. 1986
Director of Surveys
REGISTRATION
Entered and filed in the Winnipeg Land Titles Office this 20 day of NOVEMBER A.D. 1986 as PLAN Nº 23108.
Priority Nº 1095403
EXAMINER OF SURVEYS
This approval is Valid for 12 months unless registered
Approved this 26 day of NOVEMBER A.D. 1986
Examiner of Surveys
Re-approved
Re-approved
Deposit Nº 151/86
F.B. 2456
S-M-85(2)

Deposit No. 1138/94



PLAN OF SURVEY

of part of

N.E. 1/4 SEC. 12 and E. 1/2 and N.W. 1/4 SEC. 13, TP. 19 RGE. 3 E.P.M., W. 1/2 SEC. 7 and S.W. 1/4 SEC. 18 TP. 19 RGE. 4 E.P.M., and Government Road Allowance (closed)

Being part of Parcel B Plan No. 23108 and part of Plan No. 24873

R.M. OF GIMLI

MANITOBA

SCALE 1:3000

0 15 30 50 100 200 300

NOTES

All distances are in metres or decimals of a metre and may be converted to feet by multiplying by 3.28084
Survey monuments found on the ground are described and shown thus _ O
Iron posts 0.025 x 0.025 x 0.914, marked M.L.S., S.B., are placed at all points shown thus _ _ _ _ _ _ _ _ ■
Portions affected by this plan is shown bordered thus _
All plans referred to are on record in The Winnipeg Land Titles Office.
Due to the existing conditions the survey represented is not integrated.

AFFIDAVIT

I, Dewey Michael Roger Haplock, of the City of Winnipeg, Manitoba Land Surveyor, make oath and say that I did personally superintend the survey represented by this plan, that the survey was made between the dates of October 24 and October 27, 1994, and that the survey and plan are correct and true to the best of my knowledge and belief.

[redacted] M.L.S.

Sworn to before me at Winnipeg
this 9th day of December A.D. 1994
[redacted]
under The Land Surveyors Act

APPROVALS

Approved and Confirmed
this 14th day of December A.D. 1994
[redacted]

REGISTRATION

Entered and filed in the Winnipeg Land Titles Office this 3rd day of February A.D. 1995 as PLAN No. 31970

[redacted] District Registrar

Registration No. 1882895

EXAMINER OF SURVEYS

This Approval is Valid for 12 months unless registered.
Approved
this 3rd day of February [redacted]
Re-Approved _ _ _ _ _ _ _ _ _
Re-Approved _ _ _ _ _ _ _ _ _

PROVINCE OF MANITOBA
LAND INFORMATION CENTRE
SURVEY SERVICES
1007 CENTURY STREET
WINNIPEG MB.

F.B. 25337 File 634_GS/LAB_94

#1
PLAN 31970
FEE: #70.00
LAND ACQUISITION
661

1959999

APPENDIX

C GWDRILL LOGS

Location: NE-12-19-3E

Well_PID: 1041
Owner: UNKNOWN
Driller: MANITOBA GOVERNMENT
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 638114.6840
UTMY: 5609562
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1912 Apr 30

WELL LOG

From (ft.)	To (ft.)	Log
0	20.0	CLAY
20.0	40.0	HEAVY BLUE CLAY
40.0	84.9	CLAY AND STONES
84.9	89.9	CLAY, STONES, SAND
89.9	118.9	CLAY AND STONES
118.9	125.9	LIMESTONE AND SAND, WATER

No construction data for this well.

Top of Casing: 0 ft. below ground

No pump test data for this well.

REMARKS

GROUND LEVEL ELEV EST 735 FT

Location: NE-13-19-3E

Well_PID: 3524
Owner: DEPT OF TRANSPORT
Driller: HI-RATE DRILLING LTD.
Well Name:
Well Use: TEST WELL
Water Use:
UTMX: 638062.4450
UTMY: 5611205.04
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1941 Jun 01

WELL LOG

From (ft.)	To (ft.)	Log
0	13.0	WHITE YELLOWISH CLAY
13.0	45.0	SOFT AND STICKY BLUE CLAY
45.0	56.0	BLUE CLAY AND SOFT THIN STREAKS OF LIMESTONE
56.0	77.9	MEDIUM HARD LIMESTONE AND DOLOMITE
77.9	89.9	LIMESTONE AND CLAY STREAKS
89.9	90.9	HARD LIMESTONE
90.9	109.9	MEDIUM HARD LIMESTONE AND DOLOMITE
109.9	111.9	VERY HARD LIMESTONE AND DOLOMITE

No construction data for this well.

Top of Casing: 0 ft. below ground

No pump test data for this well.

REMARKS

1550 FT W OF SEC LINE, GROUND LEVEL ELEV EST 740 FT, FORMATION TOO HARD FOR DRILL RIG USED

Location: NE13-19-3E

Well_PID: 197774
Owner: RURAL MUNICIPALITY OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name:
Well Use: TEST WELL
Water Use: DOMESTIC,PUBLIC/SEMI-PUBLIC,COMM/INDUST
UTMX: 637990.9430
UTMY: 5611345.7740
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 Apr 19

WELL LOG

From (ft.)	To (ft.)	Log
0	6.0	BROWN TILL
6.0	23.0	GREY CLAY
23.0	127.0	GREY TILL
127.0	236.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	129.0	BOREHOLE	7.88				
0	129.0	CASING	5.00	5.50		INSERT	PVC
129.0	236.0	OPEN HOLE	4.75				
0	129.0	SURFACE SEAL				HOLEPLUG	BENTONITE

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 2017 Apr 19
Pumping Rate: 52.005 Imp. gallons/minute
Water level before pumping: 21.9 ft. below ground
Pumping level at end of test: 22.4 ft. below ground
Test duration: 1 hours, minutes
Water temperature: ?? degrees F

REMARKS

62 2ND AVENUE, P.O. BOX 1296, GIMLI MB, R0C 1B0. AIR LIFTING.
CONVERTED TO 12 INCH STEEL CASED PRODUCTION WELL.

Location: NE13-19-3E

Well_PID: 195108
Owner: TOWN OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: DOMESTIC,PUBLIC/SEMI-PUBLIC,COMM/INDUST
UTMX: 637990.9430
UTMY: 5611345.7740
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 May 25

WELL LOG

From (ft.)	To (ft.)	Log
0	6.0	BROWN TILL
6.0	23.0	GREY CLAY
23.0	127.0	GREY TILL
127.0	236.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	129.0	BOREHOLE	12.00	12.75		WELDED	STEEL
129.0	240.0	OPEN HOLE					

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 2017 May 25
Rate: ?? Imp. gallons/minute
Water level before pumping: 21.9 ft. below ground
Pumping level at end of test: ?? ft. below ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

REMARKS

WITN:000130; AIR LIFTING.

Location: NE13-19-3E

Well_PID: 134983
Owner: FAROEX
Driller: Interlake Water Supply
Well Name:
Well Use: PRODUCTION
Water Use: Industrial
UTMX: 638062.4450
UTMY: 5611205.04
Accuracy XY:
UTMZ:
Accuracy Z:
Date Completed: 2005 Aug 09

WELL LOG

From (ft.)	To (ft.)	Log
0	1.0	TOPSOIL
1.0	34.0	SILTY CLAY
34.0	114.0	SOFT GREY TILL WITH GRAVEL LAYERS
114.0	200.0	BROWN LIMESTONE
200.0	205.0	YELLOW LIMESTONE
205.0	222.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	134.0	CASING	6.00			INSERT	PVC
134.0	222.0	OPEN HOLE	5.80				
		CASING GROUT				CEMENT	

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 2005 Aug 09
Pumping Rate: 300.000 Imp. gallons/minute
Water level before pumping: 22.0 ft. below ground
Pumping level at end of test: 48.0 ft. below ground
Test duration: 3 hours, minutes
Water temperature: ?? degrees F

Location: NE13-19-3E

Well_PID: 197776
Owner: RURAL MUNICIPALITY OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name: (TH-02) MIDDLE MONITORING WELL
Well Use: TEST WELL
Water Use: PUBLIC/SEMI-PUBLIC
UTMX: 638375.7730
UTMY: 5611107.8120
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 Feb 14

WELL LOG

From (ft.)	To (ft.)	Log
0	11.0	BROWN TILL
11.0	21.0	GREY CLAY
21.0	73.0	GREY TILL
73.0	121.0	BROWN ROCKY TILL
121.0	216.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	123.0	BOREHOLE		7.88			
0	123.0	CASING	5.00	5.50		INSERT	PVC
123.0	216.0	OPEN HOLE		4.75			
0	123.0	SURFACE SEAL				HOLEPLUG	BENTONITE

Top of Casing: 2.000 ft. above ground

PUMPING TEST

Date: 2017 Feb 14
Pumping Rate: 100.000 Imp. gallons/minute
Water level before pumping: 20.7 ft. below ground
Pumping level at end of test: 21.4 ft. below ground
Test duration: 1 hours, minutes
Water temperature: ?? degrees F

REMARKS

62 2ND AVENUE, P.O. BOX 1296, GIMLI MB, R0C 1B0. AIR LIFTING. TEST WELL USED AS MONITORING WELL.

Location: NE13-19-3E

Well_PID: 197778
Owner: RURAL MUNICIPALITY OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name: (TH-03) NORTH MONITORING WELL
Well Use: TEST WELL
Water Use: PUBLIC/SEMI-PUBLIC
UTMX: 638344.3160
UTMY: 5611200.4410
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 Feb 15

WELL LOG

From (ft.)	To (ft.)	Log
0	4.0	FILL
4.0	23.0	BROWN TILL
23.0	35.0	GREY CLAY
35.0	82.0	GREY TILL
82.0	138.0	BROWN TILL
138.0	216.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	140.0	BOREHOLE		7.88			
0	140.0	CASING	5.00	5.50		INSERT	PVC
140.0	216.0	OPEN HOLE		4.75			
0	140.0	SURFACE SEAL				HOLEPLUG	BENTONITE

Top of Casing: 2.502 ft. above ground

PUMPING TEST

Date: 2017 Feb 15
Pumping Rate: 100.000 Imp. gallons/minute
Water level before pumping: 23.6 ft. below ground
Pumping level at end of test: 24.6 ft. below ground
Test duration: 1 hours, minutes
Water temperature: ?? degrees F

REMARKS

62 2ND AVENUE, P.O. BOX 1296, GIMLI MB, R0C 1B0 . AIR LIFTING. TEST WELL USED AS MONITORING WELL.

Location: NE13-19-3E

Well_PID: 100587
Owner: RM OF GIMLI
Driller: Stasiuk & Sons Drilling Inc.
Well Name: FAROEX MAIN WELL
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 638062.5010
UTMY: 5611198.61
Accuracy XY: 5 GENERAL [1KM-8KM] [WITHIN TOWNSHIP]
UTMZ:
Accuracy Z: UNKNOWN
Date Completed: 1996 Aug 22

WELL LOG

From (ft.)	To (ft.)	Log
0	115.0	SANDY TILL AND BOULDERS
115.0	130.0	GRAVEL, SAND AND LOOSE ROCK
130.0	222.0	BROWN ROCK

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	131.5	CASING	6.00				BLACK IRON
131.5	222.0	OPEN HOLE					

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 1996 Aug 22
Pumping Rate: 270.000 Imp. gallons/minute
Water level before pumping: 24.1 ft. below ground
Pumping level at end of test: 34.6 ft. below ground
Test duration: 2 hours, minutes
Water temperature: ?? degrees F

Location: NE13-19-3E

Well_PID: 197772
Owner: RURAL MUNICIPALITY OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name: NORTH WELL
Well Use: TEST WELL
Water Use: PUBLIC/SEMI-PUBLIC
UTMX: 638099
UTMY: 5611299.6670
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 Apr 18

WELL LOG

From (ft.)	To (ft.)	Log
0	8.0	BROWN TILL
8.0	29.0	GREY CLAY
29.0	132.0	GREY TILL
132.0	237.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	134.0	BOREHOLE	7.88				
0	134.0	CASING	5.00	5.50		INSERT	PVC
134.0	237.0	OPEN HOLE	4.75				
0	134.0	SURFACE SEAL				HOLEPLUG	BENTONITE

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 2017 Apr 18
Pumping Rate: 52.005 Imp. gallons/minute
Water level before pumping: 20.5 ft. below ground
Pumping level at end of test: 21.2 ft. below ground
Test duration: 1 hours, minutes
Water temperature: ?? degrees F

REMARKS

WITN:000129; 62 2ND AVENUE, P.O. BOX 1296, GIMLI MB, R0G 1B0. AIR LIFTING. CONVERTED TO 12 INCH STEEL CASED PRODUCTION WELL.

Location: NE13-19-3E

Well_PID: 197771
Owner: RURAL MUNICIPALITY OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name: NORTH WELL
Well Use: PRODUCTION
Water Use: PUBLIC/SEMI-PUBLIC
UTMX: 638099
UTMY: 5611299.6670
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 Apr 18

WELL LOG

From (ft.)	To (ft.)	Log
0	8.0	BROWN TILL
8.0	29.0	GREY CLAY
29.0	132.0	GREY TILL
132.0	240.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	134.0	CASING	12.00	12.75			STEEL
134.0	240.0	OPEN HOLE	10.63				
0	134.0	BOREHOLE		12.88			

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 2017 Apr 18
Pumping Rate: 650.000 Imp. gallons/minute
Water level before pumping: 20.5 ft. below ground
Pumping level at end of test: 29.4 ft. below ground
Test duration: 1 hours, minutes
Water temperature: ?? degrees F

REMARKS

WITN:000129; 62 2ND AVENUE, P.O. BOX 1296M GIMLI MB, R0G 1B0. AIR LIFTING. REPORT BY FRIESEN DRILLERS. Q: 433 USGPM PI: 100 FT.

Location: NE13-19-3E

Well_PID: 197773
Owner: RURAL MUNICIPALITY OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name: SOUTH WELL
Well Use: PRODUCTION
Water Use: PUBLIC/SEMI-PUBLIC
UTMX: 637990.9430
UTMY: 5611345.7740
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 May 25

WELL LOG

From (ft.)	To (ft.)	Log
0	6.0	BROWN TILL
6.0	23.0	GREY CLAY
23.0	127.0	GREY TILL
127.0	240.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	129.0	CASING	12.00	12.75			STEEL
129.0	240.0	OPEN HOLE	10.63				

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 2017 Jun 01
Pumping Rate: 650.000 Imp. gallons/minute
Water level before pumping: 20.6 ft. below ground
Pumping level at end of test: 29.4 ft. below ground
Test duration: 24 hours, minutes
Water temperature: ?? degrees F

REMARKS

WITN:000130; 62 2ND AVENUE, P.O. BOX 1296, GIMLI MB, R0C 1B0. AIR LIFTING. REPORT BY FRIESEN DRILLERS. Q: 433 USGPM PI: 100 FT.

Location: NE13-19-3E

Well_PID: 195109
Owner: TOWN OF GIMLI
Driller: Friesen Drillers Ltd.
Well Name: SOUTH WELL
Well Use: PRODUCTION
Water Use: DOMESTIC,PUBLIC/SEMI-PUBLIC,COMM/INDUST
UTMX: 638099
UTMY: 5611299.6670
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 228
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2017 May 18

WELL LOG

From (ft.)	To (ft.)	Log
0	8.0	BROWN TILL
8.0	29.0	GREY CLAY
29.0	132.0	GREY TILL
132.0	240.0	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	134.0	BOREHOLE	12.00	12.75		WELDED	STEEL
134.0	203.0	OPEN HOLE	10.63				
203.0	240.0	OPEN HOLE	10.00				

Top of Casing: 1.502 ft. above ground

PUMPING TEST

Date: 2017 May 18
Pumping Rate: ?? Imp. gallons/minute
Water level before pumping: 20.5 ft. below ground
Pumping level at end of test: ?? ft. below ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

REMARKS

WITN:000129; AIR LIFTING.

Location: NE13-19-3E

Well_PID: 11542
Owner: RM OF GIMLI
Driller: PRUDEN DRILLING CO. LTD.
Well Name: WELL NO. 1
Well Use: PRODUCTION
Water Use: Municipal
UTMX: 638384
UTMY: 5611173
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ:
Accuracy Z:
Date Completed: 1968 Dec 01

WELL LOG

From (ft.)	To (ft.)	Log
0	30.0	CLAY
30.0	131.9	TILL
131.9	133.9	FRACTURED LIMESTONE
133.9	149.9	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	149.9	casing	10.00				

Top of Casing: 0 ft. below ground

PUMPING TEST

Date: 1968 Dec 01
Pumping Rate: 336.860 Imp. gallons/minute
Water level before pumping: 25.0 ft. below ground
Pumping level at end of test: 28.0 ft. below ground
Test duration: 12 hours, minutes
Water temperature: ?? degrees F

REMARKS

GIMLI INDUSTRIAL PARK/ASPEN PARK - PUBLIC WATER SYSTEM WELL (COMMUNITY CODE 75.00). WELL LOCATED AT FORMER CANADIAN FORCES BASE, GIMLI. WELL LOCATED IN BASEMENT OF WATER TREATMENT PLANT. WELL INVENTORY/GPS COMPLETED BY WRB IN JUNE 2006. PREVIOUS OWNER - DEPT. OF DEFENCE.

Location: NE13-19-3E

Well_PID: 136763
Owner: RM OF GIMLI
Driller: UNKNOWN
Well Name: WELL NO. 2
Well Use: PRODUCTION
Water Use: Municipal
UTMX: 638355
UTMY: 5611196
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ:
Accuracy Z:
Date Completed: 1940 Jan 01

No well log data for this well.

No construction data for this well.

Top of Casing:

No pump test data for this well.

REMARKS

GIMLI INDUSTRIAL PARK/ASPEN PARK - PUBLIC WATER SYSTEM WELL (COMMUNITY CODE 75.00). WELL LOCATED AT FORMER CANADIAN FORCES BASE, GIMLI. WELL LOCATED IN SOFTENING PLANT. WELL INVENTORY/GPS COMPLETED BY WRB IN JUNE 2006. NO WELL LOG AVAILABLE. DRILL DATE UNKNOWN, BUT LIKELY IN THE 1940'S.

Location: NW13-19-3E

Well_PID: 54527
Owner: GIMLI DRAGWAYS
Driller: Ford Drilling Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 637307
UTMY: 5611284
Accuracy XY: 3 ACCURATE [50-350M] [WITHIN 1/4-SECTION]
UTMZ: 229
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 1985 Sep 10

WELL LOG

From (ft.)	To (ft.)	Log
0	24.0	CLAY
24.0	112.0	TILL; SILTY
112.0	137.0	LIMESTONE; MEDIUM, HARD
137.0	162.0	FRACTURED LIMESTONE
162.0	173.0	LIMESTONE; MEDIUM, HARD
173.0	181.0	SHALE
181.0	230.0	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	119.9	casing	4.00			INSERT	GALVANIZED
119.9	184.9	casing	2.00			T & C	GALVANIZED
184.9	229.8	open hole	2.00				

Top of Casing: 0 ft. below ground

PUMPING TEST

Date: 1985 Sep 17
Pumping Rate: 29.987 Imp. gallons/minute
Water level before pumping: 0 ft. below ground
Pumping level at end of test: 22.0 ft. below ground
Test duration: 5 hours, minutes
Water temperature: ?? degrees F

Location: NW13-19-3E

Well_PID: 54526
Owner: GIMLI DRAGWAYS
Driller: Ford Drilling Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 637307
UTMY: 5611284
Accuracy XY: 3 ACCURATE [50-350M] [WITHIN 1/4-SECTION]
UTMZ: 229
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 1985 Sep 11

WELL LOG

From (ft.)	To (ft.)	Log
0	28.0	CLAY
28.0	109.9	TILL; SILTY
109.9	117.9	LIMESTONE; SOFT, FRACTURED
117.9	136.9	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	120.9	casing	4.00			INSERT	GALVANIZED
120.9	136.9	open hole	3.80				

Top of Casing: 2.000 ft. above ground

PUMPING TEST

Date: 1985 Sep 11
Pumping Rate: 19.987 Imp. gallons/minute
Water level before pumping: 0 ft. below ground
Pumping level at end of test: 20.0 ft. below ground
Test duration: 3 hours, minutes
Water temperature: ?? degrees F

Location: NW-13-19-3E

Well_PID: 7617
Owner: B A C M
Driller: KARL STASIUK AND SON
Well Name:
Well Use: PRODUCTION
Water Use: Industrial
UTMX: 637272.6280
UTMY: 5611183.42
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1965 Jul 09

WELL LOG

From (ft.)	To (ft.)	Log
0	7.0	BROWN SANDY CLAY
7.0	18.0	PUTTY DARK GREY CLAY
18.0	40.0	SOFT PUTTY, DARK GREY CLAY
40.0	66.0	SOFT GREY CLAY, FEW PEBBLES
66.0	70.0	GREY CLAY AND PEBBLES
70.0	78.9	HARDER GREY CLAY, LOTS OF PEBBLES
78.9	81.9	HARDPAN AND BOULDERS
81.9	88.9	RED GRANITE BOULDER
88.9	107.9	HARDPAN WITH BOULDERS, SAND AND GRAVEL
107.9	114.9	SOFT BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	107.9	casing	4.00				
107.9	114.9	open hole					

Top of Casing: 0 ft. below ground

PUMPING TEST

Date: 1965 Jul 09
Pumping Rate: 29.987 Imp. gallons/minute
Water level before pumping: 28.0 ft. below ground
Pumping level at end of test: 29.0 ft. below ground
Test duration: 2 hours, minutes
Water temperature: 41.000 degrees F

REMARKS

54 FT S OF FRAZERWOOD RD + 130 FT E OF N/S RD ALLOW GROUND LEVEL ELEV EST 745 FT

Location: NW13-19-3E

Well_PID: 100588
Owner: RM OF GIMLI
Driller: Stasiuk & Sons Drilling Inc.
Well Name: FAROEX RETURN WELL
Well Use: RECHARGE
Water Use:
UTMX: 637272.6280
UTMY: 5611183.42
Accuracy XY: 4 FAIR [350M-1KM] [WITHIN SECTION]
UTMZ:
Accuracy Z: UNKNOWN
Date Completed: 1996 Aug 29

WELL LOG

From (ft.)	To (ft.)	Log
0	138.0	SANDY TILL AND BOULDERS
138.0	158.0	GRAVEL, SAND AND BROKEN ROCK
158.0	200.0	BROWN ROCK
200.0	205.0	YELLOW ROCK AND SAND

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	159.0	CASING	6.00				BLACK IRON
159.0	205.0	OPEN HOLE					

Top of Casing: 2.000 ft. above ground

PUMPING TEST

Date: 1996 Aug 29
Pumping Rate: ?? Imp. gallons/minute
Water level before pumping: 24.1 ft. below ground
Pumping level at end of test: ?? ft. below ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

REMARKS

POTENTIAL ERROR IN INFORMATION REGARDING THIS WELL BEING SEALED

Location: SE-13-19-3E

Well_PID: 3525
Owner: DEPT OF TRANSPORT
Driller: HI-RATE DRILLING LTD.
Well Name:
Well Use: TEST WELL
Water Use:
UTMX: 638089.28
UTMY: 5610395.33
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1941 Jun 01

WELL LOG

From (ft.)	To (ft.)	Log
0	11.0	YELLOWISH WHITE CLAY
11.0	59.0	VERY STICKY BLUE CLAY
59.0	91.9	LIMESTONE AND CLAY STREAKS
91.9	96.9	LIGHT BLUE CLAY
96.9	108.9	LIMESTONE AND CLAY
108.9	109.9	LIMESTONE AND DOLOMITE
109.9	131.9	LIMESTONE AND CLAY STREAKS
131.9	132.9	VERY HARD DOLOMITE

No construction data for this well.

Top of Casing: 0 ft. below ground

No pump test data for this well.

REMARKS

GROUND LEVEL ELEV EST 735 FT, HOLE WAS ABANDONED AS DRILLING RIG WAS NOT HEAVY ENOUGH

Location: SW-13-19-3E

Well_PID: 7618
Owner: R C A F STATION
Driller: KARL STASIUK AND SON
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 637293.1620
UTMY: 5610376.55
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1965 Jul 27

WELL LOG

From (ft.)	To (ft.)	Log
0	9.0	BROWN SANDY CLAY
9.0	34.0	SOFT BLUE CLAY
34.0	73.0	SOFT GREY CLAY WITH GRAVEL
73.0	107.9	HARDPAN AND PEBBLES
107.9	112.9	HARDPAN WITH GRAVEL, PEBBLES
112.9	124.4	GRAVEL, SAND, AND PEBBLES
124.4	132.9	HARD GREY LIMESTONE
132.9	133.9	SOFT GREY LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	124.9	casing	4.00				
124.9	133.9	open hole					

Top of Casing: 0 ft. below ground

PUMPING TEST

Date: 1965 Jul 27
Pumping Rate: 29.987 Imp. gallons/minute
Water level before pumping: 22.0 ft. below ground
Pumping level at end of test: 22.0 ft. below ground
Test duration: 7 hours, minutes
Water temperature: ?? degrees F

REMARKS
GROUND LEVEL ELEV EST 740 FT

Location: NE7-19-4E

Well_PID: 115145
Owner: JERRY ROSHICH
Driller: Ford Drilling Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 639749.1020
UTMY: 5609605.83
Accuracy XY:
UTMZ:
Accuracy Z:
Date Completed: 2000 May 09

WELL LOG

From (ft.)	To (ft.)	Log
0	2.0	LIMESTONE FILL
2.0	20.0	CLAY
20.0	45.0	SOFT TILL
45.0	65.0	TILL
65.0	117.0	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	68.0	CASING	2.00			T & C	STEEL
68.0	117.0	OPEN HOLE					

Top of Casing: 4.000 ft. above ground

PUMPING TEST

Date: 2000 May 09
Flowing Rate: 20.000 Imp. gallons/minute
Water level before pumping: 5.0 ft. above ground
Pumping level at end of test: 5.0 ft. above ground
Test duration: ??? hours, ?? minutes
Water temperature: ?? degrees F

Location: NW-7-19-4E

Well_PID: 56698
Owner: DIMAR TRAINING SYS
Driller: Stasiuk & Sons Drilling Inc.
Well Name:
Well Use: PRODUCTION
Water Use: Industrial
UTMX: 638944.7530
UTMY: 5609584.18
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1986 Apr 15

WELL LOG

From (ft.)	To (ft.)	Log
0	19.0	CLAY; BROWN
19.0	30.0	CLAY; GREY
30.0	98.9	TILL; GREY
98.9	108.9	GRAVEL AND SAND
108.9	112.9	BOULDER
112.9	140.9	GRAVEL AND SAND
140.9	150.9	BROWN LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	142.4	casing	4.25			INSERT	BLACK IRON
142.2	150.9	open hole	4.00				

Top of Casing: 1.498 ft. below ground

PUMPING TEST

Date: 1986 Apr 15
Pumping Rate: 0 Imp. gallons/minute
Water level before pumping: 15.0 ft. below ground
Pumping level at end of test: 17.0 ft. below ground
Test duration: hours, minutes
Water temperature: ?? degrees F

Location: SE-7-19-4E

Well_PID: 22012
Owner: G KMET
Driller: KARL STASIUK AND SON
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 639774.7060
UTMY: 5608810.83
Accuracy XY: UNKNOWN
UTMZ:
Accuracy Z:
Date Completed: 1974 Jun 08

WELL LOG

From (ft.)	To (ft.)	Log
0	18.0	DARK BROWN CLAY
18.0	95.9	GREY STONY TILL
95.9	115.9	GRAVEL& SAND
115.9	120.9	SAND
120.9	127.9	ROCK

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	120.9	casing	4.50				GALVANIZED
120.9	127.9	open hole	4.00				

Top of Casing: 0 ft. below ground

PUMPING TEST

Date:
Pumping Rate: 29.987 Imp. gallons/minute
Water level before pumping: 14.0 ft. below ground
Pumping level at end of test: 19.0 ft. below ground
Test duration: 2 hours, minutes
Water temperature: ?? degrees F

Location: SW7-19-4E

Well_PID: 161979
Owner: MKA KARTING, GIMLI RACE TRACK
Driller: Perimeter Drilling Ltd.
Well Name:
Well Use: PRODUCTION
Water Use: Domestic
UTMX: 638582
UTMY: 5609127
Accuracy XY: 1 EXACT [<5M] [GPS]
UTMZ: 225
Accuracy Z: 4 FAIR - Shuttle at Centroid
Date Completed: 2010 May 25

WELL LOG

From (ft.)	To (ft.)	Log
0	25.0	CLAY
25.0	32.0	TILL
32.0	34.0	BOULDERS
34.0	120.0	LIMESTONE
120.0	130.0	LIMESTONE

WELL CONSTRUCTION

From (ft.)	To (ft.)	Casing Type	Inside Dia.(in)	Outside Dia.(in)	Slot Size(in)	Type	Material
0	122.0	CASING	5.00			INSERT	PVC
122.0	130.0	OPEN HOLE	4.50				
		CASING GROUT					

Top of Casing: 1.000 ft. above ground

PUMPING TEST

Date: 2010 May 25
Pumping Rate: 100.000 Imp. gallons/minute
Water level before pumping: 8.0 ft. below ground
Pumping level at end of test: 25.0 ft. below ground
Test duration: hours, 45 minutes
Water temperature: ?? degrees F

REMARKS
GIMLI, MB.

APPENDIX

D TABLES

Table 5.1 R.M. of Gimli Historic and Current Biosolids Analysis

Analyte	Units	Results		
		2014	2019	2020
Total Kjeldahl Nitrogen	%	4.27	5.96	6.7
Total Nitorgen	%	-	6.2	6.92
Ammonia as N	lbs/ton	0.66	-	-
Available Ammonium-N	mg/kg	-	5630	4910
Available Nitrate-N	mg/kg	10.9	<42	34.4
Available Phosphate-P	mg/kg	-	4730	-
Organic Matter	%	-	57.1	-
Total Organic Carbon	%	-	33.5	-
Total Inorganic Carbon	%	-	1.22	-
Total Carbon by Combustion	%	-	34.7	-
Moisture	(%)			85.4
Total Solids	%	40.5	-	14.6
Detailed Salinity				
Total Volatile Solids (paste)	%	81.2	-	-
Conductivity Sat. Paste	dS/m	0.849	2.96	-
Sodium Absorption Ratio	-		1.31	
% Saturation	-		1200	
Calcium (Wet)	mg/kg		550	
Magnesium (Wet)	mg/kg		960	
Sodium (Wet)	mg/kg		760	
Chloride (Wet)	mg/kg		-	
Potassium (Wet)	mg/kg		1380	
Sulfate-S (Wet)	mg/kg		210	
pH	-	7.53	7.44	-
Metals				
Aluminum (Al)	mg/kg	25700	-	18900
Antimony (Sb)	mg/kg	0.89	-	0.49
Arsenic (As)	mg/kg	9.56	-	11.0
Barium (Ba)	mg/kg	545	-	195
Beryllium (Be)	mg/kg	0.22	-	0.17
Bismuth (Bi)	mg/kg	22.5		10.8
Boron (B)	mg/kg	21	29.5	16.5
Cadmium (Cd)	mg/kg	1.42	-	0.491
Calcium (Ca)	mg/kg	37300	550	18400
Chromium (Cr)	mg/kg	23.5	-	25.1
Cobalt (Co)	mg/kg	3.14	-	1.84
Copper (Cu)	mg/kg	481	-	1650
Iron (Fe)	mg/kg	9550	-	6510
Lead (Pb)	mg/kg	20.8	-	10.4
Lithium (Li)	mg/kg	-	-	<2.0
Magnesium (Mg)	mg/kg	15700	960	9400
Manganese (Mn)	mg/kg	137	-	79.7
Mercury (hg) Total	mg/kg	1.25	-	0.299

Table 5.1 R.M. of Gimli Historic and Current Biosolids Analysis

Analyte	Units	Results		
		2014	2019	2020
Molybdenum (Mo)	mg/kg	6.44	-	16.7
Nickel (Ni)	mg/kg	18.6	-	15.4
Phosphorus (P)	mg/kg	28200	-	18100
Potassium (K)	mg/kg	2940	1380	2800
Selenium (Se)	mg/kg	5.86	-	3.19
Silver (Ag)	mg/kg	2.62	-	0.91
Sodium (Na)	mg/kg	658	760	1780
Strontium (Sr)	mg/kg	270	-	189
Sulphur	mg/kg	-	210	11600
Thallium (Tl)	mg/kg	0.12	-	0.054
Tin (Sn)	mg/kg	22.3	-	11.3
Titanium (Ti)	mg/kg	108	-	30.6
Tungsten (W)	mg/kg	-	-	<0.50
Uranium (U)	mg/kg	4.84	-	2.96
Vanadium (V)	mg/kg	14.1	-	2.52
Zinc (Zn)	mg/kg	904	-	44.7
Zironium (Zr)	mg/kg	-	-	16.5

Table 5.2 R.M of Gimli Soil Analytical Results for Receiving Land Test Pit Locations

Sample Location			TP01			TP02			TP03			
UTM Coordinates			14U 0637557 5611376			14U 0637789 5610775			14U 0638836 5609302			
	Depth (inches)		0 - 6	6 - 24	24 - 60	0 - 6	6 - 24	24 - 60	0 - 6	6 - 24	24 - 60	60 - 72
Parameter	Analytical	Units										
Particle Size	Sand	%	24	26	7	20	18	8	18	22	9	<1.0
	Silt		66	55.6	63	52.4	60	56	46	54	43	16
	Clay		10	18.4	30	27.6	22	36	36	24	48	84
	Texture		Silt Loam	Silt Loam	Silty Clay Loam	Silty Clay Loam / Clay Loam	Silt Loam	Silty Clay Loam	Silty Clay Loam	Silt Loam	Silty Clay	Clay
Nutrients	Total Kjeldahl Nitrogen	%	0.236	<0.020	-	0.147	<0.02	-	0.172	0.053	-	-
	Total Nitrogen		0.219	<0.020	-	0.128	<0.02	-	-	0.05	-	-
	Available Ammonium	mg/kg	1	<1.0	-	1.6	<1.0	-	3.3	1.6	-	-
	Nitrate-N		8.8	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-	-
	Available Phosphate-P		9.7	-	-	1.6	-	-	7.8	-	-	-
	Available Potassium		120	-	-	94	-	-	164	-	-	-
	Available Sulfate-S		5.4	-	-	4	-	-	<4.0	-	-	-
Metals	Aluminum (Al)	mg/kg	8280	-	-	13300	-	-	17600	-	-	-
	Antimony (Sb)		0.1	-	-	0.1	-	-	0.15	-	-	-
	Arsenic (As)		1.83	-	-	2.1	-	-	3.3	-	-	-
	Barium (Ba)		65.4	-	-	93.7	-	-	125	-	-	-
	Beryllium (Be)		0.29			0.47			0.63			
	Boron (B)*		0.46	-	-	0.64	-	-	0.52	-	-	-
	Bismuth (Bi)		<0.2	-	-	<0.20	-	-	<0.20	-	-	-
	Cadmium (Cd)		0.173	-	-	0.189	-	-	0.146	-	-	-
	Calcium (Ca)		89300	-	-	90300	-	-	61700	-	-	-
	Chromium (Cr)		16.6	-	-	27.1	-	-	35.4	-	-	-
	Cobolt (Co)		4.28	-	-	6.36	-	-	8.89	-	-	-
	Copper (Cu)		8.34	-	-	13.9	-	-	19.3	-	-	-
	Iron (Fe)		9460	-	-	14400	-	-	18900	-	-	-
	Lead (Pb)		4.96	-	-	6.38	-	-	8.85	-	-	-
	Lithium (Li)		9	-	-	16	-	-	20.3	-	-	-
	Magnesium (Mg)		48400	-	-	46300	-	-	33300	-	-	-
	Manganese (Mn)		361	-	-	370	-	-	468	-	-	-
	Mercury (Hg)		0.0199			0.0222			0.0238			
	Molybdenum (Mo)		0.25	-	-	0.28	-	-	0.52	-	-	-
	Nickel (Ni)		11	-	-	18.3	-	-	25.9	-	-	-
	Phosphorus (P)		682	-	-	511	-	-	600	-	-	-
	Potassium (K)		1550	-	-	2660	-	-	3860	-	-	-
	Selenium (Se)		0.25	-	-	0.21	-	-	0.22	-	-	-
	Silver (Ag)		<0.1	-	-	<0.1	-	-	<0.1	-	-	-
	Sodium (Na)		122	-	-	188	-	-	245	-	-	-
	Strontium (Sr)		46	-	-	56.5	-	-	45.4	-	-	-
	Sulfur (S)		<1000	-	-	<1000	-	-	<1000	-	-	-
	Thallium (Ti)		0.097	-	-	0.152	-	-	0.217	-	-	-
	Tin (Sn)		<1.0	-	-	<1.0	-	-	<1.0	-	-	-
	Titanium (Ti)		170	-	-	318	-	-	386	-	-	-
	Tungsten (W)		<0.50	-	-	<0.50	-	-	<0.50	-	-	-
	Uranium (U)		0.644	-	-	0.915	-	-	0.741	-	-	-
	Vanadium (V)		20.2	-	-	29.8	-	-	38.8	-	-	-
	Zinc (Zn)		26.3	-	-	39.5	-	-	56.7	-	-	-
	Zirconium (Zr)		1.7	-	-	3.2	-	-	4.6	-	-	-
Basic Salinity	Calcium (Ca)	mg/L	47.8	-	-	41.7	-	-	60.9	-	-	-
	Potassium (K)		5.4	-	-	<5.0	-	-	<5.0	-	-	-
	Magnesium (Mg)		26.1	-	-	37.1	-	-	26.9	-	-	-
	Sodium (Na)		<5.0	-	-	13.5	-	-	9.9	-	-	-
	Sodium Absorption Ratio		<0.1	-	-	0.37	-	-	0.27	-	-	-
	Electrical Conductivity	dS/m	0.4	-	-	0.46	-	-	0.46	-	-	-
	% Saturation	%	61.3	-	-	58.9	-	-	64.8	-	-	-
	pH in Saturated Paste		7.96	-	-	8.13	-	-	7.82	-	-	-

Notes: *Hotwater Extraction

Table 5.3 RM of Gimli Biosolids and Application Field Trace Metal Content

Trace Element	Biosolids Trace Metals				Soil Sample Trace Metals								Application Rate (dry)	Cumulative Metal Concentration	Cumulative Weight Allowed by Guideline[2]		Applications Events Permitted before meeting applied Criteria based on Average Metal Concentrations
	2014 L1529065	2020	Mean		(TP01, 0-15cm)		(TP02, 0-15cm)		(TP03 0-15cm)		Mean						
	(mg/kg - Dry)		mg/kg Dry	(kg/T)	(mg/kg)	(kg/ha)	(mg/kg)	(kg/ha)	(mg/kg)	(kg/ha)	(mg/kg)	(kg/ha)	(kg/ha)	(kg/ha)	(mg/kg)	(kg/ha)	Count
Arsenic	9.56	11.0	10.28	0.010	1.83	3.29	2.1	3.78	3.30	5.94	2.41	4.34	0.11	4.451	12	21.6	162
Cadmium	1.42	0.491	0.96	0.001	0.173	0.31	0.189	0.34	0.15	0.26	0.17	0.30	0.01	0.315	1.4	2.5	210
Copper	481.0	1650.0	1065.50	1.066	8.34	15.01	13.9	25.02	19.30	34.74	13.85	24.92	11.72	36.645	63	113.4	8
Chromium	23.5	25.1	24.30	0.024	16.6	29.88	27.1	48.78	35.40	63.72	26.37	47.46	0.27	47.727	64	115.2	319
Lead	20.8	10.4	15.60	0.016	4.96	8.93	6.38	11.48	8.85	15.93	6.73	12.11	0.17	12.286	70	126	682
Mercury	1.3	0.299	0.77	0.001	0.02	0.04	0.02	0.04	0.02	0.04	0.02	0.04	0.01	0.048	6.6	11.9	1390
Nickle	18.6	15.4	17.00	0.017	11.00	19.80	18.30	32.94	25.90	46.62	18.40	33.12	0.19	33.307	50	90	375
Zinc	904.0	44.7	474.35	0.474	26.30	47.34	39.50	71.10	56.70	102.06	40.83	73.50	5.22	78.718	200	360	60

Notes:

[2] = Cumulative Weight Allowed by Guideline includes the metals in soils.

Inputs/Assumptions

Soil Bulk Density	1,200	kg/m3	
Sample Depth	0.15	m	
Hectare	10,000	m2/ha	
Soil Mass	1,000,000	mg/kg	
Anticipated Application Rate	11	T/ha - dry	W1/2 31-12-01W

Example of Field Prescription Application Rate, R.M. of Gimli

Date Modified: 04-Jun-20

Field ID:	Example	
Land Area Available (ac|ha):		58
Anticipated 2020 Crop	Wheat CWRS	
2020 Target Yield (bu/ac):	45	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	50	56
Fertilizer Phosphate (P2O5) total less soil residual:	24	27
1 x P2O5 Crop Removal @ target Yield:	50	56
2 x P2O5 Crop Removal @ target Yield:	100	112
3 x P2O5 Crop Removal @ target Yield:	150	168
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data

	TP01	TP01	L2386158-1	TP02	TP02	L2386158-4
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg^{-1}		kg ha^{-1}	mg kg^{-1}		kg ha^{-1}
Total Nitrogen	2190			1280		
Available Nitrate-N	08.8	1.9	26	01.9	1.9	14
Available Phosphate-P	09.7		17	1.60		3
Available Potassium	120		216	94.0		169
Available Sulfate-S	005		11	4.0		8
EC (dS/m)	0.40			0.46		

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis Pilot Project	
Estimated Biosolid Volume	In-field	m^3		17,785
Assumed Specific Gravity	As Received	g cm^{-1}		1.00
Estimated Biosolids		tonnes		17,785
Dry tonnes biosolids available (=wet tonnes x %solids)	Dried Basis	tonnes		2,597
Moisture	As Received	%	85.4	
Total Solids	As Received	%	14.6	
Organic Matter	Dry Basis	%	57.10	
Total Organic Carbon	Dry Basis	%	33.50	
C:N Ratio	Dry Basis	x:1	4.8	
C:P Ratio	Dry Basis	x:1	18.5	
N:P Ratio	Dry Basis	x:1	3.82	
pH	Saturated Paste		7.44	
Total N	Dried Basis	%	6.9	
	Dried Basis	mg kg^{-1}	69,200	
	Dried Basis	kg $Tonne^{-1}$	69.2	
Ammonium - N (NH4-N)	Dried Basis	mg kg^{-1}	4,910.00	
	Dried Basis	kg $Tonne^{-1}$	4.91	
Available Nitrate-N	Dried Basis	mg kg^{-1}	34.40	
Available Nitrate-N		kg $Tonne^{-1}$	0.034	
Total Phosphorous	Dried Basis	mg kg^{-1}	18,100	

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg^{-1}	64,290
Organic N	Dried Basis	kg $Tonne^{-1}$	64.3
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg $Tonne^{-1}$	16.1
Ammonium-nitrogen Available	Dried Basis	kg $Tonne^{-1}$	4.17
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg $Tonne^{-1}$	20.3
PAN Year 2 (@12% mineralization)	Dried Basis	kg $Tonne^{-1}$	7.7
PAN Year 3 (@6% mineralization)	Dried Basis	kg $Tonne^{-1}$	3.9
Phosphorous	Dried Basis	kg $Tonne^{-1}$	18.1
$P_2O_{5\ equivalent}$	Dried Basis	kg $Tonne^{-1}$	41.6
Total Available P_2O_5	Dried Basis	kg $Tonne^{-1}$	10.4

Application Rate based on Nitrogen				Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha^{-1}	3	**940** Ha
Amount of Available P2O5 applied	Dried Basis	kg ha^{-1}	29	2,323 Ac
P_2O_5 Application check		%	107	
Application Rate based on Phosphorous (1xCR)				**Land Area Required**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	5	**483** Ha
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	109	**1,192** Ac
		lb ac^{-1}	97	
Additional Nitrogen required		kg ha^{-1}	- 53	
		lb ac^{-1}	- 47	
Application Rate based on Phosphorous (2xCR)				**Land Area Required**
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha^{-1}	**11**	**241** Ha
Amount of Nitrogen applied	Dried Basis	kg ha^{-1}	218	**596** Ac
Additional Nitrogen required		kg ha^{-1}	- 162	

Selected Application rate based on:		**2x CR P**	
Selected Application Rate	Dried Basis	tonnes ha^{-1}	**11**
		tons ac^{-1}	**5**
	Wet Basis	tonnes ha^{-1}	80
		tons ac^{-1}	36
Estimated Biosolids Volume Applied	Wet	Tonnes	4,647
Estimated Biosolids Volume Remaining	Wet	Tonnes	13,138

Notes:

Available Ammonium N - Volatilization loss associated with different application methods (0% with Injection)

Organic N - TKN - Ammonium N

Available Organic N - Organic N x 0.20 year 1 (Ross and Racz, 2003)

Mineralization of Year 2 = 12%, Year 3 = 6%

Plant Available Nitrogen= (NO3-N)+Volatilization factor (NH4-N)+Organic N Mineralization

Estimated P2O5 Available based on 25% of total Phosphorus as directed by MSD.

Note: the biosolids are FeCl treated and fixes the majority of the total P.

Soil Phosphorous Olsen method.

* See Estimates of Ammonium-N Retained After Biosolids application

C:N exceeds 30:1, N becomes a limiting nutrient for decomposer organisms, and this can reduce the rate of decomposition and results in N immobilization

C:P ratio between 200:1 and 300:1, mineralization and immobilization balance each other to result in no net release of P from the decomposing manure. When C:P is below this range, P is released.

When animal and municipal wastes have N:P ratios ranging from 1:1 to 1:2 are applied based on N rates on soils, over time P will accumulate

APPENDIX

E CERTIFICATES OF ANALYSIS

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1529065-1 BIOSOLIDS							
Sampled By: CLIENT on 06-OCT-14 @ 12:30							
Matrix: Sludge							
Miscellaneous Parameters							
Ammonia as N	0.66		0.20	lbs/ton	16-OCT-14	16-OCT-14	R2994940
Available Nitrate-N	10.9	DLM	4.0	mg/kg	14-OCT-14	14-OCT-14	R2986329
Mercury (Hg)-Total	1.25	DLA	0.20	mg/kg	10-OCT-14	14-OCT-14	R2985548
Total Kjeldahl Nitrogen	4.27		0.020	%	14-OCT-14	15-OCT-14	R2991612
Total Solids and Total Volatile Solids							
Total Solids	40.5		0.10	%	15-OCT-14	15-OCT-14	R2991209
Total Volatile Solids (dry basis)	81.2		0.10	%	15-OCT-14	15-OCT-14	R2991209
pH and EC (1:2 Soil:Water Extraction)							
Conductivity (1:2)	0.849		0.050	dS m-1	14-OCT-14	14-OCT-14	R2984671
pH (1:2 soil:water)	7.53		0.10	pH	14-OCT-14	14-OCT-14	R2984671
Metals							
Aluminum (Al)	25700	DLA	5.0	mg/kg	10-OCT-14	15-OCT-14	R2991836
Antimony (Sb)	0.89		0.10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Arsenic (As)	9.56		0.10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Barium (Ba)	545		0.50	mg/kg	10-OCT-14	10-OCT-14	R2983668
Beryllium (Be)	0.22		0.10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Bismuth (Bi)	22.5		0.020	mg/kg	10-OCT-14	10-OCT-14	R2983668
Boron (B)	21		10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Cadmium (Cd)	1.42		0.020	mg/kg	10-OCT-14	10-OCT-14	R2983668
Calcium (Ca)	37300		100	mg/kg	10-OCT-14	10-OCT-14	R2983668
Chromium (Cr)	23.5		1.0	mg/kg	10-OCT-14	10-OCT-14	R2983668
Cobalt (Co)	3.14		0.020	mg/kg	10-OCT-14	10-OCT-14	R2983668
Copper (Cu)	481		1.0	mg/kg	10-OCT-14	10-OCT-14	R2983668
Iron (Fe)	9550		25	mg/kg	10-OCT-14	10-OCT-14	R2983668
Lead (Pb)	20.8		0.20	mg/kg	10-OCT-14	10-OCT-14	R2983668
Magnesium (Mg)	15700		10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Manganese (Mn)	137		0.50	mg/kg	10-OCT-14	10-OCT-14	R2983668
Molybdenum (Mo)	6.44		0.020	mg/kg	10-OCT-14	10-OCT-14	R2983668
Nickel (Ni)	18.6		0.50	mg/kg	10-OCT-14	10-OCT-14	R2983668
Phosphorus (P)	28200		100	mg/kg	10-OCT-14	10-OCT-14	R2983668
Potassium (K)	2940		25	mg/kg	10-OCT-14	10-OCT-14	R2983668
Selenium (Se)	5.86		0.50	mg/kg	10-OCT-14	10-OCT-14	R2983668
Silver (Ag)	2.62		0.10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Sodium (Na)	658		10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Strontium (Sr)	270		0.10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Thallium (Tl)	0.12		0.10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Tin (Sn)	22.3		5.0	mg/kg	10-OCT-14	10-OCT-14	R2983668
Titanium (Ti)	108		0.50	mg/kg	10-OCT-14	10-OCT-14	R2983668
Uranium (U)	4.84		0.020	mg/kg	10-OCT-14	10-OCT-14	R2983668
Vanadium (V)	14.1		0.50	mg/kg	10-OCT-14	10-OCT-14	R2983668
Zinc (Zn)	904		10	mg/kg	10-OCT-14	10-OCT-14	R2983668
Total Organic N - solid manure- as rec'd							
Nitrogen, Total Organic							
Total Organic Nitrogen	19.0		0.10	lbs/ton		16-OCT-14	
Total N In Solid Manure -as rec'd							
Total Nitrogen	19.7		0.10	lbs/ton	14-OCT-14	14-OCT-14	R2988828

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

20% - 40%

WSP Canada Group Limited
ATTN: DARREN KEAM
111-93 Lombard Ave
Winnipeg MB R3B 3B1

Date Received: 21-NOV-19
Report Date: 03-DEC-19 14:05 (MT)
Version: FINAL

Client Phone: 204-272-2020

Certificate of Analysis

Lab Work Order #: L2386360

Project P.O. #: 181-03988-00
Job Reference: 181-03988-00
C of C Numbers:
Legal Site Desc:

[redacted]
Judy Dalmaijer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2386360-1 GIMLI BS WSP									
Sampled By: DK on 21-NOV-19 @ 11:00									
Matrix: GRAB									
Total Carbon, TOC and TIC in soil									
Inorganic Carbon as CaCO3 Equivalent									
Inorganic Carbon (as CaCO3 Equivalent)	10.1	-		0.40	%	-		29-NOV-19	
Total Inorganic Carbon in Soil									
Inorganic Carbon	1.22	+/-0.18		0.050	%	0		29-NOV-19	R4928497
Total Organic Carbon Calculation									
Total Organic Carbon	33.5	-		0.050	%	-		29-NOV-19	
Miscellaneous Parameters									
Boron (B), Hot Water Ext.	29.5	+/-5.0	DLM	5.2	mg/kg	0	29-NOV-19	29-NOV-19	R4929553
Available Phosphate-P	4730	-	DLHC	160	mg/kg	-	29-NOV-19	29-NOV-19	R4928926
Note: Samples analyzed as received and calculated to dry									
Available Potassium	1710	+/-200	DLM	260	mg/kg	-11.8%	27-NOV-19	27-NOV-19	R4928083
Note: Samples analyzed as received and calculated to dry.									
% Saturation	1200	-		1.0	%	-	27-NOV-19	28-NOV-19	R4928008
Total Carbon by Combustion	34.7	+/-2.9		0.05	%	0	29-NOV-19	29-NOV-19	R4928917
Total Kjeldahl Nitrogen	5.96	+/-1.2	DLHC	0.60	%	0	28-NOV-19	29-NOV-19	R4928949
Total Nitrogen by LECO	6.20	+/-1.0		0.020	%	0	29-NOV-19	29-NOV-19	R4928917
Organic Matter by LOI at 375 deg C.									
Organic Matter	57.1	+/-11		1.0	%	0	28-NOV-19	29-NOV-19	R4930068
Loss on Ignition @ 375 C	72.9	+/-12		1.0	%	0	28-NOV-19	29-NOV-19	R4930068
Detail Salinity in mg/kg									
Calcium (Ca)	550	-		120	mg/kg	-		02-DEC-19	
Magnesium (Mg)	960	-		120	mg/kg	-		02-DEC-19	
Potassium (K)	1380	-		120	mg/kg	-		02-DEC-19	
Sodium (Na)	760	-		120	mg/kg	-		02-DEC-19	
Sulfur (as SO4)	210	-		120	mg/kg	-		02-DEC-19	
SAR and Cations in saturated soil									
Calcium (Ca)	46	-	DLDS	10	mg/L	-	28-NOV-19	28-NOV-19	R4928300
Potassium (K)	114	-	DLDS	10	mg/L	-	28-NOV-19	28-NOV-19	R4928300
Magnesium (Mg)	80	-	DLDS	10	mg/L	-	28-NOV-19	28-NOV-19	R4928300
Sodium (Na)	63	-	DLDS	10	mg/L	-	28-NOV-19	28-NOV-19	R4928300
SAR	1.31	-		0.10	SAR	-	28-NOV-19	28-NOV-19	R4928300
Available Ammonia-N & Nitrate-N (2N KCl)									
Available Ammonium-N									
Available Ammonium-N	5630	+/-790	DLHC	840	mg/kg	0	28-NOV-19	28-NOV-19	R4928074
Note: Samples analyzed as received and calculated to dry.									
Available Nitrate-N (2N KCl)									
Available Nitrate-N	<42	-	DLM	42	mg/kg	-	28-NOV-19	28-NOV-19	R4928348
Note: Sample analyzed as rec'd and calculated to dry									
Sat. Paste pH, EC and Sulphate									
Sulfate (SO4) in saturated soil									
Sulfur (as SO4)	18	-	DLDS	10	mg/L	-	28-NOV-19	28-NOV-19	R4928300
pH and EC (Saturated Paste)									
% Saturation	1200	+/-0.8		1.0	%	0	27-NOV-19	28-NOV-19	R4928008
pH in Saturated Paste	7.44	+/-0.06		0.10	pH	0	27-NOV-19	28-NOV-19	R4928008
Conductivity Sat. Paste	2.96	+/-0.38		0.10	dS m-1	0	27-NOV-19	28-NOV-19	R4928008

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Internal Reference Material	Sulfur (as SO4)	DLDS	L2386360-1
Internal Reference Material	Calcium (Ca)	DLDS	L2386360-1
Internal Reference Material	Magnesium (Mg)	DLDS	L2386360-1
Internal Reference Material	Potassium (K)	DLDS	L2386360-1
Internal Reference Material	Sodium (Na)	DLDS	L2386360-1
Duplicate	Sulfur (as SO4)	DLDS	L2386360-1
Duplicate	Calcium (Ca)	DLDS	L2386360-1
Duplicate	Magnesium (Mg)	DLDS	L2386360-1
Duplicate	Potassium (K)	DLDS	L2386360-1
Duplicate	Sodium (Na)	DLDS	L2386360-1
Internal Reference Material	Available Ammonium-N	DLHC	L2386360-1
Duplicate	Total Kjeldahl Nitrogen	DLHC	L2386360-1

Sample Parameter Qualifier Key:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**
B-HOTW-SK	Soil	Available Boron, Hot Water		CSSS (2008) Ch.9
Hot water is used to extract the plant-available and potentially plant-available boron from soil. Boron in the extract is determined by ICP-OES.				
C-TIC-PCT-SK	Soil	Total Inorganic Carbon in Soil		CSSS (2008) P216-217
A known quantity of acetic acid is consumed by reaction with carbonates in the soil. The pH of the resulting solution is measured and compared against a standard curve relating pH to weight of carbonate.				
C-TOC-CALC-SK	Soil	Total Organic Carbon Calculation		CSSS (2008) 21.2
Total Organic Carbon (TOC) is calculated by the difference between total carbon (TC) and total inorganic carbon. (TIC)				
C-TOT-LECO-SK	Soil	Total Carbon by combustion method		CSSS (2008) 21.2
The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.				
IC-CACO3-CALC-SK	Soil	Inorganic Carbon as CaCO3 Equivalent		Calculation
K-AVAIL-SK	Soil	Available Potassium		Comm. Soil Sci. Plant, 25 (5&6)
Plant available potassium is extracted from the soil using Modified Kelowna solution. Potassium in the soil extract is determined by flame emission at 770 nm.				
N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method		CSSS (2008) 22.4
The sample is ignited in a combustion analyzer where nitrogen in the reduced nitrous oxide gas is determined using a thermal conductivity detector.				
N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen		CSSS (2008) 22.2.3
The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.				
NH4-AVAIL-SK	Soil	Available Ammonium-N		CSSS Carter 6.2 / Comm Soil Sci 19(6)
Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.				
NO3-AVAIL-KCL-SK	Soil	Available Nitrate-N (2N KCl)		CSSS (1993) 4.2, 4.3
Available Nitrate and Nitrite are extracted from the soil using a 2N KCl solution. Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water soluble dye has a magenta color which is measured at colorimetrically at 520nm.				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**
Reference: Carter, Martin. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1993) methods 4.2, 4.3				
OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.		CSSS (1978) p. 160
The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.				
PO4-AVAIL-OLSEN-SK	Soil	Available Phosphate-P by Olsen		CSSS (2008) 8
Plant available phosphorus is extracted from air dried soil using a fixed ratio bicarbonate extraction. Phosphorus is determined by colorimetry.				
SAL-MG/KG-CALC-SK	Soil	Detail Salinity in mg/kg		Manual Calculation
SAR-CALC-SK	Soil	SAR and Cations in saturated soil		APHA 3120B
A soil extract is generated using our saturated paste procedure. Ca, Mg, Na and K in a saturated soil extract are determined by ICP-OES.				
SAT-PCNT-SK	Soil	Saturated Paste		CSSS Ch. 15
A saturated paste is generated by adding water to soil with mixing until the following criteria are met.: The sample paste glistens as it reflects light. The sample flows slightly when container is tipped, and slides freely and cleanly off the spatula. A trench carved in the soil surface will close readily upon jarring the container. There should be no free layer of water on top of the sample. An aliquot of the sample is obtained, dried at 105C and saturation percentage is determined.				
SAT/PH/EC-SK	Soil	pH and EC (Saturated Paste)		CSSS 15/CSSC 3.14
A saturated paste is generated by adding water to soil with mixing until the following criteria are met: The sample paste glistens as it reflects light. The sample flows slightly when container is tipped, and slides freely and cleanly off the spatula. A trench carved in the soil surface will close readily upon jarring the container. There should be no free layer of water on top of the sample. An aliquot of the sample is obtained, dried at 105C and saturation percentage is determined.pH of a saturated soil paste is measured using a pH meter. The EC is measured using a conductivity meter on the filtered extract.				
SO4-SAR-SK	Soil	Sulfate (SO4) in saturated soil		APHA 3120 B-ICP-OES
A soil extract is generated using our saturated paste procedure. Sulfur is analyzed by ICP-OES and reported as sulfate.				

** The indicated Method Reference is the closest nationally or internationally recognized reference for the applicable ALS test method. ALS methods may incorporate modifications from the specified reference to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

Surr - Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.
MU: Measurement Uncertainty. The reported uncertainty is an expanded uncertainty calculated using a coverage factor of 2 which gives a level of confidence of approximately 95%.
Bias: The reported method bias is the average long term deviation from the target value for a long term reference or control sample, measured in percent. Zero values indicate no detectable method bias.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: WSP Canada Group Limited
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HOTW-SK	**Soil**							
Batch R4929553								
WG3231458-1 DUP		**L2386158-4**						
Boron (B), Hot Water Ext.		0.64	0.58		mg/kg	9.5	30	29-NOV-19
WG3231458-3 IRM		**SAL814**						
Boron (B), Hot Water Ext.			87.2		%		70-130	29-NOV-19
WG3231458-4 LCS								
Boron (B), Hot Water Ext.			101.1		%		70-130	29-NOV-19
WG3231458-2 MB								
Boron (B), Hot Water Ext.			<0.20		mg/kg		0.2	29-NOV-19
C-TIC-PCT-SK	**Soil**							
Batch R4928497								
WG3228242-1 DUP		**L2387280-44**						
Inorganic Carbon		0.549	0.561		%	2.2	20	29-NOV-19
WG3228242-4 IRM		**08-109_SOIL**						
Inorganic Carbon			93.8		%		80-120	29-NOV-19
WG3228242-2 LCS								
Inorganic Carbon			95.9		%		80-120	29-NOV-19
WG3228242-3 MB								
Inorganic Carbon			<0.050		%		0.05	29-NOV-19
C-TOT-LECO-SK	**Soil**							
Batch R4928917								
WG3229994-1 DUP		**L2388370-1**						
Total Carbon by Combustion		40.5	40.6		%	0.4	20	29-NOV-19
WG3229994-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			103.0		%		80-120	29-NOV-19
WG3229994-4 LCS								
Total Carbon by Combustion			100.6		%		90-110	29-NOV-19
WG3229994-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	29-NOV-19
K-AVAIL-SK	**Soil**							
Batch R4928083								
WG3228633-3 IRM		**FARM2005**						
Available Potassium			99.9		%		70-130	27-NOV-19
WG3228633-4 LCS								
Available Potassium			94.3		%		80-120	27-NOV-19
WG3228633-2 MB								
Available Potassium			<20		mg/kg		20	27-NOV-19
N-TOT-LECO-SK	**Soil**							

Quality Control Report

Client: WSP Canada Group Limited
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOT-LECO-SK	**Soil**							
Batch R4928917								
WG3229994-1 DUP		**L2388370-1**						
Total Nitrogen by LECO		8.14	8.11		%	0.4	20	29-NOV-19
WG3229994-2 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			105.1		%		80-120	29-NOV-19
WG3229994-4 LCS								
Total Nitrogen by LECO			100.5		%		90-110	29-NOV-19
WG3229994-3 MB								
Total Nitrogen by LECO			<0.020		%		0.02	29-NOV-19
N-TOTKJ-COL-SK	**Soil**							
Batch R4928949								
WG3228542-1 DUP		**L2386360-1**						
Total Kjeldahl Nitrogen		5.96	5.96		%	0.0	20	29-NOV-19
WG3228542-2 IRM		**08-109_SOIL**						
Total Kjeldahl Nitrogen			97.4		%		80-120	29-NOV-19
WG3228542-3 LCS								
Total Kjeldahl Nitrogen			91.6		%		80-120	29-NOV-19
WG3228542-4 MB								
Total Kjeldahl Nitrogen			<0.020		%		0.02	29-NOV-19
NH4-AVAIL-SK	**Soil**							
Batch R4928074								
WG3228613-1 DUP		**L2386158-7**						
Available Ammonium-N		3.3	3.1		mg/kg	5.0	20	28-NOV-19
WG3228613-3 IRM		**SAL814**						
Available Ammonium-N			104.9		%		70-130	28-NOV-19
WG3228613-4 LCS								
Available Ammonium-N			92.1		%		80-120	28-NOV-19
WG3228613-2 MB								
Available Ammonium-N			<1.0		mg/kg		1	28-NOV-19
NO3-AVAIL-KCL-SK	**Soil**							
Batch R4928348								
WG3228614-1 DUP		**L2386158-7**						
Available Nitrate-N		<2.0	<2.0	RPD-NA	mg/kg	N/A	30	28-NOV-19
WG3228614-3 IRM		**SAL814**						
Available Nitrate-N			95.5		%		70-130	28-NOV-19
WG3228614-4 LCS								
Available Nitrate-N			96.6		%		70-130	28-NOV-19
WG3228614-2 MB								

Quality Control Report

Client: WSP Canada Group Limited
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-AVAIL-KCL-SK	**Soil**							
Batch R4928348								
WG3228614-2 MB								
Available Nitrate-N			<2.0		mg/kg		2	28-NOV-19
OM-LOI-SK	**Soil**							
Batch R4930068								
WG3229356-1 DUP		**L2386360-1**						
Organic Matter		57.1	57.1		%	0.0	20	29-NOV-19
Loss on Ignition @ 375 C		72.9	72.9		%	0.0	20	29-NOV-19
WG3229356-3 IRM		**SAL2001**						
Organic Matter			97.8		%		80-120	29-NOV-19
Loss on Ignition @ 375 C			97.4		%		80-120	29-NOV-19
WG3229356-2 MB								
Organic Matter			<1.0		%		1	29-NOV-19
Loss on Ignition @ 375 C			<1.0		%		1	29-NOV-19
PO4-AVAIL-OLSEN-SK	**Soil**							
Batch R4928926								
WG3231463-1 DUP		**L2386158-7**						
Available Phosphate-P		7.8	6.2		mg/kg	23	30	29-NOV-19
WG3231463-3 IRM		**FARM2005**						
Available Phosphate-P			87.0		%		80-120	29-NOV-19
WG3231463-4 LCS								
Available Phosphate-P			109.3		%		80-120	29-NOV-19
WG3231463-2 MB								
Available Phosphate-P			<1.0		mg/kg		1	29-NOV-19
SAR-CALC-SK	**Soil**							
Batch R4928300								
WG3229867-6 DUP		**L2386360-1**						
Calcium (Ca)		46	46		mg/L	1.0	30	28-NOV-19
Potassium (K)		114	107		mg/L	6.9	30	28-NOV-19
Magnesium (Mg)		80	77		mg/L	3.8	30	28-NOV-19
Sodium (Na)		63	63		mg/L	0.1	30	28-NOV-19
WG3229867-5 IRM		**ALS SAL 2019**						
Calcium (Ca)			103.1		%		70-130	28-NOV-19
Potassium (K)			82.2		%		70-130	28-NOV-19
Magnesium (Mg)			90.4		%		70-130	28-NOV-19
Sodium (Na)			104.3		%		70-130	28-NOV-19

Quality Control Report

Client: WSP Canada Group Limited
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAR-CALC-SK	**Soil**							
Batch R4928300								
WG3229867-4 LCS								
Calcium (Ca)			102.8		%		70-130	28-NOV-19
Potassium (K)			98.9		%		70-130	28-NOV-19
Magnesium (Mg)			99.3		%		70-130	28-NOV-19
Sodium (Na)			103.7		%		70-130	28-NOV-19
WG3229867-2 MB								
Calcium (Ca)			<5.0		mg/L		5	28-NOV-19
Potassium (K)			<5.0		mg/L		5	28-NOV-19
Magnesium (Mg)			<5.0		mg/L		5	28-NOV-19
Sodium (Na)			<5.0		mg/L		5	28-NOV-19
SAT-PCNT-SK	**Soil**							
Batch R4928008								
WG3229867-6 DUP		**L2386360-1**						
% Saturation		1200	1240		%	3.1	20	28-NOV-19
WG3229867-5 IRM		**ALS SAL 2019**						
% Saturation			96.0		%		80-120	28-NOV-19
WG3229867-4 LCS								
% Saturation			100.3		%		80-120	28-NOV-19
WG3229867-2 MB								
% Saturation			<1.0		%		1	28-NOV-19
SAT/PH/EC-SK	**Soil**							
Batch R4928008								
WG3229867-1 DUP		**L2386505-21**						
% Saturation		67.3	69.2		%	2.8	20	28-NOV-19
pH in Saturated Paste		7.67	7.71	J	pH	0.04	0.3	28-NOV-19
Conductivity Sat. Paste		8.02	8.10		dS m-1	1.0	20	28-NOV-19
WG3229867-6 DUP		**L2386360-1**						
% Saturation		1200	1240		%	3.1	20	28-NOV-19
pH in Saturated Paste		7.44	7.41	J	pH	0.03	0.3	28-NOV-19
Conductivity Sat. Paste		2.96	2.84		dS m-1	4.1	20	28-NOV-19
WG3229867-5 IRM		**ALS SAL 2019**						
% Saturation			96.0		%		80-120	28-NOV-19
pH in Saturated Paste			7.35		pH		7.01-7.61	28-NOV-19
Conductivity Sat. Paste			96.8		%		80-120	28-NOV-19
WG3229867-4 LCS								
% Saturation			100.3		%		80-120	28-NOV-19

Quality Control Report

Client: WSP Canada Group Limited
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAT/PH/EC-SK	**Soil**							
Batch R4928008								
WG3229867-4 LCS								
pH in Saturated Paste			6.95		pH		6.66-7.06	28-NOV-19
Conductivity Sat. Paste			98.4		%		80-120	28-NOV-19
WG3229867-2 MB								
% Saturation			<1.0		%		1	28-NOV-19
Conductivity Sat. Paste			<0.10		dS m-1		0.1	28-NOV-19
SO4-SAR-SK	**Soil**							
Batch R4928300								
WG3229867-6 DUP		**L2386360-1**						
Sulfur (as SO4)		18	33	J	mg/L	15	20	28-NOV-19
WG3229867-5 IRM		**ALS SAL 2019**						
Sulfur (as SO4)			99.8		%		70-130	28-NOV-19
WG3229867-2 MB								
Sulfur (as SO4)			<5.0		mg/L		5	28-NOV-19

Quality Control Report

Workorder: L2386360 Report Date: 03-DEC-19

Client: WSP Canada Group Limited
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Workorder: L2386360 Report Date: 03-DEC-19

Client: WSP Canada Group Limited
111-93 Lombard Ave
Winnipeg MB R3B 3B1
Contact: DARREN KEAM

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Plant Available Nutrients							
Available Nitrate-N (2N KCl)							
	1	21-NOV-19 11:00	26-NOV-19 12:00	3	5	days	EHT

Legend & Qualifier Definitions:

EHTR-FM: Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR: Exceeded ALS recommended hold time prior to sample receipt.
EHTL: Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT: Exceeded ALS recommended hold time prior to analysis.
Rec. HT: ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2386360 were received on 21-NOV-19 15:35.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Biosolids

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2386360-COFC

COC Number: 14 -

Page ____ of ____

Report To		Report Format / Distribution		Turnaround Time (TAT) is not available for all tests
Company:	WSP Canada Group Limited	Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)		R ☐ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Darren Keam	Quality Control (QC) Report with Report ☑ Yes ☐ No		P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	1600 Buffalo Place	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX		E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	204-259-1488	Email 1 or Fax darren.keam@wsp.com		Specify Date Required for E2,E or P:
		Email 2		

Invoice To	Same as Report To ☑ Yes ☐ No	Invoice Distribution	
	Copy of Invoice with Report ☐ Yes ☐ No	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
Company:		Email 1 or Fax apWest@wsp.com	
Contact:		Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q37455	Approver ID:	Cost Center:
Job #:	181-03988-00	GL Account:	Routing Code:
PO / AFE:	181-03988-00	Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler: D.Keam

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Available Ammonia-N & Nitrate-N	Phosphate-P by Diserr	Available Potassium	Available Sulfate-s	pH, EC, SAR	Mercury, Boron (in-holwater), CCME Metals	Total Nitrogen	Total Kjeldahl Nitrogen	[illegible]	Total Carbon, Organic Matter	Special Request			Number of Containers
	Gimli BS WSP 1	21/11/19	11am	Grab	X	X	X	X	X	X	X	X		X	X			2

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	CCME Agricultural Land Use
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐			SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☐	No ☐		Custody seal intact	Yes ☐	No ☐	
Cooling Initiated	☐						

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
7.2					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
[redacted]	Date: 21/10/19	Time: 9:15pm	Received by: CEL	Date: Nov 21	Time: 3:35	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326a v09 Front(s) January 2014

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy

1. If any water samples are taken from a **Regulated Drinking Water (DW) System**, please submit using an **Authorized DW COC form**.

WSP Canada Inc.
ATTN: DARREN KEAM
1600 Buffalo Place
Winnipeg MB R3T 6B8

Date Received: 21-NOV-19
Report Date: 27-MAR-20 08:30 (MT)
Version: FINAL REV. 2

Client Phone: 204-477-6650

Certificate of Analysis

Lab Work Order #: L2386158

Project P.O. #: 181-03988-00
Job Reference: 181-03988-00
C of C Numbers:
Legal Site Desc:

Comments: ADDITIONAL 24-MAR-20 12:46
ADDITIONAL 22-NOV-19 09:09

[redacted]
Judy Dalmaijer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2386158-1 TP01 0-6							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Miscellaneous Parameters							
Boron (B), Hot Water Ext.	0.46		0.20	mg/kg	29-NOV-19	29-NOV-19	R4929553
Available Phosphate-P	9.7		1.0	mg/kg	29-NOV-19	29-NOV-19	R4928926
Available Potassium	120		20	mg/kg	27-NOV-19	27-NOV-19	R4928083
Available Sulfate-S	5.4		4.0	mg/kg	28-NOV-19	28-NOV-19	R4928303
Mercury (Hg)	0.0199		0.0050	mg/kg	28-NOV-19	29-NOV-19	R4929523
Total Kjeldahl Nitrogen	0.236	DLHC	0.040	%	28-NOV-19	29-NOV-19	R4928949
Total Nitrogen by LECO	0.219		0.020	%	27-NOV-19	27-NOV-19	R4927526
Particle Size							
% Sand	24.0		1.0	%		02-DEC-19	R4930017
% Silt	66.0		1.0	%		02-DEC-19	R4930017
% Clay	10.0		1.0	%		02-DEC-19	R4930017
Texture	Silt loam					02-DEC-19	R4930017
Metals in Soil by CRC ICPMS							
Aluminum (Al)	8280		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Antimony (Sb)	0.10		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Arsenic (As)	1.83		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Barium (Ba)	65.4		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Beryllium (Be)	0.29		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Boron (B)	11.5		5.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Bismuth (Bi)	<0.20		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Cadmium (Cd)	0.173		0.020	mg/kg	28-NOV-19	29-NOV-19	R4928687
Calcium (Ca)	89300		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Chromium (Cr)	16.6		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Cobalt (Co)	4.28		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Copper (Cu)	8.34		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Iron (Fe)	9460		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Lead (Pb)	4.96		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Lithium (Li)	9.0		2.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Magnesium (Mg)	48400		20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Manganese (Mn)	361		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Molybdenum (Mo)	0.25		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Nickel (Ni)	11.0		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Phosphorus (P)	682		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Potassium (K)	1550		100	mg/kg	28-NOV-19	29-NOV-19	R4928687
Selenium (Se)	0.25		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Silver (Ag)	<0.10		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Sodium (Na)	122		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Strontium (Sr)	46.0		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Sulfur (S)	<1000		1000	mg/kg	28-NOV-19	29-NOV-19	R4928687
Thallium (Tl)	0.097		0.050	mg/kg	28-NOV-19	29-NOV-19	R4928687
Tin (Sn)	<1.0		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Titanium (Ti)	170		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Tungsten (W)	<0.50		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Uranium (U)	0.644		0.050	mg/kg	28-NOV-19	29-NOV-19	R4928687
Vanadium (V)	20.2		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Zinc (Zn)	26.3		2.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Zirconium (Zr)	1.7		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Available Ammonia-N & Nitrate-N (2N KCl)							
Available Ammonium-N							
Available Ammonium-N	1.0		1.0	mg/kg	28-NOV-19	28-NOV-19	R4928074
Available Nitrate-N (2N KCl)							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2386158-1 TP01 0-6							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Available Nitrate-N (2N KCl)							
Available Nitrate-N	8.8		2.0	mg/kg	28-NOV-19	28-NOV-19	R4928348
Basic Salinity							
SAR and Cations in saturated soil							
Calcium (Ca)	47.8		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Potassium (K)	5.4		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Magnesium (Mg)	26.1		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Sodium (Na)	<5.0		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
SAR	<0.10	SAR:DL	0.10	SAR	28-NOV-19	28-NOV-19	R4928300
pH and EC (Saturated Paste)							
% Saturation	61.3		1.0	%	27-NOV-19	28-NOV-19	R4928008
pH in Saturated Paste	7.96		0.10	pH	27-NOV-19	28-NOV-19	R4928008
Conductivity Sat. Paste	0.40		0.10	dS m-1	27-NOV-19	28-NOV-19	R4928008
L2386158-2 TP01 6-24							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Miscellaneous Parameters							
Total Kjeldahl Nitrogen	<0.020		0.020	%	28-NOV-19	29-NOV-19	R4928949
Total Nitrogen by LECO	<0.020		0.020	%	29-NOV-19	29-NOV-19	R4928917
Particle Size							
% Sand	26.0		1.0	%		02-DEC-19	R4930017
% Silt	55.6		1.0	%		02-DEC-19	R4930017
% Clay	18.4		1.0	%		02-DEC-19	R4930017
Texture	Silt loam					02-DEC-19	R4930017
Available Ammonia-N & Nitrate-N (2N KCl)							
Available Ammonium-N							
Available Ammonium-N	<1.0		1.0	mg/kg	28-NOV-19	28-NOV-19	R4928074
Available Nitrate-N (2N KCl)							
Available Nitrate-N	<2.0		2.0	mg/kg	28-NOV-19	28-NOV-19	R4928348
L2386158-3 TP01 24-60							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Particle Size							
% Sand	7.0		1.0	%		02-DEC-19	R4930017
% Silt	63.0		1.0	%		02-DEC-19	R4930017
% Clay	30.0		1.0	%		02-DEC-19	R4930017
Texture	Silty clay loam					02-DEC-19	R4930017
L2386158-4 TP02 0-6							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Miscellaneous Parameters							
Boron (B), Hot Water Ext.	0.64		0.20	mg/kg	29-NOV-19	29-NOV-19	R4929553
Available Phosphate-P	1.6		1.0	mg/kg	29-NOV-19	29-NOV-19	R4928926
Available Potassium	94		20	mg/kg	27-NOV-19	27-NOV-19	R4928083
Available Sulfate-S	4.0		4.0	mg/kg	28-NOV-19	28-NOV-19	R4928303
Mercury (Hg)	0.0222		0.0050	mg/kg	28-NOV-19	29-NOV-19	R4929523
Total Kjeldahl Nitrogen	0.147		0.020	%	28-NOV-19	29-NOV-19	R4928949
Total Nitrogen by LECO	0.128		0.020	%	27-NOV-19	27-NOV-19	R4927526
Particle Size							
% Sand	20.0		1.0	%		02-DEC-19	R4930017

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2386158-4 TP02 0-6							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Particle Size							
% Silt	52.4		1.0	%		02-DEC-19	R4930017
% Clay	27.6		1.0	%		02-DEC-19	R4930017
Texture	Silty clay loam / Clay loam					02-DEC-19	R4930017
Metals in Soil by CRC ICPMS							
Aluminum (Al)	13300		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Antimony (Sb)	0.10		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Arsenic (As)	2.10		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Barium (Ba)	93.7		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Beryllium (Be)	0.47		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Boron (B)	13.6		5.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Bismuth (Bi)	<0.20		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Cadmium (Cd)	0.189		0.020	mg/kg	28-NOV-19	29-NOV-19	R4928687
Calcium (Ca)	90300		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Chromium (Cr)	27.1		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Cobalt (Co)	6.36		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Copper (Cu)	13.9		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Iron (Fe)	14400		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Lead (Pb)	6.38		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Lithium (Li)	16.0		2.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Magnesium (Mg)	46300		20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Manganese (Mn)	370		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Molybdenum (Mo)	0.28		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Nickel (Ni)	18.3		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Phosphorus (P)	511		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Potassium (K)	2660		100	mg/kg	28-NOV-19	29-NOV-19	R4928687
Selenium (Se)	0.21		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Silver (Ag)	<0.10		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Sodium (Na)	188		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Strontium (Sr)	56.5		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Sulfur (S)	<1000		1000	mg/kg	28-NOV-19	29-NOV-19	R4928687
Thallium (Tl)	0.152		0.050	mg/kg	28-NOV-19	29-NOV-19	R4928687
Tin (Sn)	<1.0		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Titanium (Ti)	318		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Tungsten (W)	<0.50		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Uranium (U)	0.915		0.050	mg/kg	28-NOV-19	29-NOV-19	R4928687
Vanadium (V)	29.8		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Zinc (Zn)	39.5		2.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Zirconium (Zr)	3.2		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Available Ammonia-N & Nitrate-N (2N KCl)							
Available Ammonium-N							
Available Ammonium-N	1.6		1.0	mg/kg	28-NOV-19	28-NOV-19	R4928074
Available Nitrate-N (2N KCl)							
Available Nitrate-N	<2.0		2.0	mg/kg	28-NOV-19	28-NOV-19	R4928348
Basic Salinity							
SAR and Cations in saturated soil							
Calcium (Ca)	41.7		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Potassium (K)	<5.0		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Magnesium (Mg)	37.1		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Sodium (Na)	13.5		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
SAR	0.37		0.10	SAR	28-NOV-19	28-NOV-19	R4928300
pH and EC (Saturated Paste)							

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2386158-4 TP02 0-6							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
pH and EC (Saturated Paste)							
% Saturation	58.9		1.0	%	27-NOV-19	28-NOV-19	R4928008
pH in Saturated Paste	8.13		0.10	pH	27-NOV-19	28-NOV-19	R4928008
Conductivity Sat. Paste	0.46		0.10	dS m-1	27-NOV-19	28-NOV-19	R4928008
L2386158-5 TP02 6-24							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Miscellaneous Parameters							
Total Kjeldahl Nitrogen	<0.020		0.020	%	28-NOV-19	29-NOV-19	R4928949
Total Nitrogen by LECO	<0.020		0.020	%	27-NOV-19	27-NOV-19	R4927526
Particle Size							
% Sand	18.0		1.0	%		02-DEC-19	R4930017
% Silt	60.0		1.0	%		02-DEC-19	R4930017
% Clay	22.0		1.0	%		02-DEC-19	R4930017
Texture	Silt loam					02-DEC-19	R4930017
Available Ammonia-N & Nitrate-N (2N KCl)							
Available Ammonium-N							
Available Ammonium-N	<1.0		1.0	mg/kg	28-NOV-19	28-NOV-19	R4928074
Available Nitrate-N (2N KCl)							
Available Nitrate-N	<2.0		2.0	mg/kg	28-NOV-19	28-NOV-19	R4928348
L2386158-6 TP02 24-60							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Particle Size							
% Sand	8.0		1.0	%		02-DEC-19	R4930017
% Silt	56.0		1.0	%		02-DEC-19	R4930017
% Clay	36.0		1.0	%		02-DEC-19	R4930017
Texture	Silty clay loam					02-DEC-19	R4930017
L2386158-7 TP03 0-6							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Miscellaneous Parameters							
Boron (B), Hot Water Ext.	0.52		0.20	mg/kg	29-NOV-19	29-NOV-19	R4929553
Available Phosphate-P	7.8		1.0	mg/kg	29-NOV-19	29-NOV-19	R4928926
Available Potassium	164		20	mg/kg	27-NOV-19	27-NOV-19	R4928083
Available Sulfate-S	<4.0		4.0	mg/kg	28-NOV-19	28-NOV-19	R4928303
Mercury (Hg)	0.0238		0.0050	mg/kg	28-NOV-19	29-NOV-19	R4929523
Total Kjeldahl Nitrogen	0.172		0.020	%	28-NOV-19	29-NOV-19	R4928949
Total Nitrogen by LECO	0.172		0.020	%	26-MAR-20	26-MAR-20	R5041787
Particle Size							
% Sand	18.0		1.0	%		02-DEC-19	R4930017
% Silt	46.0		1.0	%		02-DEC-19	R4930017
% Clay	36.0		1.0	%		02-DEC-19	R4930017
Texture	Silty clay loam					02-DEC-19	R4930017
Metals in Soil by CRC ICPMS							
Aluminum (Al)	17600		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Antimony (Sb)	0.15		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Arsenic (As)	3.30		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Barium (Ba)	125		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Beryllium (Be)	0.63		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2386158-7 TP03 0-6							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Metals in Soil by CRC ICPMS							
Boron (B)	12.8		5.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Bismuth (Bi)	<0.20		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Cadmium (Cd)	0.146		0.020	mg/kg	28-NOV-19	29-NOV-19	R4928687
Calcium (Ca)	61700		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Chromium (Cr)	35.4		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Cobalt (Co)	8.89		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Copper (Cu)	19.3		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Iron (Fe)	18900		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Lead (Pb)	8.85		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Lithium (Li)	20.3		2.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Magnesium (Mg)	33300		20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Manganese (Mn)	468		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Molybdenum (Mo)	0.52		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Nickel (Ni)	25.9		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Phosphorus (P)	600		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Potassium (K)	3860		100	mg/kg	28-NOV-19	29-NOV-19	R4928687
Selenium (Se)	0.22		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Silver (Ag)	<0.10		0.10	mg/kg	28-NOV-19	29-NOV-19	R4928687
Sodium (Na)	245		50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Strontium (Sr)	45.4		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Sulfur (S)	<1000		1000	mg/kg	28-NOV-19	29-NOV-19	R4928687
Thallium (Tl)	0.217		0.050	mg/kg	28-NOV-19	29-NOV-19	R4928687
Tin (Sn)	<1.0		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Titanium (Ti)	386		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Tungsten (W)	<0.50		0.50	mg/kg	28-NOV-19	29-NOV-19	R4928687
Uranium (U)	0.741		0.050	mg/kg	28-NOV-19	29-NOV-19	R4928687
Vanadium (V)	38.8		0.20	mg/kg	28-NOV-19	29-NOV-19	R4928687
Zinc (Zn)	56.7		2.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Zirconium (Zr)	4.6		1.0	mg/kg	28-NOV-19	29-NOV-19	R4928687
Available Ammonia-N & Nitrate-N (2N KCl)							
Available Ammonium-N							
Available Ammonium-N	3.3		1.0	mg/kg	28-NOV-19	28-NOV-19	R4928074
Available Nitrate-N (2N KCl)							
Available Nitrate-N	<2.0		2.0	mg/kg	28-NOV-19	28-NOV-19	R4928348
Basic Salinity							
SAR and Cations in saturated soil							
Calcium (Ca)	60.9		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Potassium (K)	<5.0		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Magnesium (Mg)	26.9		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
Sodium (Na)	9.9		5.0	mg/L	28-NOV-19	28-NOV-19	R4928300
SAR	0.27		0.10	SAR	28-NOV-19	28-NOV-19	R4928300
pH and EC (Saturated Paste)							
% Saturation	64.8		1.0	%	27-NOV-19	28-NOV-19	R4928008
pH in Saturated Paste	7.82		0.10	pH	27-NOV-19	28-NOV-19	R4928008
Conductivity Sat. Paste	0.46		0.10	dS m-1	27-NOV-19	28-NOV-19	R4928008
L2386158-8 TP03 6-24							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Miscellaneous Parameters							
Total Kjeldahl Nitrogen	0.053		0.020	%	28-NOV-19	29-NOV-19	R4928949
Total Nitrogen by LECO	0.050		0.020	%	27-NOV-19	27-NOV-19	R4927526

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2386158-8 TP03 6-24							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Particle Size							
% Sand	22.0		1.0	%		02-DEC-19	R4930017
% Silt	54.0		1.0	%		02-DEC-19	R4930017
% Clay	24.0		1.0	%		02-DEC-19	R4930017
Texture	Silt loam					02-DEC-19	R4930017
Available Ammonia-N & Nitrate-N (2N KCl)							
Available Ammonium-N							
Available Ammonium-N	1.6		1.0	mg/kg	28-NOV-19	28-NOV-19	R4928074
Available Nitrate-N (2N KCl)							
Available Nitrate-N	<2.0		2.0	mg/kg	28-NOV-19	28-NOV-19	R4928348
L2386158-9 TP03 24-60							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Particle Size							
% Sand	9.0		1.0	%		02-DEC-19	R4930017
% Silt	43.0		1.0	%		02-DEC-19	R4930017
% Clay	48.0		1.0	%		02-DEC-19	R4930017
Texture	Silty clay					02-DEC-19	R4930017
L2386158-10 TP03 60-72							
Sampled By: DK on 21-NOV-19 @ 11:30							
Matrix: SOIL							
Particle Size							
% Sand	<1.0		1.0	%		02-DEC-19	R4930017
% Silt	16.0		1.0	%		02-DEC-19	R4930017
% Clay	84.0		1.0	%		02-DEC-19	R4930017
Texture	Clay					02-DEC-19	R4930017

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
SAR:DL	SAR is incalculable due to undetectable Na. Detection Limit represents maximum possible SAR value.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
B-HOTW-SK	Soil	Available Boron, Hot Water	CSSS (2008) Ch.9

Hot water is used to extract the plant-available and potentially plant-available boron from soil. Boron in the extract is determined by ICP-OES.

HG-200.2-CVAA-SK	Soil	Mercury in Soil by CVAAS	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

K-AVAIL-SK	Soil	Available Potassium	Comm. Soil Sci. Plant, 25 (5&6)

Plant available potassium is extracted from the soil using Modified Kelowna solution. Potassium in the soil extract is determined by flame emission at 770 nm.

MET-200.2-CCMS-SK	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020A (mod)

Soil/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

Limitations: This method is intended to liberate environmentally available metals. Silicate minerals are not solubilized. Some metals may be only partially recovered (matrix dependent), including Al, Ba, Be, Cr, S, Sr, Ti, Tl, V, W, and Zr. Elemental Sulfur may be poorly recovered by this method. Volatile forms of sulfur (e.g. sulfide, H2S) may be excluded if lost during sampling, storage, or digestion.

N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method	CSSS (2008) 22.4

The sample is ignited in a combustion analyzer where nitrogen in the reduced nitrous oxide gas is determined using a thermal conductivity detector.

N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

NH4-AVAIL-SK	Soil	Available Ammonium-N	CSSS Carter 6.2 / Comm Soil Sci 19(6)

Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.

NO3-AVAIL-KCL-SK	Soil	Available Nitrate-N (2N KCl)	CSSS (1993) 4.2, 4.3

Available Nitrate and Nitrite are extracted from the soil using a 2N KCl solution. Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water soluble dye has a magenta color which is measured at colorimetrically at 520nm.

Reference:
Carter, Martin. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1993) methods 4.2, 4.3

PO4-AVAIL-OLSEN-SK	Soil	Available Phosphate-P by Olsen	CSSS (2008) 8

Plant available phosphorus is extracted from air dried soil using a fixed ratio bicarbonate extraction. Phosphorus is determined by colorimetry.

PSA-1-ED	Soil	Particle Size	CSSS 55.3-Hydrometer

Soil samples are oven dried, ground to pass a 2 mm sieve , and soaked in Calgon solution for a minimum of 16 hours. Soil suspensions are measured for particle size by distribution using a hydrometer after specified settling times.

SAR-CALC-SK	Soil	SAR and Cations in saturated soil	APHA 3120B

A soil extract is generated using our saturated paste procedure. Ca, Mg, Na and K in a saturated soil extract are determined by ICP-OES.

SAT/PH/EC-SK	Soil	pH and EC (Saturated Paste)	CSSS 15/CSSC 3.14

A saturated paste is generated by adding water to soil with mixing until the following criteria are met:
The sample paste glistens as it reflects light.
The sample flows slightly when container is tipped, and slides freely and cleanly off the spatula.
A trench carved in the soil surface will close readily upon jarring the container.
There should be no free layer of water on top of the sample.
An aliquot of the sample is obtained, dried at 105C and saturation percentage is determined.pH of a saturated soil paste is measured using a pH meter.
The EC is measured using a conductivity meter on the filtered extract.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
SO4-AVAIL-SK	Soil	Available Sulfate-S	REC METH SOIL ANAL - AB. AG(1988)

Plant available sulfate in the soil is extracted using a weak calcium chloride solution. Sulfate in the extract is determined by ICP-OES. This extraction may also produce organic sulfur in the extracts when organic soils are analyzed.

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
ED	ALS ENVIRONMENTAL - EDMONTON, ALBERTA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: WSP Canada Inc.
1600 Buffalo Place
Winnipeg MB R3T 6B8
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HOTW-SK	**Soil**							
Batch R4929553								
WG3231458-1 DUP		**L2386158-4**						
Boron (B), Hot Water Ext.		0.64	0.58		mg/kg	9.5	30	29-NOV-19
WG3231458-3 IRM		**SAL814**						
Boron (B), Hot Water Ext.			87.2		%		70-130	29-NOV-19
WG3231458-4 LCS								
Boron (B), Hot Water Ext.			101.1		%		70-130	29-NOV-19
WG3231458-2 MB								
Boron (B), Hot Water Ext.			<0.20		mg/kg		0.2	29-NOV-19
HG-200.2-CVAA-SK	**Soil**							
Batch R4929523								
WG3230348-3 CRM		**TILL-1**						
Mercury (Hg)			110.1		%		70-130	29-NOV-19
WG3230348-2 DUP		**L2386158-1**						
Mercury (Hg)		0.0199	0.0185		mg/kg	7.1	40	29-NOV-19
WG3230348-4 LCS								
Mercury (Hg)			99.5		%		80-120	29-NOV-19
WG3230348-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	29-NOV-19
K-AVAIL-SK	**Soil**							
Batch R4928083								
WG3228633-3 IRM		**FARM2005**						
Available Potassium			99.9		%		70-130	27-NOV-19
WG3228633-4 LCS								
Available Potassium			94.3		%		80-120	27-NOV-19
WG3228633-2 MB								
Available Potassium			<20		mg/kg		20	27-NOV-19
MET-200.2-CCMS-SK	**Soil**							
Batch R4928687								
WG3230348-3 CRM		**TILL-1**						
Aluminum (Al)			95.0		%		70-130	29-NOV-19
Antimony (Sb)			102.2		%		70-130	29-NOV-19
Arsenic (As)			96.6		%		70-130	29-NOV-19
Barium (Ba)			95.2		%		70-130	29-NOV-19
Beryllium (Be)			92.3		%		70-130	29-NOV-19
Boron (B)			2.7		mg/kg		0-8.2	29-NOV-19
Bismuth (Bi)			93.4		%		70-130	29-NOV-19
Cadmium (Cd)			97.2		%		70-130	29-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R4928687								
WG3230348-3 CRM		**TILL-1**						
Calcium (Ca)			91.4		%		70-130	29-NOV-19
Chromium (Cr)			94.8		%		70-130	29-NOV-19
Cobalt (Co)			95.5		%		70-130	29-NOV-19
Copper (Cu)			96.2		%		70-130	29-NOV-19
Iron (Fe)			93.1		%		70-130	29-NOV-19
Lead (Pb)			94.0		%		70-130	29-NOV-19
Lithium (Li)			90.2		%		70-130	29-NOV-19
Magnesium (Mg)			96.7		%		70-130	29-NOV-19
Manganese (Mn)			95.9		%		70-130	29-NOV-19
Molybdenum (Mo)			93.4		%		70-130	29-NOV-19
Nickel (Ni)			96.5		%		70-130	29-NOV-19
Phosphorus (P)			99.0		%		70-130	29-NOV-19
Potassium (K)			99.1		%		70-130	29-NOV-19
Selenium (Se)			0.28		mg/kg		0.11-0.51	29-NOV-19
Silver (Ag)			0.22		mg/kg		0.13-0.33	29-NOV-19
Sodium (Na)			98.6		%		70-130	29-NOV-19
Strontium (Sr)			92.1		%		70-130	29-NOV-19
Thallium (Tl)			0.125		mg/kg		0.077-0.18	29-NOV-19
Tin (Sn)			1.0		mg/kg		0-3.1	29-NOV-19
Titanium (Ti)			85.8		%		70-130	29-NOV-19
Tungsten (W)			0.13		mg/kg		0-0.66	29-NOV-19
Uranium (U)			91.0		%		70-130	29-NOV-19
Vanadium (V)			94.6		%		70-130	29-NOV-19
Zinc (Zn)			94.4		%		70-130	29-NOV-19
Zirconium (Zr)			1.0		mg/kg		0-1.8	29-NOV-19
WG3230348-2 DUP		**L2386158-1**						
Aluminum (Al)		8280	7730		mg/kg	6.9	40	29-NOV-19
Antimony (Sb)		0.10	<0.10	RPD-NA	mg/kg	N/A	30	29-NOV-19
Arsenic (As)		1.83	1.66		mg/kg	9.9	30	29-NOV-19
Barium (Ba)		65.4	58.0		mg/kg	12	40	29-NOV-19
Beryllium (Be)		0.29	0.27		mg/kg	6.1	30	29-NOV-19
Boron (B)		11.5	10.3		mg/kg	11	30	29-NOV-19
Bismuth (Bi)		<0.20	<0.20	RPD-NA	mg/kg	N/A	30	29-NOV-19
Cadmium (Cd)		0.173	0.159		mg/kg	8.3	30	29-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R4928687								
WG3230348-2 DUP		**L2386158-1**						
Calcium (Ca)		89300	85200		mg/kg	4.7	30	29-NOV-19
Chromium (Cr)		16.6	15.3		mg/kg	8.2	30	29-NOV-19
Cobalt (Co)		4.28	3.75		mg/kg	13	30	29-NOV-19
Copper (Cu)		8.34	7.75		mg/kg	7.3	30	29-NOV-19
Iron (Fe)		9460	8630		mg/kg	9.2	30	29-NOV-19
Lead (Pb)		4.96	4.53		mg/kg	9.1	40	29-NOV-19
Lithium (Li)		9.0	8.6		mg/kg	4.4	30	29-NOV-19
Magnesium (Mg)		48400	44800		mg/kg	7.7	30	29-NOV-19
Manganese (Mn)		361	317		mg/kg	13	30	29-NOV-19
Molybdenum (Mo)		0.25	0.23		mg/kg	8.4	40	29-NOV-19
Nickel (Ni)		11.0	10.1		mg/kg	8.4	30	29-NOV-19
Phosphorus (P)		682	625		mg/kg	8.7	30	29-NOV-19
Potassium (K)		1550	1380		mg/kg	11	40	29-NOV-19
Selenium (Se)		0.25	<0.20	RPD-NA	mg/kg	N/A	30	29-NOV-19
Silver (Ag)		<0.10	<0.10	RPD-NA	mg/kg	N/A	40	29-NOV-19
Sodium (Na)		122	115		mg/kg	6.2	40	29-NOV-19
Strontium (Sr)		46.0	43.0		mg/kg	6.7	40	29-NOV-19
Sulfur (S)		<1000	<1000	RPD-NA	mg/kg	N/A	30	29-NOV-19
Thallium (Tl)		0.097	0.078		mg/kg	21	30	29-NOV-19
Tin (Sn)		<1.0	<1.0	RPD-NA	mg/kg	N/A	40	29-NOV-19
Titanium (Ti)		170	144		mg/kg	16	40	29-NOV-19
Tungsten (W)		<0.50	<0.50	RPD-NA	mg/kg	N/A	30	29-NOV-19
Uranium (U)		0.644	0.589		mg/kg	8.9	30	29-NOV-19
Vanadium (V)		20.2	18.0		mg/kg	11	30	29-NOV-19
Zinc (Zn)		26.3	24.3		mg/kg	7.8	30	29-NOV-19
Zirconium (Zr)		1.7	1.5		mg/kg	9.0	30	29-NOV-19
WG3230348-4 LCS								
Aluminum (Al)			98.9		%		80-120	29-NOV-19
Antimony (Sb)			104.2		%		80-120	29-NOV-19
Arsenic (As)			98.7		%		80-120	29-NOV-19
Barium (Ba)			98.5		%		80-120	29-NOV-19
Beryllium (Be)			93.1		%		80-120	29-NOV-19
Boron (B)			86.6		%		80-120	29-NOV-19
Bismuth (Bi)			93.3		%		80-120	29-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R4928687								
WG3230348-4 LCS								
Cadmium (Cd)			99.1		%		80-120	29-NOV-19
Calcium (Ca)			95.3		%		80-120	29-NOV-19
Chromium (Cr)			96.9		%		80-120	29-NOV-19
Cobalt (Co)			95.7		%		80-120	29-NOV-19
Copper (Cu)			93.6		%		80-120	29-NOV-19
Iron (Fe)			102.5		%		80-120	29-NOV-19
Lead (Pb)			96.6		%		80-120	29-NOV-19
Lithium (Li)			93.4		%		80-120	29-NOV-19
Magnesium (Mg)			101.5		%		80-120	29-NOV-19
Manganese (Mn)			98.3		%		80-120	29-NOV-19
Molybdenum (Mo)			96.0		%		80-120	29-NOV-19
Nickel (Ni)			95.7		%		80-120	29-NOV-19
Phosphorus (P)			103.9		%		80-120	29-NOV-19
Potassium (K)			105.8		%		80-120	29-NOV-19
Selenium (Se)			97.3		%		80-120	29-NOV-19
Silver (Ag)			101.7		%		80-120	29-NOV-19
Sodium (Na)			99.1		%		80-120	29-NOV-19
Strontium (Sr)			99.2		%		80-120	29-NOV-19
Sulfur (S)			99.98		%		80-120	29-NOV-19
Thallium (Tl)			93.9		%		80-120	29-NOV-19
Tin (Sn)			101.3		%		80-120	29-NOV-19
Titanium (Ti)			96.7		%		80-120	29-NOV-19
Tungsten (W)			97.0		%		80-120	29-NOV-19
Uranium (U)			94.6		%		80-120	29-NOV-19
Vanadium (V)			98.1		%		80-120	29-NOV-19
Zinc (Zn)			96.2		%		80-120	29-NOV-19
Zirconium (Zr)			94.3		%		80-120	29-NOV-19
WG3230348-1 MB								
Aluminum (Al)			<50		mg/kg		50	29-NOV-19
Antimony (Sb)			<0.10		mg/kg		0.1	29-NOV-19
Arsenic (As)			<0.10		mg/kg		0.1	29-NOV-19
Barium (Ba)			<0.50		mg/kg		0.5	29-NOV-19
Beryllium (Be)			<0.10		mg/kg		0.1	29-NOV-19
Boron (B)			<5.0		mg/kg		5	29-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-SK	**Soil**							
Batch R4928687								
WG3230348-1 MB								
Bismuth (Bi)			<0.20		mg/kg		0.2	29-NOV-19
Cadmium (Cd)			<0.020		mg/kg		0.02	29-NOV-19
Calcium (Ca)			<50		mg/kg		50	29-NOV-19
Chromium (Cr)			<0.50		mg/kg		0.5	29-NOV-19
Cobalt (Co)			<0.10		mg/kg		0.1	29-NOV-19
Copper (Cu)			<0.50		mg/kg		0.5	29-NOV-19
Iron (Fe)			<50		mg/kg		50	29-NOV-19
Lead (Pb)			<0.50		mg/kg		0.5	29-NOV-19
Lithium (Li)			<2.0		mg/kg		2	29-NOV-19
Magnesium (Mg)			<20		mg/kg		20	29-NOV-19
Manganese (Mn)			<1.0		mg/kg		1	29-NOV-19
Molybdenum (Mo)			<0.10		mg/kg		0.1	29-NOV-19
Nickel (Ni)			<0.50		mg/kg		0.5	29-NOV-19
Phosphorus (P)			<50		mg/kg		50	29-NOV-19
Potassium (K)			<100		mg/kg		100	29-NOV-19
Selenium (Se)			<0.20		mg/kg		0.2	29-NOV-19
Silver (Ag)			<0.10		mg/kg		0.1	29-NOV-19
Sodium (Na)			<50		mg/kg		50	29-NOV-19
Strontium (Sr)			<0.50		mg/kg		0.5	29-NOV-19
Sulfur (S)			<1000		mg/kg		1000	29-NOV-19
Thallium (Tl)			<0.050		mg/kg		0.05	29-NOV-19
Tin (Sn)			<1.0		mg/kg		1	29-NOV-19
Titanium (Ti)			<1.0		mg/kg		1	29-NOV-19
Tungsten (W)			<0.50		mg/kg		0.5	29-NOV-19
Uranium (U)			<0.050		mg/kg		0.05	29-NOV-19
Vanadium (V)			<0.20		mg/kg		0.2	29-NOV-19
Zinc (Zn)			<2.0		mg/kg		2	29-NOV-19
Zirconium (Zr)			<1.0		mg/kg		1	29-NOV-19
N-TOT-LECO-SK	**Soil**							
Batch R4927526								
WG3228458-2 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			91.5		%		80-120	27-NOV-19
WG3228458-4 LCS		**SULFADIAZINE**						
Total Nitrogen by LECO			99.4		%		90-110	27-NOV-19
WG3228458-3 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOT-LECO-SK	**Soil**							
Batch R4927526								
WG3228458-3 MB								
Total Nitrogen by LECO			<0.020		%		0.02	27-NOV-19
Batch R4928917								
WG3229994-2 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			105.1		%		80-120	29-NOV-19
WG3229994-4 LCS		**SULFADIAZINE**						
Total Nitrogen by LECO			100.5		%		90-110	29-NOV-19
WG3229994-3 MB								
Total Nitrogen by LECO			<0.020		%		0.02	29-NOV-19
Batch R5041787								
WG3298277-2 DUP		**L2386158-7**						
Total Nitrogen by LECO		0.172	0.171		%	0.5	20	26-MAR-20
WG3298277-3 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			87.0		%		80-120	26-MAR-20
WG3298277-5 LCS		**SULFADIAZINE**						
Total Nitrogen by LECO			101.7		%		90-110	26-MAR-20
WG3298277-4 MB								
Total Nitrogen by LECO			<0.020		%		0.02	26-MAR-20
N-TOTKJ-COL-SK	**Soil**							
Batch R4928949								
WG3228542-2 IRM		**08-109_SOIL**						
Total Kjeldahl Nitrogen			97.4		%		80-120	29-NOV-19
WG3228542-3 LCS								
Total Kjeldahl Nitrogen			91.6		%		80-120	29-NOV-19
WG3228542-4 MB								
Total Kjeldahl Nitrogen			<0.020		%		0.02	29-NOV-19
NH4-AVAIL-SK	**Soil**							
Batch R4928074								
WG3228613-1 DUP		**L2386158-7**						
Available Ammonium-N		3.3	3.1		mg/kg	5.0	20	28-NOV-19
WG3228613-3 IRM		**SAL814**						
Available Ammonium-N			104.9		%		70-130	28-NOV-19
WG3228613-4 LCS								
Available Ammonium-N			92.1		%		80-120	28-NOV-19
WG3228613-2 MB								
Available Ammonium-N			<1.0		mg/kg		1	28-NOV-19
NO3-AVAIL-KCL-SK	**Soil**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-AVAIL-KCL-SK	**Soil**							
Batch R4928348								
WG3228614-1 DUP		**L2386158-7**						
Available Nitrate-N		<2.0	<2.0		RPD-NA	mg/kg	N/A	30	28-NOV-19
WG3228614-3 IRM		**SAL814**						
Available Nitrate-N			95.5			%		70-130	28-NOV-19
WG3228614-4 LCS								
Available Nitrate-N			96.6			%		70-130	28-NOV-19
WG3228614-2 MB								
Available Nitrate-N			<2.0			mg/kg		2	28-NOV-19
PO4-AVAIL-OLSEN-SK	**Soil**							
Batch R4928926								
WG3231463-1 DUP		**L2386158-7**						
Available Phosphate-P		7.8	6.2			mg/kg	23	30	29-NOV-19
WG3231463-3 IRM		**FARM2005**						
Available Phosphate-P			87.0			%		80-120	29-NOV-19
WG3231463-4 LCS								
Available Phosphate-P			109.3			%		80-120	29-NOV-19
WG3231463-2 MB								
Available Phosphate-P			<1.0			mg/kg		1	29-NOV-19
PSA-1-ED	**Soil**							
Batch R4930017								
WG3232473-3 DUP		**L2386158-4**						
% Sand		20.0	18.0		J	%	2.0	5	02-DEC-19
% Silt		52.4	53.6		J	%	1.2	5	02-DEC-19
% Clay		27.6	28.4		J	%	0.8	5	02-DEC-19
WG3232473-2 IRM		**ALS SAL 2019**						
% Sand			43.0			%		36.3-46.3	02-DEC-19
% Silt			35.0			%		30.2-40.2	02-DEC-19
% Clay			22.0			%		18.5-28.5	02-DEC-19
WG3232473-1 MB								
% Sand			<1.0			%		1	02-DEC-19
% Silt			<1.0			%		1	02-DEC-19
% Clay			<1.0			%		1	02-DEC-19
SAR-CALC-SK	**Soil**							
Batch R4928300								
WG3229867-5 IRM		**ALS SAL 2019**						
Calcium (Ca)			103.1			%		70-130	28-NOV-19
Potassium (K)			82.2			%		70-130	28-NOV-19

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SAR-CALC-SK	**Soil**							
Batch R4928300								
WG3229867-5 IRM		**ALS SAL 2019**						
Magnesium (Mg)			90.4		%		70-130	28-NOV-19
Sodium (Na)			104.3		%		70-130	28-NOV-19
WG3229867-4 LCS								
Calcium (Ca)			102.8		%		70-130	28-NOV-19
Potassium (K)			98.9		%		70-130	28-NOV-19
Magnesium (Mg)			99.3		%		70-130	28-NOV-19
Sodium (Na)			103.7		%		70-130	28-NOV-19
WG3229867-2 MB								
Calcium (Ca)			<5.0		mg/L		5	28-NOV-19
Potassium (K)			<5.0		mg/L		5	28-NOV-19
Magnesium (Mg)			<5.0		mg/L		5	28-NOV-19
Sodium (Na)			<5.0		mg/L		5	28-NOV-19
SAT/PH/EC-SK	**Soil**							
Batch R4928008								
WG3229867-5 IRM		**ALS SAL 2019**						
% Saturation			96.0		%		80-120	28-NOV-19
pH in Saturated Paste			7.35		pH		7.01-7.61	28-NOV-19
Conductivity Sat. Paste			96.8		%		80-120	28-NOV-19
WG3229867-4 LCS								
% Saturation			100.3		%		80-120	28-NOV-19
pH in Saturated Paste			6.95		pH		6.66-7.06	28-NOV-19
Conductivity Sat. Paste			98.4		%		80-120	28-NOV-19
WG3229867-2 MB								
% Saturation			<1.0		%		1	28-NOV-19
Conductivity Sat. Paste			<0.10		dS m-1		0.1	28-NOV-19
SO4-AVAIL-SK	**Soil**							
Batch R4928303								
WG3228616-3 IRM		**SAL814**						
Available Sulfate-S			99.2		%		70-130	28-NOV-19
WG3228616-2 MB								
Available Sulfate-S			<4.0		mg/kg		4	28-NOV-19

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLDS	Detection Limit Raised: Dilution required due to high Dissolved Solids / Electrical Conductivity.
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Leachable Anions & Nutrients							
Total Nitrogen by combustion method							
	7	21-NOV-19 11:30	26-MAR-20 00:00	28	126	days	EHT
Plant Available Nutrients							
Available Nitrate-N (2N KCl)							
	1	21-NOV-19 11:30	26-NOV-19 12:00	3	5	days	EHT
	2	21-NOV-19 11:30	27-NOV-19 17:00	3	6	days	EHT
	4	21-NOV-19 11:30	26-NOV-19 12:00	3	5	days	EHT
	5	21-NOV-19 11:30	26-NOV-19 12:00	3	5	days	EHT
	7	21-NOV-19 11:30	26-NOV-19 12:00	3	5	days	EHT
	8	21-NOV-19 11:30	26-NOV-19 12:00	3	5	days	EHT

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2386158 were received on 21-NOV-19 15:38.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Soil

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2386158-COFC

COC Number: 14 - L2386158

Page ____ of ____

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	WSP Canada Group Limited	Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)		R ☐ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Darren Keam	Quality Control (QC) Report with Report ☑ Yes ☐ No		P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	1600 Buffalo Place	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX		E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	204-259-1488	Email 1 or Fax darren.keam@wsp.com		Specify Date Required for E2,E or P:
		Email 2		

Invoice To		Invoice Distribution	
	Same as Report To ☑ Yes ☐ No	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
	Copy of Invoice with Report ☐ Yes ☐ No	Email 1 or Fax apWest@wsp.com	
Company:		Email 2	
Contact:			

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q37455	Approver ID:	Cost Center:
Job #:	181-03988-00	GL Account:	Routing Code:
PO / AFE:	181-03988-00	Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler: D.Keam

Analysis Request

Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Available Ammonia-N & Nitrate-N	Phosphate-P by Olsen	Available Potassium	Available Sulfate-s	pH, EC, SAR	Mercury, Boron (in-holwater), CCME Metals	Soil Texture (Hydrometer)	TKN/TN						Number of Containers
1	TP01 0-6	21/11/19	1130am	Soil	✓	✓	✓	✓	✓	✓	✓	✓						1
2	TP01 6-24			Soil	✓						✓	✓						1
3	TP01 24-[illegible]60			Soil							✓							1
4	TP02 0-6			Soil	✓	✓	✓	✓	✓	✓	✓	✓						1
5	TP02 6-24			Soil	✓						✓	✓						1
6	TP02 24-[illegible]60			Soil							✓							1
7	TP03 0-6			Soil	✓	✓	✓	✓	✓	✓	✓	✓						1
8	TP03 6-24			Soil	✓						✓	✓						1
9	TP03 24-[illegible]60			Soil							✓							1
10	TP03 60-72			Soil							✓							1
				Soil														
				Soil														

PSA-FP

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	CCME Agricultural Land Use -Need to subsample
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen	☐	SIF Observations	Yes ☐	No ☐	
Ice packs	Yes ☐	No ☐	Custody seal intact	Yes ☐	No ☐
Cooling Initiated	☐				

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
2.2					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: [redacted]	Date: 21/10/19	Time: 4:15pm.	Received by: CFL	Date: Nov 21	Time: 3:58	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

WSP Canada Inc.
ATTN: DARREN KEAM
1600 Buffalo Place
Winnipeg MB R3T 6B8

Date Received: 17-APR-20
Report Date: 01-MAY-20 14:35 (MT)
Version: FINAL REV. 2

Client Phone: 204-477-6650

Certificate of Analysis

Lab Work Order #: L2437956

Project P.O. #: 181-03988-01
Job Reference: 181-03988-01
C of C Numbers:
Legal Site Desc:

Comments:
1-MAY-2020 Added MU for NO3

[redacted]
Judy Dalmaijer
Account Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L2437956-1 GIMLI BIOSOLIDS 2020							
Sampled By: CLIENT on 16-APR-20 @ 16:00							
Matrix: GRAB							
Miscellaneous Parameters							
Moisture	85.4		0.10	%		21-APR-20	R5059621
Boron (B), Hot Water Ext.	16.5	DLM	1.0	mg/kg	27-APR-20	27-APR-20	R5067078
Mercury (Hg)	0.299		0.0050	mg/kg	20-APR-20	24-APR-20	R5063258
Total Kjeldahl Nitrogen	6.7	DLHC	1.2	%	23-APR-20	24-APR-20	R5065804
Total Nitrogen by LECO	6.92		0.020	%	23-APR-20	23-APR-20	R5061682
Metals in Soil by CRC ICPMS							
Aluminum (Al)	18900		50	mg/kg	20-APR-20	20-APR-20	R5058931
Antimony (Sb)	0.49		0.10	mg/kg	20-APR-20	20-APR-20	R5058931
Arsenic (As)	11.0		0.10	mg/kg	20-APR-20	20-APR-20	R5058931
Barium (Ba)	195		0.50	mg/kg	20-APR-20	20-APR-20	R5058931
Beryllium (Be)	0.17		0.10	mg/kg	20-APR-20	20-APR-20	R5058931
Boron (B)	89.6		5.0	mg/kg	20-APR-20	20-APR-20	R5058931
Bismuth (Bi)	10.8		0.20	mg/kg	20-APR-20	20-APR-20	R5058931
Cadmium (Cd)	0.491		0.020	mg/kg	20-APR-20	20-APR-20	R5058931
Calcium (Ca)	18400		50	mg/kg	20-APR-20	20-APR-20	R5058931
Chromium (Cr)	25.1		0.50	mg/kg	20-APR-20	20-APR-20	R5058931
Cobalt (Co)	1.84		0.10	mg/kg	20-APR-20	20-APR-20	R5058931
Copper (Cu)	1650		0.50	mg/kg	20-APR-20	20-APR-20	R5058931
Iron (Fe)	6510		50	mg/kg	20-APR-20	20-APR-20	R5058931
Lead (Pb)	10.4		0.50	mg/kg	20-APR-20	20-APR-20	R5058931
Lithium (Li)	<2.0		2.0	mg/kg	20-APR-20	20-APR-20	R5058931
Magnesium (Mg)	9400		20	mg/kg	20-APR-20	20-APR-20	R5058931
Manganese (Mn)	73.7		1.0	mg/kg	20-APR-20	20-APR-20	R5058931
Molybdenum (Mo)	16.7		0.10	mg/kg	20-APR-20	20-APR-20	R5058931
Nickel (Ni)	15.4		0.50	mg/kg	20-APR-20	20-APR-20	R5058931
Phosphorus (P)	18100		50	mg/kg	20-APR-20	20-APR-20	R5058931
Potassium (K)	2800		100	mg/kg	20-APR-20	20-APR-20	R5058931
Selenium (Se)	3.19		0.20	mg/kg	20-APR-20	20-APR-20	R5058931
Silver (Ag)	0.91		0.10	mg/kg	20-APR-20	20-APR-20	R5058931
Sodium (Na)	1780		50	mg/kg	20-APR-20	20-APR-20	R5058931
Strontium (Sr)	189		0.50	mg/kg	20-APR-20	20-APR-20	R5058931
Sulfur (S)	11600		1000	mg/kg	20-APR-20	20-APR-20	R5058931
Thallium (Tl)	0.054		0.050	mg/kg	20-APR-20	20-APR-20	R5058931
Tin (Sn)	11.3		2.0	mg/kg	20-APR-20	20-APR-20	R5058931
Titanium (Ti)	30.6		1.0	mg/kg	20-APR-20	20-APR-20	R5058931
Tungsten (W)	<0.50		0.50	mg/kg	20-APR-20	20-APR-20	R5058931
Uranium (U)	2.96		0.050	mg/kg	20-APR-20	20-APR-20	R5058931
Vanadium (V)	2.52		0.20	mg/kg	20-APR-20	20-APR-20	R5058931
Zinc (Zn)	447		2.0	mg/kg	20-APR-20	20-APR-20	R5058931
Zirconium (Zr)	16.5		1.0	mg/kg	20-APR-20	20-APR-20	R5058931
Available Ammonia-N & Nitrate-N (2N KCl)							
Available Ammonium-N							
Available Ammonium-N	4910	DLM	740	mg/kg	23-APR-20	23-APR-20	R5061782
Note: Samples analyzed as received and calculated to dry							
Available Nitrate-N (2N KCl)							
Available Nitrate-N	34.4	DLM	2.0	mg/kg	28-APR-20	28-APR-20	R5068379

* Refer to Referenced Information for Qualifiers (if any) and Methodology.

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
B-HOTW-SK	Soil	Available Boron, Hot Water	CSSS (2008) Ch.9

Hot water is used to extract the plant-available and potentially plant-available boron from soil. Boron in the extract is determined by ICP-OES.

HG-200.2-CVAA-WP	Soil	Mercury in Soil	EPA 200.2/1631E (mod)

Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

MET-200.2-CCMS-WP	Soil	Metals in Soil by CRC ICPMS	EPA 200.2/6020B (mod)

Soil/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

Limitations: This method is intended to liberate environmentally available metals. Silicate minerals are not solubilized. Some metals may be only partially recovered (matrix dependent), including Al, Ba, Be, Cr, S, Sr, Ti, Tl, V, W, and Zr. Elemental Sulfur may be poorly recovered by this method. Volatile forms of sulfur (e.g. sulfide, H2S) may be excluded if lost during sampling, storage, or digestion.

MOISTURE-WP	Soil	% Moisture	CCME PHC in Soil - Tier 1 (mod)

Moisture content in solid matrices is determined gravimetrically after drying to constant weight at 105°C.

N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method	CSSS (2008) 22.4

The sample is ignited in a combustion analyzer where nitrogen in the reduced nitrous oxide gas is determined using a thermal conductivity detector.

N-TOTKJ-COL-SK	Soil	Total Kjeldahl Nitrogen	CSSS (2008) 22.2.3

The soil is digested with sulfuric acid in the presence of CuSO4 and K2SO4 catalysts. Ammonia in the soil extract is determined colrimetrically at 660 nm.

NH4-AVAIL-SK	Soil	Available Ammonium-N	CSSS Carter 6.2 / Comm Soil Sci 19(6)

Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.

NO3-AVAIL-KCL-SK	Soil	Available Nitrate-N (2N KCl)	CSSS (1993) 4.2, 4.3

Available Nitrate and Nitrite are extracted from the soil using a 2N KCl solution. Nitrate is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water soluble dye has a magenta color which is measured at colorimetrically at 520nm.

Reference:
Carter, Martin. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1993) methods 4.2, 4.3

** ALS test methods may incorporate modifications from specified reference methods to improve performance.

The last two letters of the above test code(s) indicate the laboratory that performed analytical analysis for that test. Refer to the list below:

Laboratory Definition Code	Laboratory Location
SK	ALS ENVIRONMENTAL - SASKATOON, SASKATCHEWAN, CANADA
WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.
mg/kg - milligrams per kilogram based on dry weight of sample
mg/kg wwt - milligrams per kilogram based on wet weight of sample
mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight
mg/L - unit of concentration based on volume, parts per million.
< - Less than.
D.L. - The reporting limit.
N/A - Result not available. Refer to qualifier code and definition for explanation.

Test results reported relate only to the samples as received by the laboratory.
UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.
Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.

Quality Control Report

Client: WSP Canada Inc.
1600 Buffalo Place
Winnipeg MB R3T 6B8
Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HOTW-SK	**Soil**							
Batch R5067078								
WG3312544-1 DUP		**L2437956-1**						
Boron (B), Hot Water Ext.		16.5	11.5	DUP-H	mg/kg	36	30	27-APR-20
WG3312544-3 IRM		**SAL814**						
Boron (B), Hot Water Ext.			80.0		%		70-130	27-APR-20
WG3312544-4 LCS								
Boron (B), Hot Water Ext.			94.2		%		70-130	27-APR-20
WG3312544-2 MB								
Boron (B), Hot Water Ext.			<0.20		mg/kg		0.2	27-APR-20
HG-200.2-CVAA-WP	**Soil**							
Batch R5063258								
WG3310262-4 CRM		**CANMET TILL-1**						
Mercury (Hg)			109.4		%		70-130	24-APR-20
WG3310262-5 DUP		**L2437956-1**						
Mercury (Hg)		0.299	0.299		mg/kg	0.1	40	24-APR-20
WG3310262-2 LCS								
Mercury (Hg)			109.5		%		80-120	24-APR-20
WG3310262-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	24-APR-20
MET-200.2-CCMS-WP	**Soil**							
Batch R5058931								
WG3310254-4 CRM		**CANMET TILL-1**						
Aluminum (Al)			104.9		%		70-130	20-APR-20
Antimony (Sb)			103.6		%		70-130	20-APR-20
Arsenic (As)			103.8		%		70-130	20-APR-20
Barium (Ba)			101.5		%		70-130	20-APR-20
Beryllium (Be)			96.6		%		70-130	20-APR-20
Boron (B)			2.7		mg/kg		0-8.2	20-APR-20
Bismuth (Bi)			97.1		%		70-130	20-APR-20
Cadmium (Cd)			99.2		%		70-130	20-APR-20
Calcium (Ca)			87.9		%		70-130	20-APR-20
Chromium (Cr)			96.8		%		70-130	20-APR-20
Cobalt (Co)			102.7		%		70-130	20-APR-20
Copper (Cu)			109.0		%		70-130	20-APR-20
Iron (Fe)			104.1		%		70-130	20-APR-20
Lead (Pb)			98.0		%		70-130	20-APR-20
Lithium (Li)			92.1		%		70-130	20-APR-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WP	**Soil**							
Batch R5058931								
WG3310254-4 CRM		**CANMET TILL-1**						
Magnesium (Mg)			107.7		%		70-130	20-APR-20
Manganese (Mn)			107.3		%		70-130	20-APR-20
Molybdenum (Mo)			96.2		%		70-130	20-APR-20
Nickel (Ni)			102.7		%		70-130	20-APR-20
Phosphorus (P)			100.8		%		70-130	20-APR-20
Potassium (K)			79.6		%		70-130	20-APR-20
Selenium (Se)			0.36		mg/kg		0.12-0.52	20-APR-20
Silver (Ag)			0.23		mg/kg		0.12-0.32	20-APR-20
Sodium (Na)			85.1		%		70-130	20-APR-20
Strontium (Sr)			89.7		%		70-130	20-APR-20
Thallium (Tl)			0.118		mg/kg		0.075-0.175	20-APR-20
Tin (Sn)			0.9		mg/kg		0-3.1	20-APR-20
Titanium (Ti)			78.3		%		70-130	20-APR-20
Tungsten (W)			0.14		mg/kg		0-0.66	20-APR-20
Uranium (U)			98.3		%		70-130	20-APR-20
Vanadium (V)			97.3		%		70-130	20-APR-20
Zinc (Zn)			99.2		%		70-130	20-APR-20
Zirconium (Zr)			0.7		mg/kg		0-1.8	20-APR-20
WG3310254-6 DUP		**L2437956-1**						
Aluminum (Al)		18900	18400		mg/kg	2.7	40	20-APR-20
Antimony (Sb)		0.49	0.48		mg/kg	3.0	30	20-APR-20
Arsenic (As)		11.0	10.9		mg/kg	1.3	30	20-APR-20
Barium (Ba)		195	192		mg/kg	1.2	40	20-APR-20
Beryllium (Be)		0.17	0.18		mg/kg	4.8	30	20-APR-20
Boron (B)		89.6	88.5		mg/kg	1.2	30	20-APR-20
Bismuth (Bi)		10.8	10.5		mg/kg	3.2	30	20-APR-20
Cadmium (Cd)		0.491	0.533		mg/kg	8.2	30	20-APR-20
Calcium (Ca)		18400	18200		mg/kg	1.2	30	20-APR-20
Chromium (Cr)		25.1	23.7		mg/kg	5.9	30	20-APR-20
Cobalt (Co)		1.84	1.81		mg/kg	1.8	30	20-APR-20
Copper (Cu)		1650	1630		mg/kg	0.7	30	20-APR-20
Iron (Fe)		6510	6470		mg/kg	0.6	30	20-APR-20
Lead (Pb)		10.4	13.6		mg/kg	27	40	20-APR-20
Lithium (Li)		<2.0	<2.0	RPD-NA	mg/kg	N/A	30	20-APR-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WP	**Soil**							
Batch R5058931								
WG3310254-6 DUP		**L2437956-1**						
Magnesium (Mg)		9400	9190		mg/kg	2.2	30	20-APR-20
Manganese (Mn)		73.7	73.0		mg/kg	1.0	30	20-APR-20
Molybdenum (Mo)		16.7	16.6		mg/kg	0.7	40	20-APR-20
Nickel (Ni)		15.4	15.1		mg/kg	2.0	30	20-APR-20
Phosphorus (P)		18100	17700		mg/kg	2.3	30	20-APR-20
Potassium (K)		2800	2760		mg/kg	1.7	40	20-APR-20
Selenium (Se)		3.19	3.26		mg/kg	2.3	30	20-APR-20
Silver (Ag)		0.91	0.83		mg/kg	9.0	40	20-APR-20
Sodium (Na)		1780	1730		mg/kg	2.8	40	20-APR-20
Strontium (Sr)		189	184		mg/kg	2.7	40	20-APR-20
Sulfur (S)		11600	11500		mg/kg	1.6	30	20-APR-20
Thallium (Tl)		0.054	<0.050	RPD-NA	mg/kg	N/A	30	20-APR-20
Tin (Sn)		11.3	11.4		mg/kg	0.2	40	20-APR-20
Titanium (Ti)		30.6	32.3		mg/kg	5.5	40	20-APR-20
Tungsten (W)		<0.50	<0.50	RPD-NA	mg/kg	N/A	25	20-APR-20
Uranium (U)		2.96	2.86		mg/kg	3.5	30	20-APR-20
Vanadium (V)		2.52	2.48		mg/kg	1.5	30	20-APR-20
Zinc (Zn)		447	441		mg/kg	1.2	30	20-APR-20
Zirconium (Zr)		16.5	16.2		mg/kg	1.9	30	20-APR-20
WG3310254-2 LCS								
Aluminum (Al)			102.7		%		80-120	20-APR-20
Antimony (Sb)			101.1		%		80-120	20-APR-20
Arsenic (As)			103.5		%		80-120	20-APR-20
Barium (Ba)			106.5		%		80-120	20-APR-20
Beryllium (Be)			97.8		%		80-120	20-APR-20
Boron (B)			96.2		%		80-120	20-APR-20
Bismuth (Bi)			94.3		%		80-120	20-APR-20
Cadmium (Cd)			106.4		%		80-120	20-APR-20
Calcium (Ca)			101.8		%		80-120	20-APR-20
Chromium (Cr)			105.8		%		80-120	20-APR-20
Cobalt (Co)			106.2		%		80-120	20-APR-20
Copper (Cu)			107.5		%		80-120	20-APR-20
Iron (Fe)			102.3		%		80-120	20-APR-20
Lead (Pb)			97.2		%		80-120	20-APR-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WP	**Soil**							
Batch R5058931								
WG3310254-2 LCS								
Lithium (Li)			98.4		%		80-120	20-APR-20
Magnesium (Mg)			115.5		%		80-120	20-APR-20
Manganese (Mn)			103.4		%		80-120	20-APR-20
Molybdenum (Mo)			99.3		%		80-120	20-APR-20
Nickel (Ni)			105.0		%		80-120	20-APR-20
Phosphorus (P)			108.7		%		80-120	20-APR-20
Potassium (K)			106.7		%		80-120	20-APR-20
Selenium (Se)			108.3		%		80-120	20-APR-20
Silver (Ag)			100.1		%		80-120	20-APR-20
Sodium (Na)			108.8		%		80-120	20-APR-20
Strontium (Sr)			105.3		%		80-120	20-APR-20
Sulfur (S)			98.6		%		70-130	20-APR-20
Thallium (Tl)			94.5		%		80-120	20-APR-20
Tin (Sn)			99.6		%		80-120	20-APR-20
Titanium (Ti)			101.1		%		80-120	20-APR-20
Tungsten (W)			98.3		%		70-130	20-APR-20
Uranium (U)			103.9		%		80-120	20-APR-20
Vanadium (V)			105.9		%		80-120	20-APR-20
Zinc (Zn)			102.2		%		80-120	20-APR-20
Zirconium (Zr)			95.8		%		80-120	20-APR-20
WG3310254-1 MB								
Aluminum (Al)			<50		mg/kg		50	20-APR-20
Antimony (Sb)			<0.10		mg/kg		0.1	20-APR-20
Arsenic (As)			<0.10		mg/kg		0.1	20-APR-20
Barium (Ba)			<0.50		mg/kg		0.5	20-APR-20
Beryllium (Be)			<0.10		mg/kg		0.1	20-APR-20
Boron (B)			<5.0		mg/kg		5	20-APR-20
Bismuth (Bi)			<0.20		mg/kg		0.2	20-APR-20
Cadmium (Cd)			<0.020		mg/kg		0.02	20-APR-20
Calcium (Ca)			<50		mg/kg		50	20-APR-20
Chromium (Cr)			<0.50		mg/kg		0.5	20-APR-20
Cobalt (Co)			<0.10		mg/kg		0.1	20-APR-20
Copper (Cu)			<0.50		mg/kg		0.5	20-APR-20
Iron (Fe)			<50		mg/kg		50	20-APR-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WP	**Soil**							
Batch R5058931								
WG3310254-1 MB								
Lead (Pb)			<0.50		mg/kg		0.5	20-APR-20
Lithium (Li)			<2.0		mg/kg		2	20-APR-20
Magnesium (Mg)			<20		mg/kg		20	20-APR-20
Manganese (Mn)			<1.0		mg/kg		1	20-APR-20
Molybdenum (Mo)			<0.10		mg/kg		0.1	20-APR-20
Nickel (Ni)			<0.50		mg/kg		0.5	20-APR-20
Phosphorus (P)			<50		mg/kg		50	20-APR-20
Potassium (K)			<100		mg/kg		100	20-APR-20
Selenium (Se)			<0.20		mg/kg		0.2	20-APR-20
Silver (Ag)			<0.10		mg/kg		0.1	20-APR-20
Sodium (Na)			<50		mg/kg		50	20-APR-20
Strontium (Sr)			<0.50		mg/kg		0.5	20-APR-20
Sulfur (S)			<1000		mg/kg		1000	20-APR-20
Thallium (Tl)			<0.050		mg/kg		0.05	20-APR-20
Tin (Sn)			<2.0		mg/kg		2	20-APR-20
Titanium (Ti)			<1.0		mg/kg		1	20-APR-20
Tungsten (W)			<0.50		mg/kg		0.5	20-APR-20
Uranium (U)			<0.050		mg/kg		0.05	20-APR-20
Vanadium (V)			<0.20		mg/kg		0.2	20-APR-20
Zinc (Zn)			<2.0		mg/kg		2	20-APR-20
Zirconium (Zr)			<1.0		mg/kg		1	20-APR-20
MOISTURE-WP	**Soil**							
Batch R5059621								
WG3310642-3 DUP		**L2437956-1**						
Moisture		85.4	85.4		%	0.0	20	21-APR-20
WG3310642-2 LCS								
Moisture			99.9		%		90-110	21-APR-20
WG3310642-1 MB								
Moisture			<0.10		%		0.1	21-APR-20
N-TOT-LECO-SK	**Soil**							
Batch R5061682								
WG3309524-2 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			107.1		%		80-120	23-APR-20
WG3309524-4 LCS		**SULFADIAZINE**						
Total Nitrogen by LECO			98.3		%		90-110	23-APR-20

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOT-LECO-SK	**Soil**							
Batch R5061682								
WG3309524-3 MB								
Total Nitrogen by LECO			<0.020		%		0.02	23-APR-20
N-TOTKJ-COL-SK	**Soil**							
Batch R5065804								
WG3312412-2 IRM		**08-109_SOIL**						
Total Kjeldahl Nitrogen			103.6		%		80-120	24-APR-20
WG3312412-3 LCS								
Total Kjeldahl Nitrogen			101.6		%		80-120	24-APR-20
WG3312412-4 MB								
Total Kjeldahl Nitrogen			<0.020		%		0.02	24-APR-20
NH4-AVAIL-SK	**Soil**							
Batch R5061782								
WG3311897-1 DUP		**L2437956-1**						
Available Ammonium-N		4910	4790		mg/kg	2.5	20	23-APR-20
WG3311897-3 IRM		**SAL814**						
Available Ammonium-N			98.8		%		70-130	23-APR-20
WG3311897-4 LCS								
Available Ammonium-N			96.0		%		80-120	23-APR-20
WG3311897-2 MB								
Available Ammonium-N			<1.0		mg/kg		1	23-APR-20
NO3-AVAIL-KCL-SK	**Soil**							
Batch R5068379								
WG3312197-3 IRM		**SAL814**						
Available Nitrate-N			100.3		%		70-130	28-APR-20
WG3312197-4 LCS								
Available Nitrate-N			100.0		%		70-130	28-APR-20
WG3312197-2 MB								
Available Nitrate-N			<2.0		mg/kg		2	28-APR-20

Legend:

Limit	ALS Control Limit (Data Quality Objectives)
DUP	Duplicate
RPD	Relative Percent Difference
N/A	Not Available
LCS	Laboratory Control Sample
SRM	Standard Reference Material
MS	Matrix Spike
MSD	Matrix Spike Duplicate
ADE	Average Desorption Efficiency
MB	Method Blank
IRM	Internal Reference Material
CRM	Certified Reference Material
CCV	Continuing Calibration Verification
CVS	Calibration Verification Standard
LCSD	Laboratory Control Sample Duplicate

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Plant Available Nutrients							
Available Nitrate-N (2N KCl)							
	1	16-APR-20 16:00	21-APR-20 16:00	3	5	days	EHT

Legend & Qualifier Definitions:

EHTR-FM:	Exceeded ALS recommended hold time prior to sample receipt. Field Measurement recommended.
EHTR:	Exceeded ALS recommended hold time prior to sample receipt.
EHTL:	Exceeded ALS recommended hold time prior to analysis. Sample was received less than 24 hours prior to expiry.
EHT:	Exceeded ALS recommended hold time prior to analysis.
Rec. HT:	ALS recommended hold time (see units).

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2437956 were received on 17-APR-20 12:20.

ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where available). For more information, please contact ALS.

The ALS Quality Control Report is provided to ALS clients upon request. ALS includes comprehensive QC checks with every analysis to ensure our high standards of quality are met. Each QC result has a known or expected target value, which is compared against pre-determined data quality objectives to provide confidence in the accuracy of associated test results.

Please note that this report may contain QC results from anonymous Sample Duplicates and Matrix Spikes that do not originate from this Work Order.

Chain of Custody (COC) / Analytical Request Form

ALS Environmental

www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L2437956-COFC

COC Number: 14 - L2437956

Page ___ of ___

Report To		Report Format / Distribution	Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	WSP Canada Group Limited	Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3 pm - business days)
Contact:	Darren Keam	Quality Control (QC) Report with Report ☑ Yes ☐ No	P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
Address:	1600 Buffalo Place	☐ Criteria on Report - provide details below if box checked	E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
		Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
Phone:	204-259-1488	Email 1 or Fax darren.keam@wsp.com	Specify Date Required for E2,E or P:
		Email 2	Analysis Request

Invoice To		Invoice Distribution	Indicate Filtered (F), Preserved (P) or Filtered and Preserved (F/P) below
	Same as Report To ☐ Yes ☐ No	Select Invoice Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	
	Copy of Invoice with Report ☐ Yes ☐ No		
Company:	WSP Canada Group Limited	Email 1 or Fax apwest@wsp.com	
Contact:	Apwest@wsp.com	Email 2	

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q37455	Approver ID:	Cost Center:
Job #:	181-03988-01	GL Account:	Routing Code:
PO / AFE:	181-03988-01	Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	Mercury	Boron (hot-water)	CCME Metals	Moisture	Total Nitrogen	Total Kjeldahl Nitrogen	Available Ammonia-N	Nitrate-N	Number of Containers
	Gimli Biosolids 2020	16/04/20	16:00	Grab	R	R	R	R	R	R	R	R	

Fill in date and time.

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	CCME agriculture, fine grain
Are samples for human drinking water use? ☐ Yes ☐ No	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ SIF Observations Yes ☐ No ☐

Ice packs Yes ☐ No ☐ Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C		FINAL COOLER TEMPERATURES °C		
	6.8			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by: CM	Date: 17-4-20	Time: 12:20	Received by: C	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

Failure to complete all portions of this form may delay analysis. Please fill in this form LEGIBLY. By the use of this form the user acknowledges and agrees with the Terms and Conditions as specified on the back page of the white - report copy.

1. If any water samples are taken from a Regulated Drinking Water (DW) System, please submit using an Authorized DW COC form.

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