THE MANITOBA WATER SERVICES BOARD

Town of Melita Land Application of Biosolids
Manitoba Environment Act Proposal

FINAL

KGS Group 16-0429-004
August 2016

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Environmental Approvals Branch
Manitoba Sustainable Development
Suite 160, 123 Main Street
Winnipeg, Manitoba
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ATTENTION: Ms. Tracey Braun
Director

RE: Environment Act Proposal
Town of Melita Land Application of Biosolids – Final Report

Dear Ms. Braun:

On behalf of the Manitoba Water Services Board and the Town of Melita, KGS Group is pleased to submit four (4) paper and one (1) electronic copy of the final Environment Act Proposal submission to obtain a licence for the land application of biosolids from the Town of Melita sewage lagoon. The Town of Melita recently applied for a major alteration to their existing operating licence for alterations to the town's existing wastewater treatment lagoon to address issues related to capacity requirements, leaking and flood protection. In order for the alterations to be completed, the lagoon must first be drained and the sludge removed. It is proposed that after removal, the sludge (biosolids) will be applied to agricultural land. The project is considered a Class 2 Development under Manitoba Regulation 164/88.

As part of the licensing process, a Manitoba Conservation Environment Act Proposal Form with the $7,500.00 application fee has been included with the Environmental Assessment report.

Please do not hesitate to contact the undersigned if you have any questions or require additional information.

Yours truly,

Gene Senior, M.A.
Environmental Scientist

GS/nf
Enclosure

cc: Bill Holden, Mayor, Town of Melita
Travis Parsons, Chief Engineer, Manitoba Water Services Board

EXECUTIVE SUMMARY

The Town of Melita (Melita) recently applied for a major alteration to their existing Licence (Clean Environment Commission Order No. 621) for alterations to the town's existing wastewater treatment lagoon (Figure 1) to address issues related to capacity requirements, leaking and flood protection. In order for the alterations to be completed, the lagoon will first need to be drained and the sludge removed. It is proposed that sludge will be removed down to the lagoon base. After removal, the sludge (biosolids) will be applied to agricultural land in the area as fertilizer as landfills are no longer permitted to receive organic solids resulting from wastewater treatment processes or wastewater sludge. An Environment Act License for the land application of biosolids is therefore required. Based on a 2013 sonar sludge exploration program at the lagoon, it is estimated that the current volume of sludge is in the order of 30,000 m^3.

The biosolids were analyzed for levels of nitrogen and phosphorous as well as salinity and concentrations of metals in order to determine land application rates. Seven quarter sections were identified as potential candidates for the land application of the biosolids and were subjected to a desktop Land Suitability Assessment to determine if there are any nutrient management issues with the soil types on the lands proposed for biosolids application. Prior to land application of the biosolids, each of the quarter sections will be assessed through a soil sampling program and analyzed for pH, potassium, phosphorous and metals. The biosolids analysis and Land Suitability Assessment determined that the lands proposed are appropriate and can benefit from the application of biosolids as long as they are injected beneath surface to minimize risk of nutrient loss during periods of inundation.

Project-environmental interactions were assessed to identify potential environmental effects associated with the project activities. The lands proposed for biosolid application are known to contain three rare species, however the proposed project is unlikely to affect native habitat and will not change the current land use practices. There are no other major environmental constraints such as archaeological resources on the proposed lands. Mitigation and follow-up measures were identified for potential adverse environmental effects including, air quality, soils, groundwater, surface water, fish and fish habitat, wildlife and vegetation, health and well-being, and worker safety.

Based on the available information on the project and the environment, the assessment of environmental effects outlined in this environmental assessment report, and the application of proposed mitigation measures and the conduct of required follow-up, the proposed land application of biosolids will not likely result in any significant residual adverse environmental effects.

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1.0 INTRODUCTION

The Town of Melita (Melita) recently applied for a major alteration to their existing Licence (Clean Environment Commission Order No. 621) for alterations to the town's existing wastewater treatment lagoon (Figure 1) to address issues related to capacity requirements, leaking and flood protection. In order for the alterations to be completed, the lagoon will first need to be drained and the sludge removed. It is proposed that sludge will be removed down to the lagoon base, with the sludge removal program being conducted over two years. After removal, the sludge (biosolids) will be applied to farmland in the area as fertilizer. Disposal of the sludge at a nearby landfill is not an acceptable option as landfills are no longer permitted to receive organic solids resulting from wastewater treatment processes or wastewater sludge per the *Environment Act* (C.C.S.M. c. E125) Waste Management Facilities Regulation (37/2016). An Environment Act License for the land application of biosolids is therefore required. Seven quarter sections have been identified as potential candidates for the biosolids application and were subjected to a Land Suitability Assessment.

2.0 DESCRIPTION OF DEVELOPMENT

The existing lagoon is licenced under Clean Environment Commission Order No. 621 and is located within the limits of land owned by Melita in NW31-03-26W and NE36-03-27W. It currently consists of a 3-cell facultative lagoon for wastewater treatment with a gravel access road from Highway 3 to the north. Based on a 2013 sonar sludge exploration program (1) of the lagoon, it is estimated that the current volume of sludge is in the order of 30,000 m^3. This estimate is based on 18,600 m^3 in the primary cell and 6,580 m^3 in the secondary cell and some contingency for sludge accumulation since the 2013 sonar.

An initial Land Suitability Assessment was performed on the applicable 249 ha (616 acres) portions of the seven quarter sections being considered. These were selected to provide sufficient land area as a contingency for unexpected biosolids quantity, quality, and solids content, as well as to provide adequate area for future land application, if required.

2.1 LAND OWNERSHIP AND CERTIFICATES OF TITLE

Agricultural land in close proximity to the Melita lagoon will be utilized for biosolid application for this project. Consultation with land owners and/or land lessees interested in having biosolid materials applied to their land was conducted by Mr. Bill Holden, Town of Melita Mayor, in June 2016. Land use agreements were formalized and access to lands for soil sampling for assessment of land suitability for sludge application was granted.

The quarter sections where biosolids will be applied are NE36-03-27W, SE36-03-27W, NW25-03-27W, NW26-03-27W, NE26-03-27W, SE26-03-27W, SW26-03-27W.

Certificates of Title and landowner agreements for the proposed receiving lands are available in Appendix A.

2.2 MINERAL RIGHTS

The owner of the mineral rights beneath the properties where the biosolids will be applied will remain as indicated on the Certificates of Title (Appendix A).

2.3 EXISTING AND ADJACENT LAND USE

The land use of the properties selected for biosolids application will not change and the application of biosolids to the farmland as fertilizer should improve the condition of the agricultural farmland where it is applied. Lands proposed for biosolid application have the potential to grow a variety of crops including cereals, oilseeds, soybeans and grasses. Inundation (flooding) is the most limiting factor in crop production on fields NE36-03-27W and SE36-03-27W. Moisture limitations, especially in drier years, are the most limiting factors on field 26-03-27W. These fields can benefit from the application of biosolids that will help to improve soil organic matter and soil structure. It will also provide a source of macro and micronutrients to increase crop productivity and yield potential for future crop years.

2.4 PROJECT COMPONENTS AND ACTIVITIES

2.4.1 Town of Melita Wastewater Treatment Lagoon

The Town of Melita is upgrading its existing wastewater treatment lagoon to accommodate future organic and hydraulic loading and to address a leaking tertiary cell and concerns related to flood protection. The existing lagoon site is within the limits of land owned by Melita on NE36-03-27W and NW31-03-26W and currently consists of a 3-cell facultative lagoon. Graham Creek is to the west and the Souris River to the south and east of the lagoon site.

2.4.2 Schedule

The sludge will need to be removed prior to the commencement of earthworks for the proposed lagoon upgrades. It is proposed that sludge from the primary and secondary cells be removed down to the lagoon base (i.e. all sludge removed), with the sludge removal program being conducted over two years. The application of biosolids is proposed to begin following receipt of the Environment Act Licence, hopefully in the fall of 2016.

2.4.3 Biosolid Analysis

A field sampling program to define the characteristics of the lagoon biosolids was undertaken. The sampling program included the analysis of composite biosolid samples collected from the primary and secondary cells. The quality (nutrient levels, salts and metals) and physical properties (conductivity, pH, solids) of the biosolids were assessed through laboratory analytical testing in spring 2016. Results of the laboratory analysis are included as part of the Land Suitability Assessment provided in Appendix B. The samples were analyzed for the following parameters: moisture content, specific gravity, pH, electrical conductivity, total solids, volatile solids, organic matter content, total carbon, chloride, calcium, potassium, magnesium, sodium, sulphur, Sodium Adsorption Ratio, Total Kjeldahl Nitrogen, nitrate-N, ammonia-N, total phosphorous, Olsen phosphorous, potassium, sulphate and metals.

2.4.4 Land Suitability Assessment

A Land Suitability Assessment was conducted by ToneAg Consulting Ltd. to determine baseline soil information and if there are any nutrient management issues with the soil types on the lands that are to be subject to biosolids application. An initial desktop analysis has been completed which is provided in Appendix B and summarized in Section 4.0. Prior to land application of the biosolids, however, each of the quarter sections identified as potential candidates for biosolids application, will be further assessed through a soil sampling program. Composite soil samples from the fields will be collected from 0-15 cm depth and 15-60 cm depth. The soil samples collected from the 0-15 cm depth will be analyzed for: pH, potassium, total phosphorous, Olsen phosphorous, and a metals scan. The soil samples collected from 15-60 cm depth will be analyzed for total nitrogen and nitrate-N.

2.4.5 Biosolids Application Rate Assessment

A preliminary application rate for the biosolids has been calculated using the biosolids analysis and desktop land suitability assessment (Appendix B). The application rate for biosolids on agricultural land in Manitoba is based on nutrient loading for nitrogen (N) and phosphorous (P) while considering both biosolids quality and soil background nutrient levels as outlined in the *Nutrient Management Regulation* (NMR) (62/2008). Metals concentrations for cadmium, copper,

nickel, lead, zinc, mercury, chromium and arsenic also define application rates. Metal limits are calculated from background concentrations with the accumulated biosolids metals concentration, as specified in a maximum level in kg/hectare for each individual metal.

2.4.6 Program Activities

The wastewater in the lagoon will be discharged until only approximately 10% of total volume of wastewater remains. The sludge material will then be agitated with the remaining liquids and then collected or dredged using heavy equipment. The biosolid material collected will be placed into tanker trucks and/or TerraGator® trucks and transported to the receiving land locations. The biosolids will be applied in a slurry state (approximately 90% moisture) by injection into the fields. Injecting the biosolids will alleviate concerns of odour and mitigate risks associated with spreading on soils that may be inundated. The biosolid materials will be injected at the prescribed agronomic rates in fall 2016. The target biosolid rate will be based on the targeted crop uptake and removal rates as well as soil fertility concentrations after the crops have been removed from the fields. At the commencement of the following growing season and for a period of three years from the date of application of the biosolids, the fields will be planted with a crop of cereal, forage, oil seed, field peas or lentils.

2.4.7 Storage of Gasoline and Associated Products

Gasoline and associated products may be temporarily used and stored at the lagoon site during removal of the sludge from the lagoon and at the field sites during application of the biosolids.

3.0 PHYSICAL ENVIRONMENT

3.1 LOCATION, PHYSIOGRAPHIC SETTING AND CLIMATE

Melita is located in the southwest corner of Manitoba, in the Souris River Valley, near the Saskatchewan border, approximately 100 km southwest of the city of Brandon. The Melita wastewater treatment lagoon is located approximately 370 m south of the intersection of provincial highways 3 and 83, southeast of the town of Melita, on the north bank of the Souris River. The field sites where the biosolids will be applied are within the Rural Municipality of Two Borders, south and southwest of Melita as shown on Figure 1.

The project lies within the Souris Plain of the Western Upland Physiographic division. The surface topography in the Melita area is generally flat, sloping towards the Souris River. The elevation of the property at the lagoon location is between 428 m and 429 m above sea level and the properties identified for biosolid application have elevations between 428 m and 451 m.

The project is located within the Oak Lake Ecodistrict of the Aspen Parkland Ecoregion, the driest subdivision of the Grassland Transition Ecoclimate Region [(2)]. Climate statistics for Melita based on data from 1994 to 2010 [(3)] indicate that the mean daily temperature ranges from 19.3 °C in July to -15.4 °C in January with an annual mean of 3.2 °C and 257 days with the daily maximum temperature above 0 °C. The average annual total precipitation in the area is approximately 410 mm, with 320 mm falling as rain and the rest as snow. June has the highest average rainfall (76.4 mm) and December has the highest average snowfall (22.7 cm).

3.2 GEOLOGY

The project lies within the Southwestern Uplands and has underlying bedrock that consists primarily of Precambrian aged felsic metavolcanic rocks, rhyolite and dacite [(4)]. The bedrock is overlain by a quaternary aged sequence of glacial sediments consisting of glaciofluvial sediments and glaciolacustrine sediments, as well as some sub-glacial calcareous clay diamicton [(5)]. The glaciofluvial sediments consist of fine sand, minor gravel, thin silt layers and clay interbeds (subaqueous outwash fans) deposited in glacial Lake Agassiz. The glaciolacustrine sediments consist of clay, silt and minor sand (deep water glacial Lake Agassiz

sediments). The sub-glacial clay diamicton deposits are less abundant, primarily located approximately 2 km north and 2 km south of the town of Melita [(5)].

As part of the 2013 geotechnical field investigation [(6)] at the lagoon, nine test holes were drilled on the top of the lagoon dikes. The clay fill dikes overly layers of interbedded silty and sandy clays to depths of 5.2 m to 6.1 m, followed by layers of silty and clayey sands to end of the holes at 7.6 m deep. Silty sand layers, 0.6 m to 2.2 m thick, were encountered immediately beneath the dike/foundation soils. The soil profile noted beneath the dike foundation is likely similar to that found on the properties that are designated for biosolids application. Surficial soil conditions for each subject property, according to the Canada Land Inventory (CLI), are described in Section 4, Land Suitability.

3.3 GROUNDWATER HYDROLOGY

Groundwater in the area is generally between 1 m and 5 m below surface and flows toward the Souris River. A search of the provincial GWDrill database within the proposed project quarter sections reveals a short history of test well drilling. Wells were noted in the data base within NW27-3-27W, NE36-3-27W and SE36-3-27W. The records indicate that screened wells are installed within overburden sands and silty sands, likely alluvial in origin. Shale bedrock is encountered approximately 14 m to 23 m below ground surface. Groundwater levels noted on the logs are typically approximately 2.4 m to 4.6 m below existing grade. One well log indicated a flowing artesian condition within the sands, with static water levels approximately 0.9 m above ground surface. Well capacities vary, with typical ranges of approximately 3.5 Igpm/ft drawdown to 7.5 Igpm/ft drawdown. The lowest capacity wells are in the 0.75 Igpm/ft drawdown to 2.0 Igpm/ft drawdown range. Water quality appears to be generally good to moderate, with electrical conductivities in the order of 700 µS/cm to 1150 µS/cm, hardness in the range of 240 ppm to >1000 ppm, and iron in concentrations of approximately 1.5 ppm to 5 ppm.

3.4 SURFACE WATER

The Oak Lake Ecodistrict is located within the Souris River watershed that is part of the Nelson River drainage system [(2)]. Surface water in the area includes Graham Creek on the east of

NE36-3-27W and the Souris River which lies to the east of the proposed fields and the Melita lagoon.

Water quality data for the Souris River was collected by Manitoba Sustainable Development (SD, formerly Conservation and Water Stewardship), Water Quality Management Section from 2006 to 2012 (Appendix C) east of Melita at Highway #3 (Station MB05NFS024) and near Souris at Highway #22 (Station MB05NGS004) [(7)]. Comparing the Souris River water quality data to the Canadian Council of Ministers of the Environment (CCME) Canada-wide Strategy for the Management of Municipal Wastewater Effluent, Effluent Quality Standards and the Manitoba Water Quality Standards, Objectives, and Guidelines (MWQSOG) for the Protection of Freshwater Aquatic Life, the key findings are as follows:

- The NH3 concentrations have ranged from 0.006 to 3.52 mg/L with an average of 0.234 mg/L. With the exception of the samples collected during December 2006 (1.29 mg/L) and January 2009 (3.52 mg/L) all of the measured concentrations were below the Effluent Quality Standard (1.25 mg/L). For the MWQSOG total ammonia limits shall not exceed a site-specific limit derived by Tier II calculations using pH and temperature.
- The BOD concentrations have ranged from 1.0 to 27 mg/L with an average of 3.5 mg/L. With the exception of the sample collecting during January 2009 (27 mg/L) all of the measured concentrations were below the Effluent Quality Standard for carbonaceous BOD (CBOD; 25mg/L) and the MWQSOG for BOD (25 mg/L).
- The TSS concentrations have ranged from 1.0 to 93.3 mg/L with an average of 27.8 mg/L. Approximately 40% of the samples collected and the overall average concentration exceed the Effluent Quality Standard and the MWQSOG (25 mg/L).
- The *E. Coli* concentrations have ranged from <10 to 140 CFU/100 mL with an average of 32.5 CFU/100 mL. None of the measured concentrations exceed the MWQSOG (200 CFU/100 mL).
- The TP concentrations have ranged from 0.125 to 2.71 mg/L with an average of 0.435 mg/L. With the exception of the samples collecting during January 2009 (1.04 mg/L) and July 2009 (1.57 and 2.71 mg/L) all of the measured concentrations were below the MWQSOG (1 mg/L).
- The pH values have ranged from 7.62 to 9.43 pH units with an average of 8.38 pH units. With the exception of the samples collected during July 2006 (9.43 pH units) and October 2012 (9.28 pH units) all of the measured values were within the MWQSOG (6.5 to 9 pH units).

3.5 FISH AND FISH HABITAT

As part of the 2013 environmental assessment for the lagoon expansion, Mr. Wade Biggin of Manitoba SD, Fisheries Branch, conducted a review of the FIHCS species information for the water bodies in the project area and provided a copy of species recorded (Appendix C) [(8)]. There are 48 fish species reportedly present in the Souris River, although only five species are considered common including: black bullhead, brook stickleback, carp, common shiner and fathead minnow. The remaining 43 species are categorized as having presence "unknown" which means the observation was either based on someone indicating verbally that they had observed the species or the species was noted in a report, although there are not enough reports for the species to be listed as common. While the bigmouth shiner (unknown presence) is considered provincially uncommon (S3; 21 to 100 occurrences), none of the species reportedly present are provincially rare or very rare or protected under the federal Species at Risk Act [(9)].

3.6 WILDLIFE, HABITAT AND VEGETATION

The project is located within the Oak Lake Ecodistrict of the Aspen Parkland Ecoregion and Prairie Ecozone. Historically, the area largely supported mixed and short grass prairie vegetation and meadow grasses with trembling aspen and shrubs occurring in moist areas, although most of the natural vegetation has been disturbed through cultivation and grazing [(2)]. The vegetation in and around the project is predominantly agriculture crops (cereal grains, oil seeds and hay crops), with riparian vegetation growing along the Souris River. The riparian vegetation consists of tree species such as American elm, Manitoba maple and willows, while the understorey shows evidence of disturbance being a mix of agricultural grasses and weed species including smooth brome, Canada thistle and burdock.

Terrestrial and avian wildlife and reptile/amphibian species typical of the Aspen Parkland Ecoregion include terrestrial species such as white-tail deer, coyote, red fox, ground squirrel, cottontail rabbit, hare, striped skunk, redback vole and deer mice. Avian species may include ferruginous hawk, sparrow hawk, red-tailed hawk, mourning dove, black-billed magpie, red-winged blackbird, killdeer, meadowlark and various species of ducks. Reptile and amphibian species may include: red-sided and western plains garter snakes and various frogs and toads.

As the subject properties are already disturbed by agriculture they do not provide any significant wildlife cover and it is unlikely that any wildlife sensitive to human disturbance would be present.

The Manitoba Conservation Data Centre (CDC) has developed a list of 126 vegetation and 46 vertebrate animal species of conservation concern that have been documented within the Aspen Parkland ecoregion [(10)]. Most of the listed species are globally secure and abundant, but in Manitoba some are rare and may be vulnerable to extirpation. Mr. Chris Friesen of Manitoba SD, CDC was consulted regarding rare species in the project area and he found three occurrences (Appendix C) [(11)]. Those species identified include the northern leopard frog on NE36-3-27W, the chestnut-collared longspur on SE26-3-27W and the great plains toad on SE26-3-27W and SW26-3-27W. The northern leopard frog is provincially ranked S4 and not listed under *The Endangered Species and Ecosystems Act* (ESEA), but is listed as Special Concern under the *Species at Risk Act* (SARA) and by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). The chestnut-collared longspur is provincially ranked S2B and listed as Endangered under ESEA and considered Threatened by both SARA and COSEWIC. The great plains toad is provincially ranked S2 and listed as Threatened under ESEA and considered Special Concern under both SARA and COSEWIC.

The northern leopard frog remains widespread but is of special concern as it has experienced a considerable contraction of range and the loss of populations in the past, particularly in the west [(12)]. This has been accompanied by increased isolation of remaining populations, which fluctuate widely in size, with some showing signs of recovery. The northern leopard frog uses a variety of habitats to meet its overwintering and breeding needs and in the summer is found in a wide variety of habitats, although the preferred habitat seems to be vegetation 15 to 30 cm tall that is relatively close to water [(12)]. Well-oxygenated waterbodies, such as streams or larger ponds that do not freeze solid are used for overwintering sites. Temporary ponds that often dry up in late summer that are typically 30 to 60 m in diameter, 1.5 to 2.0 m deep, located in an open area, with abundant emergent vegetation, and no fish are used for breeding sites. The species is adversely affected by habitat conversion, including wetland drainage and eutrophication, introduction of game fish, collecting, pesticide contamination and habitat fragmentation that curtails recolonization and rescue of declining populations. The proposed project will not alter any of the existing habitat area. A minimum 30 m buffer around waterbodies will provide a substantial area of habitat with emergent vegetation along the shorelines which

should mitigate any potential effects of the project on the northern leopard frog if present in the area.

The chestnut-collared longspur is a medium sized songbird [13] that faces threats from the loss and fragmentation of native prairie grassland. The bird, eggs and young are protected provincially under ESEA and federally under SARA and the 1994 *Migratory Birds Convention Act*. Chestnut-collared longspur breed in recently grazed or mowed, arid, short- or mixed-grass prairie. The species prefers short vegetation (< 20 to 30 cm high), but will breed in tall-grass prairie if it is grazed or mowed. Optimal grassland habitat in Canada for the chestnut-collared longspur is being fragmented by energy sector activity and other development and by land being converted to agricultural use. Females excavate and build a nest in the ground and lay 3-5 eggs which are then incubated for 10-12.5 days. The proposed biosolids application will not alter the existing land use or the properties. Additionally, conducting work outside of the breeding period and observing appropriate setbacks should mitigate any potential effects of the project on the chestnut-collared longspur if present in the area.

The great plains toad is a provincially Threatened amphibian, protected under ESEA, found in grasslands and dry brushy areas of the central plains, from southern Canada to central Mexico [14]. Great plains toads are generally found in dry, open grasslands. They require soft ground to burrow into during cold or dry periods. They breed primarily in temporary wetlands that only contain water in years with heavy spring or early summer rains. The edges of some permanent or semi-permanent wetlands may also be used. These shallow, clear pools are often in imperfectly drained, sandy areas in grasslands, pastures, ditches or agricultural fields and range in size from large wetlands to small puddles. The great plains toad is found from southern Manitoba, Saskatchewan and Alberta, south to central Mexico. They were found in high numbers in flooded agricultural fields near Melita in mid-May 1999. The great plains toad has been assigned a rank of rare to uncommon (S2S3) by the Manitoba CDC. Threats to the species include loss of habitat due to drainage of temporary pools preferred for breeding. However, its use of flooded agricultural fields suggests that it can handle a certain amount of disturbance and as previously noted the proposed project will not change the current land use practices. Application of pesticides and herbicides may also be a concern, given the sensitivity of amphibians to chemicals and pollutants. Roadkill by vehicles has been identified as a leading cause of mortality.

3.7 SOCIOECONOMIC

The town of Melita has a population of approximately 1,100 people and offers a number of amenities and developed infrastructure including schools, a hospital, a motel, a downtown business district, a swimming pool and golf course, and other public service facilities. A new hotel is under construction and an oilfield camp is proposed for the area.

The 2011 census indicates the population of Melita to be 1,069, a 1.7% increase over 2006 [(15)]. Approximately 64% of the total population (15 years and over) were in the labour force based [(16)]. The primary industry in Melita is agriculture with resource based industries accounting for approximately 19% of the experienced labour force, followed closely by health care and social services (14%) and educational services (11%), while retail trade, business services, construction, wholesale trade, finance/real estate and manufacturing each account for less than 10%.

3.8 HERITAGE RESOURCES

Ms. Heather McClean of the Manitoba department of Sport, Culture and Heritage, Historic Resources Branch examined Branch records and confirmed that there are no archaeological or heritage resources known to exist in the project area (Appendix C) [(17)].

4.0 LAND SUITABILITY

Biosolids are proposed to be applied to approximately 249 ha (616 acres) within portions of seven quarter sections south and west of Melita as shown in Figure 1. To determine whether the proposed lands are suitable to receive biosolid materials, a desktop study was conducted using the 1:20,000 scale provincial soil maps for the R.M. of Arthur. The assessment of the soils included a review of the dominant soil series, agricultural capability and nutrient management zone classes. Key components of the assessment are summarized in the following sections with the full report attached as Appendix B.

4.1 SOIL SERIES

Soils information for the land assessed for the application of biosolids is summarized in Table 1 providing the soil code, texture, drainage, agricultural capability, irrigation class, size and percent of area for each soil type within a quarter section. Information on the soil properties and agriculture capability indicate that the majority of the soils on the lands assessed are generally very productive under normal agriculture practices (mainly Class 2 and 3) and have minimal problems. These soils usually produce good yields of various crops including cereals and oilseeds. Approximately 5.2% of the assessed lands are rated as Class 5 and 6 and will be avoided when spreading the biosolids. Soil series descriptions are outlined in Table 2 and the codes for Tables 1 and 2 are described in Appendix C.

TABLE 1
DETAILED SOIL INFORMATION

Field	Soil	Texture	Drainage	Agri. Cap	Irrig. Class	General Rating	Acres	% by Area
E 1/2 36-03-27W1	NEI	Moderately Fine	Imperfect	3I	3w Bi	Fair	77	57
	LIG	Medium	Imperfect	3I	3w Bi	Fair	43	32
	LIG5 - GHM5	Medium	Poor	5WI	4w Ci	Poor	14	10
	TOTAL						**134**	
N 1/2 26-03-27W1	WKD	Medium	Well	2X	2kxA	Good	136	62
	NWS	Medium	Well	3M	2m A	Good	52	24
	HHY	Moderately Fine	Well	2X	2kxA	Good	17	8
	$ER xgxx	N/A	Rapid	6T	4 Dt2	Poor	7	3
	EBL	Medium	Poor	5W	4w A	Poor	7	3
	GGK	Moderately Coarse	Well	4M	2m A	Good	2	1
	TOTAL						**221**	
NW 25-03-27W1	LIG	Medium	Imperfect	3I	3w Bi	Fair	87	89
	NEI	Moderately Fine	Imperfect	3I	3w Bi	Fair	8	8
	GHM	Medium	Poor	5WI	4w Ci	Poor	2	2
	$ER xgxx	N/A	Rapid	6T	4 Dt2	Poor	1	1
	TOTAL						**98**	
S 1/2 26-03-27W1	NWS	Medium	Well	3M	2m A	Good	110	67
	MOT	Medium	Imperfect	2W	3w A	Fair	31	19
	HHY	Moderately Fine	Well	2X	2kxA	Good	21	13
	$ER xgxx	N/A	Rapid	6T	4 Dt2	Poor	1	1
	TOTAL						**163**	
	GRAND TOTAL						616	

TABLE 2
SOIL SERIES DESCRIPTIONS WITHIN PROJECT LANDS

Soil Name	Soil Code	Class	Texture	Particle Size	Drainage	Acres	Percent	Ag. Cap. Class
Eroded Slope Complex	$ER	xgxx	N/A	TX	Rapid	9	1	6T
Emblem	EBL	xxxx	L	LY	Poor	7	1	5W
George Lake	GGK	xxxx	FSL	CL/SS	Well	2	0	4M
Graham	GHM	xxxx	L	LY	Poor	9	1	5WI
Hathaway	HHY	xxxx	L-CL	FL	Well	38	6	2X
Liege	LIG	xxxx	L	LY	Imperfect	137	22	3I
Montgomery	MOT	xxxx	L	LY/FL	Imperfect	31	5	2W
Neelin	NEI	xxxx	CL-C	FL	Imperfect	85	14	3I
Newstead	NWS	xxxx	L	LY/SS/FL	Well	162	26	3M
Waskada	WKD	xxxx	L	LY/FL	Well	136	22	2X

4.2 SOIL CAPABILITY FOR AGRICULTURE

The *Nutrient Management Regulation* of the *Water Protection Act* (C.C.sMc W65, 2005) outlines nutrient application restrictions based on Canada Land Inventory (CLI) Soil Capability Classification for agriculture ratings. The CLI is a dry-land agriculture capability inventory for rural Canada. The CLI limitations are based on climate, geology, soil chemical and physical characteristics (salinity and structure), droughtiness, inundation, erosion, stoniness and landscape topography of the soils. The CLI groups mineral soils into seven classes with the same relative degree of limitation. Classes one to seven are based on increasing degree of limitation, the first three classes are capable of sustained cultivated crop production, class four is marginal for sustained arable cropping and class five is capable of pasture or hay, class six is capable of permanent pasture and class seven has no capability for arable crop or permanent pasture. There are thirteen different subclasses or limitations within the classes as described further in Section 4.2.1.

Soils rated 3I on properties E36-03-27W1 and NW25-03-27W1 (approximately 35% of assessed land) have the potential to be flooded by the Souris River in spring/heavy rainfall events every one in five years. A field visit conducted on July 19, 2016 noted standing water covering at least

25% of the fields due to excess moisture received during the 2016 growing season. The soils on those fields are still able to produce good crops and can benefit from biosolids application as long as they are injected beneath surface to minimize risk of nutrient loss during periods of inundation. The slope rating of the fields within the assessed land ranges between 0.4% and 1.6% and slope is not a limiting factor for biosolids application.

4.2.1 Agricultural Capability Class and Subclass Limitations

Agricultural capability Classes 1 to 3 are considered capable of sustained production of common field crops. The **bolded** descriptions below are limitations found within the lands that will receive biosolids application.

Class Limitations:

Class 1 - no important limitations for crop use.

Class 2 - moderate limitations that reduce the choice of crops or require moderate conservation practices.

Class 3 - moderate limitations that restrict the range of crops or require moderate conservation practices.

Class 4 - severe limitations that restrict the choice of crops or require special conservation practices or both.

Class 5 - severe limitations that restrict their capability to producing perennial forage crops.

Class 6 - capable only of producing perennial forage crops and improvement practices are not feasible.

Subclass Limitations:

E - Erosion: Includes soil where damage from erosion is a limitation.

I - Soils subjected to inundation by streams and lakes causing crop damage or restricting agricultural use.

M - Moisture limitation: soils where crops are adversely affected by droughtiness owing to inherent soil characteristics.

W - Excess water: Excess water from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.

C - Adverse climate: this subclass denotes a significant adverse climate for crop production.

D - Undesirable soil structure and/or low permeability.

F - Low fertility: this subclass is made up of soils having low fertility.

L - Coarse wood fragments: in the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.

N - Salinity: designates soils that are adversely affected by the presence of soluble salts.

P - Stoniness: this subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations.

R - Consolidated bedrock: this subclass includes soils which the presence of bedrock near the surface restricts their agricultural use.

T - Topography this subclass is made up of soils where topography is a limitation.

X - Cumulative minor adverse characteristics: this subclass consists of soils having a moderate limitation.

4.3 NUTRIENT MANAGEMENT AND BUFFER ZONES

The NMR outlines criteria for the application of nutrients (nitrogen and phosphorous) to agricultural land. The purpose of the NMR is to protect water quality by encouraging responsible nutrient planning, regulating the application of materials containing nutrients and restricting the development of certain types of facilities in environmentally sensitive areas [(18)] and limiting the application of fertilizer in proximity to certain areas.

The soil series, the associated CLI soil capability for agriculture class and subclass, and the water quality management zone within lands on which biosolids will be applied are summarized in Table 3.

TABLE 3
SOIL SERIES, CLI RATING AND WATER QUALITY MANAGEMENT ZONES

Soil Series	Agricultural Capability Class and Subclass	Water Quality Management Zone	% of Acres of Assessed Lands
Newstead	3M	N2	26
Liege	3I	N1	22
Waskada	2X	N1	22
Neelin	3I	N1	14
Hathaway	2X	N1	6
Montgomery	2W	N1	5
George Lake	4M	N2	0

The water quality management zone classification indicates the allowable limits for nitrogen application such that the residual concentration of Nitrate Nitrogen, within the top 0.6 m of soil, does not exceed these limits at any place within the application area. The nitrogen application limits within Zone N1 and Zone N2 for residual Nitrate Nitrogen at the end of the growing season are 157.1 kg/ha (140 lbs/acre) and 101 kg/ha (90 lbs/acre), respectively.

4.3.1 Potential Nitrate Leaching Index

The Potential Nitrate Leaching Index is a rating system to provide an indication of the possible and potential movement of nitrate-N from the surface layers of the soil to lower substrata or below the root zone (generally below 1 m) during periods of higher precipitation or during irrigation.

The rating is based on the infiltration rate or hydraulic conductivity and the ability of soil to hold moisture; indirectly these parameters are related to soil texture. For example, sand and gravels have a high hydraulic conductivity and low ability to hold moisture, therefore they would be rated as a high potential for nitrate-N leaching. On the opposite scale, clays have a low hydraulic conductivity, high moisture retention capacity, therefore they would be rated negligible or low rating for leaching potential.

According to the desktop analysis conducted by Tone Ag, the majority of field N½ 26-03-27W is rated as high for Potential Nitrate Leaching Index due to the fact that there are predominantly

sandy soils and a high water table across the field. This field would have a high potential for nitrate-N leaching under conditions favouring excess moisture. The wettest portion of the field with the agricultural Class 5W will be avoided, whereas the majority of the field is identified as agricultural Class 2X which places it in Water Quality Management Zone N1.

4.3.2 Buffer Zones

In order to minimise risk to the environment and human health, minimum setback distances (buffer zones) have been established in the NMR. The NMR also limits the application of any type of fertilizer: within three metres of rivers, streams, creeks, wetlands and storm water retention ponds; within 15 metres from lakes, reservoirs, springs and wells; within 15 metres of vulnerable rivers; and within 30 metres of vulnerable lakes [(19)].

5.0 PROPOSED BIOSOLID APPLICATION RATES

To determine a sustainable rate of application for the biosolid material, an analysis of its nutrient quality was conducted and samples from the primary and secondary lagoon cells were analyzed for nitrogen and phosphorus, salinity and trace metal composition (Appendix C).

5.1 NITROGEN AND PHOSPHORUS

The target biosolids application rates will be based on the targeted crop uptake and removal rates as well as soil fertility concentrations after crops have been removed from the fields this fall. Since the biosolids will be injected, nitrogen losses to the atmosphere will be minimal (<2%). The amount of N released from the mineralization of the organic N varies greatly depending on soil conditions and is difficult to accurately predict when it will become available. Generally, there is an assumption that 25% to 30% of the organic N portion of the biosolids will be in a plant available form in the first year after application. According to the Tone Ag report, the N:P ratio for the biosolids in the primary and secondary lagoon cells is 5.45:1 and 20.39:1, respectively. Crop removal for most crops (cereals and oilseeds) usually ranges from 3:1 to 4:1. Therefore, using an N based application rate, there will be no accumulation of P in the soils.

5.2 SALINITY

According to the biosolid analysis, the salinity in terms of electrical conductivity and sodium absorption ratio for the primary and secondary cells is well below previously reported averages and risks to crops due to salt in the biosolids is unlikely.

5.3 METALS

The application of heavy metals in Manitoba is restricted to limit the impact on the food chain. There are eight metals of concern for agricultural land in Manitoba: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. The cumulative weight of each metal is determined by measuring the background level in the soil prior to biosolid application and adding the calculated weight of the metal from the biosolid application. An analysis of the existing soil conditions has not yet been conducted and actual metal loading rates to the soil will be calculated once the soil test results are analyzed this fall.

5.4 PROPOSED APPLICATION RATES

The target biosolids application rates for the primary and secondary cells will be based on the nitrogen requirement of either a cereal or oilseed crop. According to the calculations performed by Tone Ag, the target N rate will be 190 lbs/acre in order to grow a 75 bushel wheat crop or 55 bushel canola crop (Appendix C). This will allow the biosolids to be spread evenly over the approximately 236 ha (584 acres) of appropriate parcels of the assessed land, avoiding areas having soils of Class 5 or Class 6.

Based on the target application rate outlined above, the lands proposed to receive biosolid material from the primary and secondary cells should be suitable as long as soil test phosphorus is below 120 ppm. Since there is no history of recent manure application on the proposed fields, the soil test results taken after harvest should be relatively low in P levels. Detailed soil analysis of each field will be provided to Manitoba SD for approval as soon as harvest is complete and prior to biosolids application.

6.0 POTENTIAL ENVIRONMENTAL EFFECTS ASSESSMENT

An environmental effect includes any change that the project may cause to the environment (biological, physical, social and economic). Environmental effects were identified from interactions between proposed project activities and environmental components. Considering the project consists of land application of biosolids to land already used for agricultural production, there will be no change to socio-economic components such as land use and public safety and therefore these are not discussed in the following sections. Mitigation measures and follow-up activities were identified for environmental effects determined to be adverse.

6.1 AIR QUALITY

Removal of the sludge from the lagoons and injecting it into the fields may result in temporary increased fugitive dust levels in the local area. Dust may be generated during sludge removal and distribution activities as well as from vehicles and farm equipment using gravel roads. It is unlikely that Manitoba's air quality guidelines would be exceeded during these activities and any effects would be very short term. Therefore the potential adverse effects on air quality were assessed to be minor. The effects may be mitigated by using an approved dust suppressant such as water, controlling vehicle speeds and limiting activities during high wind events.

Increased levels of greenhouse gases and vehicle emissions may result from transporting biosolids from the lagoon to the field sites, application of the biosolids and natural decomposition of land applied organic matter in the soil. Over the course of the project, it is anticipated that fuel will be transported to the site using a fueling truck in order to fuel equipment on-site. The potential adverse effects on air quality in the local area were assessed to be minor and short term in duration. However, proposed mitigation measures include requiring a high standard of maintenance for equipment and vehicles, limiting unnecessary long-term idling, using low sulphur-containing fuels, using appropriate dispensing equipment and limiting fuelling of equipment and vehicles. Land application of biosolids is beneficial as it may reduce fertilizer use and results in the storage of carbon in the soil, thereby minimizing greenhouse gas (GHG) emissions to the atmosphere. It is also beneficial since placing the biosolids in a landfill would contribute to methane emissions [(20)]. These benefits are expected to offset the potential emissions from machinery used during the land application program.

6.2 SOILS

Soils in the project area may become contaminated from leaks and accidental spills or releases of fuels or other hazardous substances and waste. The potential adverse effects on soil quality were assessed to be minor to moderate. Proposed mitigation includes preventing leaks, spills and releases by providing secondary containment for fuel storage, requiring drip trays for equipment, providing fuel handling training for operators, providing spill clean-up equipment and materials, complying with provincial fuel storage and dispensing regulations, storing hazardous materials in approved containers, providing an emergency (spill) response plan and periodic inspection for leaks, spills and releases. If a spill should occur the contractor would be responsible to notify Manitoba SD Emergency Response Program (204-944-4888) and the appropriate clean-up would be determined according to the size of spill and quantity of contamination. Small spills could be treated on site with regular working of the soil to aerate. Larger spills, however, would be assessed and delineated following Phase III Environmental Site Assessment standards and a remediation program would be developed to ensure that the site is cleaned to meet Manitoba SD soil remediation criteria.

Soils in the area may be subjected to increased levels of nutrients and metals from the application of the biosolids. The land suitability assessment indicates that the lands proposed for biosolid application are appropriate for the purpose. Since there is no history of recent manure application on these fields, the soil test results taken after harvest should be relatively low in P levels and crops grown on the land will benefit from the application. As such the proposed application of biosolids will have a positive effect by improving the soil matrix. Detailed soil analysis of each field will be provided to Manitoba SD, as soon as harvest is complete, for approval prior to biosolids application this fall. No further mitigation measures are proposed.

6.3 GROUNDWATER

Groundwater in the project area may become contaminated during biosolids removal from the lagoon and field application from leaks, accidental spills, or releases of fuels or other hazardous substances. Groundwater quality at the site has not been tested for hydrocarbons. The potential adverse effects on groundwater quality were assessed to be minor to moderate. Proposed mitigation includes preventing leaks, spills and releases by providing secondary containment for

fuel storage, requiring drip trays for equipment, providing fuel handling training for operators, providing spill clean-up equipment and materials, complying with provincial fuel storage and dispensing regulations, storing hazardous materials in approved containers, providing an emergency (spill) response plan and periodic inspection for leaks, spills and releases.

Groundwater in the project area may become contaminated from the application of biosolids to the fields and potential movement of nitrogen and phosphorus. The water table on property N½ 26-03-27 W1 is relatively high and one part of the field is Class 5W. In order to minimise risk to the environment and human health, appropriate buffer zones will be established around the area having Class 5W and around residences and groundwater features (wells, surface drainage, etc.). The potential adverse effects on groundwater quality were assessed to be minor to moderate. Proposed mitigation includes application of the biosolids at agronomically appropriate rates for nitrogen and phosphorous to ensure plant uptake of these nutrients over the growing season, thereby further minimizing the potential of leaching to the groundwater. Injection of the biosolid material will minimize the potential of overland flow to groundwater wells.

6.4 SURFACE WATER

Surface water in the project area may become contaminated during construction from leaks and accidental spills or releases of fuels or other hazardous substances. The potential adverse effects on water quality were assessed to be minor to moderate. Proposed mitigation includes preventing leaks, spills and releases by providing secondary containment for fuel storage, requiring drip trays for equipment, providing fuel handling training for operators, providing spill clean-up equipment and materials, complying with provincial fuel storage and dispensing regulations, storing hazardous materials in approved containers, providing an emergency (spill) response plan and periodic inspection for leaks, spills and releases.

Surface water may be potentially impacted associated with nutrient loading from surface runoff from the fields where biosolids are applied. Specifically, Graham Creek is adjacent the field in NE-36-03-27 W1 and the Souris River is adjacent the E½ 36-03-27 W1 and NW-25-03-27 W1 and these fields as previously noted are periodically subject to flooding. The potential impact to surface water was assessed as minor, however, as biosolids material will be injected into the

soil and applied at agronomically appropriate rates and adhering to required buffer zones, consistent with the NMR, thereby minimizing the potential of overland flow to the Souris River or Graham Creek.

6.5 FISH AND FISH HABITAT LOSS

Application of the biosolids will disturb the agricultural fields and can result in wind-carried dust and exposed soils that are more easily carried away with surface water run-off, which may increase nutrient loading and sedimentation to nearby water bodies. Dredging of the lagoon will be occurring within approximately 25 m of the Souris River and land application of the biosolids to E½ 36-03-27 W1 and NW-25-03-27 W1 will be adjacent the river. As such, suspended sediment levels may become temporarily elevated if exposed soil is carried into the river with surface water runoff, particularly after major precipitation events. Elevated levels of suspended sediment can reduce water quality, which may interfere with fish spawning, navigation, and the ability to locate food and escape predators. Settling suspended particles can potentially smother and kill fish eggs or larvae. The potential adverse effects were assessed to be minor. Proposed mitigation includes minimizing dust levels by using a dust suppressant such as water, limiting activities during high wind events and minimizing disturbance to the riparian vegetation along watercourses that will act as a buffer to prevent sediment run-off.

6.6 WILDLIFE, HABITAT AND VEGETATION

Land application of the biosolids will be undertaken on properties that are already used in agricultural production with no additional vegetation clearing required. The project is consistent with this current land use and is not expected to disturb any native vegetation and habitat and therefore it is unlikely that any wildlife sensitive to human disturbance would be present. The Manitoba CDC did not identify any vegetation of conservation concern on lands proposed for biosolids application, however, the northern leopard frog, the chestnut-collared longspur and the Great Plains toad were noted. The proposed project will not alter any existing northern leopard frog habitat and is unlikely to affect the chestnut-collared longspur habitat, as described in Section 3.6. While the Great Plains toad may occur in agricultural fields the proposed project will not change the current land use practices. As such the potential impacts of the project were assessed as minor. Mitigation measures proposed include minimizing the loss and disturbance

of vegetation, limiting construction activities to designated areas, providing wildlife awareness information to equipment operators, following wildlife timing windows to avoid breeding bird season and adhering to speed limits. In particular the setback distances developed by the CDC for chestnut-collared longspur nest sites of 100, 250 and 650 m for low, medium and high disturbance activities will be adhered to during the May 1 to August 15 restricted activity period [(21)].

6.7 EMPLOYMENT/ECONOMY

The application of biosolids to agricultural land provides a positive economic benefit to both the farm producers and the Town of Melita. The objective of providing prescription application rates for biosolids to crop specifics is to provide an organic source for nutrient management. Biosolids provide macro nutrients (nitrogen, phosphorous, potassium, and sulfur) and micro-nutrients (boron, copper, iron, chloride, manganese, molybdenum and zinc), all of which provide economic value to the farm producer. The biosolid material is being provided at no charge to the farm producer, thus reducing the cost to fertilize the subject properties and will provide an economic benefit to the farm producer. As the potential effects of the project on employment and economy were assessed as positive, no mitigation or follow-up has been proposed.

6.8 HUMAN HEALTH AND WELL-BEING

Soil, surface water and groundwater in the project area may become contaminated during project activities, as previously noted, from leaks and accidental spills or releases of fuels or other hazardous substances, which could adversely affect human health. The potential adverse effects of the project on human health were assessed to be minor. Proposed mitigation measures include preventing leaks, spills and releases by providing secondary containment for fuel storage, requiring drip trays for equipment, providing spill clean-up equipment and materials, providing fuel handling training for operators, complying with provincial fuel storage and dispensing regulations, storing hazardous materials in approved containers, and providing an emergency (spill) response plan.

Biological pathogens such as *E. coli* and fecal coliforms as well as nuisance odour associated with land application of biosolids may be considered to pose a public health and safety risk. The

potential hazard to human health and well-being was assessed as minor. Proposed mitigation includes application of the biosolid materials onto private lands that have restricted public access and injection of the biosolid material which will minimize odour and eliminate human exposure to pathogens. Pathogens from biosolids are often killed by exposure to sunlight, drying conditions, unfavorable pH and other macro and micro environmental conditions. Lands that receive biosolid material will also be managed on a crop rotation system for three years that includes non-root/vegetable crops which have been found to pose a minimal human health risk as uptake, removal and accumulation of heavy metals by the harvested portions of crops is minimal. In order to minimize risk to human health and safety and control odour from the application of biosolid materials, buffer zones will be established around residential areas, residences, groundwater wells and surface water drainage systems in accordance with the NMR [(19)].

6.9 HERITAGE RESOURCES

Ms. Heather McClean of Manitoba Culture, Heritage, and Tourism, Historic Resources Branch examined Branch records and confirmed that there are no known archaeological or heritage resources known to exist in the project area. Additionally the fields are already disturbed from existing agricultural land use. Therefore the potential for the project to impact archaeological or heritage resources is considered negligible and no specific mitigation measures or follow-up are proposed.

7.0 STATEMENTS OF LIMITATIONS AND CONDITIONS

7.1 THIRD PARTY USE OF REPORT

This report has been prepared for the Manitoba Water Services Board to whom this report has been addressed and any use a third party makes of this report, or any reliance on or decisions made based on it, are the responsibility of such third parties. KGS Group accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions undertaken based on this report.

7.2 GEO-ENVIRONMENTAL STATEMENT OF LIMITATIONS

KGS Group prepared the geo-environmental conclusions and recommendations for this report in a professional manner using the degree of skill and care exercised for similar projects under similar conditions by reputable and competent environmental consultants. The information contained in this report is based on the information that was made available to KGS Group during the investigation and upon the services described, which were performed within the time and budgetary requirements of the Manitoba Water Services Board. As the report is based on the available information, some of its conclusions could be different if the information upon which it is based is determined to be false, inaccurate or contradicted by additional information. KGS Group makes no representation concerning the legal significance of its findings or the value of the property investigated.

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FIGURES

TOWN OF MELITA

445

83

3

3

SOURIS RIVER

54 HA (134 ACRES)

NE-36-03-27 W

SE-36-03-27 W

MELITA WASTEWATER TREATMENT LAGOONS

GRAHAM CREEK

89 HA (220 ACRES)

NW-26-03-27 W

NE-26-03-27 W

40 HA (98 ACRES)

NW-25-03-27 W

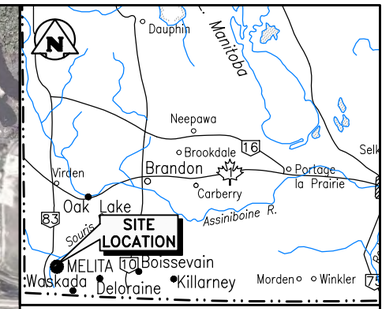
SOURIS RIVER

66 HA (163 ACRES)

SW-26-03-27 W

SE-26-03-27 W

3



KEY MAP

LEGEND:

QUARTER SECTION

PROPOSED PROJECT PROPERTY LIMITS (APPROXIMATE)

REFERENCE:

1. IMAGES FROM GOOGLE EARTH JUNE 2013.

250 0 250 500m

SCALE: 1:15000 METRIC (11x17)

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	16/08/11	ISSUED WITH FINAL REPORT	GS	SFM

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

MANITOBA WATER SERVICES BOARD

LAND APPLICATION OF BIOSOLIDS
ENVIRONMENTAL ACT PROPOSAL
MELITA, MB

SITE PLAN

AUGUST 2016 | FIGURE 01 | REV: 0

FileName: \\k-file-4\p-dgto\Projects\2016\16-0429-004\Dwg\Geo\16-0429-004_F01.dwg - Tab: F01 Plotted By: rmeilleur 16/08/11 [Thu 11:22am]
11"x17" PLOT SCALE: 1"=2"

APPENDICES

APPENDIX A

CERTIFICATES OF TITLE AND LANDOWNER AGREEMENTS

Note:

Certificates of Title and Landowner Agreements will be provided by the Town of Melita as an addendum.

APPENDIX B

LAND SUITABILITY ASSESSMENT AND PROPOSED BIOSOLIDS APPLICATION RATE

Town of Melita – Biosolids Application on Agricultural Land

Land Suitability Assessment & Proposed Biosolids Application Rate

Prepared For:

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Land Suitability Assessment

4 Soils

The parcels of land that are in the proposed project area (PPA) consist of approximately 611 acres (4 parcels). The location of the parcels is shown in Appendix 1, Figure 1.

In order to determine the suitability of the parcels to receive biosolids, a desktop study was conducted using the provincial soil maps for the R.M. of Arthur. These soils were mapped at a scale of 1:20 000. This was done in order to review the soil profile, agricultural capability, potential environmental impact, and agronomic practices conducted in the PPA.

- The soils map used for this assessment was derived from the Canada-Manitoba Soil Survey Report No. 20 - Soils of the Boissevain – Melita Area (Eilers, Hopkins and Smith, 1978).

4. 1 Soil Series Information

Soils information for each soil code and features for each parcel of land proposed for the application of biosolids was summarized to show the texture, soil drainage, agricultural capability, and extent and percent of area (Table 1). Information on the soil properties and agriculture capability indicates that the majority of the soils in the PPA are generally very productive under normal agriculture practices (mainly Class 2 and 3) and have minimal problems (Appendix 1, Figure 2). These soils usually produce good yields of various crops including cereals and oilseeds. Less than 3% (32 acres) of the PPA is rated as Class 5 and 6 (Eroded Slopes) and will be avoided when spreading, leaving 584 eligible acres (Appendix 1, Figure 2).

Table 1 – Soil Series and Extent of Acres within PPA

Field	Soil	Texture	Drainage	Agri. Cap	Irrig. Class	General Rating	Acres	% by Area
M-01 E 1/2 36-03-27 W1	NEI	Moderately Fine	Imperfect	3I	3w Bi	Fair	77	57
	LIG	Medium	Imperfect	3I	3w Bi	Fair	43	32
	LIG5 - GHM5	Medium	Poor	5WI	4w Ci	Poor	14	10
	TOTAL						**134**	
M-02 N 1/2 26-03-27 W1	WKD	Medium	Well	2X	2kxA	Good	136	62
	NWS	Medium	Well	3M	2m A	Good	52	24
	HHY	Moderately Fine	Well	2X	2kxA	Good	17	8
	$ER xgxx	N/A	Rapid	6T	4 Dt2	Poor	7	3
	EBL	Medium	Poor	5W	4w A	Poor	7	3
	GGK	Moderately Coarse	Well	4M	2m A	Good	2	1
	TOTAL						**221**	
M-03 NW 25-03-27 W1	LIG	Medium	Imperfect	3I	3w Bi	Fair	87	89
	NEI	Moderately Fine	Imperfect	3I	3w Bi	Fair	8	8
	GHM	Medium	Poor	5WI	4w Ci	Poor	2	2
	$ER xgxx	N/A	Rapid	6T	4 Dt2	Poor	1	1
	TOTAL						**98**	
M-04 S 1/2 26-03-27 W1	NWS	Medium	Well	3M	2m A	Good	110	67
	MOT	Medium	Imperfect	2W	3w A	Fair	31	19
	HHY	Moderately Fine	Well	2X	2kxA	Good	21	13
	$ER xgxx	N/A	Rapid	6T	4 Dt2	Poor	1	1
	TOTAL						**163**	
	GRAND TOTAL						616	

Where there is more than one soil in the map unit, Agricultural Capability, Irrigation Class, General Rating, and Suitability for Biosolids Application were determined by the worst of the soils, unless the soil made up less than 30% of the map unit.

Table 2 – Soil Series Descriptions within PPA

Soil Code	Modifier	Class	Soil Name	Texture	Particle Size	Drainage	Acres	Percent	Ag. Cap. Class
$ER		xgxx	Eroded Slope Complex	N/A	TX	Rapid	9	1	6T
EBL		xxxx	Emblem	L	LY	Poor	7	1	5W
GGK		xxxx	George Lake	FSL	CL/SS	Well	2	0	4M
GHM		xxxx	Graham	L	LY	Poor	9	1	5WI
HHY		xxxx	Hathaway	L-CL	FL	Well	38	6	2X
LIG		xxxx	Liege	L	LY	Imperfect	137	22	3I
MOT		xxxx	Montgomery	L	LY/FL	Imperfect	31	5	2W
NEI		xxxx	Neelin	CL-C	FL	Imperfect	85	14	3I
NWS		xxxx	Newstead	L	LY/SS/FL	Well	162	26	3M
WKD		xxxx	Waskada	L	LY/FL	Well	136	22	2X

$ER, EBL and GHM soils will be avoided when spreading biosolids (32 acres out of the 616 acres of the PPA).
More information in Texture and Particle Size can be seen in Tables 12 and 13 in Appendix 2.

Table 3 – Soil Profile Information within PPA

ORDER	GREAT GROUP	SUBGROUP	SOIL SERIES DESCRIPTION
Chernozemic Soils with surface horizons darkened by organic matter accumulation. A chernozemic A horizon must be at least 10 cm thick and be dark in colour.	Black	Orthic Black	**George Lake (GGK)** developed on thin (25 to 100 cm), weakly to moderately calcareous, moderately coarse textured (VFS, LVFS, FSL), lacustrine sediments overlying coarse textured, deltaic, beach and out-wash deposits. This soil has a loamy very fine sand surface texture, very gently sloping, complex topography, good drainage, rapid permeability and low surface runoff. This soil is non-saline, non-stony and usually cultivated.
			Newstead (NWS) developed on thin (25 to 95 cm), strongly calcareous, medium to moderately fine textured lacustrine sediments overlying strongly calcareous, medium to moderately fine textured glacial till. Newstead soils commonly have loam to fine sandy loam surface textures, gently sloping to very gently sloping topography; moderate permeability and slow surface runoff.
			Waskada (WKD) developed on thin (< 1 m) (< 3.28 ft), strongly calcareous, loamy (L, CL, SiCL) lacustrine sediments overlying strongly calcareous, loamy glacial till. These soils have complex, gently sloping topography, moderately good drainage, loam to clay loam surface texture, moderate permeability and moderate surface runoff. The depth to water table is estimated to (3 m) (10 ft) during the growing season.
		Rego Black	**Hathaway (HHY)** developed on deep, strongly calcareous, medium to moderately fine textured glacial till. These soils have a loam to clay loam surface texture, gently undulating topography, moderate permeability and rapid surface runoff.
Regosolic Weekly developed soils that lack a recognizable B horizon (< 5 cm thick).	Black	Gleyed Rego Black	**Liege (LIG)** developed on deep, moderately calcareous, loamy alluvial sediments. These soils generally have a silt loam to very fine sandy loam surface texture, nearly level to gently undulating topography, moderate permeability and moderate surface runoff. The drainage is imperfect and the estimated depth to water table is (< 2 m) (<6.56 ft).

ORDER	GREAT GROUP	SUBGROUP	SOIL SERIES DESCRIPTION
Regosolic	Black	Gleyed Rego Black	**Montgomery (MOT)** developed on thin (25 to 100 cm) (10 to 40 in), strongly calcareous, medium textured, discontinuous aeolian and lacustrine sediments overlying strongly calcareous medium to moderately fine textured glacial till. This soil has a fine sandy loam surface texture, gently sloping to depressional topography, moderate permeability and moderate surface runoff. This soil has an estimated depth to water table within (2 m) (6.56 ft) and is imperfectly drained.
			Neelin (NEI) developed on deep, moderately calcareous, fine loamy to clayey recent fluvial sediments. The topography is level to depressional, surface runoff is very slow, and permeability is slow. The depth to water table is estimated at (2 to 3 m) (6.56 to 9.84 ft).
Gleysolic Poorly drained soils that have undergone prolonged periods of intermittent or continuous saturation with water that results in gleying and dull colours and mottling.	Humic Gleysol	Rego Humic	**Emblem (EBL)** developed on strongly calcareous, loamy lacustrine sediments. These soils occur on lower slope to depressional topographic positions in very gently sloping to undulating landscapes and along meandering drainage channels. Poorly drained.
			Graham (GHM) developed on deep, moderately calcareous, medium textured, recent alluvial sediments. Graham soils, have complex gently undulating topography, a silt loam surface texture, slow permeability and very slow surface runoff.

Source: Manitoba Agriculture, 2010.

4. 2 Soil Capability

The Water Protection Act (C.C.sMc W65, 2005) Nutrient Management Regulation (62/2008) outlines nutrient application restrictions based on Canada Land Inventory (CLI) Soil Capability Classification for agriculture ratings. There are seven classes and thirteen subclasses for mineral soils with limitations to crop production based on climate, geology, soil chemical and physical characteristics, droughtiness, inundation, erosion, stoniness, and landscape topography of the soils (MMM Group, 2013).

The following are a description of the classes and subclasses for mineral soils found in Manitoba. The **bolded** descriptions are limitations found within the areas that will receive biosolids application within the PPA:

Soils rated 3I (36% of PPA) in fields M-01 and M-03 may have the potential to be flooded from nearby Souris River in spring/heavy rainfall events every one in five years. A recent field visit was done to these fields on July 19, 2016 and there was standing water covering at least 25% of the fields due to excess moisture received during this year's growing season. Even though these two fields are poor choices and not ideal, these soils are still able to produce good crops and can benefit from biosolids application as long as they are injected beneath surface to minimize risk of nutrient loss during periods of inundation.

The slope rating of the fields within the PPA range between 0.4% and 1.6% and is not a limiting factor for biosolids application.

AGRICULTURAL CAPABILITY SUBCLASS LIMITATIONS

The first three classes are considered capable of sustained production of common field crops.
Class 1 - no important limitations for crop use.
Class 2 - moderate limitations that reduce the choice of crops or require moderate conservation practices.
Class 3 - moderate limitations that restrict the range of crops or require moderate conservation practices.
Class 4 - severe limitations that restrict the choice of crops or require special conservation practices or both.
Class 5 - severe limitations that restrict their capability to producing perennial forage crops.
Class 6 - capable only of producing perennial forage crops and improvement practices are not feasible.

AGRICULTURAL CAPABILITY SUBCLASS LIMITATIONS

E - Erosion: Includes soil where damage from erosion is a limitation.
I - Soils subjected to inundation by streams and lakes causing crop damage or restricting agricultural use.
M - Moisture limitation: soils where crops are adversely affected by droughtiness owing to inherent soil characteristics.
W - Excess water: Excess water from inadequate soil drainage, a high water table, seepage or runoff from surrounding areas.
C - Adverse climate: this subclass denotes a significant adverse climate for crop production.
D - Undesirable soil structure and/or low permeability.
F - Low fertility: this subclass is made up of soils having low fertility.
L - Coarse wood fragments: in the rating of organic soils, woody inclusions in the form of trunks, stumps and branches (>10 cm diameter) in sufficient quantity to significantly hinder tillage, planting and harvesting operations.
N - Salinity: designates soils that are adversely affected by the presence of soluble salts.

P - Stoniness: this subclass is made up of soils sufficiently stony to significantly hinder tillage, planting, and harvesting operations.
R - Consolidated bedrock: this subclass includes soils which the presence of bedrock near the surface restricts their agricultural use.
T - Topography this subclass is made up of soils where topography is a limitation.
X - Cumulative minor adverse characteristics: this subclass consists of soils having a moderate limitation.

4. 3 Nutrient Management and Potential Environmental Impacts within PPA

The Water Protection Act (C.C.sMc W65, 2005) Nutrient Management Regulation (62/2008) outline criteria for the application of nutrients (nitrogen and phosphorus) to agricultural land. The purpose of the NMR is to protect water quality by encouraging responsible nutrient planning and application. The objective is to regulate the application of substances (livestock manure, biosolids, etc.) containing nitrogen or phosphorus to land in a proactive and protective manner for sensitive water bodies and/or groundwater (Manitoba Water Stewardship, 2008).

Table 4 below outlines the soil series, CLI rating, and Water Quality Management Zone within the PPA:

Table 4 – Soil Series, CLI Rating, and Water Quality Management Zone within PPA

Soils Series	Ag Capability Class and Subclass	Water Quality Management Zone	% of Acres in PPA
Emblem	5W	N3	1
George Lake	4M	N2	0
Graham	5WI	N3	1
Hathaway	2X	N1	6
Liege	3I	N1	22
Montgomery	2W	N1	5
Neelin	3I	N1	14
Newstead	3M	N2	26
Waskada	2X	N1	22

The Water Quality Management Zone nitrogen application limits are in shown in Table 5.

Table 5 – Nitrogen Limits (0-60cm)

Ag Capability Class	Water Quality Management Zone	Residual Limit of Nitrate Nitrogen (lbs./ac) at end of growing season	Residual Limit of Nitrate Nitrogen (lbs./ac) during growing season
1,2,3 (except 3M or 3MW)	N1	140 (157.1 kg/ha)	280 (314.2 kg/ha)
3M, 3MW, 4	N2	90 (101 kg/ha)	180 (202 kg/ha)
5	N3	30 (33.6 kg/ha)	60 (67.2 kg/ha)

New regulations came into effect on November 10, 2013 restricting the amount of allowable phosphorous in the soil. Fields with soil P levels > 60 ppm (120 lbs/acre) are to be applied on the basis of crop removal of P in zones between N1 and N3. 60-120 ppm equals 2X crop P removal and 120-180 ppm equals 1x crop P removal application rates. Fields with P between 60 and 180 ppm can have up to 5 years' worth of P applied to them, but then the field cannot be manured again during that period unless soil test P is reduced below the original levels. Fields with soil P levels > 180 ppm (360 lbs/acre) cannot have manure applied to them.

Potential Environmental Impact (PEI)

Four degrees of risk are used when evaluating soils for environmental impact: Minimal, Low, Moderate, and High.

Six factors are considered in determining potential environmental impact.
1) **Soil texture** is a description of the relative proportions of fine and coarse particles that make up the soil.
2) **Geological Uniformity** considers the thickness of soil layers and the mixtures of different soil types and textures.
3) **Hydraulic Conductivity** measures the soil's ability of transmit water and leachate either vertically or horizontally.
4) Soils with a shallow **depth to water table** have a greater risk of contamination than soils with a deep water table.
5) High levels of **salinity** may affect groundwater due to leaching of the salts.
6) **Topography**, or slope, is also a consideration as risk of runoff, local flooding, buildup of water tables, and soil erosion increases with slope gradient.

Adapted from Soils of the Rural Municipality of Louise, D83. Manitoba Soil Resource, 1998, p. 77.

The PEI on the various parcels of land is provided in Table 6.

Potential Nitrate Leaching Index (PNLI)

The PNLI is a rating system to provide an indication of the possible and potential movement of nitrate-N from the surface layers of the soil to the lower substrata or below the root zone (generally below 1 m) during periods of higher precipitation or during irrigation.

The rating is based on the infiltration rate or hydraulic conductivity and the ability of soil to hold moisture; indirectly these parameters are related to soil texture. For example, sand and gravels have a high hydraulic conductivity and low ability to hold moisture, therefore they would be rated as a high potential for nitrate-N leaching. On the opposite scale, clays have a low hydraulic conductivity, high moisture retention capacity, therefore they would be rated negligible or low rating for leaching potential.

Soil texture groupings as provided for the Potential Environmental Impact Rating (PEI) (as referenced in the Land Resource Unit for Roland, 1999) have been used mainly used to rate the soils in the PPA. The soils in each quarter (Table 5) were used to determine the range in the soil textures. Soils, which had the dominant and subdominant distribution, were chosen and the particle size class was assigned. The particle size class was then interpreted for PNLI. For the PNLI rating, the following classes were used: N for negligible, L for low, M for moderate, and H for high. The PNLI for the parcels in the PPA are provided in Table 6. Note that the ratings are similar to the PEI ratings.

The majority of field M-02 is rated as high for PEI as well as PNLI due to the fact that there are predominantly sandy soils and a high water table across the field. This field would have a high potential for nitrate-N leaching under conditions favouring excess moisture.

Table 6 – Potential Nitrogen Leaching Index

Field	Legal Description	Particle Size	Potential Environmental Impact	Potential Nitrogen Leaching Index (PNLI)
M-01	E 1/2 36-03-27 W1	LY/FL	Low	Low
M-02	N 1/2 26-03-27 W1	LY/SS/FL	High	High
M-03	NW 25-03-27 W1	LY/FL	Low	Low
M-04	S 1/2 26-03-27 W1	LY/SS/FL	Moderate	Moderate

Buffer Zones

In order to minimise risk to the environment and human health, minimum setbacks distances (buffer zones) have been established in the Nutrient Management Regulation (62/2008) under the Water Protection Act (C.C.S.M. c. W65). Buffer zones around groundwater features (wells, surface drainage, etc.) will be established with recommended setback distances as outlined in Table 7 below.

Table 7 – Nutrient Buffer Zones for Manure/Biosolids Application

Water Body	Setback if applicable area is covered with permanent vegetation (Column A)	Setback if applicable area is not covered with permanent vegetation (Column B)
• a roadside ditch or an Order 1 or 2 drain†	No direct application to ditches and Order 1 and 2 drains	
• a groundwater feature	15 m (49 ft)	20 m (66 ft)
• a wetland, bog, marsh or swamp other than a major wetland, bog, marsh or swamp‡	Distance between the water's edge and the high water mark	
• a lake or reservoir designated as vulnerable**	30 m (98 ft)	35 m (115 ft)
• a lake or reservoir (not including a constructed stormwater retention pond) not designated as vulnerable** • a river, creek or stream designated as vulnerable**	15 m (49 ft)	20 m (66 ft)
• a river, creek or stream not designated as vulnerable** • an Order 3 or higher drain† • a major wetland, bog, marsh or swamp‡ • a constructed stormwater retention pond	3 m (10 ft)	8 m (26 ft)

*Nutrient Buffer Zone is measured from the water body's high water mark or the top of the outermost bank on that side of the waterbody, whichever is further from the water.

†Designated on a Manitoba Water Stewardship plan that shows the designation of drains.

‡As defined in 1(2) in the Nutrient Management Regulation under The Water Protection Act. "For the purposes of this regulation, a wetland, bog, marsh or swamp is major if:

- it has an area greater than 2 ha (4.94 acres)
- it is connected to one or more downstream water bodies or groundwater features; and
- it contains standing water or saturated soils for periods of time sufficient to support the development of hydrophytic vegetation."

**Designated as vulnerable if listed in the Schedule in the Nutrient Management Regulation under the Water Protection Act.

Source: Manitoba Sustainable Development, 2016.

4. 4 Agronomic Practices with PPA

Fields within the PPA have the potential to grow a variety of crops including cereals, oilseeds, soybeans and grasses. Inundation (flooding) is the most limiting factor in crop production on fields M-01 and M-03. Moisture limitations, especially in drier years, are the most limiting factors on fields M-02 and M-04. These fields can benefit from the application of biosolids that will help to improve soil organic matter and soil structure. It will also provide a source of macro and micronutrients to increase crop productivity and yield potential for future crop years.

Proposed Biosolids Application Rate

5 Biosolids

The plan is for the biosolids to be applied in a slurry state (approximately 90% moisture). After the water is decanted, the sludge material will be dredged, agitated with remaining liquids (roughly 10% of total volume of wastewater) and injected into the fields. This will alleviate concerns of odour and mitigate risks of spreading on inundated soils (M-01 and M-03). It should be noted that **biosolids cannot be applied into standing water and furrows must be covered after injection**. If furrows are not completely covered, it is recommended that a tillage pass be done within 48 hours after application. Failure to do so can result in potential runoff of biosolids into the nearby Souris River.

5. 1 Biosolid Sampling Procedure

KGS Group was on-site on June 9, 2016 to complete the sludge sampling from the Primary and Secondary Cells. Samples were collected from a boat utilizing an Ekman Dredge to collect the samples from the estimated central portion of the sludge zone. Samples were collected at four locations in a uniform pattern across each cell and combined in a container in order to obtain a composite sample for each cell. The composite samples were submitted to ALS Environmental Ltd. in Winnipeg, MB for analysis of:

- Moisture content, total and volatile solids, organic matter content, total carbon, and specific gravity
- Salinity (chloride, calcium, magnesium, potassium, sodium, sulfur, SAR, electrical conductivity, and pH)
- Nutrients (total kjeldahl nitrogen, nitrate-nitrogen, ammonium-nitrogen), total and bi-carbonate phosphorous, potassium and sulfate-S.
- Metals

5. 2 Biosolid Quantity

Based on the available information, the estimated current volume of sludge within the primary and secondary cells of the lagoon is in the order of 30,000 m3. This is based on a 2013 estimate of 25,180 m3 (18,600 m3 in the primary cell, 6,580 m3 in the secondary cell), and some contingency for sludge accumulation since 2013.r).

5. 3 Biosolid Quality

ALS Certificate of Analysis for the biosolid material is attached as Appendix 3 for the primary and secondary cells.

5. 4 Nitrogen and Phosphorus in Biosolid Material

To determine what a sustainable rate of application is for the biosolid material, a breakdown of its nutrient quality needed to be conducted. Since the material will be applied in a slurry state, the lab results (mg/kg) have been converted into what the custom manure applicator will use (lbs/1,000 imperial gallons) at time of application. The target manure rate will be based on the targeted crop uptake and removal rates as well as soil fertility concentrations after crop is off this fall. The nutrient content (nitrogen and phosphorus profile) of the primary and secondary cells can be seen below in Table 8. Please note the specific gravity will be rounded to 1 kg/L in calculation of application rates.

Table 8 – Biosolid Characteristics (Nitrogen and Phosphorus) for Primary and Secondary Cells

Name	Description	Unit	Primary Cell Results	Secondary Cell Results
Volume (Plus 10%)	Field	m3	20,000	10,000
Specific Gravity	As Received	Kg/L	1.04	1.08
Moisture	As Received	%	92.8	84
Nitrogen Characteristics				
Total Kjeldahl N	% Dried Basis	%	0.53	0.68
Total Kjeldahl N	Dried Basis	mg/kg	5,300	6,800
Total Kjeldahl N	Dried Basis	lbs/1000 imp. gal	53	68
Ammonium N	Dried Basis	mg/kg	1,030	316
Ammonium N	Dried Basis	lbs/1000 imp. gal	10.3	3.16
Available Nitrate	Dried Basis	mg/kg	0	0
Available Nitrate-N	Dried Basis	mg/kg	0	0
Organic N	Dried Basis	mg/kg	4,270	6,484
Organic N	Dried Basis	lbs/1000 imp. gal	42.7	64.84
Application Method			Injection	Injection
Anticipated Weather			Cool/Wet	Cool/Wet
Anticipated Volatilization			0%	0%
Available Organic N	Dried Basis	lbs/1000 imp. gal	10.68	16.21
Available Ammonium N	Dried Basis	lbs/1000 imp. gal	10.3	3.16
Total Available N (Year 1)	Dried Basis	lbs/1000 imp. gal	20.98	19.37
Mineralization N (Year 2)	Dried Basis	lbs/1000 imp. gal	5.12	7.78
Mineralization N (Year 3)	Dried Basis	lbs/1000 imp. gal	2.56	3.89
Phosphorus Characteristics				
Total Phosphorus (Olsen)	Dried Basis	mg/kg	334	82.2
Phosphorus	Dried Basis	lbs/1000 imp. gal	3.34	0.82
P2O5 (P * 2.3)	Dried Basis	lbs/1000 imp. gal	7.69	1.89
Total Available P2O5 (50% Available)	Dried Basis	lbs/1000 imp. gal	3.85	0.95
C:N Ratio				
Total Organic Carbon	Dried Basis	%	1.71	2.1
C:N Ratio	Dried Basis	X:1	3.23	3.09
N:P Ratio	Dried Basis	X:1	5.45	20.39
pH	Saturated Paste		6.7	7.4

Source: Tri-Provincial Manure Application and Use Guidelines, 2004 and MMM Group, 2013.

Since the biosolids will be injected, nitrogen losses to the atmosphere will be minimal (0-2%). The amount of N released from the mineralization of the organic N varies greatly depending on soil conditions and is difficult to accurately predict when it will become available. Generally, there is an assumption that 25% of the organic N portion of the biosolids will be in a plant available form in the first year after application (Tri-Provincial Manure Application and Use Guidelines, 2004).

The N:P ratio for the primary and secondary cells is 5.45:1 and 20.39:1, respectively. Crop removal for most crops (cereals and oilseeds) usually ranges from 3:1 to 4:1. Using an N based application rate, there will be no accumulation of P in the soils.

5. 5 Salinity

The primary and secondary cells have an electrical conductivity (EC) value of 1.77 dS m-1 and 1.76 dS m-1, respectively. The sodium absorption ratio (SAR) is 1.81 for the primary cell and 2.06 for the secondary cell. A comparison was done using a study done by Racz and Fitzgerald (2001) which measured the EC and SAR values of 145 hog manure samples across Manitoba. They found an average EC of 16 ds m-1. Also, they reported that the SAR values were relatively low with an average of 5.1. The primary and secondary cell's EC and SAR values are well below the averages in the report, and thus, risks to subsequent crops are very unlikely. Appendix C contains more information on the salt contents of the sludge samples.

5. 6 Trace Metals

The application of heavy metals in Manitoba is restricted to limit the impact on the food chain. The cumulative weight of each metal is determined by measuring the background level in the soil prior to any biosolid application and adding the calculated weight of the metal from the biosolid application (Van Den Bosh, 2001). As this proposal does not yet have any current soil test results at the time of application, average trace elements were used based on the Haluschak et al (1998) study done for the Melita area. Actual metal loading rates to the soil will be calculated once the soil test results are analyzed this fall. There are eight metals of concern for agricultural land in Manitoba: arsenic, cadmium, chromium, copper, lead, mercury, nickel and zinc. Based on the target application rates for the primary and secondary cells outlined in Section 5.8, the mean loading rate of trace metals will be below the established limits. Tables 9 and 10 show the levels of trace metals of concern for the primary and secondary cells along with the established guidelines, respectively.

Table 9 – Primary Cell Trace Elements

Trace Element	Primary Cell		Typical Soil Concentrations*			Loading Rate @ 11,000 imp. gal/acre		Cumulative Metal Concentration		Cumulative Weight Allowed by CCME Guidelines	
	mg/kg	lbs/1000 imp. gal	mg/kg	kg/ha	lbs/acre	kg/ha	lbs/acre	kg/ha	lbs/acre	kg/ha	lbs/acre
Arsenic (As)	4.37	0.044	6	0.25	0.22	0.542	0.484	0.79	0.70	21.6	19.3
Cadmium (Cd)	2.28	0.023	0.2	0.01	0.01	0.284	0.253	0.29	0.26	2.52	2.25
Chromium (Cr)	20	0.2	45	1.87	1.67	2.47	2.2	4.34	3.87	115.2	102.8
Copper (Cu)	602	6.02	17	0.71	0.63	74.22	66.22	74.93	66.85	113.4	101.2
Lead (Pb)	30.3	0.303	18	0.75	0.67	3.736	3.333	4.49	4	126	112.4
Mercury (Hg)	0.337	0.003	43	1.78	1.59	0.037	0.033	1.82	1.62	11.9	10.6
Nickel (Ni)	19.4	0.194	22	0.91	0.81	2.392	2.134	3.30	2.95	90	80.3
Zinc (Zn)	346	3.46	68	2.82	2.52	42.66	38.06	45.48	40.58	360	321.2

* Waskada Soil Series used to represent the mean trace element for the PPA
Source: Haluschak et al., 1998

Table 10 – Secondary Cell Trace Elements

Trace Element	Secondary Cell		Typical Soil Concentrations*			Loading Rate @ 11,800 imp. gal/acre		Cumulative Metal Concentration		Cumulative Weight Allowed by CCME Guidelines	
	mg/kg	lbs/1000 imp. gal	mg/kg	kg/ha	lbs/acre	kg/ha	lbs/acre	kg/ha	lbs/acre	kg/ha	lbs/acre
Arsenic (As)	3.32	0.033	6	0.25	0.22	0.436	0.389	0.68	0.61	21.6	19.3
Cadmium (Cd)	0.711	0.007	0.2	0.01	0.01	0.093	0.083	0.1	0.09	2.52	2.25
Chromium (Cr)	23.4	0.234	45	1.87	1.67	3.094	2.761	4.97	4.43	115.2	102.8
Copper (Cu)	253	2.53	17	0.71	0.63	33.46	29.85	34.16	30.48	113.4	101.2
Lead (Pb)	16	0.16	18	0.75	0.67	2.118	1.89	2.87	2.56	126	112.4
Mercury (Hg)	0.151	0.002	43	1.78	1.59	0.027	0.024	1.8	1.61	11.9	10.6
Nickel (Ni)	20.3	0.203	22	0.91	0.81	2.69	2.4	3.6	3.21	90	80.3
Zinc (Zn)	165	1.65	68	2.82	2.52	21.82	19.47	24.65	21.99	360	321.2

* Waskada Soil Series used to represent the mean trace element for the PPA
Source: Haluschak et al., 1998

5. 7 Soil Sampling

Benchmark random composite sampling will be conducted on the four fields within the PPA immediately after harvest. For each parcel of land, one composite sample will taken from both the 0-15 cm (0-6") and 15-60 cm (6-24") depths. The samples will be sent to ALS Labs in Saskatoon and will be measured for nitrate-nitrogen, phosphorus, potassium, sulfate-sulphur, pH, E.C., and heavy metals. The target application rates will be adjusted based on the results of the soil tests for each parcel and will be sent to Manitoba Sustainable Development for review.

5. 8 Proposed Application Rates

The target biosolids application rates for the primary and secondary cells will be based on the nitrogen requirement of either a cereal or oilseed crop (ie. spring wheat or canola). The target N rate will be 190 lbs/acre in order to grow a 75 bushel wheat crop or 55 bushel canola crop. This will allow the biosolids to be spread evenly over the eligible acres (584 acres out of 616 total acres in PPA). Table 11 below shows the biosolids application rate based on N requirement and P2O5 crop removal for comparison.

Table 11 – Application Rate Calculation Worksheet (Imperial Units)

Name	Unit	Primary Cell	Secondary Cell
Nitrogen Based Application Rate			
Total Kjeldahl N	lbs/1000 imp. gal	53	68
Ammonium N	lbs/1000 imp. gal	10.3	3.16
Available Nitrate-N	lbs/1000 imp. gal	0	0
Organic N	lbs/1000 imp. gal	42.7	64.84
Application Method		Injection	Injection
Anticipated Weather		Cool/Wet	Cool/Wet
Anticipated Volatilization		0%	0%
Available Organic N	lbs/1000 imp. gal	10.68	16.21
Available Ammonium N	lbs/1000 imp. gal	10.3	3.16
Total Available N	lbs/1000 imp. gal	20.98	19.37
Fall Application Adjustment (Total Available N * 83%)		17.41	16.08
N based Rate	imp. gal/acre	11,000	11,800
Total N Applied	lbs/acre	190	190
Total P2O5	lbs/1000 imp. gal	7.69	1.89
Total Available P2O5 (50% Available)	lbs/1000 imp. gal	3.85	0.95
Amount of P2O5 applied	lbs/acre	84.6	22.3
Crop Removal Rate	lbs/acre	47	47
Area of Land Required	acres	385	199

Based on the application rate outlined in Table 11, the nitrogen application rates for both primary and secondary cells (11,000 and 11,800 imp. gal/acre, respectively) are suitable for the receiving land within the PPA as long as soil test phosphorus is below 120 ppm (threshold of applications based on 2X crop removal rate of P2O5). Since there is no history of recent manure application on these fields, the soil test results taken after harvest should be relatively low in P levels. The total land area required for application is anticipated to be 584 acres (236 ha) based on a nitrogen application rate. Detailed soil analysis of each field will be provided to Manitoba Sustainable Development as soon as harvest is complete for approval prior to biosolids application this fall.

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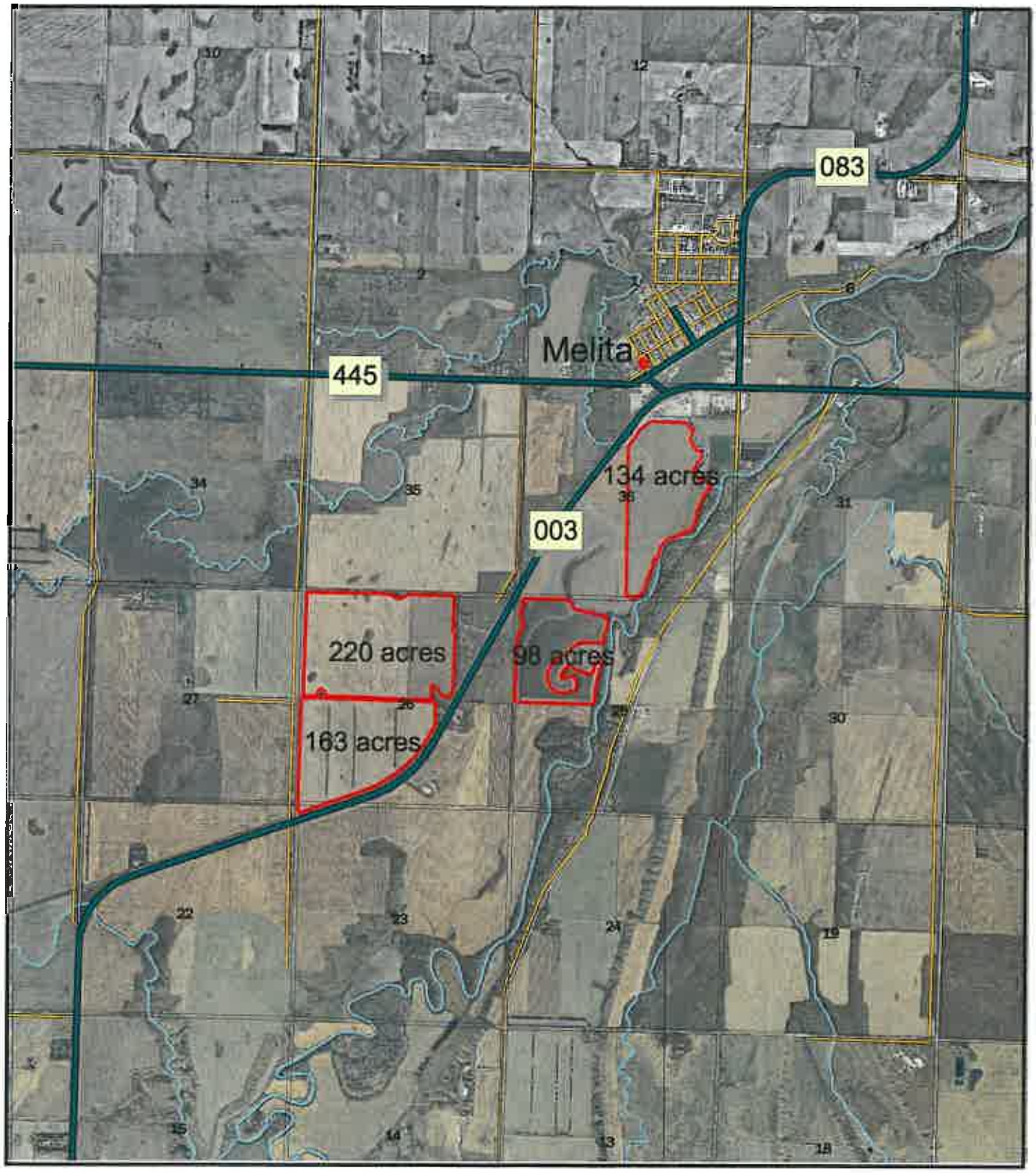
Appendix 1 Maps

KGS-Melita
Overview (3-27W)



0 1 Miles

1:40000

Fields
Towns
Highways
Municipal Roads
Drainage

Data Sources:
Fields drawn by Tone Ag in consultation with landowner, and subject to change.
Orthophotos are 1:60,000 from Manitoba Land Initative website
Highwsys are from Manitoba Highways and Transportation 1:60,000 map 1994
Sections are from Manitoba Land Initative website

N
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2016-07-11

T·A·C
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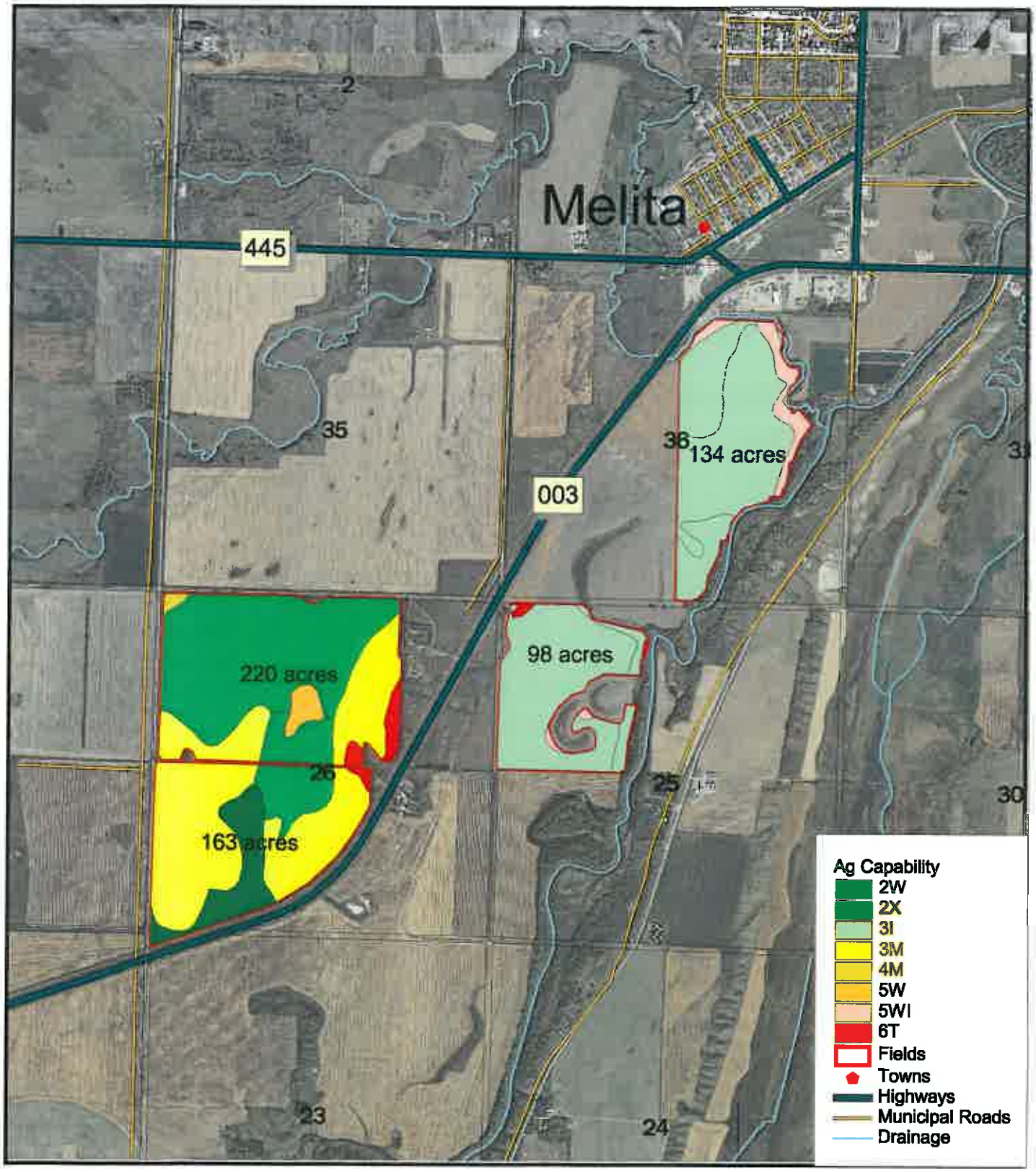
KGS-Melita
Ag Capability (3-27W)



0 1 Miles

1:25000

Data Sources:
Fields drawn by Tone Ag in consultation with landowner, and subject to change.
Orthophotos are 1:50,000 from Manitoba Land Initative website
Highways are from Manitoba Highways and Transportation 1:60,000 map 1934
Sections are from Manitoba Land Initative website

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2016-07-13

T·A·C
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Appendix 2 Soil Descriptions

Table 12 – Soil Textures - Mineral Soils

Textural Group	Class Symbol	Class Name
Very Coarse	VCoS	Very Coarse Sand
	CoS	Coarse Sand
	S	Sand
Coarse	LCoS	Loamy Coarse Sand
	LS	Loamy Sand
	FS	Fine Sand
	LFS	Loamy Fine Sand
Moderately Coarse	CoSL	Coarse Sandy Loam
	SL	Sandy Loam
	FSL	Fine Sandy Loam
	VFS	Very Fine Sand
	LVFS	Loamy Very Fine Sand
Medium	Si	Silt
	VFSL	Very Fine Sandy Loam
	L	Loam
	SiL	Silt Loam
Moderately Fine	SCL	Sandy Clay Loam
	SiCL	Silty Clay Loam
	CL	Clay Loam
Fine	SC	Sandy Clay
	SiC	Silty Clay
	C	Clay
Very Fine	HC	Heavy Clay

Organic Soils - Degree of Decomposition

Fibric - f - Low decomposition, high plant material
Mesic - m - Moderately decomposed, presence of recognized plant material
Humic - h - Highly decomposed, little or no plant material present
f,m, and h are used with O to indicate Organic Soils.
ME - Mesic Family Particle size

Table 13 – Particle Size

Particle Size	Symbol	Description
Coarse-Loamy	CL	A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction
Clayey-Skeletal	CS	Particles 2mm – 25cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1mm; the fraction finer than 2mm is that defined for the clayey particle-size class.
Coarse-Silty	CSi	A loamy particle size that has 15% or more by weight of fine sand (0.25-0.1mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction
Clayey	CY	The fine earth contains 35% or more clay by weight and has less than 18% clay in the fine earth fraction and particles 2mm – 25cm occupy less than 35% by volume
Fine-Clayey	FC	A clayey particle size that has 35-60% clay in the fine earth fraction
Fibric (Organic)	FI	The least decomposed of all organic materials; there is a large amount of well-preserved fiber that is readily identifiable as to botanical origin. Fibers retain their character upon rubbing.
Fine-Loamy	FL	A loamy particle size that has less 15% by weight of fine sand (0.25-0.1mm) or coarser particles, including fragments up to 7.5 cm, and has 18-35% clay in the fine earth fraction
Fragmental	FR	Stones, cobbles, and gravel, with too little fine earth to fill interstices larger than 1mm
Fine-Silty	FSi	A loamy particle size that has less than 15% by weight of fine sand (0.25-0.1mm) or coarser particles, including fragments up to 7.5 cm, and has less than 18% clay in the fine earth fraction
Humic (Organic)	HU	Highly decomposed organic material; small amounts of fiber are present that can be identified as to their botanical origin. Fibers can be easily destroyed by rubbing.
Leaf Litter	L	Leaf litter and twigs - undecomposed
Loamy-Skeletal	LS	Particles 2mm – 25cm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1mm; the fraction finer than 2mm is that defined for the loamy particle-size class.
Loamy	LY	The texture of fine earth includes loamy very fine sand, very fine sand, and textures with less than 35% clay;; particles 2mm – 25cm occupy less than 35% by volume
Mesic (Organic)	ME	Organic materials in an intermediate stage of decomposition; intermediate amounts of fiber are present that can be identified as to their botanical origin.
Bedrock	RK	The solid rock that underlies soil and the regolith or that is exposed at the surface.

Particle Size	Symbol	Description
Sandy-Coarse	SC	Soils that are developed on dominantly medium to coarse sand (but without significant gravel). These have lower water holding capacities than other sandy soils.
Sandy-Fine	SF	Soils that are developed on dominantly loamy fine sand to fine sand. have higher water holding capacities than coarse sands. Most Manitoba soils developed on sand are in this category.
Skeletal	SK	Soils with greater than 35% coarse fragments by volume, but with enough fines to fill the smaller pore spaces. This is normally used with a description of the fine material associated with it, such as SS (sandy skeletal) or LS (loamy skeletal).
Sandy-Skeletal	SS	Particles coarser than 2mm occupy 35% or more by volume with enough fine earth to fill interstices larger than 1mm; the fraction finer than 2mm is that defined for the sandy particle-size class.
Sandy	SY	The texture of fine earth includes sands and loamy sands, exclusive of loamy very fine sand and very fine sand textures; particles 2mm – 25cm occupy less than 35% by volume
Texture Complex	TX	Used for soils with a very wide range of parent material textures. For example, Eroded Slopes Complex.
Undifferentiated	UD	Used for soils where the texture of the underlying parent material is variable (SY, LY, CY), but it doesn't affect the soil series designation.
Very-Fine-Clayey	VC	A clayey particle size that has 60% or more clay in the fine earth fraction

DRAINAGE

Very rapidly drained - Water is removed from the soil very rapidly in relation to supply.
Rapidly drained - Water is removed from the soil rapidly in relation to supply.
Well drained - Water is removed from the soil readily but is not rapidly.
Moderately well drained - Water is removed from the soil somewhat slowly in relation to supply.
Imperfectly drained - Water is removed from the soil sufficiently slow in relation to the supply to keep the soil wet for a significant part of the growing season.
Poorly drained - Water is removed so slowly in relation to the supply that the soil remains wet for a comparatively large part of the time when the soil is not frozen.
Very poorly drained - Water is removed from the soil so slowly that the water table remains at or on the surface for a greater part of the time the soil is not frozen.

Appendix 3 ALS Certificate of Analysis

KGS Group Consultants (Winnipeg)
ATTN: Kenton Thiessen
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4

Date Received: 10-JUN-16
Report Date: 24-JUN-16 15:17 (MT)
Version: FINAL

Client Phone: 204-896-1209

Certificate of Analysis

Lab Work Order #: L1781394
Project P.O. #: NOT SUBMITTED
Job Reference: 16-0429-004
C of C Numbers:
Legal Site Desc:

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1781394-1 PRIMARY							
Sampled By: JO/AN on 09-JUN-16 @ 12:30							
Matrix: Sludge							
Miscellaneous Parameters							
Total Available Nitrogen	1030		98	mg/kg		17-JUN-16	
Boron (B), Hot Water Ext.	11.1	NSSM	4.0	mg/kg	16-JUN-16	16-JUN-16	R3481132
Note: Done as received and calculated to dry							
Available Phosphate-P	769	NSSM	10	mg/kg	16-JUN-16	16-JUN-16	R3482378
Note: Done as Received, back calc to dry							
Available Potassium	690		180	mg/kg	16-JUN-16	16-JUN-16	R3482495
Note: Done as Received, back calc to dry							
Available Sulfate-S	186	NSSM	84	mg/kg	16-JUN-16	16-JUN-16	R3482035
Note: Done as received and calculated to dry							
Chloride (Cl)	124	NSSM	1.0	mg/L	16-JUN-16	16-JUN-16	R3482533
Mercury (Hg)	0.337		0.050	mg/kg	13-JUN-16	14-JUN-16	R3479523
% Moisture	92.8		0.10	%	15-JUN-16	15-JUN-16	R3479722
% Saturation	Oversat		1.0	%	15-JUN-16	15-JUN-16	R3480699
Specific Gravity	1.04		0.010	kg/L		20-JUN-16	R3483558
Total Carbon by Combustion	1.71		0.05	%	15-JUN-16	15-JUN-16	R3480694
Total Kjeldahl Nitrogen	0.53	DLHC	0.20	%	21-JUN-16	21-JUN-16	R3486371
Organic Matter by LOI at 375 deg C.							
Organic Matter	8.4		1.0	%	17-JUN-16	17-JUN-16	R3483086
Loss on Ignition @ 375 C	10.4		1.0	%	17-JUN-16	17-JUN-16	R3483086
Total Solids and Total Volatile Solids							
Total Solids	8.03		0.10	%	17-JUN-16	17-JUN-16	R3482763
Total Volatile Solids (dry basis)	29.3		0.10	%	17-JUN-16	17-JUN-16	R3482763
pH and Conductivity							
pH	6.73		0.10	pH	15-JUN-16	15-JUN-16	R3480699
Conductivity (EC)	1.77		0.20	dS m-1	15-JUN-16	15-JUN-16	R3480699
pH and EC (1:2 Soil:Water Extraction)							
Conductivity (1:2)	1.35		0.050	dS m-1	17-JUN-16	17-JUN-16	R3482586
pH (1:2 soil:water)	8.14		0.10	pH	17-JUN-16	17-JUN-16	R3482586
Detailed Salinity in dry-weight mg/kg							
Chloride (Cl)	1600		13	mg/kg dwt		17-JUN-16	
Calcium (Ca)	1320		64	mg/kg dwt		17-JUN-16	
Magnesium (Mg)	942		64	mg/kg dwt		17-JUN-16	
Potassium (K)	221		64	mg/kg dwt		17-JUN-16	
Sodium (Na)	1270		64	mg/kg dwt		17-JUN-16	
Sulfur (as SO4)	258		64	mg/kg dwt		17-JUN-16	
Detailed Salinity in wet-weight mg/kg							
Chloride (Cl)	115		0.93	mg/kg wwt		17-JUN-16	
Calcium (Ca)	95.0		4.6	mg/kg wwt		17-JUN-16	
Magnesium (Mg)	67.8		4.6	mg/kg wwt		17-JUN-16	
Potassium (K)	15.9		4.6	mg/kg wwt		17-JUN-16	
Sodium (Na)	91.1		4.6	mg/kg wwt		17-JUN-16	
Sulfur (as SO4)	18.5		4.6	mg/kg wwt		17-JUN-16	
Metals							
Aluminum (Al)	13200		500	mg/kg	13-JUN-16	14-JUN-16	R3479690
Antimony (Sb)	1.34		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Arsenic (As)	4.37		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Barium (Ba)	360		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Beryllium (Be)	0.43		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Bismuth (Bi)	8.87		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Boron (B)	16		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Cadmium (Cd)	2.28		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1781394-1 PRIMARY							
Sampled By: JO/AN on 09-JUN-16 @ 12:30							
Matrix: Sludge							
Metals							
Calcium (Ca)	94300		100	mg/kg	13-JUN-16	14-JUN-16	R3479690
Chromium (Cr)	20.0		1.0	mg/kg	13-JUN-16	14-JUN-16	R3479690
Cobalt (Co)	5.05		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Copper (Cu)	602		1.0	mg/kg	13-JUN-16	14-JUN-16	R3479690
Iron (Fe)	13500		25	mg/kg	13-JUN-16	14-JUN-16	R3479690
Lead (Pb)	30.3		0.20	mg/kg	13-JUN-16	14-JUN-16	R3479690
Magnesium (Mg)	11700		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Manganese (Mn)	485		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Molybdenum (Mo)	11.2		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Nickel (Ni)	19.4		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Phosphorus (P)	5440		100	mg/kg	13-JUN-16	14-JUN-16	R3479690
Potassium (K)	1890		25	mg/kg	13-JUN-16	14-JUN-16	R3479690
Selenium (Se)	13.5		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Silver (Ag)	4.52		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Sodium (Na)	1250		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Strontium (Sr)	312		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Thallium (Tl)	0.32		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Tin (Sn)	10.7		5.0	mg/kg	13-JUN-16	14-JUN-16	R3479690
Titanium (Ti)	36.7		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Uranium (U)	20.4		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Vanadium (V)	29.2		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Zinc (Zn)	346		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Total Available N & NO3-N, NO2-N & NH4							
Available Ammonium-N							
Available Ammonium-N	1030	NSSM	88	mg/kg	16-JUN-16	16-JUN-16	R3482481
Note: Done as Rec'd, back calc to dry							
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL							
Nitrite-N	<8.8	NSSM	8.8	mg/kg	16-JUN-16	16-JUN-16	R3482594
Nitrate+Nitrite-N	<44	NSSM	44	mg/kg	16-JUN-16	16-JUN-16	R3482594
Nitrate-N	<44	NSSM	44	mg/kg	16-JUN-16	16-JUN-16	R3482594
Note: Done as Received, Back Calc to dry							
Detailed Salinity -over sat'd waste							
SAR and Cations (over sat'd)							
Calcium (Ca)	102		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Potassium (K)	17.1		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Magnesium (Mg)	73.1		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Sodium (Na)	98.2		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Sulfur (as SO4)	20.0		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
SAR	1.81		0.10	SAR	16-JUN-16	16-JUN-16	R3481147
L1781394-2 SECONDARY							
Sampled By: JO/AN on 09-JUN-16 @ 13:15							
Matrix: Sludge							
Miscellaneous Parameters							
Total Available Nitrogen	316		45	mg/kg		17-JUN-16	
Boron (B), Hot Water Ext.	9.7	NSSM	2.0	mg/kg	16-JUN-16	16-JUN-16	R3481132
Note: Done as received and calculated to dry							
Available Phosphate-P	189	NSSM	5.0	mg/kg	16-JUN-16	16-JUN-16	R3482378
Note: Done as Received, back calc to dry							
Available Potassium	723		80	mg/kg	16-JUN-16	16-JUN-16	R3482495
Note: Done as Received, back calc to dry							
Available Sulfate-S	222	NSSM	44	mg/kg	16-JUN-16	16-JUN-16	R3482035

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1781394-2 SECONDARY							
Sampled By: JO/AN on 09-JUN-16 @ 13:15							
Matrix: Sludge							
Note: Done as received and calculated to dry							
Chloride (Cl)	135	NSSM	1.0	mg/L	16-JUN-16	16-JUN-16	R3482533
Mercury (Hg)	0.151		0.050	mg/kg	13-JUN-16	14-JUN-16	R3479523
% Moisture	84.0		0.10	%	15-JUN-16	15-JUN-16	R3479722
% Saturation	Oversat		1.0	%	15-JUN-16	15-JUN-16	R3480699
Specific Gravity	1.08		0.010	kg/L		20-JUN-16	R3483558
Total Carbon by Combustion	2.10		0.05	%	15-JUN-16	15-JUN-16	R3480694
Total Kjeldahl Nitrogen	0.68	DLHC	0.40	%	21-JUN-16	21-JUN-16	R3486371
Organic Matter by LOI at 375 deg C.							
Organic Matter	10.1		1.0	%	17-JUN-16	17-JUN-16	R3483086
Loss on Ignition @ 375 C	12.6		1.0	%	17-JUN-16	17-JUN-16	R3483086
Total Solids and Total Volatile Solids							
Total Solids	11.8		0.10	%	17-JUN-16	17-JUN-16	R3482763
Total Volatile Solids (dry basis)	18.9		0.10	%	17-JUN-16	17-JUN-16	R3482763
pH and Conductivity							
pH	7.42		0.10	pH	15-JUN-16	15-JUN-16	R3480699
Conductivity (EC)	1.76		0.20	dS m-1	15-JUN-16	15-JUN-16	R3480699
pH and EC (1:2 Soil:Water Extraction)							
Conductivity (1:2)	1.32		0.050	dS m-1	17-JUN-16	17-JUN-16	R3482586
pH (1:2 soil:water)	8.27		0.10	pH	17-JUN-16	17-JUN-16	R3482586
Detailed Salinity in dry-weight mg/kg							
Chloride (Cl)	711		5.3	mg/kg dwt		17-JUN-16	
Calcium (Ca)	532		26	mg/kg dwt		17-JUN-16	
Magnesium (Mg)	451		26	mg/kg dwt		17-JUN-16	
Potassium (K)	109		26	mg/kg dwt		17-JUN-16	
Sodium (Na)	611		26	mg/kg dwt		17-JUN-16	
Sulfur (as SO4)	173		26	mg/kg dwt		17-JUN-16	
Detailed Salinity in wet-weight mg/kg							
Chloride (Cl)	114		0.84	mg/kg wwt		17-JUN-16	
Calcium (Ca)	85.2		4.2	mg/kg wwt		17-JUN-16	
Magnesium (Mg)	72.2		4.2	mg/kg wwt		17-JUN-16	
Potassium (K)	17.5		4.2	mg/kg wwt		17-JUN-16	
Sodium (Na)	97.8		4.2	mg/kg wwt		17-JUN-16	
Sulfur (as SO4)	27.7		4.2	mg/kg wwt		17-JUN-16	
Metals							
Aluminum (Al)	13300		500	mg/kg	13-JUN-16	14-JUN-16	R3479690
Antimony (Sb)	0.63		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Arsenic (As)	3.32		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Barium (Ba)	180		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Beryllium (Be)	0.59		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Bismuth (Bi)	2.06		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Boron (B)	25		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Cadmium (Cd)	0.711		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Calcium (Ca)	84100		100	mg/kg	13-JUN-16	14-JUN-16	R3479690
Chromium (Cr)	23.4		1.0	mg/kg	13-JUN-16	14-JUN-16	R3479690
Cobalt (Co)	6.46		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Copper (Cu)	253		1.0	mg/kg	13-JUN-16	14-JUN-16	R3479690
Iron (Fe)	18000		25	mg/kg	13-JUN-16	14-JUN-16	R3479690
Lead (Pb)	16.0		0.20	mg/kg	13-JUN-16	14-JUN-16	R3479690
Magnesium (Mg)	12300		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Manganese (Mn)	402		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Molybdenum (Mo)	4.15		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690

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

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	Qualifier*	D.L.	Units	Extracted	Analyzed	Batch
L1781394-2 SECONDARY							
Sampled By: JO/AN on 09-JUN-16 @ 13:15							
Matrix: Sludge							
Metals							
Nickel (Ni)	20.3		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Phosphorus (P)	2870		100	mg/kg	13-JUN-16	14-JUN-16	R3479690
Potassium (K)	2780		25	mg/kg	13-JUN-16	14-JUN-16	R3479690
Selenium (Se)	7.97		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Silver (Ag)	2.97		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Sodium (Na)	963		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Strontium (Sr)	233		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Thallium (Tl)	0.26		0.10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Tin (Sn)	5.8		5.0	mg/kg	13-JUN-16	14-JUN-16	R3479690
Titanium (Ti)	93.6		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Uranium (U)	16.4		0.020	mg/kg	13-JUN-16	14-JUN-16	R3479690
Vanadium (V)	41.4		0.50	mg/kg	13-JUN-16	14-JUN-16	R3479690
Zinc (Zn)	165		10	mg/kg	13-JUN-16	14-JUN-16	R3479690
Total Available N & NO3-N, NO2-N & NH4							
Available Ammonium-N							
Available Ammonium-N	316	NSSM	40	mg/kg	16-JUN-16	16-JUN-16	R3482481
Note: Done as Rec'd, back calc to dry							
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL							
Nitrite-N	<4.0	NSSM	4.0	mg/kg	16-JUN-16	16-JUN-16	R3482594
Nitrate+Nitrite-N	<20	NSSM	20	mg/kg	16-JUN-16	16-JUN-16	R3482594
Nitrate-N	<20	NSSM	20	mg/kg	16-JUN-16	16-JUN-16	R3482594
Note: Done as Received, Back Calc to dry							
Detailed Salinity -over sat'd waste							
SAR and Cations (over sat'd)							
Calcium (Ca)	101		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Potassium (K)	20.8		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Magnesium (Mg)	86.0		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Sodium (Na)	116		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
Sulfur (as SO4)	33.0		5.0	mg/L	16-JUN-16	16-JUN-16	R3481147
SAR	2.06		0.10	SAR	16-JUN-16	16-JUN-16	R3481147

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

Reference Information

Sample Parameter Qualifier Key:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
NSSM	Non-standard sample matrix. Modified methods were used for sample processing and analysis.
NSSM	Non-standard sample matrix. Modified methods were used for sample processing and analysis.

Test Method References:

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

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

C-TOT-LECO-SK	Soil	Total Carbon by combustion method	SSSA (1996) P. 973-974

The sample is ignited in a combustion analyzer where carbon in the reduced CO2 gas is determined using a thermal conductivity detector.

CL-COL-SK	Waste	Chloride (Cl)	APHA 4110B
ETL-N-TOT-AVAIL-SK	Soil	Available Ammonium-N - Calculation	Soil Methods of Analysis (1993) CSSS
HG-200.2-CVAF-WP	Soil	Mercury in Soil by CVAFS	EPA 200.2/1631E (mod)

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

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

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

MET-200.2-MS-WP	Soil	Metals	EPA 200.2/6020A

Samples for analysis are homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested by block digester (EPA 200.2). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A).

Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.

MOIST-SK	Soil	Moisture Content	ASTM D2216-80

The weighed portion of soil is placed in a 105 C oven overnight. The dried soil is allowed to cooled to room temperature, weighed and the % moisture is calculated.

Reference: ASTM D2216-80

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

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

N2/N3-AVAIL-KCL-SK	Soil	Nitrate, Nitrite & Nitrate+Nitrite-N(KCL	CSSS (1993) p. 26-28

Plant available nitrate and nitrite are extracted from the sample with 2N KCl. Nitrate and Nitrite in the filtered extract are determined colorimetrically by Technicon auto-analyzer or flow injection analyzer at 520 nm.

NH4-AVAIL-SK	Soil	Available Ammonium-N	CSSS(1993) 4.2/COMM SOIL SCI 19(6)

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

OM-LOI-SK	Soil	Organic Matter by LOI at 375 deg C.	CSSS (1978) p. 160

The dry-ash method involves the removal of organic matter by combustion at 375 degrees C for a minimum of 16 hours. Samples are dried prior to combustion.

Reference: McKeague, J.A. Soil Sampling and Methods of Analysis. Can. Soc. Soil Sci.(1978) method 4.23

PH,EC-1:2-SK	Soil	pH and EC (1:2 Soil:Water Extraction)	AB Ag (1988) p.7

1 part dry soil and 2 parts de-ionized water (by volume) is mixed. The slurry is allowed to stand with occasional stirring for 30 - 60 minutes. After equilibration, pH of the slurry is measured using a pH meter. Conductivity of the filtered extract is measured by a conductivity meter.

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**
PH/EC-SK	Waste	pH and Conductivity	APHA 4500-H,2510
PO4-AVAIL-OLSEN-SK	Soil	Available Phosphate-P by Olsen	CSSS (1993) 7.2,7.3.1
Plant available phosphorus is extracted from the sample with sodium bicarbonate. PO4-P in the filtered extract is determined colorimetrically at 880 nm.			
SAL-D50-DRYCALC-SK	Waste	Detailed Salinity in dry-weight mg/kg	Calculation
Conversion of Saturation Extract soluble ions from units of mg/L to dry-weight mg/kg. For over-saturated wastes: mg/kg dwt = mg/L * % Moisture / (100% - % Moisture) For under-saturated wastes: mg/kg dwt = mg/L * (% Saturation / 100%)			
SAL-D50-WETCALC-SK	Waste	Detailed Salinity in wet-weight mg/kg	Calculation
Conversion of Saturation Extract soluble ions from units of mg/L to wet-weight mg/kg. For over-saturated wastes: mg/kg wwt = mg/L * % Moisture / 100% For under-saturated wastes: mg/kg wwt = mg/L * (% Saturation / 100%) * (100% - % Moisture) / 100%			
SALINITY-INTCHECK-SK	Soil		CSSS 18.4-Calculation
SAR-CALC-SK	Waste	SAR and Cations (over sat'd)	APHA 3120B
SAT-PCNT-SK	Soil	Saturated Paste	CSSS (1993) 18.2.2
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.			
SOLIDS-TOT/TOTVOL-SK	Manure	Total Solids and Total Volatile Solids	APHA 2540G
A well-mixed sample is evaporated in a weighed dish and dried to constant weight in an oven at 103-105°C. The increase in weight over that of the empty dish represents the Total Solids. The crucible is then ignited at 550°–10°C for 1 hour. The remaining solids represent the Total Fixed Solids, while the weight lost on ignition represents the Total Volatile Solids.			
SPECGRAV-CL	Soil	Specific Gravity	ASTM D 5057 - 90
A portion of sample is weighed in a container that is calibrated for volume. Specific Gravity is reported as the mass of sample per mass of an equal volume of pure water, where the density of pure water is taken to be 1.00 g/mL.			

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

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

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

Chain of Custody Numbers:

Reference Information

Test Method References:

ALS Test Code	Matrix	Test Description	Method Reference**

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

Client: KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
Contact: Kenton Thiessen

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
B-HOTW-SK	Soil							
Batch R3481132								
WG2327459-2 IRM		**SAL814**						
Boron (B), Hot Water Ext.			89.3		%		70-130	16-JUN-16
WG2327459-1 MB								
Boron (B), Hot Water Ext.			<0.20		mg/kg		0.2	16-JUN-16
C-TOT-LECO-SK	Soil							
Batch R3480694								
WG2327376-1 DUP		**L1781394-1**						
Total Carbon by Combustion		1.71	1.72		%	0.6	20	15-JUN-16
WG2327376-2 IRM		**08-109_SOIL**						
Total Carbon by Combustion			104.3		%		80-120	15-JUN-16
WG2327376-3 MB								
Total Carbon by Combustion			<0.05		%		0.05	15-JUN-16
HG-200.2-CVAF-WP	Soil							
Batch R3479523								
WG2327478-3 CRM		**CANMET TILL-1**						
Mercury (Hg)			0.100		mg/kg		0.048-0.148	14-JUN-16
WG2327478-4 CRM		**PACS-3**						
Mercury (Hg)			102.7		%		70-130	14-JUN-16
WG2327478-5 DUP		**L1781394-1**						
Mercury (Hg)		0.337	0.321		mg/kg	4.8	40	14-JUN-16
WG2327478-2 LCS								
Mercury (Hg)			102.5		%		80-120	14-JUN-16
WG2327478-1 MB								
Mercury (Hg)			<0.050		mg/kg		0.05	14-JUN-16
K-AVAIL-SK	Soil							
Batch R3482495								
WG2327460-2 IRM		**FARM2005**						
Available Potassium			90.0		%		70-130	16-JUN-16
WG2327460-1 MB								
Available Potassium			<20		mg/kg		20	16-JUN-16
MET-200.2-MS-WP	Soil							
Batch R3479690								
WG2327003-3 CRM		**CANMET TILL-1**						
Aluminum (Al)			99.1		%		70-130	14-JUN-16
Antimony (Sb)			110.3		%		70-130	14-JUN-16
Arsenic (As)			108.1		%		70-130	14-JUN-16
Barium (Ba)			103.5		%		70-130	14-JUN-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	Soil							
Batch R3479690								
WG2327003-3 CRM		**CANMET TILL-1**						
Beryllium (Be)			100.3		%		70-130	14-JUN-16
Bismuth (Bi)			111.4		%		70-130	14-JUN-16
Cadmium (Cd)			97.7		%		70-130	14-JUN-16
Calcium (Ca)			104.6		%		70-130	14-JUN-16
Chromium (Cr)			102.5		%		70-130	14-JUN-16
Cobalt (Co)			101.7		%		70-130	14-JUN-16
Copper (Cu)			99.6		%		70-130	14-JUN-16
Iron (Fe)			96.7		%		70-130	14-JUN-16
Lead (Pb)			103.1		%		70-130	14-JUN-16
Magnesium (Mg)			99.5		%		70-130	14-JUN-16
Manganese (Mn)			102.1		%		70-130	14-JUN-16
Molybdenum (Mo)			97.7		%		70-130	14-JUN-16
Nickel (Ni)			103.1		%		70-130	14-JUN-16
Phosphorus (P)			108.2		%		70-130	14-JUN-16
Potassium (K)			98.2		%		70-130	14-JUN-16
Selenium (Se)			115.2		%		70-130	14-JUN-16
Silver (Ag)			115.9		%		70-130	14-JUN-16
Sodium (Na)			96.7		%		70-130	14-JUN-16
Strontium (Sr)			104.9		%		70-130	14-JUN-16
Thallium (Tl)			0.15		mg/kg		0.03-0.23	14-JUN-16
Tin (Sn)			94.7		%		70-130	14-JUN-16
Titanium (Ti)			87.7		%		70-130	14-JUN-16
Uranium (U)			113.8		%		70-130	14-JUN-16
Vanadium (V)			105.6		%		70-130	14-JUN-16
Zinc (Zn)			99.9		%		70-130	14-JUN-16
WG2327003-4 CRM		**PACS-3**						
Aluminum (Al)			103.4		%		70-130	14-JUN-16
Antimony (Sb)			124.4		%		70-130	14-JUN-16
Arsenic (As)			103.1		%		70-130	14-JUN-16
Barium (Ba)			72.6		%		70-130	14-JUN-16
Beryllium (Be)			128.5		%		70-130	14-JUN-16
Boron (B)			120.1		%		70-130	14-JUN-16
Cadmium (Cd)			100.7		%		70-130	14-JUN-16
Calcium (Ca)			120.7		%		70-130	14-JUN-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	Soil							
Batch R3479690								
WG2327003-4 CRM		**PACS-3**						
Chromium (Cr)			104.9		%		70-130	14-JUN-16
Cobalt (Co)			105.7		%		70-130	14-JUN-16
Copper (Cu)			106.0		%		70-130	14-JUN-16
Iron (Fe)			100.7		%		70-130	14-JUN-16
Lead (Pb)			114.0		%		70-130	14-JUN-16
Magnesium (Mg)			119.7		%		70-130	14-JUN-16
Manganese (Mn)			101.1		%		70-130	14-JUN-16
Molybdenum (Mo)			116.2		%		70-130	14-JUN-16
Nickel (Ni)			103.7		%		70-130	14-JUN-16
Phosphorus (P)			100.1		%		70-130	14-JUN-16
Potassium (K)			101.3		%		70-130	14-JUN-16
Selenium (Se)			1.07		mg/kg		0.51-1.51	14-JUN-16
Silver (Ag)			118.8		%		70-130	14-JUN-16
Sodium (Na)			107.0		%		70-130	14-JUN-16
Strontium (Sr)			106.8		%		70-130	14-JUN-16
Thallium (Tl)			0.34		mg/kg		0.23-0.43	14-JUN-16
Tin (Sn)			100.4		%		70-130	14-JUN-16
Titanium (Ti)			91.4		%		70-130	14-JUN-16
Uranium (U)			127.1		%		70-130	14-JUN-16
Vanadium (V)			107.5		%		70-130	14-JUN-16
Zinc (Zn)			103.1		%		70-130	14-JUN-16
WG2327003-2 LCS								
Aluminum (Al)			101.2		%		80-120	14-JUN-16
Antimony (Sb)			106.8		%		80-120	14-JUN-16
Arsenic (As)			104.5		%		80-120	14-JUN-16
Barium (Ba)			108.1		%		80-120	14-JUN-16
Beryllium (Be)			101.1		%		80-120	14-JUN-16
Bismuth (Bi)			103.1		%		80-120	14-JUN-16
Boron (B)			101.1		%		80-120	14-JUN-16
Cadmium (Cd)			103.0		%		80-120	14-JUN-16
Calcium (Ca)			107.7		%		80-120	14-JUN-16
Chromium (Cr)			105.7		%		80-120	14-JUN-16
Cobalt (Co)			105.0		%		80-120	14-JUN-16
Copper (Cu)			102.5		%		80-120	14-JUN-16

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	Soil							
Batch R3479690								
WG2327003-2 LCS								
Iron (Fe)			101.5		%		80-120	14-JUN-16
Lead (Pb)			105.1		%		80-120	14-JUN-16
Magnesium (Mg)			110.9		%		80-120	14-JUN-16
Manganese (Mn)			105.0		%		80-120	14-JUN-16
Molybdenum (Mo)			106.8		%		80-120	14-JUN-16
Nickel (Ni)			103.7		%		80-120	14-JUN-16
Phosphorus (P)			119.8		%		80-120	14-JUN-16
Potassium (K)			106.4		%		80-120	14-JUN-16
Selenium (Se)			106.7		%		80-120	14-JUN-16
Silver (Ag)			108.7		%		80-120	14-JUN-16
Sodium (Na)			105.0		%		80-120	14-JUN-16
Strontium (Sr)			108.1		%		80-120	14-JUN-16
Thallium (Tl)			96.9		%		80-120	14-JUN-16
Tin (Sn)			103.6		%		80-120	14-JUN-16
Titanium (Ti)			103.3		%		80-120	14-JUN-16
Uranium (U)			107.7		%		80-120	14-JUN-16
Vanadium (V)			106.7		%		80-120	14-JUN-16
Zinc (Zn)			100.4		%		80-120	14-JUN-16
WG2327003-1 MB								
Aluminum (Al)			<5.0		mg/kg		5	14-JUN-16
Antimony (Sb)			<0.10		mg/kg		0.1	14-JUN-16
Arsenic (As)			<0.10		mg/kg		0.1	14-JUN-16
Barium (Ba)			<0.50		mg/kg		0.5	14-JUN-16
Beryllium (Be)			<0.10		mg/kg		0.1	14-JUN-16
Bismuth (Bi)			<0.020		mg/kg		0.02	14-JUN-16
Boron (B)			<10		mg/kg		10	14-JUN-16
Cadmium (Cd)			<0.020		mg/kg		0.02	14-JUN-16
Calcium (Ca)			<100		mg/kg		100	14-JUN-16
Chromium (Cr)			<1.0		mg/kg		1	14-JUN-16
Cobalt (Co)			<0.020		mg/kg		0.02	14-JUN-16
Copper (Cu)			<1.0		mg/kg		1	14-JUN-16
Iron (Fe)			<25		mg/kg		25	14-JUN-16
Lead (Pb)			<0.20		mg/kg		0.2	14-JUN-16
Magnesium (Mg)			<10		mg/kg		10	14-JUN-16

Quality Control Report

Workorder: L1781394 Report Date: 24-JUN-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-MS-WP	Soil							
Batch R3479690								
WG2327003-1 MB								
Manganese (Mn)			<0.50		mg/kg		0.5	14-JUN-16
Molybdenum (Mo)			<0.020		mg/kg		0.02	14-JUN-16
Nickel (Ni)			<0.50		mg/kg		0.5	14-JUN-16
Phosphorus (P)			<100		mg/kg		100	14-JUN-16
Potassium (K)			<25		mg/kg		25	14-JUN-16
Selenium (Se)			<0.50		mg/kg		0.5	14-JUN-16
Silver (Ag)			<0.10		mg/kg		0.1	14-JUN-16
Sodium (Na)			<10		mg/kg		10	14-JUN-16
Strontium (Sr)			<0.10		mg/kg		0.1	14-JUN-16
Thallium (Tl)			<0.10		mg/kg		0.1	14-JUN-16
Tin (Sn)			<5.0		mg/kg		5	14-JUN-16
Titanium (Ti)			<0.50		mg/kg		0.5	14-JUN-16
Uranium (U)			<0.020		mg/kg		0.02	14-JUN-16
Vanadium (V)			<0.50		mg/kg		0.5	14-JUN-16
Zinc (Zn)			<10		mg/kg		10	14-JUN-16
MOIST-SK	Soil							
Batch R3479722								
WG2327270-1 DUP		**L1781394-1**						
% Moisture		92.8	91.1		%	1.9	20	15-JUN-16
N-TOTKJ-COL-SK	Soil							
Batch R3486371								
WG2329725-2 IRM		**08-109_SOIL**						
Total Kjeldahl Nitrogen			88.8		%		80-120	21-JUN-16
WG2329725-3 MB								
Total Kjeldahl Nitrogen			<0.020		%		0.02	21-JUN-16
N2/N3-AVAIL-KCL-SK	Soil							
Batch R3482594								
WG2327462-2 IRM		**SAL814**						
Nitrate+Nitrite-N			95.8		%		70-130	16-JUN-16
WG2327462-1 MB								
Nitrite-N			<1.0		mg/kg		1	16-JUN-16
Nitrate+Nitrite-N			<2.0		mg/kg		2	16-JUN-16
NH4-AVAIL-SK	Soil							

Quality Control Report

Workorder: L1781394 Report Date: 24-JUN-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NH4-AVAIL-SK	Soil							
Batch R3482481								
WG2327465-2 IRM		**SAL814**						
Available Ammonium-N			77.4		%		70-130	16-JUN-16
WG2327465-1 MB								
Available Ammonium-N			<1.0		mg/kg		1	16-JUN-16
OM-LOI-SK	Soil							
Batch R3483086								
WG2329956-3 IRM		**SAL2001**						
Organic Matter			101.5		%		80-120	17-JUN-16
Loss on Ignition @ 375 C			101.3		%		80-120	17-JUN-16
WG2329956-2 MB								
Organic Matter			<1.0		%		1	17-JUN-16
Loss on Ignition @ 375 C			<1.0		%		1	17-JUN-16
PH,EC-1:2-SK	Soil							
Batch R3482586								
WG2327470-2 IRM		**SAL814**						
Conductivity (1:2)			82.2		%		80-120	17-JUN-16
pH (1:2 soil:water)			8.17		pH		7.65-8.25	17-JUN-16
WG2327470-1 MB								
Conductivity (1:2)			<0.050		dS m-1		0.05	17-JUN-16
PO4-AVAIL-OLSEN-SK	Soil							
Batch R3482378								
WG2327477-2 IRM		**FARM2005**						
Available Phosphate-P			95.7		%		70-130	16-JUN-16
WG2327477-1 MB								
Available Phosphate-P			<1.0		mg/kg		1	16-JUN-16
SO4-AVAIL-SK	Soil							
Batch R3482035								
WG2327475-2 IRM		**SAL814**						
Available Sulfate-S			97.3		%		70-130	16-JUN-16
WG2327475-1 MB								
Available Sulfate-S			<4.0		mg/kg		4	16-JUN-16
SPECGRAV-CL	Soil							
Batch R3483558								
WG2330191-2 DUP		**L1781394-1**						
Specific Gravity		1.04	1.05		kg/L	1.0	20	20-JUN-16
WG2330191-1 IRM		**DI_H2O**						
Specific Gravity			102.0		%		90-110	20-JUN-16

Quality Control Report

Workorder: L1781394 Report Date: 24-JUN-16

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
CL-COL-SK	Waste							
Batch R3482533								
WG2328078-1 MB								
Chloride (Cl)			<1.0		mg/L		1	16-JUN-16
PH/EC-SK	Waste							
Batch R3480699								
WG2328078-1 MB								
Conductivity (EC)			<0.20		dS m-1		0.2	15-JUN-16
SAR-CALC-SK	Waste							
Batch R3481147								
WG2328078-1 MB								
Calcium (Ca)			<5.0		mg/L		5	16-JUN-16
Potassium (K)			<5.0		mg/L		5	16-JUN-16
Magnesium (Mg)			<5.0		mg/L		5	16-JUN-16
Sodium (Na)			<5.0		mg/L		5	16-JUN-16
Sulfur (as SO4)			<5.0		mg/L		5	16-JUN-16
SOLIDS-TOT/TOTVOL-SK	Manure							
Batch R3482763								
WG2327574-1 DUP		**L1781394-1**						
Total Solids		8.03	8.66		%	7.6	25	17-JUN-16
Total Volatile Solids (dry basis)		29.3	28.4		%	3.1	25	17-JUN-16

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

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.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1781394-COFC

COC Number: 15 - 571625

Page 1 of 1

Report To	Contact and company name below will appear on the final report	Report Format / Distribution		Turnaround Time (TAT) Requested
Company:	KGS GROUP	Select Report Format:	PDF EXCEL EDD (DIGITAL)	Regular [R]
Contact:	Kenton Thiessen	Quality Control (QC) Report with Report	YES NO	PRIORITY (Business Days): 4 day [P4] / 3 day [P3] / 2 day [P2]
Phone:	204-896-1209	Compare Results to Criteria on Report - provide details below if box checked		EMERGENCY: 1 Business day [E1] / Same Day, Weekend or Statutory holiday [E0]
	Company address below will appear on the final report	Select Distribution:	EMAIL MAIL FAX	Date and Time Required for all E&P TATs:
Street:	3rd Floor-865 Waverley Street	Email 1 or Fax	kthiessen@kgsgroup.com	For tests that can not be performed according to the service level selected, you will be contacted.
City/Province:	Winnipeg, MB	Email 2	pnguyen@kgsgroup.com	
Postal Code:	R3T 5P4	Email 3		
Invoice To	Same as Report To YES NO	Invoice Distribution		
	Copy of Invoice with Report YES NO	Select Invoice Distribution:	EMAIL MAIL FAX	
Company:	KGS Group	Email 1 or Fax	~~kthiessen@kgsgroup.com~~	
Contact:	Bill MacQuarrie	Email 2	WMacQuarrie@KGSGroup.com	

Project Information		Oil and Gas Required Fields (client use)	
ALS Account # / Quote #:	Q56403	AFE/Cost Center:	PO#
Job #:	16-0429-004	Major/Minor Code:	Routing Code:
PO / AFE:		Requisitioner:	
LSD:		Location:	
ALS Lab Work Order # (lab use only):		ALS Contact:	Sampler: J.O'Connor/A.Nuttall

Analysis Request

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	TKN	Nitrate - N	Nitrite - N	Avail Ammonium - N	Total Avail Nitrogen	Total Phosphorous	Total Solid, total Volatile	Moisture	Total Carbon	Avail. Potassium	Avail. Sulfate	Detailed Salinity	Specific Gravity	Metals	Number of Containers
	Primary	09-06-16	12:30	Sludge	X	X	X	X	X	X	X	X	X	X	X	X	X	X	66
	Secondary	09-06-16	13:15	Sludge	X	X	X	X	X	X	X	X	X	X	X	X	X	X	66

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report by clicking on the drop-down list below (electronic COC only)
Are samples taken from a Regulated DW System? YES NO	Lagoon Sludge
Are samples for human drinking water use? YES NO	

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen		SIF Observations	Yes	No	
Ice Packs	Ice Cubes	Custody seal intact	Yes	No	
Cooling Initiated					

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			14.4°C		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
AO'Connor	June 10, 2016	1015		10/06/16	10:15am			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

OCTOBER 2015 FRONT

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

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

APPENDIX C

GOVERNMENT CORRESPONDENCE

Shaun Moffatt

From: Page, Elaine (CWS) [Elaine.Page@gov.mb.ca]
Sent: Thursday, September 12, 2013 1:21 PM
To: smoffatt@kgsgroup.com
Subject: Souris River - Water Quality Data Request
Attachments: Souris River Water Quality Data.xlsx; SMoffatt.September 12 2013.doc

Hi Shaun. Please see attached for the water quality data request for the Souris River. As I mentioned on our call, there are three active water quality monitoring stations on the Souris River - these stations are located at Melita, Souris, and Wawanesa. The Melita station would be the most relevant for your intended application, but I have included the other two water quality stations for comparison.

The water quality stations located at Melita and Souris are monitored on a quarterly basis and the water quality station located at Wawanesa is monitored on a monthly basis. We initiated water quality monitoring at the Melita and Souris stations in 2006, so I have included all relevant data since 2006 at all three stations. Note that we increased our sampling frequency in 2011 at the Melita and Wawanesa stations in response to the flood. Also note that the water quality station at Wawanesa was formerly located at Treesbank (1973 to June 2011). However, the bridge at Treesbank was washed out during the flood of 2011 and the station was relocated to Wawanesa.

Please do not hesitate to contact me if you have any questions with respect to these data or if you require any further information.

Thanks,

Elaine

Elaine Page
A/Manager
Water Quality Management Section
Water Science and Management Branch
Manitoba Conseravtion and Water Stewardship
Suite 160, 123 Main Street
Winnipeg, Manitoba R3C 1A5
Phone: (204) 945-5344
Fax: (204) 948-2357

Conservation and Water Stewardship

Water Science and Management Branch
Suite 160, 123 Main Street, Winnipeg, Manitoba, Canada R3C 1A5
T 204-945-5344 **F** 204-948-2357
www.manitoba.ca/waterstewardship

September 12, 2013

Shaun Moffatt
KGS Group
3rd Floor – 865 Waverley St.
Winnipeg, MB R3T 5P4

WATER QUALITY DATA: Souris River Data Request

In accordance with your request, please find attached water quality data for the above mentioned water bodies. Should these data be used in a report, technical manuscript, or other document, would you please reference as follows:

Water Quality Management Section 2013
Manitoba Conservation and Water Stewardship
123 Main Street, Suite 160
Winnipeg MB R3C 1A5

Although we have taken all reasonable measures to ensure that the enclosed data are correct and free of errors, it is recommended that you review these data carefully in the context of your intended application. *Please direct any requests for these data from a third party to the undersigned.*

Should you have any questions with regard to this information or identify data that may be anomalous, please do not hesitate to contact me at the above address, by calling (204) 945-5344, Toll Free at 1-800-282-8069 (5344), or e-mail at Elaine.Page@gov.mb.ca.

Sincerely,

Elaine Page
Manitoba Conservation and Water Stewardship

WATER QUALITY IN THE SOURIS RIVER EAST OF MELITA ON HWY#3 (STATION NO. MB05NFS024)

YEAR	MONTH	DAY	AMMONIA (NH3)	CARBON TOTAL INORGANIC	CARBON TOTAL ORGANIC (CALCD_)	CARBON TOTAL	COLOUR TRUE	CONDUCTIVITY (AT 25C)	E_ COLI	HARDNESS TOTAL (CALCD_) CACO3	NITROGEN DISSOLVED NO3 & NO2	NITROGEN TOTAL KJELDAHL (TKN)	OXYGEN BIOCHEMICAL DEMAND	OXYGEN DISSOLVED	PHOSPHOROUS-TOTAL-ACID REACTIVE	PHOSPHOROUS-TOTAL-ORTHO	PHOSPHORUS DISSOLVED ORTHO	PHOSPHORUS PARTICULATE (CALCD_)	PHOSPHORUS TOTAL (P)	PHOSPHORUS TOTAL DISSOLVED	PHOSPHORUS TOTAL INORGANIC	PH	TOTAL DISSOLVED SOLIDS	TOTAL SUSPENDED SOLIDS	TURBIDITY
			mg/L	mg/L	mg/L	mg/L	CU	US/CM	CFU/100 mL	MG/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MG/L	pH units	MG/L @180C	mg/L	Ntu
2006	7	26	<0.01	46	34	80	52	1300		307	0.12	4.1		7.5				0.444	0.532	0.088		9.43	960	39	28
2006	8	30	0.06	69	41	110	82	1580		325	<0.01	4.3		5.7				0.271	0.598	0.327		8.98	1150	43	18.6
2006	12	14	1.29	125	21	146	44	1810		519	0.2	4.7		7.6				0.162	0.445	0.283		7.86	1180	7	5.4
2007	5	9	0.04	56	17	72	20	968		303	0.01	2	5	11.2		0.043		0.174	0.304	0.13		8.55	592	21	11
2007	10	15	0.04	73	22	95	49	1470		383	<0.01	2.6	3	9.2		0.024		0.089	0.145	0.056		8.54	1060	16	13.2
2008	1	22	1.18	135	26	161	38	2640	<10	748	<0.01	3.8	4	1.6		0.138		0.26	0.415	0.155		7.69	1420	6	9.7
2008	4	29	0.06	39	11	50	17	721		262	<0.01	2.26	5	13		0.029		0.06	0.141	0.081		8.92	471	22	9.6
2008	7	22	0.05	68	26	94	33	1780		471	<0.01	2.7	4	7		0.21		0.105	0.33	0.225		8.97	1270	13	8.4
2008	10	7	0.07	100	42	143	54	1940		424	<0.01	3.3	7	8.1		0.036		0.162	0.305	0.143		8.77	1280	32	11.5
2009	1	20	3.52	173	39	212	54	2880	<10	763	0.28	9.6	27	0.3		0.434		0.752	1.04	0.288		7.7	1900	28	15.8
2009	4	16	0.146	30.9	18	48.9	60	450	<10	156	0.139	1.87	5.8	7.9			0.181	0.079	0.345	0.221	0.3	8.26	296	83	40
2009	7	14	0.055	70.5	21.1	91.5	60	998	<10	323	0.018	1.45	1.2	7.1			0.203	1	2.71	1.71	2.71	8.78	726	8	6
2009	10	6	0.16	102	22.8	124	60	1480	61	401	0.108	2.14	2	8.2			0.205	0.004	0.264	0.224	0.228	8.53	1040	21	24
2010	1	19	0.16	180	31.8	211	60	2370	<10	729	0.127	2.51	1.8	2.7			0.142	0.019	0.191	0.172	0.191	7.99	1690	8	9.6
2010	4	15	0.0188	43.8	17.7	61.5	60	681	<10	251	<0.006	2.33	7.5	9			0.0199	0.15	0.349	0.0515	0.201	8.55	478	54	33.9
2010	7	5	0.0589	69.3	21.4	90.7	75	990		346	0.021	1.79	1.9	4.7			0.386	<0.003	0.494	0.422	0.479	8.26	690	31	13.9
2010	10	7	0.0376	82.3	17.7	100	30	1250	70	378	<0.006	1.75	1.6	1.6			0.132	0.063	0.207	0.144	0.171	8.62	884	27	14.4
2011	1	11	0.422	125	23.3	148	28.1	1620	<10	637	0.294	1.95	1.5	1.8			0.183	0.06	0.224	0.164	0.215	8.04	1310	12	4.78
2011	4	11	0.142	38.2	15.2	53.4	71	583	40	196	0.45	1.88	5.6	9.4	0.253			0.17	0.403	0.233	0.358	8.08	366	77	34.1
2011	6	28	0.107	48.2	20.4	68.6		776	20		0.108	1.74	2.1		0.385			0.057	0.532	0.475	0.48	8.05		10	
2011	6	30	0.147	56	18.7	74.8		792			0.063	1.77	1.7		0.383			0.026	0.536	0.51	0.517	8.04		69	
2011	7	7	0.078	56	17.8	73.8		798	<10		<0.05	1.72	1.4		0.331				0.436	0.44	0.407	8.13		18	
2011	7	12	0.153	20.6	10.1	30.8		735	10		<0.05	1.68	2.4		0.414			0.076	0.601	0.525	0.5	8.06		8	
2011	7	19	0.146	53.7	18.2	71.9		701	10		0.194	1.29	2.1		0.485			0.015	0.569	0.554	0.581	8.04		7	
2011	7	21	0.186	52.9	18.2	71.1		700	<10		0.196	2	1.6		0.572			0.038	0.623	0.585	0.58	8.13		8	
2011	7	26	0.094	56.2	18.3	74.5		710	<10		0.234	1.97	2.8		0.568			0.066	0.618	0.552	0.58	8.45		16	
2011	7	28	0.083	56.2	17.8	74.1		698	10		0.057	1.98	1.4		0.437			0.032	0.516	0.484	0.473	8.22		20	
2011	8	4	0.101	60	18.9	78.9		713	<10		0.087	1.89	2.6		0.484			0.091	0.771	0.68	0.741	8.48		20	
2011	8	11	0.078	63	18.5	81.5		730	<10		0.09	1.6	2.7		0.641			0.063	0.702	0.639	0.687	8.19		10	
2011	8	18	0.073	64.2	19.2	83.4		760	<10		<0.05	2.1	1.8		0.543			0.084	0.618	0.534	0.61	8.28		71	
2011	8	25	0.027	68.5	19.5	88		763	<10		<0.05	1.88	2.1		0.501			0.035	0.57	0.535	0.535	8.3		23	
2011	9	1	0.066	73.7	18.8	92.5		876	10		<0.05	2.11	2.3		0.475			0.081	0.584	0.503	0.57	8.27		27	
2011	10	13	0.04	79.9	17.3	97.2	40.5	1000	10	330	<0.05	2.27	3.7	8.4	0.145			0.156	0.284	0.128	0.226	8.55	736	93.3	51.3
2012	1	24	0.028	106	18.4	125	27.5	1310	<10	591	0.178	2.18	3.2	11.6	0.054			0.076	0.141	0.065	0.115	8.4	1010	13	10.5
2012	4	16	0.018	48.9	16.4	65.4	24.1	929	<10		<0.05	1.74	4.9	9.3	0.078			0.064	0.13	0.066	0.141	8.3	672	36	22.8
2012	7	3	0.091	81.4	19.6	101	40	1390	<10			1.91	1.9	5.7	0.274			0.059	0.375	0.316	0.38	8.65	1090	53	26.9
2012	10	4	0.126	54.3	25.5	79.8	43.1	1660	<10		0.226	2.8	2.8	8.9	0.331			0.076	0.384	0.308	0.343	9.28	1180	35	30.5

WATER QUALITY IN THE SOURIS RIVER AT PTH#22 AT SOURIS (STATION NO. MB05NGS004)

YEAR	MONTH	DAY	AMMONIA (NH3)	CARBON TOTAL INORGANIC	CARBON TOTAL ORGANIC (CALCD_)	CARBON TOTAL	COLOUR TRUE	CONDUCTIVITY (AT 25C)	E_ COLI	HARDNESS TOTAL (CALCD_) CACO3	NITROGEN DISSOLVED NO3 & NO2	NITROGEN TOTAL KJELDAHL (TKN)	OXYGEN BIOCHEMICAL DEMAND	OXYGEN DISSOLVED	PHOSPHOROUS-TOTAL-ACID REACTIVE	PHOSPHOROUS-TOTAL-ORTHO	PHOSPHORUS DISSOLVED ORTHO	PHOSPHORUS PARTICULATE (CALCD_)	PHOSPHORUS TOTAL (P)	PHOSPHORUS TOTAL DISSOLVED	PHOSPHORUS TOTAL INORGANIC	PH	TOTAL DISSOLVED SOLIDS	TOTAL SUSPENDED SOLIDS	TURBIDITY
			mg/L	mg/L	mg/L	mg/L	CU	US/CM	CFU/100 mL	MG/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MG/L	pH units	MG/L @180C	mg/L	Ntu
2006	7	26	<0.01	73	24	97	44	1240		389	<0.01	3.9		11.2				0.326	0.412	0.086		8.92	907	30	25.8
2006	8	30	0.25	73	28	101	65	1380		345	0.03	3.3		5.7				0.079	0.807	0.728		8.43	967	21	19.4
2006	12	14	0.18	111	25	136	37	1720		465	0.05	2.7		7.5				0.05	0.13	0.08		8.21	1190	6	6
2007	5	9	0.04	51	16	67	29	1030		325	0.02	1.3	2	8.1		0.069		0.061	0.165	0.104		8.32	668	10	7.8
2007	10	15	0.04	72	14	86	38	1170		386	<0.01	1.7	3	11		0.063		0.081	0.134	0.053		8.44	839	6	5.9
2008	1	22	0.86	135	23	158	39	1980	<10	734	0.49	3	2	3.7		0.145		0.06	0.195	0.135		7.66	1870	1	4.7
2008	4	29	0.06	62	13	74	17	1350		433	<0.01	1.6	3	10.7		0.014		0.061	0.127	0.066		8.53	931	11	6.1
2008	7	22	0.28	67	28	95	33	1600		521	0.01	3.2	8	8		0.174		0.065	0.279	0.214		8.8	1170	4	3.4
2008	10	7	0.06	80	32	112	23	1780		444	<0.01	2.1	1	7.8		0.055		0.029	0.125	0.096		8.74	1200	8	1.8
2009	1	20	0.93	132	28	160	32	1880	<10	588	0.16	2.6	2	1.9		0.239		0.071	0.32	0.249		7.62	1290	3	3.5
2009	4	16	0.118	24.4	17.5	41.9	60	311	10	119	0.148	1.65	4.3	8.6			0.182	0.118	0.333	0.22	0.338	8.21	210	65	35
2009	7	14	0.056	72.5	19.3	91.9	60	993	<10	336	0.0406	1.32	<1	6.8			0.277	<0.001	1.57	1.62	1.57	8.62	744	6	6.9
2009	10	6	0.0058	102	22.5	124	60	1460	10	412	0.17	1.9	2	8			0.227	0.02	0.304	0.265	0.285	8.57	936	7	8.5
2010	1	19	0.437	132	20.5	153	40	1700	<10	555	0.338	2.01	1.1	3.4			0.127	0.028	0.162	0.134	0.162	7.95	1200	<5	7.7
2010	4	15	0.0228	41.1	15.6	56.8	60	621	<10	227	<0.006	1.71	5.8	10.4			0.0483	0.089	0.268	0.074	0.163	8.52	432	42	19.5
2010	7	5	0.0823	60.4	26.6	87	50	939		326	0.0532	1.84	1.9	4.2			0.464	<0.003	0.601	0.516	0.569	8.27	648	54	19.8
2010	10	7	0.0479	84.4	17.5	102	40	1240	20	375	0.0545	1.49	1.9	8.2			0.164	0.034	0.21	0.176	0.188	8.62	864	21	11.9
2011	1	11	0.423	119	22	141	31.9	1550	140	570	0.173	1.88	1.2	1.8			0.204	0.049	0.258	0.209	0.235	8.05	1180	7	4.31
2011	4	11	0.307	52.4	15.4	67.8	53.4	847	50	344	0.384	1.92	3.1	10	0.317			0.113	0.416	0.303	0.378	8.16	598	35	17.8
2011	10	13	0.171	83.5	17.2	101	43.1	1010	30	352	0.174	2.13	2.3	6.1	0.19			0.104	0.28	0.176	0.248	8.47	738	91.3	53.9
2012	1	24	0.094	91.5	16.3	108	23.8	1150	<10	501	0.257	1.72	2.9	10.6	0.063			0.066	0.142	0.076	0.117	8.42	856	15	11.1
2012	4	16	0.027	53.2	14.7	67.9	21.6	922	<10		0.083	1.83	4.9	8.3	0.036			0.093	0.14	0.047	0.142	8.3	672	30	20.2
2012	7	3	0.036	79.2	19.3	98.5	35.9	1390	<10			2.8	4.2	6.2	0.207			0.203	0.455	0.252	0.424	8.52	1090	64	32.9
2012	10	4	0.102	79.2	23	102	34.2	1450	20		0.094	2.77	4.1	0.4	0.121			0.162	0.255	0.093	0.192	8.53	1070	46	28.8

Shaun Moffatt

From: Biggin, Wade (CWS) [Wade.Biggin@gov.mb.ca]
Sent: Monday, September 30, 2013 11:36 AM
To: 'Shaun Moffatt'
Subject: SOURIS RIVER AND GRAHAM CREEK
Attachments: shaun_moffatt_fihcs_20130930.pdf

FIHCS - Fisheries Inventory & Habitat Classification System

Waterbody: Graham Creek

Provincial Waterbody Id #	Watershed	Region	District	Map Sheet	Latitude:	49 15 36
2184.00	5NFC	Western	Virden	62F07	Longitude:	100 59 15

Habitat Suitability

Seasonal Habitat Suitability*

All	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	None

*The month(s) the waterbody is useable for fish Habitat (without human intervention)

Resource Access

Resource	Distance (km)

Habitat Classifications

Habitat Class	Class

*

General Uses

General Use	Harvest Weight

Needed Improvements

Year	Improvements	Comments
2001		Occupies narrow, shallow, meandering valley extensively grazed to banks (Neilson 1977). Occasional white sucker dipnetting (Neilson 1977)
2005	The creek has little flow and appears to have been dry recently (June 1, 2004). There is lots of woody debris in the creek.	
	1999 Milani's "2002-2004 Agricultural Drain Inventory" in addition to Barbour et al. which may also be found online at http://www.epa.gov/OWOW/monitoring/techmon.html	
	1999 Note: Milani conducted a visual-based habitat assessment on this waterbody. The parameters of this assessment are outlined in (continued)	"Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition" by Barbour, Gerritsen, Snyder and Stribling. For the condition category of each habitat parameter consult (continued)

BIOLOGY

	Presence
FATHEAD MINNOW *Pimephales promelas*	Unknown
NORTHERN PIKE *Esox lucius*	Unknown
WHITE SUCKER *Catostomus commersoni*	Unknown

Creel

Year	Species	Catch/Unit Effort*

*Catch/Unit Effort = Catch/Hour

Waterbody: Souris River

Provincial Waterbody Id #	Watershed	Region	District	Map Sheet	Latitude:	49 39 51
2527.00	5NGA	Western	Brandon	62G12	Longitude:	99 34 17

Habitat Suitability

Seasonal Habitat Suitability*

All Y	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	None

*The month(s) the waterbody is useable for fish Habitat (without human intervention)

Resource Access

Resource	Distance (km)
Aircraft on Floats	0
Aircraft on Wheels	5
All Season Road	0
Electrical Power	0
Seasonal Road	0

Habitat Classifications

Habitat Class	Class
Classification based on habitat rating	Class 4
Condition of the waterbody 5 years ago	Class 4
Intuitive classification of the waterbody	Class 4
Predicted classification in 5 years	Class 4
Predicted classification in 5 years if controlled	Class 3
Rating of the best waterbody in the same or adjacent watershed	Class 2

*Interbasin management is critical, need more winter water. U.S. has to supply 20cfs from June to October but has no obligation to provide any flow during the remaining months.

General Uses

General Use	Harvest Weight
Recreational Angling	6587

Needed Improvements

Year	Improvements	Comments
1994	The invading stonecats and native longnose dace share similar habitat preferences. Both prefer medium to large streams/rivers with relatively fast water and a rocky substrate (riffle habitat).	McCulloch examines the dispersal and interactions of the stonecat.
2001		Test netted - Sept. 1/92.
	1999 Note: Milani conducted a visual-based habitat assessment on this waterbody. The parameters of this assessment are outlined in (continued)	"Rapid Bioassessment Protocols For Use in Streams and Wadeable Rivers: Periphyton, Benthic Macroinvertebrates, and Fish, Second Edition" by Barbour, Gerritsen, Snyder and Stribling. For the condition category of each habitat parameter consult (continued)
	1999 Milani's "2002-2004 Agricultural Drain Inventory" in addition to Barbour et al. which may also be found online at http://www.epa.gov/OWOW/monitoring/techmon.html .	

Waterbody: Souris River

Provincial Waterbody Id #	Watershed	Region	District	Map Sheet	Latitude:	49 39 51
2527.00	5NGA	Western	Brandon	62G12	Longitude:	99 34 17

BIOLOGY

	Presence
BIGMOUTH SHINER *Notropis dorsalis*	Unknown
BLACK BULLHEAD *Ictalurus melas*	Common
BLACKCHIN SHINER *Notropis heterodon*	Unknown
BLACKNOSE DACE *Rhinichthys atratulus*	Unknown
BLACKNOSE SHINER *Notropis heterolepis*	Unknown
BLACKSIDED DARTER *Percina maculata*	Unknown
BRASSY MINNOW *Hybognathus hankinsoni*	Unknown
BROOK STICKLEBACK *Culaea inconstans*	Common
BROOK TROUT *Salvelinus fontinalis*	Extirpated
BROWN BULLHEAD *Ictalurus nebulosus*	Unknown
BURBOT *Lota lota*	Unknown
CARP *Cyprinus carpio*	Common
CENTRAL MUDMINNOW *Umbra limi*	Unknown
CHESTNUT LAMPREY *Ichthyomyzon castaneus*	Unknown
COMMON SHINER *Notropis cornutus*	Common
CREEK CHUB *Semotilus atromaculatus*	Unknown
EMERALD SHINER *Notropis atherinoides*	Unknown
FATHEAD MINNOW *Pimephales promelas*	Common
FLATHEAD CHUB *Platygobio gracilis*	Unknown
FRESHWATER DRUM *Aplodinotus grunniens*	Unknown
GOLDEYE *Hiodon alosoides*	Unknown
IOWA DARTER *IOWA DARTER exile*	Unknown
JOHNNY DARTER *Etheostoma nigrum*	Unknown
LAKE CHUB *Couesius plumbeus*	Unknown
LAKE WHITEFISH *Coregonus clupeaformis*	Unknown
LONGNOSE DACE *Rhinichthys cataractae*	Unknown
LONGNOSE SUCKER *Catostomus catostomus*	Unknown

Creel

Year	Species	Catch/Unit Effort*
1976	Northern Pike	0.44
	Walleye	0.04
	Yellow Perch	0.01

*Catch/Unit Effort = Catch/Hour

Waterbody: Souris River

Provincial Waterbody Id #	Watershed	Region	District	Map Sheet	Latitude:	49 39 51
2527.00	5NGA	Western	Brandon	62G12	Longitude:	99 34 17

MOONEYE *Hiodon tergisus*	Unknown
NINESPINE STICKLEBACK *Pungitius pungitius*	Unknown
NORTHERN PIKE *Esox lucius*	Unknown
NORTHERN REDBELLY DACE *Chrosomus eos*	Unknown
PEARL DACE *Semotilus margarita*	Unknown
RAINBOW TROUT *Salmo gairneri*	Extirpated
RIVER SHINER *Notropis blennius*	Unknown
ROCK BASS *Amblopites rupestris*	Unknown
SAND SHINER *Notropis stramineus*	Unknown
SAUGER *Stizostedion canadense*	Unknown
SHORTHEAD REDHORSE *Moxostoma*	Unknown
SILVER REDHORSE *Moxostoma anisurum*	Unknown
SLIMY SCULPIN *Cottus cognatus*	Unknown
SMALLMOUTH BASS *Micropterus dolomieui*	Unknown
SPOTTAIL SHINER *Notropis hudsonius*	Unknown
STONECAT *Noturus flavus*	Unknown
TADPOLE MADTOM *Noturus gyrinus*	Unknown
TROUT PERCH *Percopsis omiscomaycus*	Unknown
WALLEYE *Stizostedion vitreum*	Unknown
WHITE SUCKER *Catostomus commersoni*	Unknown
YELLOW PERCH *Perca flavescens*	Unknown

Gene Senior

From: Friesen, Chris (SD) <Chris.Friesen@gov.mb.ca>
Sent: July-15-16 10:46 AM
To: 'Gene Senior'
Subject: RE: CDC data request: Melita biosolids application
Attachments: Melita SAR.xlsx

Gene

Thank you for your information request. I completed a search of the Manitoba Conservation Data Centre's rare species database for your area of interest.

I am attaching an excel table summarizing these occurrences. The table includes scientific and common names, the provincial (SRank) rank for each species as well as MB Endangered Species and Ecosystem Act, COSEWIC and SARA designations. Further information on this ranking system can be found on our website at http://www.gov.mb.ca/conservation/cdc/consranks.html and these designations can be found at http://web2.gov.mb.ca/laws/statutes/ccsm/e111e.php, http://www.cosewic.gc.ca/ and http://www.sararegistry.gc.ca/default_e.cfm.

Manitoba's recommended setback distances can be found at http://www.gov.mb.ca/conservation/cdc/pubs.html

The information provided in this letter is based on existing data known to the Manitoba Conservation Data Centre of the Wildlife and Ecosystem Protection Branch at the time of the request. These data are dependent on the research and observations of our scientists and reflects our current state of knowledge. An absence of data does not confirm the absence of any rare or endangered species. Many areas of the province have never been thoroughly surveyed, therefore, the absence of data in any particular geographic area does not necessarily mean that species or ecological communities of concern are not present. The information should not be regarded as a final statement on the occurrence of any species of concern, nor should it substitute for on-site surveys for species or environmental assessments. Also, because our Biotics database is continually updated and because information requests are evaluated by type of action, any given response is only appropriate for its respective request.

Please contact the Manitoba CDC for an update on this natural heritage information if more than six months passes before it is utilized.

Third party requests for products wholly or partially derived from our Biotics database must be approved by the Manitoba CDC before information is released. Once approved, the primary user will identify the Manitoba CDC as data contributors on any map or publication using data from our database, as the Manitoba Conservation Data Centre; Wildlife & Fisheries Branch, Manitoba Conservation and Water Stewardship.

This letter is for information purposes only - it does not constitute consent or approval of the proposed project or activity, nor does it negate the need for any permits or approvals required by the Province of Manitoba.

We would be interested in receiving a copy of the results of any field surveys that you may undertake, to update our database with the most current knowledge of the area.

If you have any questions or require further information contact me directly at (204) 945-7747.

Chris Friesen
Coordinator
Manitoba Conservation Data Centre

204-945-7747
chris.friesen@gov.mb.ca
http://www.manitoba.ca/conservation/cdc/

From: Gene Senior [mailto:GSenior@kgsgroup.com]
Sent: July-07-16 10:43 AM
To: Friesen, Chris (SD)
Subject: CDC data request: Melita biosolids application

Chris:

KGS Group is conducting an Environment Act Proposal and Land Suitability Assessment for the land application of bio-solids for the Town of Melita sewage lagoon. We are requesting information regarding the locations of any plant, wildlife or aquatic Species at Risk occurrences on or near the project land. The information will be used to assess potential project impacts on species at risk and their habitat (if any) and to develop appropriate mitigation measures and follow-up.

The properties that will be affected by the project are as follows:
NW 25-3-27W
NE 36-3-27W
SE 36-3-27W
NE 26-3-27W
NW 26-3-27W
SE 26-3-27W
SW 26-3-27W

Our preference is to receive the data by email and for the data to be presented in Microsoft Excel Spreadsheet (providing the location of each occurrence).

Thanks!

Gene Senior <gsenior@kgsgroup.com>
Environmental Scientist

KGS GROUP CONSULTING ENGINEERS

865 Waverley Street
Winnipeg, Manitoba R3T 5P4
p. 204.896.1209 ext. 357
c. 204.218.3285
f. 204.896.0754
http://www.kgsgroup.com

Scientific Name	Common Name	S Rank	ESEA	SARA	COSEWIC	NW 25-3-27W	NE 36-3-27W	SE 36-3-27W	NE 26-3-27W	NW 26-3-27W	SE 26-3-27W	SW 26-3-27W
Lithobates pipiens	Northern Leopard Frog	S4		Special Concern	Special Concern		X					
Calcarius ornatus	Chestnut-collared Longspur	S2B	Endangered	Threatened	Threatened						X	
Anaxyrus cognatus	Great Plains Toad	S2	Threatened	Special Concern	Special Concern						X	X

Gene Senior

From: McClean, Heather (SCH) <Heather.McClean@gov.mb.ca>
Sent: July-08-16 10:06 AM
To: 'Gene Senior'
Subject: RE: Heritage data request: Melita biosolids application

Gene – a search of the database reveals that there are no KNOWN heritage/archaeology sites located within the project area.

Heather McClean
Heritage Resources Registrar
Historical Assessment Services
Historic Resources Branch
Main Floor, 213 Notre Dame Avenue
Winnipeg MB R3B 1N3
Heather.McClean@gov.mb.ca
Phone: (204) 945-7146
Fax: (204) 948-2384

From: Gene Senior [mailto:GSenior@kgsgroup.com]
Sent: July-07-16 10:43 AM
To: McClean, Heather (SCH)
Subject: Heritage data request: Melita biosolids application

Heather:

KGS Group is conducting an Environment Act Proposal and Land Suitability Assessment for the land application of bio-solids for the Town of Melita sewage lagoon. We are requesting a location and description of any known heritage or archaeological resources located on or near the project land. The information will be used to assess potential project impacts on heritage and archaeological resources (if any) and to develop appropriate mitigation measures and follow-up.

The properties that will be affected by the project are as follows:
NW 25-3-27W
NE 36-3-27W
SE 36-3-27W
NE 26-3-27W
NW 26-3-27W
SE 26-3-27W
SW 26-3-27W

Our preference is to receive the data by email and for the data to be in Excel or ArcView format (or PDF mapsheet).

If you have any questions don't hesitate to contact me, thanks.

Gene Senior <gsenior@kgsgroup.com>
Environmental Scientist