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DES NEDHE GRASSWOOD DEVELOPMENT WASTEWATER TREATMENT AND DISPOSAL AGRICULTURAL FEASIBILITY REPORT FOR IRRIGATION

Final Report

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EXECUTIVE SUMMARY

Due to ongoing development within the Grasswoods Indian Reserve 192J, located just south of Saskatoon, on-site wastewater treatment and disposal is necessary. To meet this need, Des Nedhe Development (Des Nedhe), the economic development corporation of the English River First Nation, is exploring the feasibility of constructing a membrane bio-reactor (MBR) wastewater treatment facility. The Grasswood Development Wastewater Treatment and Disposal Project (the Project) would involve the generation of liquid effluent which would be disposed of via treated wastewater irrigation on approximately 22.5 hectares (ha) of land within the reserve.

Canada North Environmental Services (CanNorth) was retained by MPE Engineering Limited (MPE Engineering) on behalf of Des Nedhe to conduct an assessment of the suitability of the land for irrigation. An assessment of the soil and topography was completed on November 7th, 2019. Soils in the proposed irrigation area were predominantly Orthic Dark Brown Chernozems developed in undulating glaciolacustrine deposits, ranging in slope from >2% to 9%. Calcareous Dark Brown Chernozems and Gleyed Dark Brown Chernozems were also present in limited extent.

The results of the assessment found that 13.1 ha of the proposed irrigation area is currently suitable for effluent irrigation without the implementation of reclamation measures, though minor portions of the area may be at risk of salinization under poor irrigation practices. The southern portion of the proposed irrigation area was not assessed at the time of the field survey as it had been highly disturbed, containing large stockpiles of subsoil and topsoil. Additional soil berms had been constructed near the northeastern corner of the proposed irrigation area, near an existing rail line, and various trails had been bladed into the soil throughout. The disturbed land in the southern portion of the proposed irrigation area and additional treed areas investigated were classified as nonirrigable; however, these areas may become irrigable following reclamation and would lead to a total of 21.2 ha of land potentially suitable for irrigation. A small portion of the proposed irrigation area (1.3 ha) is riparian and is thus nonirrigable; reclamation of this riparian area in an attempt to make it irrigable is not recommended.

1.0 INTRODUCTION

Des Nedhe Development (Des Nedhe), the economic development corporation of the English River First Nation, is exploring the feasibility of constructing a membrane bio-reactor (MBR) wastewater treatment facility within the Grasswoods Indian Reserve 192J (Grasswood Reserve; Figure 1). The Grasswood Development Wastewater Treatment and Disposal Project (the Project) would involve the generation of liquid effluent which would be disposed of via treated wastewater irrigation on approximately 22.5 hectares (ha) of land within the Grasswood Reserve (Urban Systems 2019a). As such, MPE Engineering Limited (MPE Engineering), on behalf of Des Nedhe, contracted Canada North Environmental Services (CanNorth) to determine the suitability of these lands for irrigation with treated effluent.

1.1 Grasswood Development

The English River First Nation Grasswood Reserve is located just south of the City of Saskatoon, adjacent to Highway 11. The reserve covers an area of approximately 54 ha (134 acres [ac]) and plans for development of the reserve include a phased approach for construction of both commercial and industrial developments. Due to the absence of City of Saskatoon (the City) underground infrastructure within the Grasswood Reserve, or any plans by the City to extend sewer lines to the area in the near future, on-site wastewater treatment and disposal is necessary (Urban Systems 2019a).

1.2 Membrane Bio-Reactor System

Various feasibility studies have been conducted for proposed wastewater treatment systems for the English River First Nation Grasswood Reserve, including the following:

- *English River First Nation Wastewater Lagoon Feasibility Assessment* (Clifton Associates Limited [Clifton Associates] 2014);
- *English River Property Management Conceptual Sanitary Sewer Servicing Plan* (Associated Engineering Limited [Associated Engineering] 2016);
- *English River First Nation Servicing Study* (Clifton Associates 2017); and
- *Grasswood Reserve Development Project: Conceptual Servicing Plan* (Urban Systems 2019b).

Of the various wastewater treatment systems assessed, the MBR system was selected as the preferred option due to the compact footprint, modular design, and the comparatively low cost relative to other options, among other factors.

Membrane bio-reactor systems consist of a combination of an ultrafiltration membrane and a biological wastewater treatment process, typically used in association with mechanical pre-treatment, resulting in high-quality effluent which may be disposed of via land irrigation. Waste solids are concentrated so they can be properly managed.

1.3 Regulatory Framework

As MBR systems are still relatively novel in Saskatchewan, provincial regulations covering all aspects of such systems are not currently in place (Urban Systems 2019a). As such, where local provincial regulatory guidance is absent, other jurisdictions were consulted. With respect to the assessment of agricultural feasibility for irrigation, the following guidance documents are referenced:

- *Treated Municipal Wastewater Irrigation Guidelines* (Water Security Agency [WSA] 2015a);
- *Sewage Works Design Standard* (WSA 2012);
- *Procedures Manual for the Classification of Land for Irrigation in Alberta* (Alberta Agriculture, Food and Rural Development [AAFRD] 2004a);
- *Standards for the Classification of Land for Irrigation in the Province of Alberta* (AAFRD 2004b); and
- *Guideline for Preparing Agricultural Feasibility Reports for Irrigation Projects* (AESRD 2012).

1.4 Proposed Effluent Irrigation Lands

The lands proposed for irrigation using the MBR system effluent are located within the English River First Nation Grasswood Reserve on NE 02-36-05 west of the Third Meridian (W3M) (Figure 2; Urban Systems 2019a). The proposed effluent irrigation lands are bordered on the north by a railway line and on the east by Highway 11; an open-water wetland lies to the southwest. As per comments from the WSA, the following setbacks have been implemented for the proposed effluent irrigation lands from the surrounding land uses:

- A setback of 30 meters (m) from adjacent properties unless written permission is obtained from adjacent property owners.
- A setback of 60 m from seasonal/drainage courses, major public roads, and railway lines.
- A setback of 100 m from lakes, streams, rivers, dugouts, watercourses, water wells, water reservoirs, and isolated human habitation.
- A setback of 300 m from occupied dwellings, water wells, and built-up habituated areas.

Applying these setbacks to the proposed phased development of the Grasswood Reserve results in an area of 22.51 ha that may be used for effluent irrigation (Figure 2; adapted from Urban Systems 2019a). The proposed location of the MBR system is directly south and adjacent to these lands, on SE 02-36-05 W3M. It is anticipated that a sprinkler irrigation system will be used, which is discussed in more detail in Section 4.1.

2.0 LAND IRRIGATION SUITABILITY

Land irrigation suitability was determined following the protocols outlined in AAFRD (2004a, b). Prior to the field survey, information on terrain and soils in the proposed irrigation area was obtained from the National Soil Database detailed soil survey data (Saskatchewan Land Resource Unit [SLRU] 2004). Field investigations, including assessments of soil and topography at the proposed irrigation site, were completed by CanNorth on November 7th, 2019.

Prior to performing the field survey, the level of intensity of the investigations was determined based on the total irrigation site area. As the proposed irrigation site is > 8 ha (> 20 ac), a 'Level II' intensity of investigation for irrigation map and information was determined to be required (AESRD 2012).

2.1 Survey Methodology

The Level II survey intensity requires an inspection density of at least 10 soil investigation sites per 65 ha (160 ac), including a minimum of three 2-m and one 3-m deep sites (AAFRD 2004a, b). Based on the area of the proposed irrigation lands, a total of 4 deep (>1 m) soil investigation sites (SS01 to SS04) were completed (Figure 3), meeting the Level II survey inspection density requirement. As previous hydrogeological investigations with boreholes drilled to depths of between 5.3 m and 9.9 m have been completed at the proposed irrigation site (Clifton Associates 2016), no 2-m and 3-m soil investigations were completed during the November 7th, 2019 soil survey. Six surface inspections were completed to a depth of approximately 0.3 m at the discretion of the surveyors to confirm homogeneity (Figure 3; SS05 to SS10).

At each deep soil inspection site a soil pit was dug using various hand tools (pickaxe, shovels, and Dutch augers) to a depth of >1 m; at topsoil inspection sites, soil pits were dug to a depth of 0.3 m. Information on all exposed horizons was documented, including horizon depth and designation, Munsell colour description, structure (grade, class, and kind), and texture. Additionally, evidence of effervescence, salts, and periodic or continual saturation (e.g., mottles or gleying) was noted, if present. Soils were classified according to the Canadian System of Soil Classification (Soil Classification Working Group 1998) to the subgroup level. At deep soil inspections, the geological deposit was categorized according to AAFRD (2004a, b). Drainability was qualitatively determined based on

observations of soil morphology (e.g., soil texture). Based on this information, soils were assigned a Basic Soil Rating (B.S.R.) as per AAFRD (2004a, b). Previous work (Clifton Associates 2016) was referenced as required to determine the presence or absence of shallow bedrock and water table (AAFRD 2004a, b).

At each inspection location, terrain information recorded included: an estimate of earth moving requirement (<400 m^3/ac^{-1} or >400 m^3/ac^{-1}), field size and shape, maximum downfield slope (%), surface stoniness (%), brush/tree cover (%), and the depth of any surface drainages (<1.2 m or >1.2 m). Note that snow cover at the time of the survey limited the viewable area of the ground. As such, the surveyors' ability to accurately assess some topographic parameters (e.g., surface stoniness) may have been impeded; values provided for such parameters should be regarded as approximations. Topography was then assigned a category as described in AAFRD (2004a, b).

In order to satisfy the requirement of the WSA to collect chemical information on A, B and C horizons (WSA 2012, 2015a) while still having chemical information relevant to inform soil salinity and sodicity level ratings for the 0 m to 0.5 m, 0.5 m to 1 m, >1 m depth increments required by AAFRD (2004a, b), the following increments were sampled from the four deep soil inspection sites:

- A horizon (typically occurring within the 0 m to 0.5 m increment; depths vary);
- B horizon (typically occurring within the 0 m to 0.5 m increment; depths vary);
- 0 m to 0.5 m;
- 0.5 m to 1.0 m; and
- > 1 m (i.e., C horizon).

Soil samples were kept at or below 4°C and were submitted to Australian Laboratory Services (ALS) in Saskatoon for analysis on the day of sample collection to ensure timely analysis. Analytes measured on all soil samples included detailed salinity (pH, electrical conductivity, sodium absorption ratio, percent saturation, soluble cations in a saturated paste) and particle size. Available nitrogen, phosphorus, potassium, and sulphur were also measured on samples collected from the A horizon, B horizon, and the 0 m to 0.5 m increment.

For the quality assurance/quality control (QA/QC) program, duplicate samples from approximately 10% of the soil horizons/depth increments sampled were submitted for

analysis. For all parameters analyzed, the relative percent difference (RPD) was calculated between the test sample and the duplicate sample. The data quality objective (DQO) for the RPDs was set at 40% for all soil parameters. The intent of applying this DQO was to provide a benchmark for the initial data screening process, which determined whether the results were acceptable or required further investigation. It is estimated that at concentrations near the detection limit, measurement uncertainty is very high, increasing as concentrations approach the detection limit (B. Morgan, ALS, pers. comm., 2017). Thus, RPDs of greater than 40% were only considered a potential issue if the test and duplicate results were greater than five times the detection limit, outside the range of laboratory precision, and outside of instrument accuracy.

2.2 Results

According to available remote sensing imagery, lands proposed for effluent irrigation were previously used for the production of agricultural crops but are currently fallow and appear to no longer be in production. Ground cover is dominated by weedy species, including absinthe (*Artemisia absinthium*), which is designated as noxious under *The Weed Control Act*. Additionally, ongoing construction within the Grasswood Reserve directly south of the proposed irrigation lands appears to have been using the area for temporary workspace, with stockpiles of subsoil and topsoil occupying portions of the lands proposed for effluent irrigation (Appendix A, Photo 1).

2.2.1 Soils and Topography

According to the SLRU (2004), the proposed irrigation area occurs on hummocky and undulating terrain, ranging from nearly level (>0.5% to 2% gradient) to very gently sloping (>2% to 5% gradient). Soils are Dark Brown Chernozems with loam, fine sandy loam, or sandy loam textures formed in glaciofluvial and glaciolacustrine deposits.

Results of the field survey largely confirmed the desktop screening results. Soils within the proposed irrigation area are predominantly Orthic Dark Brown Chernozems developed on undulating glaciolacustine deposits (Table 1; Appendix A, Photo 2). Two low-lying treed depressions are present near the northwestern corner of the proposed irrigation area (Appendix A, Photos 3 and 4). These depressions are characterized by Gleyed Dark Brown Chernozems, which are similar to Orthic Dark Brown Chernozems but differ in that they have weak mottling and/or gleying indicative of periodic saturation. Calcareous Dark

Brown Chernozems occupy a small portion of the proposed irrigation area, and were limited in extent to the area immediately surrounding the treed depressions. However, rather than being the result of groundwater discharge, as often occurs around wetlands, electrical conductivities increased with depth suggesting that the area is a zone of groundwater recharge (Pennock et al. 2011).

Topography throughout the area was undulating, with slopes ranging from very gentle (>2% to 5% gradient) to gentle (>5% to 9% gradient; Table 1). As noted above, large stockpiles of subsoil and topsoil occupied a relatively large portion of the southern portion and the far northeastern corner of the proposed irrigation area, totaling approximately 7.1 ha. For the purposes of this report, it is assumed that the stockpiles will be removed from the site and the ground below the stockpiles will have equivalent soil characteristics and topography to the surrounding assessed area.

The water table was not directly observed during the soil and topography survey; however, data from boreholes investigated by Clifton Associates (2016) was interpreted. Of the boreholes that fell within or adjacent to the proposed irrigation lands, only two had water tables at depths <2 m. The first was located within the riparian area in the southwestern corner of the proposed irrigation lands, with drainage leading to the buffered wetland west of the proposed irrigation area; here, seepage was documented at 0.45 m. The second was located just west of the proposed irrigation lands, approximately 75 m northeast of the northern extent of the buffered wetland; here seepage was documented at 1.8 m. Hydraulic conductivities were measured at three of the boreholes which fell within or adjacent to the proposed irrigation lands, and ranged from 2.3 mm h^{-1} to 5.1 mm h^{-1} (Clifton Associates 2016). Soils with hydraulic conductivities >1 mm h^{-1} are generally considered suitable for irrigation (AAFRD 2004a, b). Full details on water table locations and hydraulic conductivities are presented in Clifton Associates (2016).

Soil map units were delineated based on similarities in soil and topographic properties to yield two polygons of a simple map unit (containing predominantly one soil type) and one polygon of a compound map unit (containing one primary soil type with minor [<20%] inclusions of a second soil type). Disturbed lands and riparian areas were also delineated. These map units are depicted in Figure 3 and are described in detail below. Laboratory analytical results are summarized in Table 2 and are presented in full in Appendix B.

O.DB; CA.DB Lu$^{4-3}$ 3 a1b1n1e1m1; a3b2n1e2m1 W1; W2	Soils are primarily Orthic with minor inclusions of Calcareous Dark Brown Chernozems developed in undulating lacustrine deposits with very gentle slopes (>2% to 5%). Soils are of textural class 3 (sandy loam, fine sandy loam) to 4 (loam, silt loam, very fine sandy loam). Salinity, evident as elevated electrical conductivities, are present in a minor portion of the soils investigated. Sodicity does not affect these soils. According to Clifton Associates (2016), the water table occurs at depths of >2 m at all but one location, where the water table was found between 1 m to 2 m in a borehole adjacent to the map unit.
GL.DB Lu^{4} 4 a1b1n1e1m1	Soils are Gleyed Dark Brown Chernozems developed in undulating lacustrine deposits with gentle slopes (>5% to 9%). Soils are of textural class 4 (loam, silt loam, very fine sandy loam). Neither salinity nor sodicity affects these soils. None of the boreholes investigated by Clifton Associates (2016) fell within the delineated polygons and the water table was not observed during the soil and topography field survey.
D.L.	Disturbed land. Soils and topography were not investigated due to the presence of subsoil and topsoil stockpiles.

The riparian area was excluded from the investigation. Final soil ratings for all deep inspections are presented in Table 3, and were used in calculation of the land classification for irrigation, discussed below.

2.2.2 Land Classification for Irrigation

Based on the soil and topography categories assigned to the delineated map units as per AAFRD (2004a, b), map units were classified as either land class 4 (irrigable, restricted) or land class 5 (nonirrigable pending reclamation). Details regarding how map units were classified are presented in Appendix C (Tables 1 and 2). Where inspections were completed within the proposed irrigation area, approximately 13.1 ha are currently considered irrigable and 1.0 ha are nonirrigable pending reclamation (Table 4). No inspections were

completed in disturbed and riparian areas in the southern portion of the proposed irrigation area due to their status at the time of the field survey; however, these areas are assumed to be nonirrigable pending reclamation (disturbed land; 7.1 ha) and nonirrigable (riparian; 1.3 ha) (Table 4). Irrigable map units within the proposed irrigation area are restricted in irrigation capability, while nonirrigable map units and disturbed lands may become irrigable pending the implementation of reclamation measures; implementing reclamation measures on riparian lands is not recommended. Limitations range from irregular field shape to steep slopes and brush/tree cover. Significant earth-moving will be required on disturbed land.

Land class map units are depicted in Figure 4, are described in detail below:

$4\frac{\mathrm{ST}}{13}\mathrm{Y,J}$	Restricted irrigation capability due to irregular field shape (J), suitable for sprinkler irrigation only. A special irrigation system design may be required to fully utilize the entire area. Soils are primarily Orthic with minor inclusions of Calcareous Dark Brown Chernozems. There is a shallow depth to carbonates in a minor portion of the soils investigated within this map unit.
$5\frac{\mathrm{ST}}{24}\mathrm{X,J,G,B}$	Nonirrigable pending implementation of reclamation measures. The soils are nonirrigable due to the small irregular field shape and size (J), steep slopes (G), and brush/tree cover (B). Brush/tree clearing may improve the feasibility of irrigation; however, a special irrigation system design may be required to prevent runoff, erosion, and ponding in depressions. Soils are Gleyed Dark Brown Chernozems.
D.L.	Disturbed land. Soils and topography were not investigated due to the presence of subsoil and topsoil stockpiles. Nonirrigable pending implementation of reclamation measures and follow-up investigations.

The riparian area was excluded from the investigation. An areal summary of the land classification is provided in Table 4, and a visual representation of irrigation suitability is provided in Figure 5.

3.0 ANNUAL WATER REQUIREMENT

The annual water requirement for an alfalfa crop is calculated below, and is based on mean seasonal values unless otherwise stated. Alfalfa is used as the standard crop when determining annual water requirements for irrigation because of its high water use, resulting from its deep root system, substantial biomass production, and relatively long growing season (Alberta Agriculture and Forestry 2016).

3.1 Net Seasonal Consumptive Use (Et)

Net seasonal consumptive use (Et) refers to the amount of moisture required to produce a good crop stand. While the water requirement for alfalfa depends on a variety of factors (cultivar selection, growth stage, harvest date[s], climate, etc.), under optimal conditions in southern Alberta it requires between 540 mm to 680 mm of water per growing season (Alberta Agriculture and Forestry 2016). For the Brown Soil Zone in Saskatchewan, where the Project is located, the consumptive use of alfalfa is approximately 660 mm (Saskatchewan Ministry of Agriculture 2012); as such, this value is used in subsequent calculations.

3.2 Estimated Mean Effective Precipitation (P)

Based on the Canadian Climate Normals 1981-2010 data for the Saskatoon Diefenbaker International Airport station (Government of Canada 2019a), precipitation received between April and September totals 258.5 mm. Notably, due to the nature of the climate normals data this total includes all precipitation received, including minor rainfall events where amounts accumulated are less than 3 mm, which would likely be subject to evaporation rather than contribute to plant uptake. As such, data for the most recent 10 years (2009 to 2019) from the Saskatoon RCS weather station (Government of Canada 2019b) was analyzed to determine the estimated mean effective precipitation through the growing season (April 15th to September 15th). Precipitation data was used as a proxy for rainfall during the growing season as rainfall data was unavailable for all months, and days with <3 mm were excluded from the calculation. Water lost as runoff was assumed to be negligible, and water losses via deep percolation were not accounted for in the calculations. Based on this information, the estimated mean effective precipitation received during the growing season (P) is 197.0 mm.

3.3 Estimated Effective Stored Moisture (Ms)

The estimated effective stored moisture (Ms) is the total amount of readily available soil moisture accumulated outside the growing season (AESRD 2012). As such precipitation occurs during cooler weather, less is lost due to evapotranspiration. Therefore, all out-of-season precipitation received is included in the calculation. For Saskatoon, this amount is 120.4 mm (Government of Canada 2019b). The available moisture holding capacity for soils in the Project area was estimated to range from 180 mm m^{-1} (for loam soils) to 200 mm m^{-1} (for clay loam soils) based on observed soil textures as well as the average physical characteristics of southern Alberta soils (AAFRD 2004a), which are assumed to be similar to Saskatchewan soils. As the available moisture holding capacity exceeds the mean amount of out-of-season precipitation, it is anticipated that, with the exception of unusually wet years, all out-of-season precipitation would be retained in the rooting zone (which extends to a depth of approximately 1.2 m for alfalfa; Alberta Agriculture and Forestry 2016) for use by the subsequent year's crop.

3.4 Estimated Net Irrigation Requirement (Ain)

The estimated net irrigation requirement (Ain) is calculated as Ain = Et – P – Ms (AESRD 2012); it represents the deficit between received precipitation and crop uptake. Using the values for Et, P, and Ms determined above, the estimated net irrigation requirement for an alfalfa crop in the Project area would be 342.6 mm.

3.5 Estimated Gross Irrigation Requirement (Aig)

The estimated gross irrigation requirement (Aig) accounts for inefficiencies in the application of irrigation water using a specific irrigation method (AESRD 2012). Depending on the type of sprinkler system used, design efficiencies may range from 55% to 95% (Alberta Agriculture and Forestry 2016), resulting in an estimated gross irrigation requirement between 622.9 mm for an inefficient system and 360.6 mm for an efficient system. Typical wheel move sprinkler systems have design efficiencies of approximately 70% (Alberta Agriculture and Forestry 2016), which would lead to an estimated gross irrigation requirement of 489.4 mm.

4.0 IRRIGATION SYSTEM AND WATER USE

4.1 Method of Irrigation

The proposed system for irrigation is a sprinkler system. Modifications will need to be made if a conventional irrigation system is used to accommodate the irregular field shape (i.e., not rectangular, square, or circular). The irrigation system should be designed based on the crop selected and leaching requirements (if any). Consideration should be given to avoiding runoff, operating flexibility, alternate short-term water sources (if required) and natural precipitation variations.

The quality of effluent, the timing and quantity of effluent applications, and the use of other land treatments (e.g., fertilizer) should be documented. Storage capabilities should be considered to accommodate effluent generated outside the growing season and a contingency plan developed to dispose of effluent by other means. It is noted that the quality of effluent must be suitable for irrigation and must comply with relevant regulations, guidelines, and permit conditions. These may include, but are not limited to, the following:

- *Treated Municipal Wastewater Irrigation Guidelines* (WSA 2015a);
- *Sewage Works Design Standard* (WSA 2012);
- *The Waterworks and Sewage Works Regulations*; and
- *Surface Water Quality Objectives* (WSA 2015b).

Forage crops such as alfalfa are generally recommended for effluent irrigation because of their long growing season, high water demand, and ability to remove significant concentrations of nutrients. Furthermore, the selection of forage crops for effluent irrigation is also beneficial in that it provides several degrees of separation between potential pathogens and human health. If the production of food crops is considered, effluent may require additional treatment prior to application.

Effluent should only be applied at rates to meet, but not exceed, crop nutritional demands. Consideration of precipitation, season of application, soil moisture content, soil nutrient content, crop water needs, and mineralization rates should also be considered when planning effluent applications (Canadian Council of Ministers of the Environment [CCME] 2012). For example, application of effluent following heavy rainfalls, on top of snow, onto frozen soil, or during plant dormancy increases the risk of nutrient leaching. Significant

leaching may lead to detrimental environmental effects such as the eutrophication of groundwater (CCME 2012). In general, light frequent irrigation will result in more evaporation and less leaching than less frequent higher volume effluent applications, and are recommended. Notably, leaching may become necessary if there is excessive salt buildup in the rooting zone, as determined via soil quality monitoring.

4.2 Rate of Diversion

As effluent will be used as sole source for irrigation, there will be no need to divert water from surface waters, groundwater, or other water sources. It is anticipated that effluent will be generated at a rate of 188 m^3 per day (69,000 m^3 annually) initially during Phase 1 of the planned development within the Grasswood Reserve. This rate is expected to increase to 288 m^3 per day (105,000 m^3 annually) in future phases of development (C. McRae, MPE Engineering, pers. comm. December 12th, 2019). The remainder of this report focuses on the land requirement for irrigation considering the initial effluent generation rate of 188 m^3 per day, which is anticipated during Phase 1 of the Grasswood development. Other disposal methods or larger areas will be required to accommodate the greater rates of effluent generation associated with future phases of the development, and are not considered herein.

4.3 Annual Volume

To ensure that the full volume of effluent generated by the MBR system in Phase 1 of the development may be disposed of via land irrigation (provided the anticipated rate of effluent generation is not exceeded), between 11.1 ha and 19.1 ha of land would be needed for effluent application based on the Aig values of 622.9 mm and 360.6 mm, respectively. Using the Aig value of 489.4 mm associated with a sprinkler irrigation system with a 70% design efficiency (e.g., a typical wheel move sprinkler system), 14.1 ha of land would be required to dispose of the 69,000 m^3 of effluent anticipated to be generated annually during Phase 1 of the development.

As only approximately 13.1 ha are currently considered irrigable, approximately 1.0 ha (but up to 6.0 ha) of additional area would be required to allow for the disposal of all effluent generated during Phase 1 of the proposed development. This additional area may be obtained through the implementation of reclamation measures on lands currently considered nonirrigable pending reclamation (i.e., treed areas categorized as land class 5 [1.0 ha] and/or disturbed lands [7.1 ha]; Table 4), or through the acquisition of additional

irrigable land. Reclamation of the riparian area (1.3 ha) to facilitate irrigation is not recommended. If no reclamation is to be completed and only the 13.1 ha of currently irrigable land is considered, the annual volume of effluent that could be disposed of via irrigation would range from 47,239 m^3 to 81,600 m^3, depending on the efficiency of the irrigation system used.

Other disposal methods or larger irrigation areas (totaling between 16.9 ha and 29.1 ha) will be required to meet the anticipated effluent generation rates associated with future phases of the development.

4.4 Monitoring

Recommendations for ongoing monitoring include assessments of soil and groundwater quality to determine the long-term sustainability of soil productivity for agricultural purposes and to ensure the protection of groundwater quality for human health and ecological protection.

For the soil monitoring program, it is recommended that samples from a minimum of three soil profiles be collected and analyzed twice annually, preferably in the spring and fall (Thornton and Smith 1987). Specific parameters to be assessed should be determined based on the quality of effluent, but may include pH, electrical conductivity, sodium absorption ratio, total nitrogen, nitrate, ammonium, phosphorus, organic matter, bulk density, fecal coliforms, concentrations of salts (e.g., sodium, chloride, sulphate), boron, heavy metals, and cations of sodium, calcium, magnesium, and potassium in soil saturated paste extracts. At minimum, soils should be collected and analyzed for salts and nutrients once every two years and trace elements once every four years (WSA 2015a).

For groundwater quality monitoring, it is recommended that three groundwater wells be installed prior to use of the proposed irrigation lands for effluent disposal and baseline samples should be collected. Parameters to be analyzed should be determined based on the quality of effluent, but may include nitrate, total phosphorus, biochemical oxygen demand, fecal coliform bacteria, conductivity, pH, alkalinity, calcium, magnesium, sodium, bicarbonate, carbonate, chloride, and sulphate. The depth to the water table should also be recorded. Lazarova and Bahri (2005) recommend monthly monitoring of nutrients, salinity indicators, and pathogens and annual measurements for trace elements or metals in irrigation wastewater during the season of application. At minimum, the monitoring

guidelines detailed by WSA (2015a) should be followed, including: monitoring of fecal coliform levels (frequency depending on the type of agricultural reuse), monitoring of electrical conductivity and sodium absorption ratio annually, and monitoring of sodium, boron, coper, calcium, magnesium, iron, manganese, and chloride every two years.

Detailed records of the results of the monitoring program as well as crop growth and yield, irrigation volumes and periods, and wastewater application rates should be maintained. These records should be used to inform management practices. For example, results of soil quality monitoring may indicate that leaching is required due to a buildup of soluble salts in the rooting zone, or an excessively high water table may warrant tile drainage. Specific monitoring and reporting requirements may be specified in the permit to operate issued by the WSA.

5.0 RECOMMENDATION

Based on the investigations completed for the Project, approximately 13.1 ha of the proposed irrigation lands are currently suitable for irrigation. One of the ten soil investigations revealed that there is a potential salinization hazard under poor irrigation practices; however, it is anticipated that this soil type is limited in extent, representing only a minor (<20%) occurrence within the compound map unit.

Of the remaining 9.4 ha within the proposed irrigation area, approximately 8.1 ha may become suitable for irrigation following the implementation of reclamation measures. This includes disturbed lands (7.1 ha) as well as currently nonirrigable lands (1.0 ha). Reclamation measures to be implemented include brush clearing and/or earth-moving. The remaining approximately 1.3 ha are classified as riparian due to the presence of a high water table, and currently serves as drainage leading to the buffered wetland adjacent to the proposed irrigation area. The implementation of reclamation measures to allow for irrigation of the riparian area is not recommended.

It is anticipated that no adverse effects will result from the irrigation of the lands currently considered suitable for irrigation provided appropriate irrigation management practices are adhered to and soil and groundwater quality monitoring results are used to inform adaptive management. Further investigations may be necessary to confirm the suitability of lands currently considered nonirrigable following the implementation of reclamation measures (e.g., earth-moving).

6.0 STATEMENT OF LIMITATIONS

This agricultural feasibility report for irrigation was designed and completed with the intention of identifying whether the lands proposed for effluent irrigation within the Grasswood Reserve are suitable for irrigation. The information detailed in this report is not to be construed as a complete representation of the environmental condition of the proposed irrigation lands. Our recommendations do not constitute a design, in whole or in part, of the proposed works.

The investigations and associated laboratory results are indicative only of conditions at the specific locations and times investigated, only to the depth investigated, and only for the soil properties tested. Characteristics may vary between the investigations and with time. An assessment of effluent quality was not included in the scope of work for this study, and the findings do not imply the effluent is suitable for irrigation.

The information presented in this report is based on information obtained by and/or provided to CanNorth as well as the investigations as described herein. There are no assurances regarding the accuracy and completeness of this information. All information received from the client or third parties has been assumed to be correct. CanNorth assumes no responsibility for any inaccuracy or omissions of information obtained from the client or third parties.

CanNorth arrived at the conclusions presented herein based on the best information presently known to us and the professional judgement of the assessors. We have used due care and attention in reaching our conclusions and recommendations; however, there is no assurance that this work has uncovered all potential limitations of the proposed irrigation lands. No warranty, expressed or implied, is given concerning the suitability of the proposed irrigation lands for irrigation.

Conclusions and recommendations presented in this report are based solely on the scope of work described in the report. They are not a certification of the property's environmental condition. It should be noted that the information and resultant conclusions presented in this report are representative only of the condition of the investigated sites of the proposed irrigation lands at the time of the assessment. If further information becomes available that differs significantly from the current understanding of the environmental conditions of the

reserve lands as presented in this report, CanNorth disclaims any responsibility to update the conclusions in this report.

This agricultural feasibility report for irrigation was prepared by CanNorth for the exclusive use of MPE Engineering on behalf of Des Nedhe Development and may not be used or relied upon, in whole or in part, by any other party. CanNorth assumes no responsibility for losses, damages, liabilities, or claims incurred as a result from any third party use of this report, portion thereof, or any reliance on or decisions to be based on it.

This report is limited by the following:

- Variable snow cover limited the viewable area of the ground during the field survey.
- The presence of subsoil and topsoil stockpiles as well as construction equipment precluded access to disturbed areas for investigations.
- CanNorth spent only a limited amount of time on the proposed irrigation lands, and as such is not aware of any activities conducted on the property prior to or following the field survey.

7.0 CLOSING

In closing, we trust that this report presents the information you require. Should you have any further questions or comments, please do not hesitate to contact our office.

Kendra Fisher, M.Sc., PAg
Soil and Reclamation Specialist/Project Manager

Canada North Environmental Services Limited Partnership

8.0 MAP SOURCES AND DISCLAIMERS

CanNorth has exercised all reasonable care in the compilation, interpretation, and production of the map figures contained in this document. However, it is not possible to warrant or guarantee the accuracy, precision, currency, suitability, or reliability of any of the displayed or underlying data contained in the figures. Therefore, these are presented for reference and/or illustrative purposes; they are neither intended for legal delineation of any geographic feature nor for navigational use. The user must accept the data “as is" and CanNorth assumes no responsibility for loss or damage incurred as a result of any user reliance on this data.

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FIGURES

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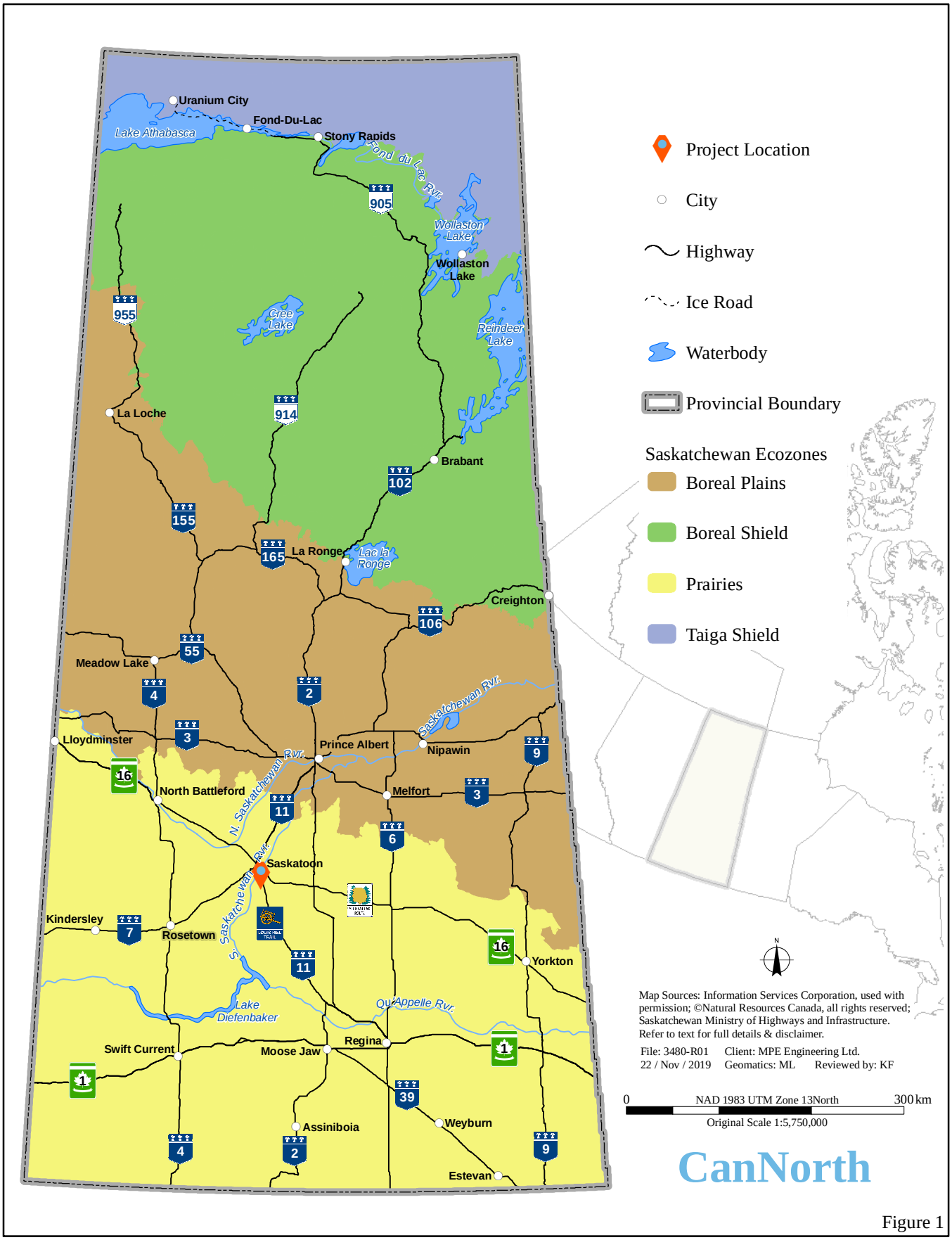

Figure 1. Location of the English River First Nation Grasswood Reserve.

Proposed Irrigation Area
Setbacks
Road
Railroad
Quarter Section Grid
Wetland

Map Sources: Information Services Corporation of Saskatchewan, Saskgrid Township Fabric Map, used with permisson.; Saskatchewan Geospatial Imagery Collaborative, FlySask.; Saskatchewan Ministry of Highways and Infrastructure, Saskatchewan Road Network Database 2014.

Refer to text for full details & disclaimer.

File: 3480-R02 Client: MPE Engineering Ltd.
16 / Dec / 2019 Geomatics: ML Reviewed by: KF

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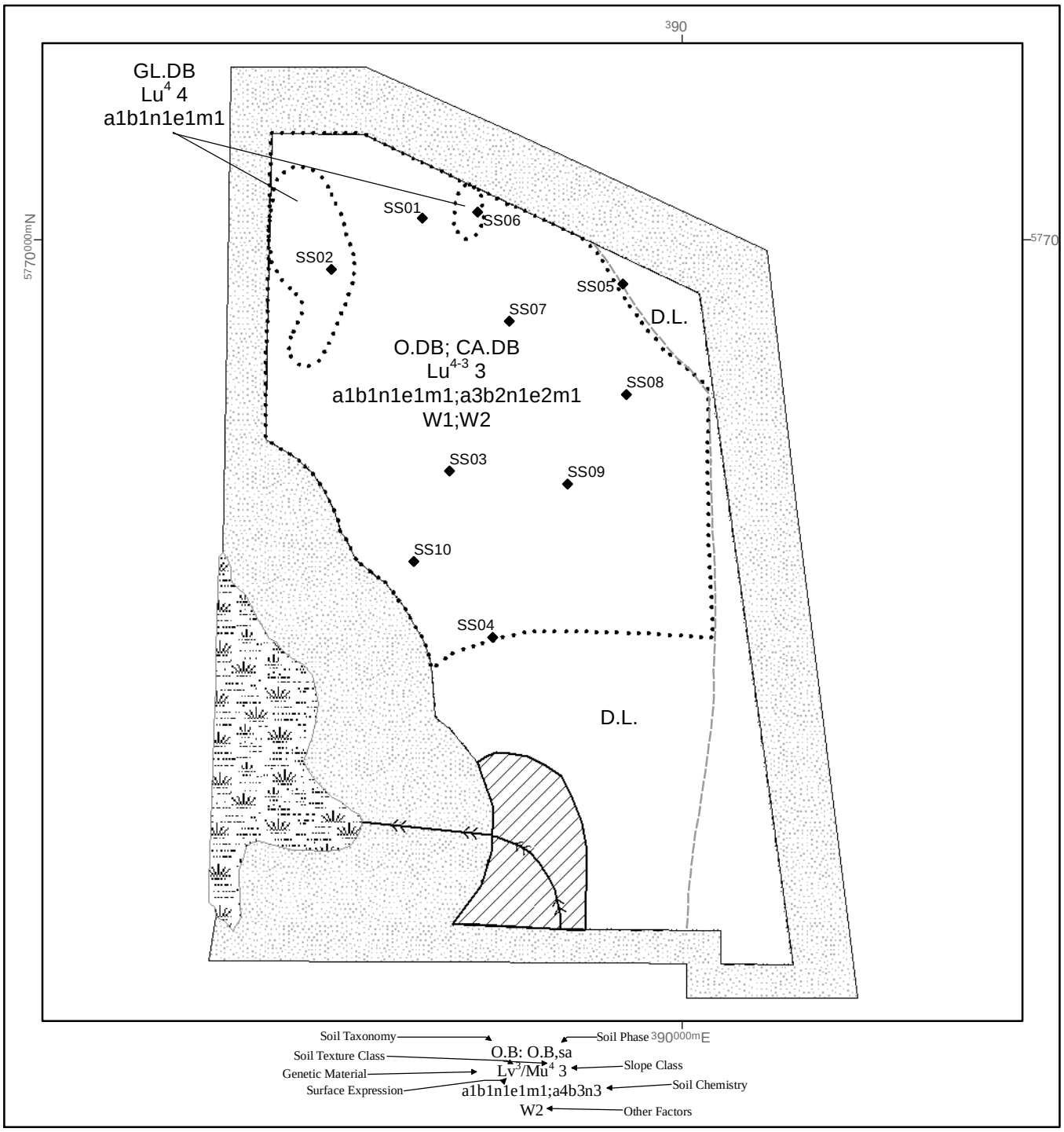
Original document scale 1:5,000

CanNorth

Figure: 2

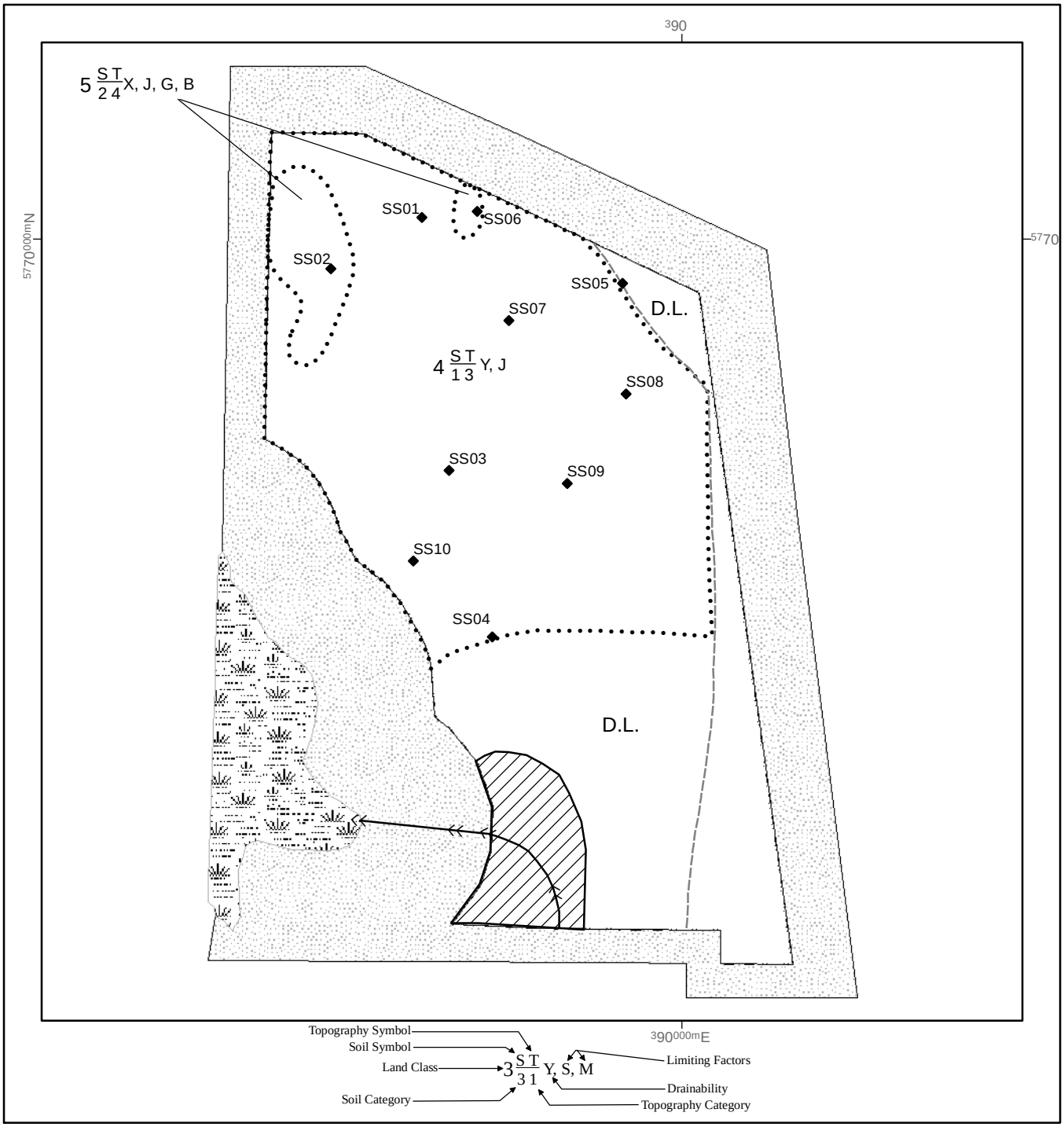
Figure 2. Proposed Grasswood wastewater treatment and disposal irrgiation area.



Inspection IDs
Trail
Drainage Channel
D.L. Disturbed Land
Soil Boundary
Riparian
Wetland
Proposed Irrigation Area
Setbacks

File: 3480-R03 Client: MPE Engineering Ltd.
13 / Dec / 2019 Geomatics: ML Reviewed by: KF
0 NAD 1983 UTM Zone 13North 200 m
Original document scale 1:5,400
CanNorth
Figure: 3

Figure 3. Level II soil map for the proposed Grasswood wastewater treatment and disposal irrigation area.



Inspection IDs
Trail
Drainage Channel
D.L. Disturbed Land
Land Class Boundary
Riparian
Wetland
Proposed Irrigation Area
Setbacks

File: 3480-R04 Client: MPE Engineering Ltd.
16 / Dec / 2019 Geomatics: ML Reviewed by: KF
0 NAD 1983 UTM Zone 13North 200m
Original document scale 1:5,400
CanNorth
Figure: 4

Figure 4. Level II land classification for irrigation map for the proposed Grasswood wastewater treatment and disposal irrigation area.

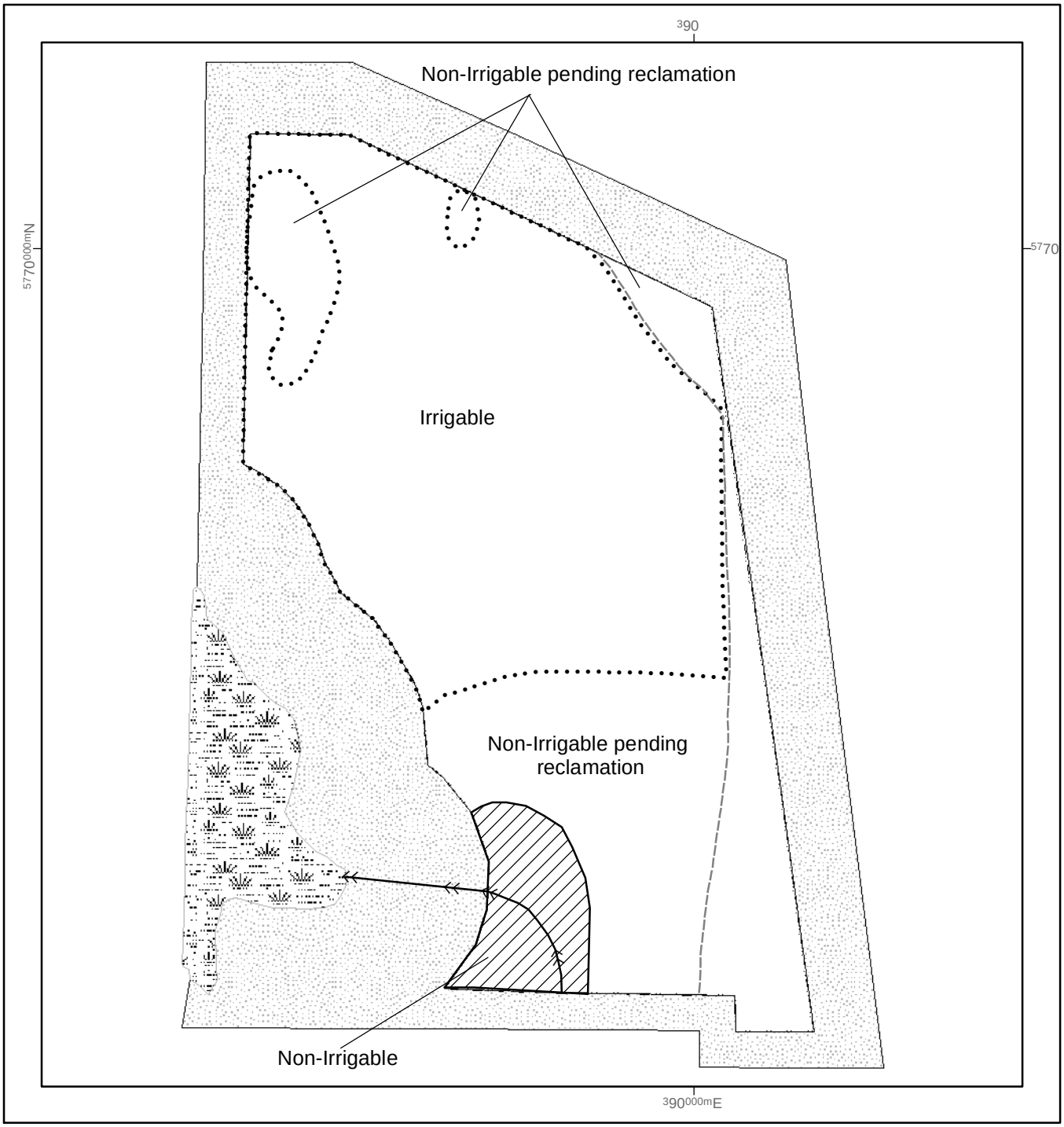


Figure 5. Potential irrigation area for the Grasswood wastewater treatment and disposal project.

TABLES

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TABLE 1

Terrain characteristics and soil profile descriptions for inspections within the proposed Grasswood wastewater treatment and disposal irrigation area.

Soil Inspection ID	Inspection Type	Landform	Parent Material	Slope		Soil Classification[1]	Horizon Designation[2]	Depth (cm)		Colour		Texture	Structure			Coarse Fragments[4] (%)
				Gradient (%)	Position			Upper	Lower	Munsell Notation[3]	Description		Grade	Class	Kind	
SS01	Deep	Undulating	Glacio-lacustrine	2 to 5	Middle slope	CA.DBC	Ap	0	17	10YR 3/2	Very dark grayish brown	Loam	Moderate	Coarse	Subangular blocky	0
							Btk	17	25	10YR 4/3	Brown	Silty clay loam	Weak	Coarse	Subangular blocky	0
							Ck	25	116	2.5Y 5/3	Light olive brown	Silt loam	-	-	Massive	0
SS02	Deep	Undulating	Glacio-lacustrine	5 to 9	Middle slope	GL.DBC	Ah	0	17	10YR 2/2	Very dark brown	Silt loam	Moderate	Medium	Granular	0
							Bgj	17	30	10YR 3/2	Very dark grayish brown	Silt loam	Weak	Medium	Subangular blocky	0
							Ck	30	105	10YR 4/3	Brown	Loam	-	-	Massive	0
SS03	Deep	Undulating	Glacio-lacustrine	2 to 5	Upper slope	O.DBC	Ap	0	22	10YR 3/1	Very dark gray	Loam	Moderate	Coarse	Subangular blocky	0
							Bt	22	44	10YR 4/4	Dark yellowish brown	Loam	Moderate	Coarse	Subangular blocky	0
							Ck	44	117	2.5Y 5/4	Light olive brown	Silt loam	-	-	Massive	0
SS04	Deep	Undulating	Glacio-lacustrine	2 to 5	Upper slope	O.DBC	Ap	0	16	10YR 3/2	Very dark grayish brown	Sandy loam	Moderate	Medium	Subangular blocky	0
							Bt	16	46	2.5Y 4/4	Olive brown	Sandy loam	Weak	Medium	Subangular blocky	0
							Ck	46	110	2.5Y 5/3	Light olive brown	Clay loam	-	-	Massive	0
SS05	Topsoil	Undulating	Glacio-lacustrine	2 to 5	Middle slope	O.DBC	Ap	0	12	10YR 2/2	Very dark brown	Loam	Moderate	Medium	Subangular blocky	0
							Bt	12	38	10YR 4/4	Dark yellowish brown	Clay loam	Weak	Medium	Subangular blocky	0
							Ck	38	44	2.5Y 5/3	Light olive brown	Clay loam	-	-	Massive	0
SS06	Topsoil	Undulating	Glacio-lacustrine	5 to 9	Depression	GL.DBC	Ap	0	29	10YR 2/1	Black	Loam	Moderate	Fine	Granular	0
							Bgj	29	42	10YR 4/2	Dark grayish brown	Loam	Moderate	Fine	Granular	0
SS07	Topsoil	Undulating	Glacio-lacustrine	2 to 5	Upper slope	O.DBC	Ap	0	15	10YR 2/2	Very dark brown	Loam	Moderate	Medium	Subangular blocky	0
							Bt	15	30	10YR 5/4	Yellowish brown	Clay loam	Moderate	Medium	Subangular blocky	0
SS08	Topsoil	Undulating	Glacio-lacustrine	2 to 5	Middle slope	O.DBC	Ap	0	15	10YR 3/2	Very dark grayish brown	Loam	Moderate	Medium	Subangular blocky	0
							Bt	15	28	10YR 4/3	Brown	Clay loam	Moderate	Medium	Subangular blocky	0
SS09	Topsoil	Undulating	Glacio-lacustrine	2 to 5	Middle slope	O.DBC	Ap	0	32	10YR 3/1	Very dark gray	Loam	Moderate	Coarse	Subangular blocky	0
							Bm	32	40	10YR 3/3	Dark brown	Loam	Weak	Medium	Subangular blocky	0
SS10	Topsoil	Undulating	Glacio-lacustrine	2 to 5	Upper slope	O.DBC	Ap	0	14	10YR 2/2	Very dark brown	Loam	Moderate	Medium	Subangular blocky	0
							Bt	14	31	2.5Y 4/4	Olive brown	Clay loam	Weak	Medium	Subangular blocky	0

[1]Soil classification follows the Canadian System of Soil Classification (Soil Classification Working Group 1998). O.DBC = Orthic Dark Brown Chernozem (a grassland soil enriched with organic matter having an A horizon color value darker than 3.5 and a chroma usually of 1.5 or less when dry); CA.DBC = Calcareous Dark Brown Chernozem (differs from O.DBC by having a B horizon from which primary carbonates have not been removed completely); GL.DBC = Gleyed Dark Brown Chernozem (differs from O.DBC by having faint to distinct mottles that indicate gleying within 50 cm of the mineral soil surface).

[2]Mineral horizons: A = Surficial mineral soil horizon subject to maximum leaching of materials and/or accumulation of organic matter; B = Subsurface mineral soil horizon showing evidence of various pedogenic processes; C = Subsurface mineral soil horizon comparatively unaffected by pedogenic processes. Lowercase suffixes: g = a horizon characterized by grey colours or mottling; h = horizon enriched with organic matter; j = a modifier used to denote of expression of but failure to meet the required criteria of the suffix it modifies; k = horizon containing carbonates as indicated by effervescence when dilute hydrochloric acid is applied; m = horizon slightly altered to give a change in colour and/or structure; p = horizon modified by human activities (e.g., cultivation, logging, habitation); t = horizon enriched in silicate clay minerals.

[3]Munsell notation given as: hue value/chroma.

[4]Refers to particles >2 mm diameter.

TABLE 2

Soil analytical results from deep (>1 m) inspections within the proposed Grasswood wastewater treatment and disposal irrigation area.

Soil Inspection ID	Sample ID	Depth (cm)		Particle Size			Soil Texture	pH (pH units)	Available Nutrients				Electrical Conductivity (dS/m)	Sodium Absorption Ratio (SAR)
		Upper	Lower	Sand (%)	Silt (%)	Clay (%)			Nitrate-N (mg/kg)	Inorganic Phosphorus (mg/kg)	Dissolved Potassium (mg/kg)	Dissolved Sulphate (mg/kg)		
SS01	ERFN_GRW_201911_SOI_01	0	17	32.2	47.9	19.8	Loam	6.83	< 2.0	7.2	532	6.5	0.553	< 0.10
	ERFN_GRW_201911_SOI_02	17	25	13.7	51.2	35.2	Silty clay loam	6.63	< 2.0	< 2.0	196	4.3	0.471	0.22
	ERFN_GRW_201911_SOI_03	0	50	11.7	60.5	27.8	Silt loam/Silty clay loam	7.92	< 2.0	< 2.0	139	824	**4.61**	1.18
	ERFN_GRW_201911_SOI_04	50	100	13.6	56.7	29.8	Silty clay loam	8.22	-	-	-	-	**7.18**	3.74
	ERFN_GRW_201911_SOI_05	100	+	11.0	62.5	26.5	Silt loam	8.48	-	-	-	-	**9.16**	5.64
SS02	ERFN_GRW_201911_SOI_06	0	17	35.6	54.3	10.1	Silt loam	7.18	2.6	32.3	1150	16.1	0.818	0.21
	ERFN_GRW_201911_SOI_07	17	30	36.1	53.0	10.9	Silt loam	5.94	< 2.0	31.2	565	< 4.0	0.295	0.23
	ERFN_GRW_201911_SOI_08	0	50	36.1	52.0	11.9	Silt loam	6.53	< 2.0	30.1	810	9.7	0.505	0.18
	ERFN_GRW_201911_SOI_09	50	100	38.2	47.6	14.2	Loam	5.65	-	-	-	-	0.33	0.27
	ERFN_GRW_201911_SOI_10	100	+	29.8	46.7	23.5	Loam	5.83	-	-	-	-	1.38	0.42
SS03	ERFN_GRW_201911_SOI_11	0	22	37.8	47.7	14.5	Loam	6.13	< 2.0	22.3	580	5.9	0.273	< 0.20
	ERFN_GRW_201911_SOI_12	22	44	41.1	37.9	21.1	Loam	6.34	< 2.0	3.8	178	4.2	0.252	0.26
	ERFN_GRW_201911_SOI_13	0	50	41.1	39.6	19.3	Loam	6.80	< 2.0	5.5	260	5.4	0.703	0.18
	ERFN_GRW_201911_SOI_14	50	100	22.3	55.9	21.9	Silt loam	8.08	-	-	-	-	0.584	1.27
	ERFN_GRW_201911_SOI_15	100	+	19.2	62.0	18.8	Silt loam	8.43	-	-	-	-	2.66	5.94
SS04	ERFN_GRW_201911_SOI_16	0	16	60.5	28.9	10.6	Sandy loam	7.09	< 2.0	12.8	483	5.1	0.451	< 0.20
	ERFN_GRW_201911_SOI_17	16	46	53.2	29.6	17.2	Sandy loam	6.86	< 2.0	2	155	< 4.0	0.258	< 0.20
	ERFN_GRW_201911_SOI_18	0	50	51.7	31.9	16.4	Loam	6.84	< 2.0	2.1	156	< 4.0	0.25	< 0.20
	ERFN_GRW_201911_SOI_19	50	100	62.5	24.2	13.2	Sandy loam	7.90	-	-	-	-	0.46	0.16
	ERFN_GRW_201911_SOI_20	100	+	23.2	48.4	28.4	Clay loam	8.38	-	-	-	-	0.345	0.35

Bold values indicate soil salinity or sodicity levels >1 as per AAFRD (2004a, b).

TABLE 3

Soil suitability for irrigation of deep (>1 m) inspections within the proposed Grasswood wastewater treatment and disposal irrigation area.

Site ID	Soil Profile		Geological Deposit		Surface Texture		B.S.R.	Modifiers		Final Soil Rating	Final Soil Category[3]	Remarks
	Classification[1]	Rating (P)	Description	Rating (G)	Class	Rating (T)		Salinity-Sodicity[2]	Drainage			
SS01	CA.DBC	80	Moderately fine grading to medium textured glaciolacustrine sediments with EC_e > 8 dS m^{-1}	70	Silt loam/ Silty clay loam[4]	100	56	70	100	39.2	Fair (3)	Potential salinization hazard under poor irrigation practices.
SS02	GL.DBC	70	Medium textured glaciolacustrine sediments	100	Silt loam	100	70	100	100	70	Good (2)	-
SS03	O.DBC	100	Medium textured glaciolacustrine sediments	100	Loam	100	100	100	100	100	Excellent (1)	-
SS04	O.DBC	100	Moderately coarse grading to moderately fine textured glaciolacustrine sediments	70	Loam	100	70	100	100	70	Good (2)	-

All ratings calculated using the 0 cm to 50 cm, 50 cm to 100 cm, and >100 cm increments as per AAFRD (2004a, b).

B.S.R. = Basic soil rating; EC_e = Electrical conductivity of the 1 m to 2 m depth increment.

[1]See Table 1 for soil classification definitions.

[2]Where salinity-sodicity levels varied with depth, the most restrictive modifier was used to obtain a conservative final soil rating.

[3]Soil categories for irrigation capability are defined based on final soil ratings as follows: ≤25 = nonirrigable (4); 26 to 45 = fair (3); 46 to 71 = good (2); 72 to 100 = excellent (1).

[4]Silt loam was used to assign the texture rating based on the loam texture of an additional sample collected from the A horizon (see Table 2).

TABLE 4

Areal summary of suitability for irrigation within the proposed Grasswood wastewater treatment and disposal irrigation area.

Land Class Symbol	Soil Category	Topography Category	Land Class	Drainability	Limiting Factors	Approximate Area (ha)
Irrigable						
$4\frac{ST}{13}Y, J$	1	3	4	Slowly permeable (Y)	Field size/shape (J)	13.1
Nonirrigable						
$5\frac{ST}{24}X, J, G, B$ [1]	2	4	5	Moderately to rapidly permeable (X)	Field size/shape (J), maximum downfield slope (G), brush/tree cover (B)	1.0
Disturbed Land[1]	-	-	-	-	-	7.1
Riparian	-	-	-	-	-	1.3
Total						22.5

Determined as per AAFRD (2004a, b).

[1]Nonirrigable pending reclamation.

APPENDICES

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APPENDIX A

PHOTOGRAPHS

LIST OF PHOTOGRAPHS

Photo 1. Weedy ground cover within proposed irrigation area showing stockpiled soil in the background, view south. November 7th, 2019.

Photo 2. Orthic Dark Brown Chernozem soil profile at inspection SS04. November 7th, 2019.

Photo 3. Copse of trees visible at inspection SS02 in background, view west. November 7th, 2019.

Photo 4. Copse of trees at inspection SS06, view west. November 7th, 2019.

APPENDIX B

ANALYTICAL LABORATORY CERTIFICATE OF ANALYSIS

Canada North Environmental Services
ATTN: Kendra Fisher
211 Wheeler Street
SASKATOON SK S7P 0A4

Date Received: 07-NOV-19
Report Date: 19-NOV-19 10:06 (MT)
Version: FINAL REV. 2

Client Phone: 306-652-4432

Certificate of Analysis

Lab Work Order #: L2379628

Project P.O. #: NOT SUBMITTED
Job Reference:
C of C Numbers:
Legal Site Desc:

Comments:
19-NOV-2019 Revised sample ID's

Brian Morgan, B.Sc. Hons.
Client Services Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-1 3480_QAQC_01_201911_SOI									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	15.0	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	72.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	12.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	2.2	+/-0.8	DLM	2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4910207
Available Sulfate-S									
Available Sulfate-S	19.7	+/-5.0	DLM	8.0	mg/kg	0	14-NOV-19	14-NOV-19	R4910186
Plant Available Phosphorus and Potassium									
Available Phosphate-P	60.6	+/-10	DLHC	4.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Available Potassium	1590	+/-270	DLHC	100	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	80.0	+/-7.8		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	59.4	+/-10		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	17.5	+/-3.2		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	101	+/-17		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	48	+/-9		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.702	+/-0.11		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	38	-		16	mg/kg	-		13-NOV-19	
Calcium (Ca)	47.5	-		4.0	mg/kg	-		13-NOV-19	
Magnesium (Mg)	14.0	-		4.0	mg/kg	-		13-NOV-19	
Potassium (K)	80.4	-		4.0	mg/kg	-		13-NOV-19	
Sodium (Na)	<4.0	-		4.0	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	40.6	-		4.8	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	<0.10	-	SAR:DL	0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	50.7	+/-9.8		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.80	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-2 3480_QAQC_02_201911_SOI									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	36.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	53.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	9.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4910207
Available Sulfate-S									
Available Sulfate-S	4.2	+/-3.0		4.0	mg/kg	0	14-NOV-19	14-NOV-19	R4910186

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-2 3480_QAQC_02_201911_SOI									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Plant Available Phosphorus and Potassium									
Available Phosphate-P	34.4	+/-6.2		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Available Potassium	560	+/-96	DLHC	40	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	50.0	+/-4.9		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	28.7	+/-5.1		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	9.0	+/-1.6		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	23.4	+/-4.0		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	5.2	+/-1.0		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	20	+/-4		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.306	+/-0.050		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	10	-		10	mg/kg	-		13-NOV-19	
Calcium (Ca)	14.3	-		2.5	mg/kg	-		13-NOV-19	
Magnesium (Mg)	4.5	-		2.5	mg/kg	-		13-NOV-19	
Potassium (K)	11.7	-		2.5	mg/kg	-		13-NOV-19	
Sodium (Na)	2.6	-		2.5	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	22.3	-		3.0	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.22	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	44.6	+/-8.6		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.09	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-3 3480_QAQC_03_201911_SOI									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	33.3	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	46.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	20.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905915
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	50.7	+/-4.9		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	43.5	+/-7.7		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	13.5	+/-2.5		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	19.5	+/-3.3		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	12.0	+/-2.1		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	57	+/-11		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.504	+/-0.078		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	29	-		10	mg/kg	-		13-NOV-19	
Calcium (Ca)	22.0	-		2.5	mg/kg	-		13-NOV-19	
Magnesium (Mg)	6.8	-		2.5	mg/kg	-		13-NOV-19	

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-3 3480_QAQC_03_201911_SOI									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Salinity in mg/kg									
Potassium (K)	9.9	-		2.5	mg/kg	-		13-NOV-19	
Sodium (Na)	6.1	-		2.5	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	58.5	-		3.0	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.41	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	116	+/-22		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	5.51	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-4 ERFN_GRW_201911_SOI_01									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	32.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	47.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	19.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4910207
Available Sulfate-S									
Available Sulfate-S	6.5	+/-3.2		4.0	mg/kg	0	14-NOV-19	14-NOV-19	R4910186
Plant Available Phosphorus and Potassium									
Available Phosphate-P	7.2	+/-2.0		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Available Potassium	532	+/-92	DLHC	40	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	55.3	+/-5.4		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	50.4	+/-8.9		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	24.3	+/-4.4		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	45.7	+/-7.8		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	30	+/-6		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.553	+/-0.085		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	17	-		11	mg/kg	-		13-NOV-19	
Calcium (Ca)	27.9	-		2.8	mg/kg	-		13-NOV-19	
Magnesium (Mg)	13.5	-		2.8	mg/kg	-		13-NOV-19	
Potassium (K)	25.3	-		2.8	mg/kg	-		13-NOV-19	
Sodium (Na)	<2.8	-		2.8	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	28.0	-		3.3	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	<0.10	-	SAR:DL	0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	50.6	+/-9.7		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.83	-		0.10	pH	-		12-NOV-19	R4905781

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-5 ERFN_GRW_201911_SOI_02									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	13.7	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	51.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	35.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silty clay loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4910207
Available Sulfate-S									
Available Sulfate-S	4.3	+/-3.0		4.0	mg/kg	0	14-NOV-19	14-NOV-19	R4910186
Plant Available Phosphorus and Potassium									
Available Phosphate-P	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4911108
Available Potassium	196	+/-36		20	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	68.7	+/-6.7		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	45.1	+/-8.0		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	24.0	+/-4.3		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	5.1	+/-0.9		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	7.3	+/-1.3		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	21	+/-4		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.471	+/-0.073		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	15	-		14	mg/kg	-		13-NOV-19	
Calcium (Ca)	31.0	-		3.4	mg/kg	-		13-NOV-19	
Magnesium (Mg)	16.5	-		3.4	mg/kg	-		13-NOV-19	
Potassium (K)	3.5	-		3.4	mg/kg	-		13-NOV-19	
Sodium (Na)	5.0	-		3.4	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	31.5	-		4.1	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.22	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	45.8	+/-8.8		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.63	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-6 ERFN_GRW_201911_SOI_03									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	11.7	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	60.5	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	27.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam / Silty clay loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4910207
Available Sulfate-S									

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-6 ERFN_GRW_201911_SOI_03									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Available Sulfate-S									
Available Sulfate-S	824	+/-140	DLHC	20	mg/kg	0	14-NOV-19	14-NOV-19	R4910186
Plant Available Phosphorus and Potassium									
Available Phosphate-P	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4911108
Available Potassium	139	+/-27		20	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	66.7	+/-6.5		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	459	+/-80		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	540	+/-97		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	16.0	+/-2.8		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	158	+/-27		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	98	+/-18		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	4.61	+/-0.66		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	65	-		13	mg/kg	-		13-NOV-19	
Calcium (Ca)	306	-		3.3	mg/kg	-		13-NOV-19	
Magnesium (Mg)	360	-		3.3	mg/kg	-		13-NOV-19	
Potassium (K)	10.7	-		3.3	mg/kg	-		13-NOV-19	
Sodium (Na)	105	-		3.3	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	2180	-		4.0	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	1.18	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	3280	+/-620		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	7.92	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-7 ERFN_GRW_201911_SOI_04									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	13.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	56.7	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	29.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silty clay loam	-				-	12-NOV-19	13-NOV-19	R4905915
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	60.0	+/-5.8		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	442	+/-77		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	907	+/-160		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	26.5	+/-4.5		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	598	+/-100		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	67	+/-13		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	7.18	+/-1.0		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	40	-		12	mg/kg	-		13-NOV-19	

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-7 ERFN_GRW_201911_SOI_04									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Salinity in mg/kg									
Calcium (Ca)	265	-		3.0	mg/kg	-		13-NOV-19	
Magnesium (Mg)	544	-		3.0	mg/kg	-		13-NOV-19	
Potassium (K)	15.9	-		3.0	mg/kg	-		13-NOV-19	
Sodium (Na)	359	-		3.0	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	3380	-		3.6	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	3.74	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	5630	+/-1100		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	8.22	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-8 ERFN_GRW_201911_SOI_05									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	11.0	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	62.5	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	26.5	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	66.7	+/-6.5		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	422	+/-74		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	1170	+/-210		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	30.4	+/-5.2		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	993	+/-170		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	96	+/-18		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	9.16	+/-1.3		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	64	-		13	mg/kg	-		13-NOV-19	
Calcium (Ca)	281	-		3.3	mg/kg	-		13-NOV-19	
Magnesium (Mg)	778	-		3.3	mg/kg	-		13-NOV-19	
Potassium (K)	20.2	-		3.3	mg/kg	-		13-NOV-19	
Sodium (Na)	662	-		3.3	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	4790	-		4.0	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	5.64	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	7190	+/-1400		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	8.48	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-9 ERFN_GRW_201911_SOI_06									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	35.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-9 ERFN_GRW_201911_SOI_06									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Silt (0.05mm - 2um)	54.3	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	10.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	2.6	+/-0.8	DLM	2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4910207
Available Sulfate-S									
Available Sulfate-S	16.1	+/-4.5	DLM	8.0	mg/kg	0	14-NOV-19	14-NOV-19	R4910186
Plant Available Phosphorus and Potassium									
Available Phosphate-P	32.3	+/-5.8		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Available Potassium	1150	+/-190	DLHC	100	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	160	+/-16		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	62.7	+/-11		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	19.1	+/-3.5		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	110	+/-19		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	7.5	+/-1.3		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	34	+/-7		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.818	+/-0.12		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	54	-		32	mg/kg	-		13-NOV-19	
Calcium (Ca)	100	-		8.0	mg/kg	-		13-NOV-19	
Magnesium (Mg)	30.6	-		8.0	mg/kg	-		13-NOV-19	
Potassium (K)	176	-		8.0	mg/kg	-		13-NOV-19	
Sodium (Na)	12.0	-		8.0	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	81.6	-		9.6	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.21	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	51.0	+/-9.8		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	7.18	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-10 ERFN_GRW_201911_SOI_07									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	36.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	53.0	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	10.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4910207
Available Sulfate-S									
Available Sulfate-S	<4.0	-		4.0	mg/kg	-	14-NOV-19	14-NOV-19	R4910186
Plant Available Phosphorus and Potassium									
Available Phosphate-P	31.2	+/-5.7		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911108

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-10 ERFN_GRW_201911_SOI_07									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Plant Available Phosphorus and Potassium									
Available Potassium	565	+/-97	DLHC	40	mg/kg	0	14-NOV-19	14-NOV-19	R4911108
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	45.3	+/-4.4		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	23.7	+/-4.2		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	8.8	+/-1.6		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	21.1	+/-3.6		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	5.1	+/-0.9		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	34	+/-7		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.295	+/-0.048		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	15.5	-		9.1	mg/kg	-		13-NOV-19	
Calcium (Ca)	10.7	-		2.3	mg/kg	-		13-NOV-19	
Magnesium (Mg)	4.0	-		2.3	mg/kg	-		13-NOV-19	
Potassium (K)	9.6	-		2.3	mg/kg	-		13-NOV-19	
Sodium (Na)	2.3	-		2.3	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	17.5	-		2.7	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.23	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	38.7	+/-7.5		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	5.94	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-11 ERFN_GRW_201911_SOI_08									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	36.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	52.0	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	11.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	15-NOV-19	15-NOV-19	R4911110
Available Sulfate-S									
Available Sulfate-S	9.7	+/-3.6		4.0	mg/kg	0	15-NOV-19	15-NOV-19	R4914986
Plant Available Phosphorus and Potassium									
Available Phosphate-P	30.1	+/-5.5		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Available Potassium	810	+/-140	DLHC	100	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	87.3	+/-8.5		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	50.4	+/-8.9		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	14.7	+/-2.7		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	52.7	+/-9.0		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	5.7	+/-1.0		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-11 ERFN_GRW_201911_SOI_08									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	37	+/-7		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.505	+/-0.078		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	32	-		17	mg/kg	-		13-NOV-19	
Calcium (Ca)	44.0	-		4.4	mg/kg	-		13-NOV-19	
Magnesium (Mg)	12.8	-		4.4	mg/kg	-		13-NOV-19	
Potassium (K)	46.0	-		4.4	mg/kg	-		13-NOV-19	
Sodium (Na)	5.0	-		4.4	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	42.5	-		5.2	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.18	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	48.6	+/-9.4		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.53	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-12 ERFN_GRW_201911_SOI_09									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	38.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	47.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	14.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905915
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	50.0	+/-4.9		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	24.4	+/-4.3		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	8.0	+/-1.5		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	26.6	+/-4.6		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	6.0	+/-1.1		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	51	+/-10		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.330	+/-0.053		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	26	-		10	mg/kg	-		13-NOV-19	
Calcium (Ca)	12.2	-		2.5	mg/kg	-		13-NOV-19	
Magnesium (Mg)	4.0	-		2.5	mg/kg	-		13-NOV-19	
Potassium (K)	13.3	-		2.5	mg/kg	-		13-NOV-19	
Sodium (Na)	3.0	-		2.5	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	20.7	-		3.0	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.27	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	41.4	+/-8.0		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	5.65	-		0.10	pH	-		12-NOV-19	R4905781

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-13 ERFN_GRW_201911_SOI_10									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	29.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	46.7	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	23.5	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905915
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	63.3	+/-6.2		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	172	+/-30		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	54.1	+/-9.8		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	21.2	+/-3.6		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	24.8	+/-4.2		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	108	+/-20		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	1.38	+/-0.20		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	68	-		13	mg/kg	-		13-NOV-19	
Calcium (Ca)	109	-		3.2	mg/kg	-		13-NOV-19	
Magnesium (Mg)	34.3	-		3.2	mg/kg	-		13-NOV-19	
Potassium (K)	13.4	-		3.2	mg/kg	-		13-NOV-19	
Sodium (Na)	15.7	-		3.2	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	364	-		3.8	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.42	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	575	+/-110		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	5.83	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-14 ERFN_GRW_201911_SOI_11									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	37.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	47.7	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	14.5	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	15-NOV-19	15-NOV-19	R4911110
Available Sulfate-S									
Available Sulfate-S	5.9	+/-3.1		4.0	mg/kg	0	15-NOV-19	15-NOV-19	R4914986
Plant Available Phosphorus and Potassium									
Available Phosphate-P	22.3	+/-4.3		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Available Potassium	580	+/-100	DLHC	100	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	66.7	+/-6.5		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	26.1	+/-4.6		5.0	mg/L	0		12-NOV-19	R4905169

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-14 ERFN_GRW_201911_SOI_11									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Magnesium (Mg)	8.4	+/-1.5		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	15.1	+/-2.6		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.273	+/-0.045		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	<13	-		13	mg/kg	-		13-NOV-19	
Calcium (Ca)	17.4	-		3.3	mg/kg	-		13-NOV-19	
Magnesium (Mg)	5.6	-		3.3	mg/kg	-		13-NOV-19	
Potassium (K)	10.1	-		3.3	mg/kg	-		13-NOV-19	
Sodium (Na)	<3.3	-		3.3	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	21.9	-		4.0	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	<0.20	-	SAR:DL	0.20	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	32.9	+/-6.4		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.13	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-15 ERFN_GRW_201911_SOI_12									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	41.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	37.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	21.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	15-NOV-19	15-NOV-19	R4911110
Available Sulfate-S									
Available Sulfate-S	4.2	+/-3.0		4.0	mg/kg	0	15-NOV-19	15-NOV-19	R4914986
Plant Available Phosphorus and Potassium									
Available Phosphate-P	3.8	+/-1.5		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Available Potassium	178	+/-34		20	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	57.3	+/-5.6		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	25.8	+/-4.6		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	8.6	+/-1.6		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Sodium (Na)	5.9	+/-1.1		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.252	+/-0.042		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	11	-		11	mg/kg	-		13-NOV-19	
Calcium (Ca)	14.8	-		2.9	mg/kg	-		13-NOV-19	

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-15 ERFN_GRW_201911_SOI_12									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Salinity in mg/kg									
Magnesium (Mg)	4.9	-		2.9	mg/kg	-		13-NOV-19	
Potassium (K)	<2.9	-		2.9	mg/kg	-		13-NOV-19	
Sodium (Na)	3.4	-		2.9	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	13.6	-		3.4	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.26	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	23.6	+/-4.6		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.34	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-16 ERFN_GRW_201911_SOI_13									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	41.1	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	39.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	19.3	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	15-NOV-19	15-NOV-19	R4911110
Available Sulfate-S									
Available Sulfate-S	5.4	+/-3.1		4.0	mg/kg	0	15-NOV-19	15-NOV-19	R4914986
Plant Available Phosphorus and Potassium									
Available Phosphate-P	5.5	+/-1.7		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Available Potassium	260	+/-47		20	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	60.7	+/-5.9		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	95.2	+/-17		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	29.7	+/-5.4		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	8.0	+/-1.4		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	7.7	+/-1.4		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.703	+/-0.11		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	<12	-		12	mg/kg	-		13-NOV-19	
Calcium (Ca)	57.8	-		3.0	mg/kg	-		13-NOV-19	
Magnesium (Mg)	18.0	-		3.0	mg/kg	-		13-NOV-19	
Potassium (K)	4.9	-		3.0	mg/kg	-		13-NOV-19	
Sodium (Na)	4.7	-		3.0	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	15.4	-		3.6	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.18	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	25.4	+/-5.0		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.80	-		0.10	pH	-		12-NOV-19	R4905781

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-16 ERFN_GRW_201911_SOI_13									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
L2379628-17 ERFN_GRW_201911_SOI_14									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	22.3	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	55.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	21.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	54.7	+/-5.3		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	34.3	+/-6.1		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	26.1	+/-4.7		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Sodium (Na)	40.5	+/-6.9		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	61	+/-12		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.584	+/-0.089		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	34	-		11	mg/kg	-		13-NOV-19	
Calcium (Ca)	18.8	-		2.7	mg/kg	-		13-NOV-19	
Magnesium (Mg)	14.3	-		2.7	mg/kg	-		13-NOV-19	
Potassium (K)	<2.7	-		2.7	mg/kg	-		13-NOV-19	
Sodium (Na)	22.1	-		2.7	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	37.0	-		3.3	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	1.27	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	67.6	+/-13		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	8.08	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-18 ERFN_GRW_201911_SOI_15									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	19.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	62.0	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	18.8	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Silt loam	-				-	12-NOV-19	13-NOV-19	R4905915
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	58.0	+/-5.6		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	59.9	+/-11		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	146	+/-26		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	9.0	+/-1.6		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	373	+/-63		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-18 ERFN_GRW_201911_SOI_15									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	28	+/-6		20	mg/L	0		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	2.66	+/-0.38		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	17	-		12	mg/kg	-		13-NOV-19	
Calcium (Ca)	34.7	-		2.9	mg/kg	-		13-NOV-19	
Magnesium (Mg)	84.4	-		2.9	mg/kg	-		13-NOV-19	
Potassium (K)	5.2	-		2.9	mg/kg	-		13-NOV-19	
Sodium (Na)	217	-		2.9	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	803	-		3.5	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	5.94	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	1380	+/-260		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	8.43	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-19 ERFN_GRW_201911_SOI_16									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	60.5	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	28.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	10.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Sandy loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	15-NOV-19	15-NOV-19	R4911110
Available Sulfate-S									
Available Sulfate-S	5.1	+/-3.0		4.0	mg/kg	0	15-NOV-19	15-NOV-19	R4914986
Plant Available Phosphorus and Potassium									
Available Phosphate-P	12.8	+/-2.8		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Available Potassium	483	+/-84	DLHC	40	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	54.7	+/-5.3		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	52.3	+/-9.2		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	16.7	+/-3.0		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	28.1	+/-4.8		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.451	+/-0.070		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	<11	-		11	mg/kg	-		13-NOV-19	
Calcium (Ca)	28.6	-		2.7	mg/kg	-		13-NOV-19	
Magnesium (Mg)	9.1	-		2.7	mg/kg	-		13-NOV-19	
Potassium (K)	15.4	-		2.7	mg/kg	-		13-NOV-19	
Sodium (Na)	<2.7	-		2.7	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	15.6	-		3.3	mg/kg	-		13-NOV-19	

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-19 ERFN_GRW_201911_SOI_16									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Sodium Adsorption Ratio (Sat. Paste)									
SAR	<0.20	-	SAR:DL	0.20	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	28.6	+/-5.6		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	7.09	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-20 ERFN_GRW_201911_SOI_17									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	53.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Silt (0.05mm - 2um)	29.6	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
% Clay (<2um)	17.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905915
Texture	Sandy loam	-				-	12-NOV-19	13-NOV-19	R4905915
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	15-NOV-19	15-NOV-19	R4911110
Available Sulfate-S									
Available Sulfate-S	<4.0	-		4.0	mg/kg	-	15-NOV-19	15-NOV-19	R4914986
Plant Available Phosphorus and Potassium									
Available Phosphate-P	<2.0	-		2.0	mg/kg	-	14-NOV-19	14-NOV-19	R4911086
Available Potassium	155	+/-30		20	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	50.0	+/-4.9		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	31.6	+/-5.6		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	9.4	+/-1.7		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Sodium (Na)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.258	+/-0.043		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	<10	-		10	mg/kg	-		13-NOV-19	
Calcium (Ca)	15.8	-		2.5	mg/kg	-		13-NOV-19	
Magnesium (Mg)	4.7	-		2.5	mg/kg	-		13-NOV-19	
Potassium (K)	<2.5	-		2.5	mg/kg	-		13-NOV-19	
Sodium (Na)	<2.5	-		2.5	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	16.9	-		3.0	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	<0.20	-	SAR:DL	0.20	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	33.9	+/-6.6		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.86	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-21 ERFN_GRW_201911_SOI_18									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-21 ERFN_GRW_201911_SOI_18									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	51.7	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
% Silt (0.05mm - 2um)	31.9	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
% Clay (<2um)	16.4	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
Texture	Loam	-				-	12-NOV-19	13-NOV-19	R4905916
Available N, P, K and S									
Available Nitrate-N									
Available Nitrate-N	<2.0	-		2.0	mg/kg	-	15-NOV-19	15-NOV-19	R4911110
Available Sulfate-S									
Available Sulfate-S	<4.0	-		4.0	mg/kg	-	15-NOV-19	15-NOV-19	R4914986
Plant Available Phosphorus and Potassium									
Available Phosphate-P	2.1	+/-1.4		2.0	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Available Potassium	156	+/-30		20	mg/kg	0	14-NOV-19	14-NOV-19	R4911086
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	48.7	+/-4.7		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	29.1	+/-5.2		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	9.1	+/-1.7		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Sodium (Na)	<5.0	-		5.0	mg/L	-		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.250	+/-0.042		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	<9.7	-		9.7	mg/kg	-		13-NOV-19	
Calcium (Ca)	14.2	-		2.4	mg/kg	-		13-NOV-19	
Magnesium (Mg)	4.4	-		2.4	mg/kg	-		13-NOV-19	
Potassium (K)	<2.4	-		2.4	mg/kg	-		13-NOV-19	
Sodium (Na)	<2.4	-		2.4	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	6.8	-		2.9	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	<0.20	-	SAR:DL	0.20	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	14.1	+/-2.9		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	6.84	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-22 ERFN_GRW_201911_SOI_19									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	62.5	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
% Silt (0.05mm - 2um)	24.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
% Clay (<2um)	13.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
Texture	Sandy loam	-				-	12-NOV-19	13-NOV-19	R4905916
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	43.3	+/-4.2		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	52.9	+/-9.3		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	22.9	+/-4.2		5.0	mg/L	0		12-NOV-19	R4905169

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-22 ERFN_GRW_201911_SOI_19									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Potassium (K)	6.3	+/-1.1		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	5.4	+/-1.0		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.460	+/-0.071		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	<8.7	-		8.7	mg/kg	-		13-NOV-19	
Calcium (Ca)	22.9	-		2.2	mg/kg	-		13-NOV-19	
Magnesium (Mg)	9.9	-		2.2	mg/kg	-		13-NOV-19	
Potassium (K)	2.7	-		2.2	mg/kg	-		13-NOV-19	
Sodium (Na)	2.3	-		2.2	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	37.2	-		2.6	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.16	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	85.8	+/-16		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									
pH in Saturated Paste	7.90	-		0.10	pH	-		12-NOV-19	R4905781
L2379628-23 ERFN_GRW_201911_SOI_20									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
Particle Size Analysis:Mini-Pipet Method									
% Sand (2.0mm - 0.05mm)	23.2	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
% Silt (0.05mm - 2um)	48.4	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
% Clay (<2um)	28.4	+/-3.0		1.0	%	0	12-NOV-19	13-NOV-19	R4905916
Texture	Clay loam	-				-	12-NOV-19	13-NOV-19	R4905916
Detailed Salinity for BC and SK Regs									
% Saturation									
% Saturation	58.0	+/-5.6		1.0	%	0		12-NOV-19	R4905781
Ca,K,Mg,Na in Soil (Paste) by ICPOES									
Calcium (Ca)	19.7	+/-3.5		5.0	mg/L	0		12-NOV-19	R4905169
Magnesium (Mg)	25.3	+/-4.6		5.0	mg/L	0		12-NOV-19	R4905169
Potassium (K)	5.8	+/-1.0		5.0	mg/L	0		12-NOV-19	R4905169
Sodium (Na)	9.9	+/-1.7		5.0	mg/L	0		12-NOV-19	R4905169
Chloride in Soil (Paste) by Colorimetry									
Chloride (Cl)	<20	-		20	mg/L	-		13-NOV-19	R4906038
Conductivity in Soil (Paste) by Meter									
Conductivity Sat. Paste	0.345	+/-0.055		0.010	dS/m	0		12-NOV-19	R4905781
Salinity in mg/kg									
Chloride (Cl)	<12	-		12	mg/kg	-		13-NOV-19	
Calcium (Ca)	11.4	-		2.9	mg/kg	-		13-NOV-19	
Magnesium (Mg)	14.7	-		2.9	mg/kg	-		13-NOV-19	
Potassium (K)	3.4	-		2.9	mg/kg	-		13-NOV-19	
Sodium (Na)	5.7	-		2.9	mg/kg	-		13-NOV-19	
Sulfur (as SO4)	10.1	-		3.5	mg/kg	-		13-NOV-19	
Sodium Adsorption Ratio (Sat. Paste)									
SAR	0.35	-		0.10	SAR	-		13-NOV-19	
Sulphate (SO4)									
Sulfur (as SO4)	17.4	+/-3.5		6.0	mg/L	0		12-NOV-19	R4905169
pH in Saturated Paste									

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2379628-23 ERFN_GRW_201911_SOI_20									
Sampled By: CLIENT on 07-NOV-19 @ 09:00									
Matrix: SOIL									
pH in Saturated Paste									
pH in Saturated Paste	8.38	-		0.10	pH	-		12-NOV-19	R4905781

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

Reference Information

Report Comments:

19-NOV-2019 Revised sample ID's

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Duplicate	Available Potassium	DLHC	L2379628-1, -10, -2, -4, -5, -6, -9

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).
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	Preparation Method Reference	Method Reference**
CL-PASTE-COL-CL	Soil	Chloride in Soil (Paste) by Colorimetry		CSSS, APHA 4500-Cl E
A soil extract produced by the saturated paste extraction procedure is analyzed for Chloride by Colourimetry.				
EC-PASTE-CL	Soil	Conductivity in Soil (Paste) by Meter		CSSS ch.15
This analysis is adapted from the methods outlined in "Soil Sampling and Methods of Analysis" by M. Carter. In summary, 200 to 500 grams of sample is extracted for a minimum of 4 hours with an amount of deionized water as required to create a saturated paste. The sample is then filtered or centrifuged and decanted to produce an extract that is ready for analysis. Conductivity is determined using a conductivity electrode.				
MET-PASTE-ICP-CL	Soil	Ca,K,Mg,Na in Soil (Paste) by ICPOES		CSSS CH15/EPA 6010D
A soil extract produced by the saturated paste extraction procedure is analyzed for Calcium, Magnesium, Potassium, Sodium by ICPOES.				
NO3-AVAIL-SK	Soil	Available Nitrate-N		Alberta Ag / APHA 4500 NO3F
Available Nitrate and Nitrite are extracted from the soil using a dilute calcium chloride solution. Nitrate is quantitatively reduced to nitrite by passing 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.				
PH-PASTE-CL	Soil	pH in Saturated Paste		CSSS Ch. 15
A soil extract produced by the saturated paste extraction procedure is analyzed by pH meter.				
PO4/K-AVAIL-SK	Soil	Plant Available Phosphorus and Potassium		Comm. Soil Sci. Plant Anal, 25 (5&6)
Plant available phosphorus and potassium are extracted from the soil usng Modified Kelowna solution. Phosphorous in the soil extract is determined colorimetrically at 880 nm, while potassiumis determined by flame emission at 770 nm.				
PSA-1-SK	Soil	Particle Size Analysis:Mini-Pipet Method		SSIR-51 Method 3.2.1
Dry, < 2 mm soil is treated with sodium hexametaphosphate to ensure complete dispersion of primary soil particles. After treatment, sub-samples of the homogenized soil suspension are taken at specific times and sampling depths as determined by Stoke's Law. The dry weight of soil found in each sub-sample is used determine the silt and clay content. The sand fraction is determined by difference.				
The soil texture is determined according to the CSSC soil texture triangle.				
SAL-MG/KG-CALC-CL	Soil	Salinity in mg/kg		Manual Calculation
SALINITY-INTCHECK-CL	Soil			CSSS 18.4-Calculation
SAR-PASTE-CALC-CL	Soil	Sodium Adsorption Ratio (Sat. Paste)		CSSS 15.4.4-Calculation
Sodium Adsorption Ratio (SAR) is calculated as per "Soil Sampling and Methods of Analysis" by M. Carter.				
SAT-PCNT-CL	Soil	% Saturation		CSSS 18.2-Calculation
Saturation Percentage (SP) is the total volume of water present in a saturated paste (in mL) divided by the dry weight of the sample (in grams), expressed as a percentage, as described in "Soil Sampling and Methods of Analysis" by M. Carter.				
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.				
SO4-PASTE-ICP-CL	Soil	Sulphate (SO4)		CSSS CH15/EPA 6010D
A soil extract produced by the saturated extraction procedure is analyzed for sulfate by ICPOES.				

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**

** 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
CL	ALS ENVIRONMENTAL - CALGARY, ALBERTA, CANADA

Chain of Custody Numbers:

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

Workorder: L2379628 Report Date: 19-NOV-19

Client: Canada North Environmental Services
211 Wheeler Street
SASKATOON SK S7P 0A4
Contact: Kendra Fisher

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-PASTE-COL-CL	**Soil**							
Batch R4906038								
WG3215700-10 DUP		**L2379628-22**						
Chloride (Cl)		<20	<20	RPD-NA	mg/L	N/A	30	13-NOV-19
WG3215700-5 DUP		**L2379628-2**						
Chloride (Cl)		20	20		mg/L	0.7	30	13-NOV-19
WG3215700-4 IRM		**SAL-STD10**						
Chloride (Cl)			92.5		%		70-130	13-NOV-19
WG3215700-9 IRM		**SAL-STD10**						
Chloride (Cl)			91.5		%		70-130	13-NOV-19
WG3215700-3 LCS								
Chloride (Cl)			103.4		%		70-130	13-NOV-19
WG3215700-8 LCS								
Chloride (Cl)			104.1		%		70-130	13-NOV-19
WG3215700-1 MB								
Chloride (Cl)			<20		mg/L		20	13-NOV-19
WG3215700-6 MB								
Chloride (Cl)			<20		mg/L		20	13-NOV-19
EC-PASTE-CL	**Soil**							
Batch R4905781								
WG3215700-10 DUP		**L2379628-22**						
Conductivity Sat. Paste		0.460	0.476		dS/m	3.4	20	12-NOV-19
WG3215700-5 DUP		**L2379628-2**						
Conductivity Sat. Paste		0.306	0.310		dS/m	1.3	20	12-NOV-19
WG3215700-4 IRM		**SAL-STD10**						
Conductivity Sat. Paste			88.5		%		80-120	12-NOV-19
WG3215700-9 IRM		**SAL-STD10**						
Conductivity Sat. Paste			96.5		%		80-120	12-NOV-19
WG3215700-1 MB								
Conductivity Sat. Paste			<0.010		dS/m		0.01	12-NOV-19
WG3215700-6 MB								
Conductivity Sat. Paste			<0.010		dS/m		0.01	12-NOV-19
MET-PASTE-ICP-CL	**Soil**							
Batch R4905169								
WG3215700-10 DUP		**L2379628-22**						
Calcium (Ca)		52.9	52.3		mg/L	1.2	30	12-NOV-19
Magnesium (Mg)		22.9	22.5		mg/L	1.9	30	12-NOV-19
Potassium (K)		6.3	6.1		mg/L	2.7	30	12-NOV-19
Sodium (Na)		5.4	5.3		mg/L	1.3	30	12-NOV-19

Quality Control Report

Client: Canada North Environmental Services
211 Wheeler Street
SASKATOON SK S7P 0A4
Contact: Kendra Fisher

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-PASTE-ICP-CL	**Soil**							
Batch R4905169								
WG3215700-5 DUP		**L2379628-2**						
Calcium (Ca)		28.7	28.4		mg/L	0.9	30	12-NOV-19
Magnesium (Mg)		9.0	8.9		mg/L	1.1	30	12-NOV-19
Potassium (K)		23.4	23.7		mg/L	1.0	30	12-NOV-19
Sodium (Na)		5.2	5.2		mg/L	0.4	30	12-NOV-19
WG3215700-4 IRM		**SAL-STD10**						
Calcium (Ca)			80.6		%		70-130	12-NOV-19
Magnesium (Mg)			76.5		%		70-130	12-NOV-19
Potassium (K)			78.6		%		70-130	12-NOV-19
Sodium (Na)			82.7		%		70-130	12-NOV-19
WG3215700-9 IRM		**SAL-STD10**						
Calcium (Ca)			90.1		%		70-130	12-NOV-19
Magnesium (Mg)			86.9		%		70-130	12-NOV-19
Potassium (K)			75.7		%		70-130	12-NOV-19
Sodium (Na)			83.5		%		70-130	12-NOV-19
WG3215700-3 LCS								
Calcium (Ca)			104.2		%		80-120	12-NOV-19
Magnesium (Mg)			102.7		%		80-120	12-NOV-19
Potassium (K)			100.5		%		80-120	12-NOV-19
Sodium (Na)			108.7		%		80-120	12-NOV-19
WG3215700-8 LCS								
Calcium (Ca)			99.0		%		80-120	12-NOV-19
Magnesium (Mg)			96.5		%		80-120	12-NOV-19
Potassium (K)			92.6		%		80-120	12-NOV-19
Sodium (Na)			101.0		%		80-120	12-NOV-19
WG3215700-1 MB								
Calcium (Ca)			<5.0		mg/L		5	12-NOV-19
Magnesium (Mg)			<5.0		mg/L		5	12-NOV-19
Potassium (K)			<5.0		mg/L		5	12-NOV-19
Sodium (Na)			<5.0		mg/L		5	12-NOV-19
WG3215700-6 MB								
Calcium (Ca)			<5.0		mg/L		5	12-NOV-19
Magnesium (Mg)			<5.0		mg/L		5	12-NOV-19
Potassium (K)			<5.0		mg/L		5	12-NOV-19
Sodium (Na)			<5.0		mg/L		5	12-NOV-19
NO3-AVAIL-SK	**Soil**							

Quality Control Report

Client: Canada North Environmental Services
211 Wheeler Street
SASKATOON SK S7P 0A4
Contact: Kendra Fisher

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-AVAIL-SK	**Soil**							
Batch R4910207								
WG3217947-1 DUP		**L2379495-7**						
Available Nitrate-N		64.8	62.1		mg/kg	4.3	30	14-NOV-19
WG3217947-3 IRM		**SAL814**						
Available Nitrate-N			105.5		%		70-130	14-NOV-19
WG3217947-4 LCS								
Available Nitrate-N			71.1		%		70-130	14-NOV-19
WG3217947-2 MB								
Available Nitrate-N			<2.0		mg/kg		2	14-NOV-19
Batch R4911110								
WG3217949-1 DUP		**L2379971-6**						
Available Nitrate-N		<2.0	<2.0	RPD-NA	mg/kg	N/A	30	15-NOV-19
WG3217949-3 IRM		**SAL814**						
Available Nitrate-N			99.4		%		70-130	15-NOV-19
WG3217949-4 LCS								
Available Nitrate-N			80.5		%		70-130	15-NOV-19
WG3217949-2 MB								
Available Nitrate-N			<2.0		mg/kg		2	15-NOV-19
PH-PASTE-CL	**Soil**							
Batch R4905781								
WG3215700-10 DUP		**L2379628-22**						
pH in Saturated Paste		7.90	7.93	J	pH	0.03	0.3	12-NOV-19
WG3215700-5 DUP		**L2379628-2**						
pH in Saturated Paste		6.09	6.06	J	pH	0.03	0.3	12-NOV-19
WG3215700-4 IRM		**SAL-STD10**						
pH in Saturated Paste			7.33		pH		6.94-7.54	12-NOV-19
WG3215700-9 IRM		**SAL-STD10**						
pH in Saturated Paste			7.35		pH		6.94-7.54	12-NOV-19
PO4/K-AVAIL-SK	**Soil**							
Batch R4911086								
WG3217931-1 DUP		**L2380047-1**						
Available Phosphate-P		34.1	34.2		mg/kg	0.3	30	14-NOV-19
Available Potassium		146	150		mg/kg	2.9	30	14-NOV-19
WG3217931-3 IRM		**FARM2005**						
Available Phosphate-P			98.4		%		80-120	14-NOV-19
Available Potassium			99.2		%		70-130	14-NOV-19
WG3217931-4 LCS								
Available Phosphate-P			94.2		%		80-120	14-NOV-19

Quality Control Report

Client: Canada North Environmental Services
211 Wheeler Street
SASKATOON SK S7P 0A4
Contact: Kendra Fisher

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PO4/K-AVAIL-SK	**Soil**							
Batch R4911086								
WG3217931-4 LCS								
Available Potassium			96.1		%		80-120	14-NOV-19
WG3217931-2 MB								
Available Phosphate-P			<2.0		mg/kg		2	14-NOV-19
Available Potassium			<20		mg/kg		20	14-NOV-19
Batch R4911108								
WG3217929-1 DUP		**L2379495-9**						
Available Phosphate-P		16.7	17.2		mg/kg	2.7	30	14-NOV-19
Available Potassium		557	566		mg/kg	1.6	30	14-NOV-19
WG3217929-3 IRM		**FARM2005**						
Available Phosphate-P			91.9		%		80-120	14-NOV-19
Available Potassium			102.2		%		70-130	14-NOV-19
WG3217929-4 LCS								
Available Phosphate-P			94.4		%		80-120	14-NOV-19
Available Potassium			92.9		%		80-120	14-NOV-19
WG3217929-2 MB								
Available Phosphate-P			<2.0		mg/kg		2	14-NOV-19
Available Potassium			<20		mg/kg		20	14-NOV-19
PSA-1-SK	**Soil**							
Batch R4905915								
WG3214880-1 DUP		**L2379628-7**						
% Sand (2.0mm - 0.05mm)		13.6	15.2	J	%	1.6	5	13-NOV-19
% Silt (0.05mm - 2um)		56.7	54.0	J	%	2.6	5	13-NOV-19
% Clay (<2um)		29.8	30.8	J	%	1.0	5	13-NOV-19
WG3214880-2 IRM		**2017-PSA**						
% Sand (2.0mm - 0.05mm)			50.9		%		45.8-55.8	13-NOV-19
% Silt (0.05mm - 2um)			34.9		%		28.6-38.6	13-NOV-19
% Clay (<2um)			14.2		%		10.6-20.6	13-NOV-19
Batch R4905916								
WG3214883-1 DUP		**L2379628-22**						
% Sand (2.0mm - 0.05mm)		62.5	62.3	J	%	0.2	5	13-NOV-19
% Silt (0.05mm - 2um)		24.2	24.2	J	%	0.0	5	13-NOV-19
% Clay (<2um)		13.2	13.5	J	%	0.2	5	13-NOV-19
WG3214883-2 IRM		**2017-PSA**						
% Sand (2.0mm - 0.05mm)			49.7		%		45.8-55.8	13-NOV-19
% Silt (0.05mm - 2um)			35.8		%		28.6-38.6	13-NOV-19

Quality Control Report

Client: Canada North Environmental Services
211 Wheeler Street
SASKATOON SK S7P 0A4
Contact: Kendra Fisher

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
PSA-1-SK	**Soil**							
Batch R4905916								
WG3214883-2 IRM		**2017-PSA**						
% Clay (<2um)			14.4		%		10.6-20.6	13-NOV-19
SAT-PCNT-CL	**Soil**							
Batch R4905781								
WG3215700-10 DUP		**L2379628-22**						
% Saturation		43.3	45.3		%	4.5	20	12-NOV-19
WG3215700-5 DUP		**L2379628-2**						
% Saturation		50.0	49.3		%	1.3	20	12-NOV-19
WG3215700-4 IRM		**SAL-STD10**						
% Saturation			97.4		%		80-120	12-NOV-19
WG3215700-9 IRM		**SAL-STD10**						
% Saturation			106.0		%		80-120	12-NOV-19
SO4-AVAIL-SK	**Soil**							
Batch R4910186								
WG3217950-1 DUP		**L2379495-7**						
Available Sulfate-S		80.7	75.9		mg/kg	6.2	30	14-NOV-19
WG3217950-3 IRM		**SAL814**						
Available Sulfate-S			99.8		%		70-130	14-NOV-19
WG3217950-2 MB								
Available Sulfate-S			<4.0		mg/kg		4	14-NOV-19
Batch R4914986								
WG3217952-1 DUP		**L2379971-6**						
Available Sulfate-S		13.9	14.5		mg/kg	4.3	30	15-NOV-19
WG3217952-3 IRM		**SAL814**						
Available Sulfate-S			100.7		%		70-130	15-NOV-19
WG3217952-2 MB								
Available Sulfate-S			<4.0		mg/kg		4	15-NOV-19
SO4-PASTE-ICP-CL	**Soil**							
Batch R4905169								
WG3215700-10 DUP		**L2379628-22**						
Sulfur (as SO4)		85.8	85.3		mg/L	0.6	30	12-NOV-19
WG3215700-5 DUP		**L2379628-2**						
Sulfur (as SO4)		44.6	45.5		mg/L	1.8	30	12-NOV-19
WG3215700-4 IRM		**SAL-STD10**						
Sulfur (as SO4)			79.1		%		70-130	12-NOV-19
WG3215700-9 IRM		**SAL-STD10**						

Quality Control Report

Client: Canada North Environmental Services
211 Wheeler Street
SASKATOON SK S7P 0A4
Contact: Kendra Fisher

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-PASTE-ICP-CL	**Soil**							
Batch R4905169								
WG3215700-9 IRM		**SAL-STD10**						
Sulfur (as SO4)			90.6		%		70-130	12-NOV-19
WG3215700-3 LCS								
Sulfur (as SO4)			94.4		%		80-120	12-NOV-19
WG3215700-8 LCS								
Sulfur (as SO4)			94.5		%		80-120	12-NOV-19
WG3215700-1 MB								
Sulfur (as SO4)			<6.0		mg/L		6	12-NOV-19
WG3215700-6 MB								
Sulfur (as SO4)			<6.0		mg/L		6	12-NOV-19

Quality Control Report

Workorder: L2379628 Report Date: 19-NOV-19

Client: Canada North Environmental Services
211 Wheeler Street
SASKATOON SK S7P 0A4
Contact: Kendra Fisher

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).
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.

Hold Time Exceedances:

All test results reported with this submission were conducted within ALS recommended hold times.

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.

Environmental Services

COC ID:

L2379628-COFC

PROJECT

Facility Code	Central_Sask
Project Number	3480_19_SOI
Project Description	English River Grasswood Land Irrigation
	Canada North Environmental Services
Address	211 Wheeler Street
City	Saskatoon
Prov.	SK
Postal Code	S7P 0A4
Country	Canada
Phone Number	306-652-4432
Project Manager	Kendra Fisher
Email Address	kendra.fisher@cannorth.com

LABORATORY

Lab Name	ALS LABORATORY GROUP
Lab Contact	Brian Morgan
Email	Brian.Morgan@ALSGlobal.com
Address	819 58th Street East
City	Saskatoon
Prov.	SK
Postal Code	S7K 6X5
Country	Canada
Phone Number	3066688370
Quote Number	Q77330; Q77331
PO Number	

OTHER INFO

Email Invoice To	
Invoice Reports	accounting@cannorth.com
Email Report To	
Email Reports	samples@cannorth.com

SAMPLE DETAILS / ANALYSIS REQUESTED

Filtered - F, Field, L: Lab, FL: Field & Lab, N: None

Sample ID	Location	End Depth	Depth Unit	Field Matrix	Sample Description	Date	G=Grab C=Comp	Total # Of Cont.	Q77330	Q77331	HORIZON	START DEPTH (cm)	END DEPTH (cm)	WAYPOINT NUMBER
3480_QAQC_01_201911_SOI	ERFN_GRW			SOI	3480 QAQC 01 soil sample	7Nov19	G	1	✓		A	0	17	2
3480_QAQC_02_201911_SOI	ERFN_GRW			SOI	3480 QAQC 02 soil sample	7Nov19	G	1	✓		B	17	30	2
3480_QAQC_03_201911_SOI	ERFN_GRW			SOI	3480 QAQC 03 soil sample	7Nov19	G	1		✓	—	30	100	2
ERFN_GRW_201911_SOI_01	ERFN_GRW			SOI	English River FN - Grasswood soil sample 01	7Nov19	G	1	✓		A	0	17	1
ERFN_GRW_201911_SOI_02	ERFN_GRW			SOI	English River FN - Grasswood soil sample 02	7Nov19	G	1	✓		B	17	25	1
ERFN_GRW_201911_SOI_03	ERFN_GRW			SOI	English River FN - Grasswood soil sample 03	7Nov19	G	1	✓		—	0	50	1
ERFN_GRW_201911_SOI_04	ERFN_GRW			SOI	English River FN - Grasswood soil sample 04	7Nov19	G	1		✓	—	50	100	1
ERFN_GRW_201911_SOI_05	ERFN_GRW			SOI	English River FN - Grasswood soil sample 05	7Nov19	G	1		✓	—	100	+	1
ERFN_GRW_201911_SOI_06	ERFN_GRW			SOI	English River FN - Grasswood soil sample 06	7Nov19	G	1	✓		A	0	17	2
ERFN_GRW_201911_SOI_07	ERFN_GRW			SOI	English River FN - Grasswood soil sample 07	7Nov19	G	1	✓		B	17	30	2

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
			CS	7/11/19
			Temp 2°C	

NB OF BOTTLES RETURNED/DESCRIPTION				
	Supervisor Name	Kendra Fisher	Mobile #	306 850 7340
	Supervisor Signature	KFisher	Date/Time	Nov 7 2019 16:15

Environmental Services

L2379628-COFC

COC ID:

PROJECT			
Facility Code	Central_Sask		
Project Number	3480_19_SOI		
Project Description	English River Grasswood Land Irrig		
	Canada North Environmental Services		
Address	211 Wheeler Street		
City	Saskatoon	Prov.	SK
Postal Code	S7P 0A4	Country	Canada
Phone Number	306-652-4432		
Project Manager	Kendra Fisher		
Email Address	kendra.fisher@cannorth.com		

LABORATORY			
Lab Name	ALS LABORATORY GROUP		
Lab Contact	Brian Morgan		
Email	Brian.Morgan@ALSGlobal.com		
Address	819 58th Street East		
City	Saskatoon	Prov.	SK
Postal Code	S7K 6X5	Country	Canada
Phone Number	3066688370		
Quote Number	Q77330; Q77331		
PO Number			

OTHER INFO	
Email Invoice To	
Invoice Reports	accounting@cannorth.com
Email Report To	
Email Reports	samples@cannorth.com

SAMPLE DETAILS

ANALYSIS REQUESTED

Filtered - F: Field, L: Lab, FL: Field & Lab, N: None

Sample ID	Location	End Depth	Depth Unit	Field Matrix	Sample Description	Date	G=Grab C=Comp	Total # Of Cont.	Q77330	Q77331	HORIZON	START DEPTH (cm)	END DEPTH (cm)	WAYPOINT NUMBER
ERFN_GRW_201911_SOI_08	ERFN_GRW			SOI	English River FN - Grasswood soil sample 08	7Nov19	G	1	✓		–	0	50	2
ERFN_GRW_201911_SOI_09	ERFN_GRW			SOI	English River FN - Grasswood soil sample 09	7Nov19	G	1		✓	–	50	100	2
ERFN_GRW_201911_SOI_10	ERFN_GRW			SOI	English River FN - Grasswood soil sample 10	7Nov19	G	1		✓	–	100	+	2
ERFN_GRW_201911_SOI_11	ERFN_GRW			SOI	English River FN - Grasswood soil sample 11	7Nov19	G	1	✓		A	0	22	3
ERFN_GRW_201911_SOI_12	ERFN_GRW			SOI	English River FN - Grasswood soil sample 12	7Nov19	G	1	✓		B	22	44	3
ERFN_GRW_201911_SOI_13	ERFN_GRW			SOI	English River FN - Grasswood soil sample 13	7Nov19	G	1	✓		–	0	50	3
ERFN_GRW_201911_SOI_14	ERFN_GRW			SOI	English River FN - Grasswood soil sample 14	7Nov19	G	1		✓	–	50	100	3
ERFN_GRW_201911_SOI_15	ERFN_GRW			SOI	English River FN - Grasswood soil sample 15	7Nov19	G	1		✓	–	100	+	3
ERFN_GRW_201911_SOI_16	ERFN_GRW			SOI	English River FN - Grasswood soil sample 16	7Nov19	G	1	✓		A	0	16	4
ERFN_GRW_201911_SOI_17	ERFN_GRW			SOI	English River FN - Grasswood soil sample 17	7Nov19	G	1	✓		B	16	46	4

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
				7/11/19

NO OF BOTTLES RETURNED/DESCRIPTION

Supervisor Name	Kendra Fisher	Mobile #	306 850 7340
Supervisor Signature		Date/Time	Nov 7 2019 16:15

onmental Services

COC ID: 3480_

L2379628-COFC

PROJECT/CLIENT

Facility Code	Central_Sask
Project Number	3480_19_SOI
Project Description	English River Grasswood Land Irrigation
	Canada North Environmental Services
Address	211 Wheeler Street
City	Saskatoon
Prov.	SK
Postal Code	S7P 0A4
Country	Canada
Phone Number	306-652-4432
Project Manager	Kendra Fisher
Email Address	kendra.fisher@cannorth.com

LABORATORY

Lab Name	ALS LABORATORY GROUP
Lab Contact	Brian Morgan
Email	Brian.Morgan@ALSGlobal.com
Address	819 58th Street East
City	Saskatoon
Prov.	SK
Postal Code	S7K 6X5
Country	Canada
Phone Number	3066688370
Quote Number	Q77330; Q77331
PO Number	

OTHER INFO

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Email Report To	
Email Reports	samples@cannorth.com

SAMPLE DETAILS

ANALYSIS REQUESTED

Filtered - E: Field, L: Lab, FL: Field & Lab, N: None

Sample ID	Location	End Depth	Depth Unit	Field Matrix	Sample Description	Date	G=Grab C=Comp	Total # Of Cont.	Q77330	Q77331	HORIZON	START DEPTH (cm)	END DEPTH (cm)	WAYPOINT NUMBER
ERFN_GRW_201911_SOI_18	ERFN_GRW			SOI	English River FN - Grasswood soil sample 18	7 Nov 19	G	1	✓		–	0	50	4
ERFN_GRW_201911_SOI_19	ERFN_GRW			SOI	English River FN - Grasswood soil sample 19	7 Nov 19	G	1		✓	–	50	100	4
ERFN_GRW_201911_SOI_20	ERFN_GRW			SOI	English River FN - Grasswood soil sample 20	7 Nov 19	G	1		✓	–	100	+	4
ERFN_GRW_201911_SOI_21	ERFN_GRW			SOI	English River FN - Grasswood soil sample 22									
ERFN_GRW_201911_SOI_22	ERFN_GRW			SOI	English River FN - Grasswood soil sample 23									
ERFN_GRW_201911_SOI_23	ERFN_GRW			SOI	English River FN - Grasswood soil sample 24									
ERFN_GRW_201911_SOI_24	ERFN_GRW			SOI	English River FN - Grasswood soil sample 25									
ERFN_GRW_201911_SOI_25	ERFN_GRW			SOI	English River FN - Grasswood soil sample 26									
ERFN_GRW_201911_SOI_26	ERFN_GRW			SOI	English River FN - Grasswood soil sample 27									
ERFN_GRW_201911_SOI_27	ERFN_GRW			SOI	English River FN - Grasswood soil sample 28									

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
			CES	7/11/19

NB OF BOTTLES RETURNED/DESCRIPTION				
	Supervisor Name	Kendra Fisher	Mobile #	306 850 7340
	Supervisor Signature	K Fisher	Date/Time	Nov 7 2019 16:15

Canada North Environmental Services

COC ID:

L2379628-COFC

Facility Code	Central_Sask				**LABORATORY**				**OTHER INFO**
Project Number	3480_19_SOI				**Lab Name**	ALS LABORATORY GROUP			Email Invoice To
Project Description	**English River Grasswood Lan**				**Lab Contact**	Brian Morgan			Invoice Reports **accounting@cannorth.com**
	Canada North Environmental				**Email**	Brian.Morgan@ALSGlobal.com			Email Report To
Address	**211 Wheeler Street**				**Address**	819 58th Street East			Email Reports **samples@cannorth.com**
City	**Saskatoon**	Prov.	**SK**		**City**	Saskatoon	Prov.	SK	
Postal Code	**S7P 0A4**	Country	**Canada**		**Postal Code**	S7K 6X5	Country	Canada	
Phone Number	**306-652-4432**				**Phone Number**	3066688370			
Project Manager	Kendra Fisher				**Quote Number**	Q77330; Q77331			
Email Address	kendra.fisher@cannorth.com				**PO Number**				

SAMPLE DETAILS | **ANALYSIS REQUESTED**

Filtered - F: Field, L: Lab, FL: Field & Lab, N: None

Sample ID	Location	End Depth	Depth Unit	Field Matrix	Sample Description	Date	G=Grab C=Comp	Total # Of Cont.	Q77330	Q77331	HORIZON	START DEPTH (cm)	END DEPTH (cm)	WAYPOINT NUMBER
ERFN_GRW_201911_SOI_28	ERFN_GRW			SOI	English River FN - Grasswood soil sample 29									
ERFN_GRW_201911_SOI_29	ERFN_GRW			SOI	English River FN - Grasswood soil sample 30									
ERFN_GRW_201911_SOI_30	ERFN_GRW			SOI	English River FN - Grasswood soil sample 31									
ERFN_GRW_201911_SOI_31	ERFN_GRW			SOI	English River FN - Grasswood soil sample 32									
ERFN_GRW_201911_SOI_32	ERFN_GRW			SOI	English River FN - Grasswood soil sample 33									
ERFN_GRW_201911_SOI_33	ERFN_GRW			SOI	English River FN - Grasswood soil sample 34									

ADDITIONAL COMMENTS/SPECIAL INSTRUCTIONS	RELINQUISHED BY/AFFILIATION	DATE/TIME	ACCEPTED BY/AFFILIATION	DATE/TIME
			CCS	7/11/19

NB OF BOTTLES RETURNED/DESCRIPTION

Supervisor Name	Kendra Fisher	**Mobile #**	306 850 7340
Supervisor Signature		**Date/Time**	Nov 7 2019.

APPENDIX C

DETAILED MAP UNIT RATING TABLES

LIST OF TABLES

APPENDIX C, TABLE 1

Determination of final soil ratings for map units within the proposed Grasswood wastewater treatment and disposal irrigation area.

Soil Map Unit	Site ID	Proportion of Map Unit (%)[1]	B.S.R.	Modifiers Index	Partial Soil Rating Index
O.DB; CA.DB Lu[4-3] 3 a1b1n1e1m1;a3b2n1e2m1 W1;W2	SS01	20	56	70	8
	SS03	40	100	100	40
	SS04	40	70	100	28
	Final Soil Rating for Map Unit				76
	Final Soil Category for Map Unit				1 (Excellent)
GL.DB Lu[4] 4 a1b1n1e1m1	SS02	100	70	100	70
	Final Soil Rating for Map Unit				70
	Final Soil Category for Map Unit				2 (Good)

All ratings calculated as per AAFRD (2004a, b).

B.S.R. = Basic soil rating.

[1]The proportion of a map unit comprised by each soil type is an approximation made based on the knowledge and experience of the surveyor and takes into account surface inspections completed to confirm homogeneity.

APPENDIX C, TABLE 2

Determination of final topography ratings for map units within the proposed Grasswood wastewater treatment and disposal irrigation area.

Soil Map Unit	Earth Moving Requirement (m^3 ac^{-1})	Field Size (ac)	Field Shape	Maximum Downfield Slope (%)	Stoniness (%)	Brush/Tree Cover (%)	Surface Drainage, Depth of Cut (m)	Topography Category[1]
O.DB; CA.DB Lu^{4-3} 3 a1b1n1e1m1;a3b2n1e2m1 W1;W2	<400	>20	**Irregular**	5	<15	<15	<1.2	3 (Sprinkler)
GL.DB Lu^{4} 4 a1b1n1e1m1	<400	<20	Irregular	9	<15	**>15**	<1.2	4 (Nonirrigable)

All ratings calculated as per AAFRD (2004a, b).

Bold values denote the most limiting factor for each soil map unit.

[1]Topgraphy category was determined based on the most limiting factor as per criteria set out in AAFRD (2004a, b).