



CITY OF WINNIPEG
REPORT NUMBER: 619-2016

CITY OF WINNIPEG BIOSOLIDS LAND APPLICATION PROGRAM ANNUAL SUMMARY REPORT 2021

JANUARY 31, 2022

FINAL





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CITY OF WINNIPEG

FINAL REPORT

PROJECT NO.: 17M-00008-03

CLIENT REF: 619-2016

DATE: JANUARY 31, 2022

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January 31, 2022

FINAL

CITY OF WINNIPEG
Wastewater Services Division, Water and Wastewater Department
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Winnipeg, MB R2V 4T8

Attention: Mr. Matthew Klowak, Wastewater Contracts Officer

Dear Mr. Klowak:

Subject: City of Winnipeg Biosolids Land Application Program –2021 Summary of Activities Report
Client ref.: 619-2016

WSP Canada Inc. (WSP) was retained by the City of Winnipeg, Water and Waste Department to complete their 2021 biosolids land application program.

Please accept the submission of this annual summary report in support of the project:

— City of Winnipeg Biosolids Land Application, 2021 Summary Report of Activities, January 31, 2022, Prepared for: City of Winnipeg. Prepared by: WSP Canada Inc.

If you have any questions or concerns, please contact the undersigned at your convenience at (204) 259-1488 or Darren.keam@wsp.com.

Yours sincerely,


Darren Keam, M.Sc., P.Ag.
Regional Manager, Earth and Environment

DS/dk
Encl.
cc: Robert Boswick, Manitoba Conservation and Climate, Environmental Approvals Branch
WSP ref.: 17M-00008-04

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This limitations statement is considered an integral part of this report.

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EXECUTIVE SUMMARY

In 2016-2017, the City of Winnipeg (City) commenced development of a full scale Biosolids Land Application Program (Program) that involves the annual spreading of Class B biosolids onto local farmland. The land application is an environmentally sustainable practice that supplies valuable nutrients for crop production and provides an opportunity to reuse wastewater biosolids.

The goal of the Program is to conduct biosolids land application in a manner that maximizes beneficial use of biosolids, minimizes the associated environmental and health risks, and that complies with all applicable regulations. As such, the Program has been designed to be allied with cooperating farm producer fertilization and crop management practices and implements beneficial management practices such as good neighbour practices.

Three agricultural fields within the Rural Municipality (RM) of Macdonald were put forward by two participating agricultural producers to receive land application of biosolids in 2021 including:

- Field 1 (260 hectares in size) entire Section 15, Township 09, Range 01WPM;
- Field 2 (260 hectares in size) entire Section 14, Township 09, Range 01WPM.
- Field 3 (40 hectares) on Section 05, Township 10, Range 01EPM in the Rural Municipality of Macdonald to meet obligations made to a farm producer in 2020; the biosolids were direct hauled and land applied, i.e. no on-site storage of biosolids occurred at this field in 2021.

The year 2021, marked the fourth year of the full-scale Program that included:

- In-field stockpiling and storage of the biosolids materials on agricultural land where land application is to take place for a given year.
 - Two biosolids storage site was established for the 2021 program; for Field 1 the storage area was located at the SE side of the Section along Mile Road 2W and for Field 2 the storage area was located at the southwest corner of the Section off Mile Roads 2W and 50N. A berm was formed around the perimeter of the in-field storage areas consisting of round straw bales. Straw material was blown on the ground surface in the storage areas prior to stockpiling of biosolids for leachate management and was also applied over the biosolids each evening after deliveries to cap the biosolids to ensure odour and vector control.
 - Biosolids were first deposited within the storage area on Field 2 on June 7, 2021 with delivery continuing over approximately 14 weeks with the last load of biosolids received at the Field 2 storage area on September 13. The storage site on Field 1 was established on September 11, 2021 with delivery continuing over approximately six weeks with the last load of biosolids received at the Field 1 storage area on October 22. Approximately 16,931 wet tonnes of biosolids were delivered and stockpiled at the storage sites in 2021.
 - In addition to the biosolids stored at the two in-field storage sites, forty-seven truck loads (881 wet tonnes) of biosolids were hauled and direct land applied over the dates of September 15, 16, 22 and 23 to the cooperating farm producer's field site located off La Verendrye Road on SE-05-10-01EPM to complete the application to that cooperating farm producer's land base from the 2020 program.
- Odour assessments of the biosolids storage site at Field 2 were continued in 2021 following the protocol established since 2017 for the Program.
 - Odour assessments were completed on five separate dates at the stockpile site. Typically, the strongest odour levels were detected within 5-10 metres from the biosolids stockpiles. The overall average odour assessment ratings ranged from 0.1 to 1.76 (no odour to annoying).
 - In 2021, an odour assessment was also completed at mile road sites during land application on September 14 for Field 2 and October 22 for Field 1 to assess odour levels that may be experienced by neighbors during land application. Highest odour level recorded was 2 (annoying) at locations adjacent to application fields.

- Biosolids land application after crop harvest onto agricultural fields at agronomic rates that matched crop uptake of nutrients.
 - A total of 16,931 wet tonnes of biosolids materials were land applied in 2021 onto 560 hectares of agricultural land (three agricultural fields) within the Rural Municipality of Macdonald.
- The fulfillment of monitoring and reporting requirements as outlined in the City’s Notice of Alteration to their Environment Act License No. 1089E RR including completion of:
 - Soil sample collection and biosolids quality assessment for development and submission of land application prescription rates for biosolids;
 - Soil monitoring of agricultural fields that previously received biosolids as part of the Program (including year 3 post-application);
 - Submission of monthly summary reports to Manitoba Conservation and Climate, Environmental Approvals Branch.



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1 INTRODUCTION

1.1 BACKGROUND

As part of the City of Winnipeg's (City) Biosolids Master Plan (2014) to reuse biosolids in an environmentally sustainable manner, the City initiated a new Biosolids Land Application Program (Program) in 2017 under a pilot project. Since the completion of the pilot project, the City has continued with a full-scale Program that involves the spreading of Class B biosolids² on farmland located primarily to the west of the City's municipal boundary (within approximately 50-60 kilometers [km] of the City) in the Rural Municipalities (RM) of Rosser and Macdonald.

Biosolids are a nutrient-rich, solid by-product of wastewater treatment. Applying biosolids to local farmland supplies valuable nutrients for crop production and provides an opportunity to reuse wastewater biosolids instead of disposing of them in a landfill.

The goal of the Program is to provide a means of reusing a portion of the annual biosolids produced by the City in an environmentally sustainable manner through land application that maximizes beneficial use of biosolids, minimizes the associated environmental and health risks, and that complies with all applicable regulations. As such, the Program has been designed to be allied with cooperating farm producers' fertilization and crop management programs while also implementing beneficial management practices that include good neighbour policies.

An Environment Act Proposal (EAP) was submitted in 2017 to the Manitoba Conservation and Climate (MCC) Environment Approvals Branch (EAB) for an Environment Act License (EAL) in support of the Biosolids Land Application Program. Pending approval of a new EAL by MCC, land application of biosolids is occurring under an annual Notice of Alteration (NoA) to the City's pre-existing EAL No. 1089E RR.

This year (2021), marked the fourth year of the full-scale Program that included:

- In-field stockpiling and storage of the biosolids materials on agricultural land in the immediate vicinity of where land application is to take place;
- The land application of the biosolids after harvest onto agricultural fields at agronomic rates that match crop uptake of nutrients; and,
- The fulfillment of monitoring and reporting requirements as outlined in the Program's 2021 NoA to EAL No. 1089E RR.

1.2 OBJECTIVE

The purpose of this report is to provide the City and the Regulator (MCC) with a summary of activities undertaken in 2021 in support of the City's Biosolids Land Application Program including for the:

- Temporary field storage and stockpiling of biosolids;
- Application prescription rates for the land application of the biosolids;
- Biosolids volumes applied;
- Field observations collected for the 2021 application season; and,
- Soil monitoring of fields utilized in prior years for the Program as per regulatory requirements.

² The US Environmental Protection Agency (EPA) guidelines refer to different categories of biosolids: Exceptional Quality, Class A and Class B. The difference between Class A and Class B biosolids is the level of pathogens. Class A biosolids are treated to a greater degree and have less pathogens. There are less restrictions on Class A biosolids reuse (e.g., can be packaged as a soil amendment for public use).

2 SUMMARY OF 2021 ACTIVITIES

2.1 OVERVIEW OF LAND APPLICATION APPROACH

The City's approach for the full-scale Program is to reuse the biosolids materials produced by the City's population/workforce in an environmentally sustainable manner. In consultation with the cooperating farm producers and their agronomic advisors, the Program applies biosolids based on crop nutrient uptake and removal; this means matching agronomic needs with biosolids nutrient content. Therefore, application rates are based on crop uptake and removal of phosphorus for a multi-year application event with the objective of returning to the same agricultural fields on a three to four-year land rotation. This allows crops to uptake the nutrients released from the biosolids material over several cropping seasons and minimizes the potential for build up of nutrients and metals in the soil profile.

Biosolids are only applied to lands where the cropping system includes cereals, oil seeds, field peas, soybeans, lentils, corn and is not applied to systems that include direct edible crops such as potatoes and vegetables, or direct grazing by livestock.

The annual cycle of the biosolids land application program consists of the following steps (refer to **Figure 1**):

1. Engagement with cooperating farm producers (December to February) to ensure land use and potential future cropping plans align with Program needs and with local Municipal Council(s) to obtain approval and address concerns.
2. In-field storage sites are selected and established on cooperating farm producers' field sites.
3. Biosolids are generated at the North End Water Pollution Control Centre and starting early in the growing season (after road restrictions are lifted) biosolids are trucked to the in-field storage site(s) located on cooperating farm producer field(s).
4. Post harvest soil sampling occurs to confirm residual crop nitrogen, phosphorus and metal concentrations to determine suitable application rates (prescription rates).
5. Following development of prescription rates, fall application of biosolids is completed by subcontractor with near immediate tillage following spreading completed by farm producer(s).
6. Reporting of application rates and prescription values back to the cooperating farm producer(s) and MCC.
7. For three years following an application event, crop management data and soil sampling for nutrient profiles is completed and reported to MCC.

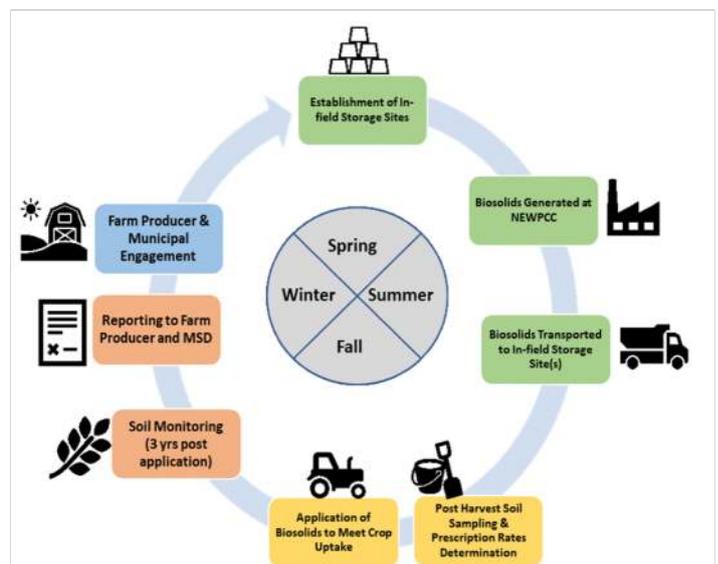


Figure 1. Annual Biosolids Land Application Program Cycle

2.2 REGULATORY REQUIREMENTS

The 2021 Program, was managed in accordance with the City’s associated NoA (April 9, 2021) to their EAL No. 1089E RR as well as in accordance with the Manitoba regulatory framework including the following Acts and Regulations:

- The *Environment Act* C.C.S.M. c. E125 (1987)
 - *Livestock Manure and Mortalities Management Regulation* 42/98
- The *Water Protection Act* C.C.S.M. c. W65 (2005)
 - *Nutrient Management Regulation* 62/2008
- The published EAP developed for this program.
- Guidance documents include the Canadian Council of Ministers of the Environment (CCME) Guidance Document for the Beneficial Use of Municipal Biosolids, Municipal sludge and Treated Septage document.
- Applicable academic research. Including by the University of Manitoba Soil Science Department.

2.3 TARGETED BIOSOLIDS APPLICATION RATES AND AGRICULTURAL LANDS FOR 2021

Three biosolids applications fields were selected for the 2021 program, two fields were located adjacent to one another, across Mile Road 2W in the Rural Municipality (RM) of Macdonald and the third field was the balance of a field not completed in 2020. Planning for the 2021 Program targeted an application volume of approximately 20,000 wet tonnes of biosolids with an estimated land requirement of between 400 - 450 hectares (990 – 1,110 acres) to meet 2x the crop removal rate for phosphorous. The agricultural fields were put forward by two participating farm producers to receive land application of biosolids (refer to **Figure 1, Appendix A**) including:

- Field 1 (260 hectares in size) Southeast quarter and the south half of the southwest Section 15, Township 09, Range 01WPM, and the in-field biosolids storage area was located at the southeast quarter of the Section off of Mile Road 2W;
- Field 2 (260 hectares in size) entire Section 14, Township 09, Range 01WPM, less the rural residence, and the in-field biosolid storage area was located at the southwest corner of the Section off Mile Roads 2W and 50N;
- Field 3 (40 hectares) on Section 05, Township 10, Range 01EPM in the Rural Municipality of Macdonald to meet obligations made to a farm producer in 2020; the biosolids were direct hauled and land applied, i.e. no on-site storage of biosolids occurred at this field in 2021.

An overview of the Program’s timeline is provided in **Figure 2**.

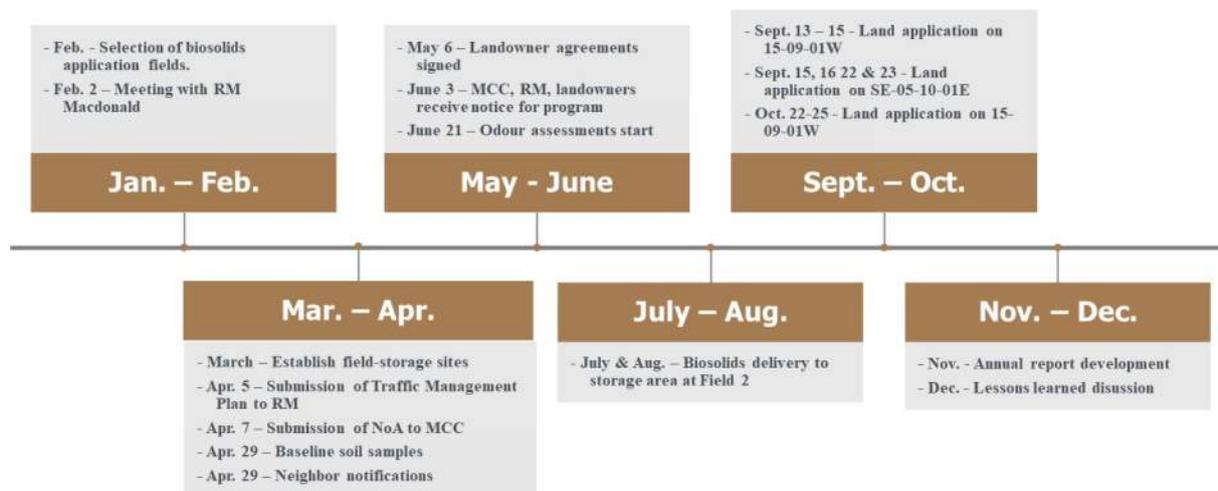


Figure 2. 2021 Biosolids Land Application Program Timeline

2.4 COMMUNICATIONS AND APPROVALS

2.4.1 MANITOBA CONSERVATION AND CLIMATE

The City submitted a NoA for EAL No. 1089E RR to the MCC, EAB on April 7, 2021. The purpose of the NoA was to seek regulatory approval for the temporary in-field storage and land application of up to 20,000 wet tonnes of biosolids onto agricultural land within the RM of Macdonald in 2021. The NoA was submitted as an interim measure while the EAL application for a new in-field biosolids storage and land application program is under review by the EAB. The City received approval for the NoA to EAL 1089E RR on April 27, 2021. A requirement of the NoA approval was the submission of monthly reports to the MCC, EAB as well as the provision of baseline soil nutrient and metal concentrations in the receiving lands as well as application prescription rates (refer to **Appendix C** and **Appendix D** respectively).

On June 3, 2021, the assigned MCC Environment Officer, the RM of Macdonald and the landowners received notification of the commencement of the Program with delivery of biosolids to begin at Field 2 within the week.

2.4.2 RM OF MACDONALD

Council

On February 2, 2021 WSP submitted a letter to the Chief Administrative Officer (CAO) of the RM of Macdonald to outline the 2021 potential land application program and the City's Transportation Management Plan for road improvement to the biosolids storage sites for 2021. This information was presented to the RM of Macdonald Council for their consideration on February 9th, 2021. Approval from the RM for the land application program and the Transportation Management Plan was received by email in early March 2021.

Public Notification

On April 29, 2021, neighbour notifications were delivered to adjacent residences located within 1.6 km (1 mile) of the storage sites informing these neighbours about the Program and providing City contact information to address any concerns (refer to **Figure 3**).



Water and Waste
Eaux et déchets

NOTICE TO RESIDENTS
(Français au verso)

City of Winnipeg Biosolids Stockpiling and Land Application Program

The City of Winnipeg is conducting a biosolids land application program this summer on the farmland identified in the map below. Biosolids will be stockpiled and covered with straw daily (Monday through Friday), from May until the end of September. Biosolids will be applied to the fields after crop harvest and tilled within 48 hours for proper odour and nutrient management.

Biosolids are a nutrient-rich, solid by-product of wastewater treatment. At the City's sewage treatment plants, the solids are separated from the liquid wastewater. These solids are further treated and dewatered. After treatment, the solids are called biosolids.

Biosolids are applied to soil to supply nutrients and improve soil structure. Land application is a widely accepted method to reuse biosolids. The City's program will apply approximately 20,000 tonnes of biosolids to local farmland in 2021. Biosolids land application is regulated by the Province of Manitoba through the Nutrient Management Regulation and a project specific Environment Act Licence which outline requirements for soil suitability, timing of application, rate of application, setback distances and nutrient management monitoring. Your local municipality is aware of the biosolids land application program being completed by the City.

Application rates will be matched to crop uptake and removal for crop nitrogen and phosphorus. These rates will be developed by a registered Professional Agrologist and follow the principles of 4R Nutrient Stewardship, including the use of the right fertilizer source at the right rate, at the right time and in the right place.

For more information

- visit winnipeg.ca/BiosolidsLandApplication
- contact Kerri Barenz, Project Coordinator, Water & Wastewater Services, City of Winnipeg, by:
 - email at BiosolidsLandApplication@winnipeg.ca
 - or call 1-888-882-3391



1199 Pacific Avenue, Winnipeg, Manitoba R3E 3S8
1199, avenue Pacific, Winnipeg (Manitoba) R3E 3S8

winnipeg.ca

Figure 3. Public Neighbour Notification

2.5 IN-FIELD STORAGE AREAS

To ensure sufficient volume of biosolids were available for land application and to limit the handling of biosolids, two in-field storage sites were established in 2021; one was established in March 2021 on Field 2 (14-09-01WPM) and the second was established in September on Field 1 (15-09-01WPM) (refer to **Figure 2, Appendix A** and to **Photos 1 and 2, Appendix B**). At each site a berm was formed around the in-field storage area consisting of round straw bales. Additional bales were supplied to the sites and straw material was blown on the ground surface in the storage areas prior to stockpiling of biosolids for leachate management. Biosolids were first deposited within the storage area at Field 2 on June 7, 2021 with delivery continuing over approximately 14 weeks with the last load of biosolids received at the Field 2 storage area on September 13. The storage site on Field 1 was established on September 11, 2021 with delivery continuing over approximately six weeks with the last load of biosolids received at the Field 1 storage area on October 22. Straw was applied over the biosolids each evening after deliveries to cap the biosolids to ensure odour and vector control (refer to **Photo 3, Appendix B**). The biosolids materials stockpiled at Field 2 were land applied September 13 to 15 and those stockpiled at Field 1 were land applied from October 22 to 25 (refer to Section 2.7).

In addition to the biosolids stored at the two in-field storage sites, forty-seven truck loads (881 wet tonnes) of biosolids were hauled and direct land applied over the dates of September 15, 16, 22 and 23 to the cooperating farm producer's field site located off La Verendrye Road on SE-05-10-01EPM to complete the application to that cooperating farm producer's land base from the 2020 program (refer to **Figure 3, Appendix A**). As indicated in **Table 1** approximately 16,931 wet tonnes were stockpiled at the in-field storage sites.

2.5.1 OFF-LOAD INCIDENT

Overall, the operation to deliver biosolids to the storage sites, including off-load and management, occurred as typical throughout the season with one incident occurring where a Wintec (hauling company contractor) transport truck became stuck as it attempted to back into Site 2. On June 10, 2021 the second truck of the day for biosolids delivery attempted to back off Mile 2W into the site onto the all-weather mud mats; the highway transport truck slipped off the south side corner of the gravel entrance to the field and became stuck. The highway transport truck blocked part of the mile road, however vehicular traffic still able to pass in front of the transport truck cautiously. The Assiniboine Injections tractor operator placed four large square bales along the south side of the mud mats up to the truck and two wide creating a barrier along the south edge of the tailgate of the transport truck trailer. Additional straw was then placed on the mud mats and around the back of the truck. As the tailgate of the transport truck trailer was on the mud mats and within the Site boundary, the intent was to off load the biosolids slowly into the bucket of the tractor to control the release and remove the biosolids from the area. The bucket of the tractor was placed tight up to the tailgate of the transport truck trailer and the Wintec operator then opened the tailgate and permitted the biosolids to be slowly released from the trailer until the bucket of the loader was full. The tailgate was closed, and the tractor removed the biosolids from the area to the stockpile. This process was repeated until the trailer was emptied. Biosolids did overflow from the tractor bucket onto the straw and up against the four bails placed along the south side of the mud mats, however no biosolids escaped from this area. When the transport truck trailer was empty, the straw bed and biosolids were removed from behind the trailer creating a clean area for the Wintec transport truck and trailer to be pulled into a better position. The full, written incident report was submitted to the City of Winnipeg, MCC and the RM of Macdonald on June 13, 2021

Table 1. Summary of In-field Biosolids Storage Volume

Month	Field 1		Field 2		Direct Haul and Apply to SE 05 10 1E	
	# of Truckloads	Volume of Biosolids (wet tonnes)	# of Truckloads	Volume of Biosolids (wet tonnes)	# of Truckloads	Volume of Biosolids (wet tonnes)
June (7-30)	0	0	137	3,229	0	0
July (1-30)	0	0	137	3,322	0	0
August (1-31)	0	0	160	3,826	0	0
September (1-30)	64	1,760	60	1,426	47	881
October (1-22)	106	2,488	0	0	0	0
TOTAL	170	4,248	494	11,803	47	881

2.5.2 STORAGE AREA DECOMMISSIONING

Once the final biosolids from the in-field storage areas were land applied in 2021, the storage areas at Fields 2 and 1 were decommissioned on September 13 to 15 and October 22 to 25, respectively (at the same time as the land applications). This included removal of straw bales used for the berms, the ramp, catch box and mud mats from the sites. In addition, the cooperating farm producer completed a tillage operation of the storage area to incorporate the remaining biosolids layer.

2.6 ODOUR ASSESSMENTS

To evaluate the odour level associated with the in-field storage of biosolids and land application in 2021, odour assessments were completed on seven separate dates following the same protocol used since 2017 for the Program.

2.6.1 ODOUR ASSESSMENT PROCEDURE

Individuals that participated as odour assessors on any given assessment date were asked to rate the degree of odoriferousness following a methodology adapted from the *Good Practices Guide for Odour Management in Alberta, 2015, Clean Air Strategic Alliance* as outlined below:

Odour Assessment of Storage Area:

Five separate odour assessments were completed at the in-field storage area 2 (June 21, July 5, July 16, July 30 and Aug. 13). At each assessment date, an area was selected away from the storage site to provide a location for the collection of a background odour baseline. Odour assessors were asked to wear a carbon filtered mask for vapours (suitable for nuisance level organic vapour relief) for about two minutes to clear their noses (refer to **Photo 4, Appendix B**). Assessors then removed their masks, breathed normally, and recorded (on the provided field data recording sheet) a level of annoyance to the odour based on a scale of 0 to 4 as per the scale outlined in **Table 2**. This same method was then used to record the odour level at each of four pre-determined distances from the storage site - approximately 50 m, 25 m, 10 m, and 5 m (down wind of storage area based on that day's wind direction). Assessors started at the farthest distance point (i.e., 50 m) and moved forward to each distance point in descending sequence.

Odour Assessment of Field Application:

To assess the level of odour that may be experienced by local area residents during land application, select locations along mile roads surrounding the application fields were assessed during application/decommissioning of the in-field

storage sites. Odour assessors were asked to wear a vapour filtered mask for about two minutes to clear their noses. Assessors then removed their masks, breathed normally, and recorded a level of annoyance to the odour based on a scale of 0 to 4 as per the scale outlined in **Table 2**. This same method was then used to record the odour level at each of the selected sites surrounding the application fields. Two assessment dates were completed, September 14 and October 22 at mile road sites for Field 2 and Field 1, respectively. Locations of assessment sites by field are provided in **Figure 4, Appendix A**.

Table 2. Odour Scale Used During Odour Assessment of Storage Area

Numerical Value	Annoyance Level	Intensity Level*
0	no odour	No offending odour observed.
1	a little annoying	Faint - The odour is barely detectable: you need to stand still and inhale while facing into the wind to notice it.
2	annoying	Moderate - The odour is easily detected while walking and breathing normally but it is not overpowering.
3	very annoying	Strong - The odour is penetrating; you can't get away from it and it can easily be detected at all times.
4	extremely annoying	Pungent - suffocating, causing a gag reflex.

Notes: *Adapted from: Good Practices Guide for Odour Management in Alberta, 2015, Clean Air Strategic Alliance.

2.6.2 SUMMARY OF ODOUR ASSESSMENT RESULTS

The odour assessment activities completed for the 2021 Program included five odour assessments completed at Field Storage Site 2 from June through August. A summary of the average odour rank values based on annoyance levels that were assigned by odour assessors are provided in **Table 3**. In addition, two odour assessments were completed during the land application/decommissioning of each of the in-field storage sites; odour assessments were completed at points along the mile road surrounding each land application field. A summary of the average odour rank values based on annoyance levels that were assigned by odour assessors at the mile road locations are provided in **Tables 4 and 5**.

Odour assessments were completed on:

- June 21, 2021: An odour assessment of the storage area at Field 2 was conducted by four WSP staff from the Environment department.
- July 5, 2021: An odour assessment of the storage area at Field 2 was conducted by four WSP staff from the Environment department.
- July 16, 2021: An odour assessment of the storage area at Field 2 was conducted by three WSP staff from the Environment department, two City of Winnipeg staff and one Environment staff person from MCC.
- July 30, 2021: An odour assessment of the storage area at Field 2 was conducted by four WSP staff from the Environment department, two City of Winnipeg staff and five Environment staff from MCC.
- August 13, 2021: An odour assessment of the storage area at Field 1 was conducted by two WSP staff from the Environmental department after the storage site was “re-activated”.

- September 14, 2021: An odour assessment was completed at select locations along the mile roads around Field 2 (14-09-01WPM) as the in-field storage site was being decommissioned and land application of the biosolids was occurring. The assessment was conducted by two WSP staff from the Environmental department.
- October 22, 2021: An odour assessment was completed at select locations along the mile roads around Field 1 (15-09-01WPM) as the in-field storage site was being decommissioned and land application of the biosolids was occurring. The assessment was conducted by three WSP staff from the Environmental department and two City of Winnipeg staff.

Table 3. Average Odour Rank Perceived during Odour Assessment at In-field Storage Site at Field 2

Date	Distance from Biosolids Storage Area (metres)					# of Participants
	50	25	10	5	Control	
June 21	0.0	0.0	0.0	0.5	0.0	4
July 5	1.8	2.0	1.5	2.3	0.5	5
July 16	1.3	1.3	1.8	1.8	0.0	6
July 30*	0.0	0.1	1.1	1.4	0.0	11
Aug, 15	0.7	1.3	2.0	2.8	0.0	7
Average	0.76	0.94	1.26	1.76	0.1	

Notes: *Fresh biosolids were delivered and deposited at the storage site during the odour assessment.

Table 4. Odour Rank at Field 2 During Decommissioning of Storage Site 2 and Land Application - Sept. 14

Participant	Assessment Site Location Number (refer to Figure 4, Appendix A)						
	1	2	3	4	5	6	7
1	2.0	1.0	0.0	0.0	0.0	0.0	0
2	2.0	2.0	0.0	0.0	0.0	0.0	0
Average	2.0	1.5	0.0	0.0	0.0	0.0	0.0

Notes: Odour assessment completed at mile roads surrounding application fields (wind NWN at 13 km/hr).

Table 5. Odour Rank at Field 1 During Decommissioning of Storage Site 1 and Land Application – Oct. 22

Participant	Assessment Site Location Number (refer to Figure 4, Appendix A)					
	1	2	3	4	5	6
1	1.0	1.0	1.0	2.0	2.0	1.0
2	1.0	2.0	3.0	3.0	3.0	0.0
3	0.0	0.0	2.0	3.0	2.0	0.0
4	0.0	0.0	1.0	2.0	2.0	0.0
5	1.0	1.0	3.0	3.0	2.0	0.0
Average	0.6	0.8	2.0	2.6	2.2	0.2

Participant	Assessment Site Location Number (refer to Figure 6, Appendix A)				
	7	8	9	10	11
1	0	0	0	0	0
2	0	0	0	0	0
3	0	0	0	0	0
4	0	0	0	0	0
5	0	0	0	0	1
Average	0.0	0.0	0.0	0.0	0.2

2.7 BIOSOLIDS LAND APPLICATION

Soil samples were collected after crop harvest on September 3 and September 27 from Fields 2 and 1, respectively to determine biosolids prescription rates (refer to **Photos 5 and 6, Appendix B**). Prescription rates were determined based on soil analytical results received from ALS Laboratory Group and Farmer’s Edge as well as biosolids quality information supplied by the City. A copy of the laboratory Certificates of Analysis and prescription rates are provided in **Appendix C** and **Appendix D** respectively. **Table 6** summarizes biosolids application information for Fields 1 and 2 (main fields) and Field 3 (the direct haul/application field) in the 2021 Program.

Table 6. Summary of Biosolids Land Application in 2021

Field #	Legal Location	Soil Sample Collection for Prescription Rate Calculations	Application Dates	Volume of Biosolids* (wet tonnes)	Field Area Biosolids Applied To (hectares)
1	Full section of 15-09-01- 1WPM	Sept. 27	Oct. 22-25	4,248	260
2	Full section of 14-09-01-1WPM	Sept. 3	Sept. 13-15	11,803	260
3	SE-05-10-01EPM	Sept. 3	Sept. 15, 16, 22 and 23	881	40
TOTAL				16,931	560

Biosolids were applied at a target rate of 46 wet tonnes per hectare on Fields 1 and 2. The overall objective of the land application program is to achieve 20,000 wet tonnes of biosolids. A total of approximately 16,931 wet tonnes of biosolids were actually land applied in 2021 which achieved 85% of the 2021 target objective (refer to **Appendix D** for prescription rates).

2.7.1 SUMMARY OF TOTAL BIOSOLIDS APPLIED TO DATE IN PROGRAM

Since the start of the City’s current biosolids land application program initiated with the Pilot Project in 2017, over 55,837 wet tonnes (14,781 dry tonnes) of biosolids have been applied to cooperating farm producers’ agricultural land in the RMs of Macdonald and Rosser (refer to **Table 7**). The re-use of nutrients in the biosolids has equated to over 568 dry tonnes of nitrogen and 281 dry tonnes of total phosphorus made available to crops over the past 5 years of the Program.

In addition, over 4,538 dry tonnes of carbon have been amended to the soil from the biosolids land application program. According to Northwest Biosolids, for every truck of biosolids that is land applied, an average of 33 tons of CO₂ is stored in the soil. One ton of biosolids provides that same amount of carbon storage as 26 tree seedlings grown for ten years (Northwest Biosolids, 2021³).

A study looking at carbon and nitrogen storage in biosolids amended soils was completed by Young, Xiao, Cogger, Bary and Pan (2014⁴) from Washington State University in 2014. The study found that based on the U.S. Environmental Protection Agency’s (EPA) lifecycle analysis values for carbon dioxide (CO₂) emissions, trucking one ton of biosolids 400 miles (round trip) emits 262 lbs CO₂equivalents (CO₂e). In comparison Young et al (2014) found that based on biosolids with a carbon content of 33% and a soil retention rate of 77%, 1863 lbs CO₂e can be stored in soil carbon for each ton of biosolids applied. Young et al (2014) estimated that the 50,000 tons of biosolids applied to land each year (in the State of Washington) have the potential to sequester tens of thousands of tons of CO₂e as soil carbon.

Table 7. Estimated Total Biosolids, Nitrogen, Phosphorus and Carbon Land Applied in Program to Date (based on 2020 values)

Year	Volume Applied (wT)	Area (Ha)		Average Total Nitrogen	PAN (Yr1)	Total Phosphorus	Total Available P2O5	Total Carbon
		Hectares	Acres	38.4 kg/Tonne	13.2 kg/Tonne	19 kg/Tonne	10.9 kg/Tonne	304 kg/Tonne
2017	2,621	55	136	26,650	9,161	13,186	7,565	213,058
2018	10,932	260	642	111,130	38,201	54,986	31,545	888,458
2019	14,178	326	805	144,115	49,540	71,307	40,908	1,152,171
2020	11,175	239	590	113,587	39,046	56,202	32,242	908,106
2021	16,931	331.15	818	172,109	59,162	85,185	48,854	1,375,974
Totals	55,838	1,211	2992	567,590	195,109	280,839	161,113	4,537,767

³ Northwest Biosolids, 2021, You can go carbon neutral with biosolids. Retrieved on November 30, 2021 from: <https://nwbiosolids.org/node/16>.

⁴ Young, L., Xiao, Y., Cogger, C.G., Bary, A.I., and W.L. Pan. 2014 Carbon and Nitrogen Storage in Biosolids Amended Soils. Washington Sate University. Regional Approaches to Climate Change – Pacific Northwest Agriculture. Retrieved on November 30, 2021 from: <https://www.reacchpna.org/posters-and-presentations?page=8>.

2.8 SOIL MONITORING

Annual soil monitoring of nutrient concentrations (nitrogen and phosphorus) in agricultural fields that previously received biosolids is required under the City’s EAL for three years post-application. The soil monitoring schedule for agricultural fields in the Program as of 2021 is provided in **Table 8**. Each year, as new agricultural fields are added to the Program, post-application monitoring will continue for each field for the required three-years.

Table 8. Example of Soil Monitoring Schedule for Agricultural Fields in the Program

RM Name	Field Location	Year							
		1 (2017)	2 (2018)	3 (2019)	4 (2020)	5 (2021)	6 (2022)	7 (2023)	8 (2024)
Macdonald	NE, SE-31-08-01EPM (strip test areas for Pilot Program of Phase 2)	X	√	√	√				
Rosser	NE, SE, SW and NW-36-12-02WPM (first year of full-scale program of Phase 3)		X	√	√	√			
Rosser	W ^{1/2} - 31-12-01WPM, S ^{1/2} -28-12-01WPM, E ^{1/2} -29-12-01WPM			X	√	√	√		
Rosser	N ^{1/2} -32-09-1EPM, W ^{1/2} -SE-32-09-1EPM, E ^{1/2} -SE-32-09-1EPM, E ^{1/2} -SW-32-09-1EPM				X	√	√	√	
Rosser	SE-05-10-1EPM				X	√	√	√	
Macdonald	S1/2 of SW & SE 15-09-01- 1WPM					X	√	√	√
Macdonald	Full section of 14-09-01WPM					X	√	√	√
Macdonald	SE-05-10-01EPM					X	√	√	√

Notes:

X = year biosolids applied

√ = soil monitoring year

2.8.1 SOIL SAMPLE COLLECTION METHODS

Composite soil samples were collected from a 20 m diameter area around a centroid georeferenced location established during the benchmark year for each field. Soil samples were collected from depths of 0-15 cm and 15-60 cm and submitted to an accredited laboratory for analysis for available nitrate-nitrogen and available phosphate-phosphorus and soil metals when required.

2.8.2 BENCHMARK SOIL SAMPLING RESULTS

Biosolids Preapplication Soil Monitoring Results

(SE05-10-01EPM, 14-09-01WPM, S1/2 SW 15-09-01WPM, and SE15-09-01WPM)

The analytical results are presented in **Table A, Appendix E**. In general, the post harvest residual nitrate-nitrogen (0-15 and 15-60 cm) results were greater than anticipated in a post harvest scenario. These elevated concentrations of nitrate-nitrogen are likely due to the drought conditions experience through the 2021 growing season and resulting crop failure. This is a consistent observation from the majority of agricultural fields sampled in this program in the fall of 2021.

Where as, the available Olsen-P is below the applicable Nutrient Management Guidelines of 60 parts per million (ppm) for soils sampled across all fields and was suitable for the land application of biosolids.

Soil total trace elements (Arsenic, Cadmium, Copper, Chromium, Lead, Mercury, Nickle and Zinc) are all within expected parameter ranges for the Red River Valley clays. At the given soil concentrations plus the application rate of biosolids, the cumulative metal concentrations of each of the elements are not limiting to receiving biosolids land application and in most cases are permissible of numerous land application events (**Table A, Appendix E**).

2.8.3 POST APPLICATION SOIL MONITORING RESULTS

Third Year Post- Biosolids Application Monitoring Results

(NE, NW, SE and SW 36-12-02WPM – RM Rosser)

The analytical results are presented in **Table A, Appendix E**. The post harvest residual nitrate-nitrogen (0-60 cm) is greater than anticipated likely due to the drought conditions experience through the 2021 growing season and resulting crop failure. This is a consistent observation from the majority of agricultural fields sampled in this program in the fall of 2021. The available Olsen-P is below the applicable Nutrient Management Guidelines of 60 parts per million (ppm) for soils sampled in Year 3 of the Program for each field.

The benchmark soil sample in 2018 indicted that the average Olsen-P concentration was 15.2 milligrams per kilogram (mg/kg). The annual soil monitoring average Olsen-P concentrations are: 43.25 mg/kg, 18.45 mg/kg and 27.8 mg/kg in monitoring years 1, 2 and 3 respectfully. As indicated in the 2019 annual report the elevated concentration in Year 1 post monitoring can be attributed to poor crop conditions (drought). The average Olsen-P concentrations in Year 2 monitoring indicates that soil concentrations have near returned to pre-application concentrations with a red spring wheat crop yield of 38 bu/ac in 2020. The post harvest residual Olsen-P concentration average is slightly elevated again in 2021, likely due to the crop failure associated with drought.

Second Year Post- Biosolids Application Monitoring Results (NW & SW 31-12-01WPM, S1/2 28-12-01WPM and E1/2 29-12-01WPM – RM Rosser)

The analytical results are presented in **Table A, Appendix E**. The post harvest residual nitrate-nitrogen (0-60 cm) is greater than anticipated likely due to the drought conditions experience through the 2021 growing season and resulting crop failure. This is a consistent observation from the majority of agricultural fields sampled in this program in the fall of 2021. The available Phosphate – P is below the applicable Nutrient Management Guidelines of 60 ppm for soils sampled in Year 2 of the Program for each field.

In NW & SW 31-12-01WPM benchmark soil samples in 2019 indicated that the average Olsen-P concentration was 11.1 mg/kg; the Year 1, 2020 post application soil monitoring average Olsen-P concentrations 15.3 mg/kg was near the benchmark concentration after one year of cropping. The Year 2, 2021 post application soil monitoring average Olsen-P concentrations was 22 mg/kg and is considered acceptable for year 2 of a monitoring program.

First Year Post- Biosolids Application Monitoring Results (N^{1/2}-32-09-1EPM, W^{1/2}-SE-32-09-1EPM, E^{1/2}-SE-32-09-1EPM, E^{1/2}-SW-32-09-1EPM and SE-05-10-1EPM – RM Macdonald)

The analytical results presented in **Table A, Appendix E**. The post harvest residual nitrate-nitrogen (0-60 cm) is greater than anticipated likely due to the drought conditions experience through the 2021 growing season and resulting crop failure. This is a consistent observation from the majority of agricultural fields sampled in this program in the fall of 2021. The available Phosphate – P is below the applicable Nutrient Management Guidelines of 60 ppm for soils sampled in Year 1 of the Program for each field.

The benchmark soil samples in the fields in 2020 indicated that the average Olsen-P concentration was 11.6 mg/kg; the Year 1, 2021 post application soil monitoring average Olsen-P concentrations was 24.6 mg/kg. While the Year 1 post application monitoring does demonstrate an increase in Olsen-P concentration, this may be due to the crop failure of 2021 rather than a contribution from biosolids application as this is not consistent with the observations in years past.

3 CONCLUSIONS

The City's approach for the full-scale Program is to reuse the biosolids materials produced by the City's population/workforce in an environmentally sustainable manner. In consultation with the cooperating farm producers and their agronomic advisors, the Program applies biosolids based on crop nutrient uptake that matches agronomic needs with biosolids nutrient content. Therefore, application rates are based on crop uptake and removal of phosphorus for a multi-year application event with the objective of returning to the same agricultural fields on a three to four-year land rotation. This allows crops to uptake the nutrients released from the biosolids material over several cropping seasons and minimizes the potential for build up of nutrients and metals in the soil profile.

Three biosolids applications fields were selected for the 2021 program, two fields were located adjacent to one another, across Mile Road 2W in the RM of Macdonald and the third field was the balance of a field not completed in 2020, providing a total potential land application area of 560 ha.

To ensure sufficient volume of biosolids were available and to limit the handling of biosolids, two in-field storage sites were established in 2021; one was established in March 2021 on Field 2 (14-09-01WPM) and the second was established in September on Field 1 (15-09-01WPM). At each site a berm was formed around the in-field storage area consisting of round straw bales. Additional bales were supplied to the sites and straw material was blown on the ground surface in the storage areas prior to stockpiling of biosolids for leachate management. Biosolids were first deposited within the storage area at Field 2 on June 7, 2021 with delivery continuing over approximately 14 weeks with the last load of biosolids received at the Field 2 storage area on September 13. The storage site on Field 1 was established on September 11, 2021 with delivery continuing over approximately six weeks with the last load of biosolids received at the Field 1 storage area on October 22. Straw was applied over the biosolids each evening after deliveries to cap the biosolids to ensure odour and vector control. The biosolids materials stockpiled at Field 2 were land applied September 13 to 15 and those stockpiled at Field 1 were land applied from October 22 to 25, 2021.

Biosolids were applied at a target rate of 46 wet tonnes per hectare on Fields 1, 2 and 3. The overall objective of the land application program is to achieve 20,000 wet tonnes of biosolids. A total of approximately 16,931 wet tonnes of biosolids were land applied in 2021 which achieved 85% of the 2021 target objective. Since the start of the City's current biosolids land application program initiated with the Pilot Project in 2017, over 55,837 wet tonnes (14,781 dry tonnes) of biosolids have been applied to cooperating farm producer's agricultural land in the RMs of Macdonald and Rosser. The re-use of nutrients in the biosolids has equated to over 568 dry tonnes of nitrogen and 281 dry tonnes of total phosphorus made available to crops over the past 5 years of the Program. In addition, over 4,538 dry tonnes of carbon have been amended to the soil from the biosolids land application program.

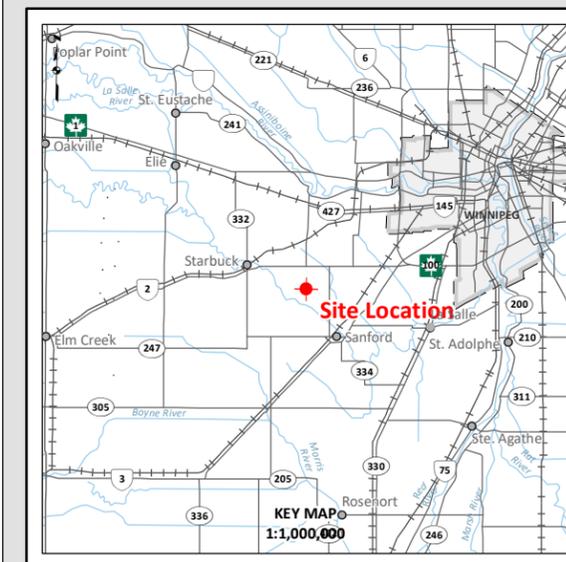
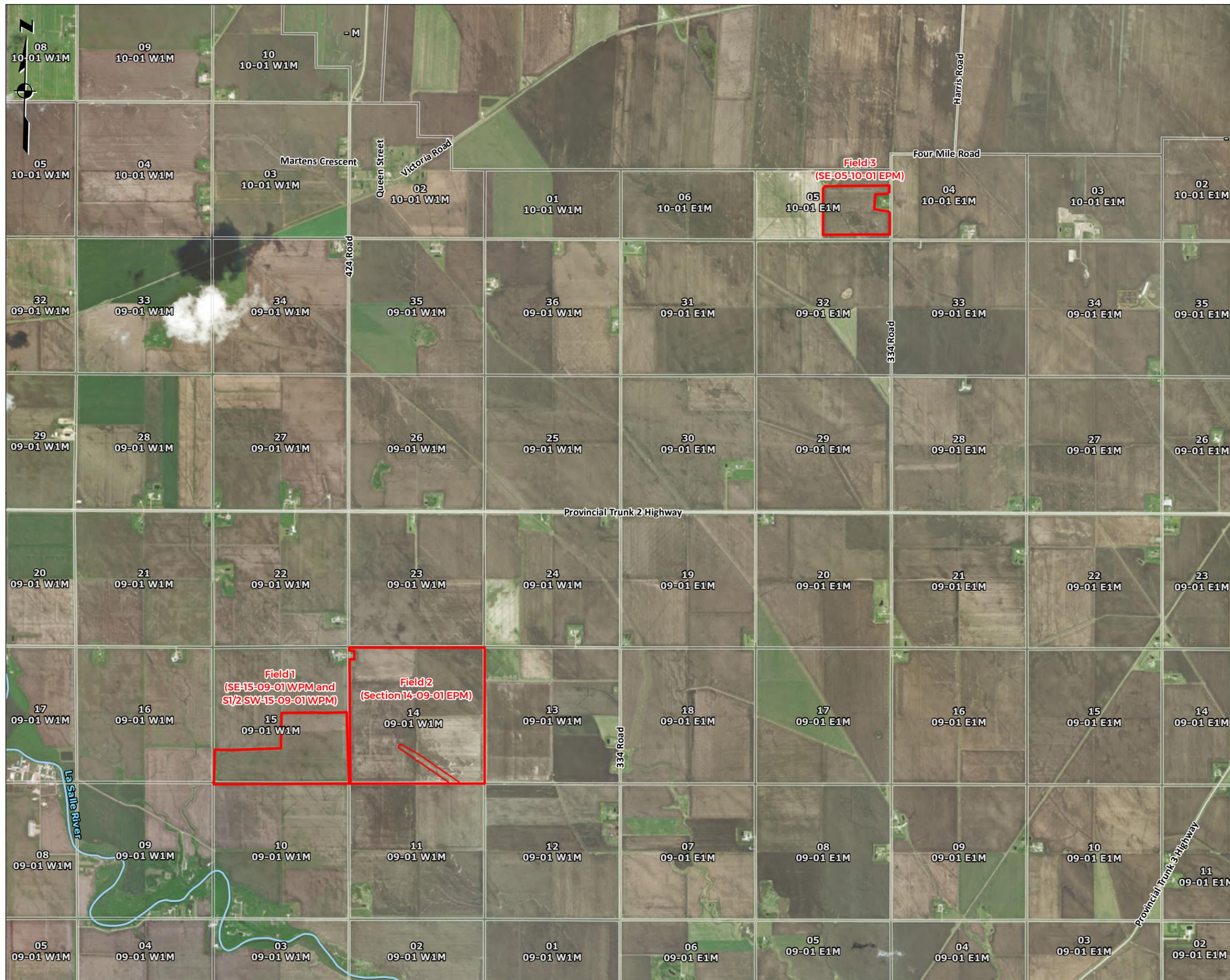
The benchmark soil sampling program observed that in general, the post harvest residual nitrate-nitrogen (0-15 and 15-60 cm) results were greater than anticipated. These elevated concentrations of nitrate-nitrogen are likely due to the drought conditions experienced through the 2021 growing season and resulting crop failure. This is a consistent observation from the majority of agricultural fields sampled in this program in the fall of 2021. Part of the approach to continued management of the excessive nitrogen includes the three-year required nutrient monitoring for residual nutrients (N and P) and advisement to the cooperating farm producers that no additional nitrogen is to be applied to future crops until the soil testing demonstrates a need. Additional mitigation measures for nitrogen management include:

- Soils at the site are all lacustrine clay to depth, thus limiting the potential for leaching and loss of nitrogen from the system;
- Buffer zones are being implemented for all drains as per Manitoba regulatory requirements; and,
- The biosolids are tilled into the soil within 48 hours of application.

Through the three-year post land application monitoring program, it has been observed that the full value of the crop available nutrients, specifically phosphorus, are not effectively being allocated. The post land application soil monitoring indicates that there may be an under application of phosphorus and no development of a reservoir of plant available phosphorus. This may be due to the overestimate of plant available phosphorus at 25% mineralization as established by MCC in 2017. Further consideration should be given to evaluating the mineralization rate specifically for phosphorus, through a targeted study, Program management, and annual monitoring.

APPENDIX

A MAP FIGURES



Legend

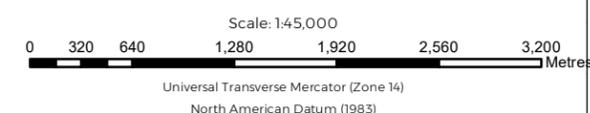
Land Application Area

Draft



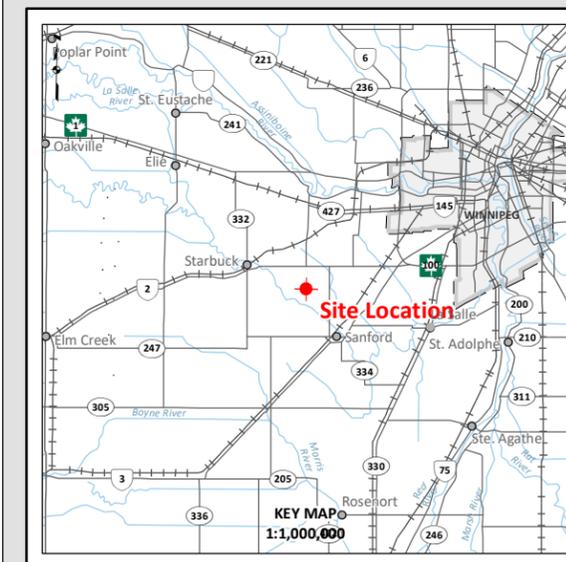
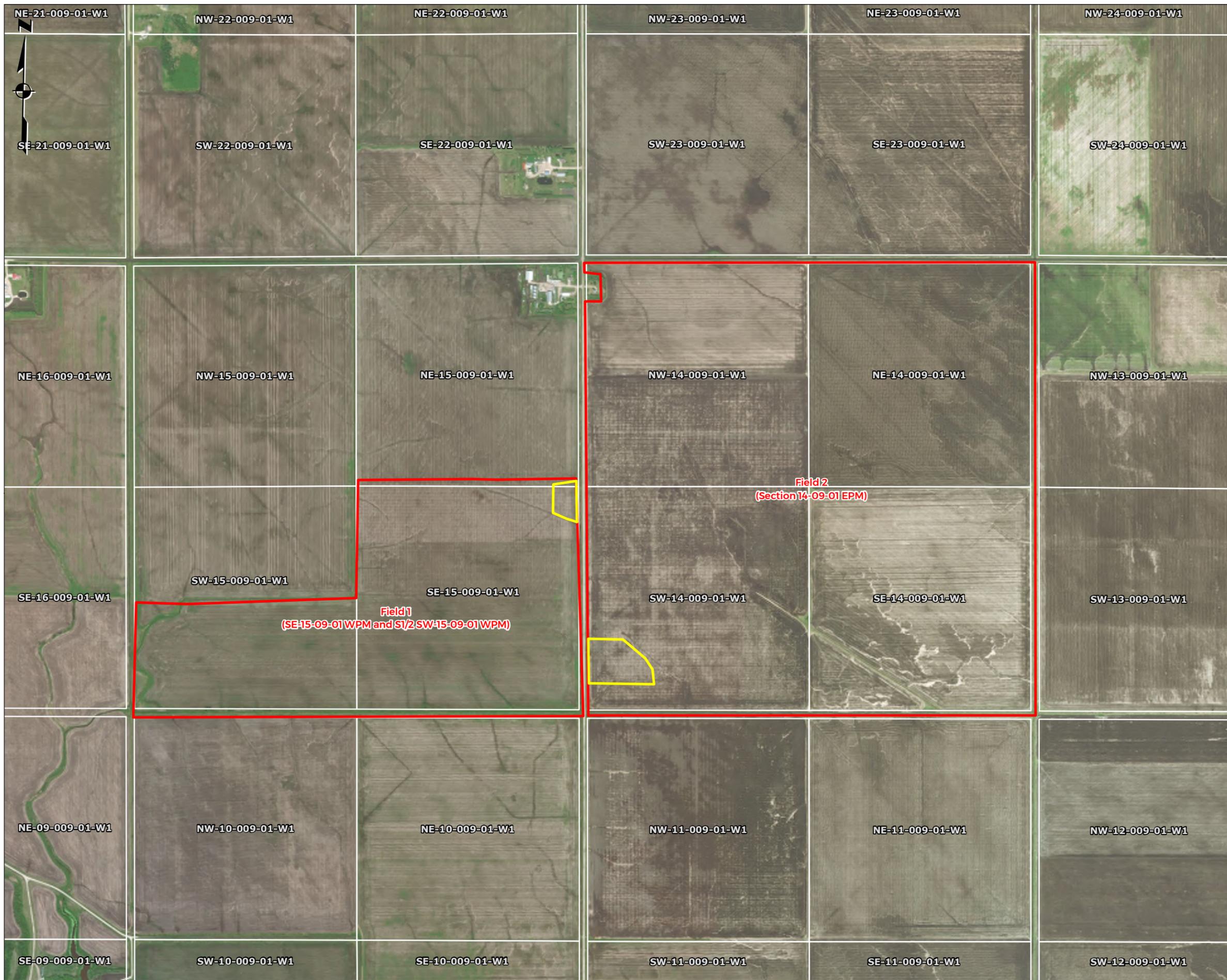
City of Winnipeg
Biosolids Land Application
Program, 2021
Figure 1

Overall Sites 2021
Rural Municipality of Macdonald
Manitoba



Report By: DS WSP Job #: 17M-00008-04
Drawn by: JH Date: December 15, 2021
Reviewed By: DS Office: Winnipeg

Notes: Imagery Source: ESRI Imagery Service



Legend

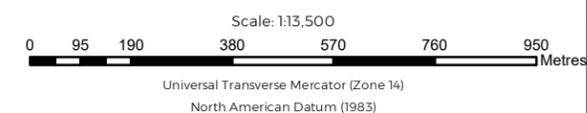
- Land Application Area
- Storage Site

Draft



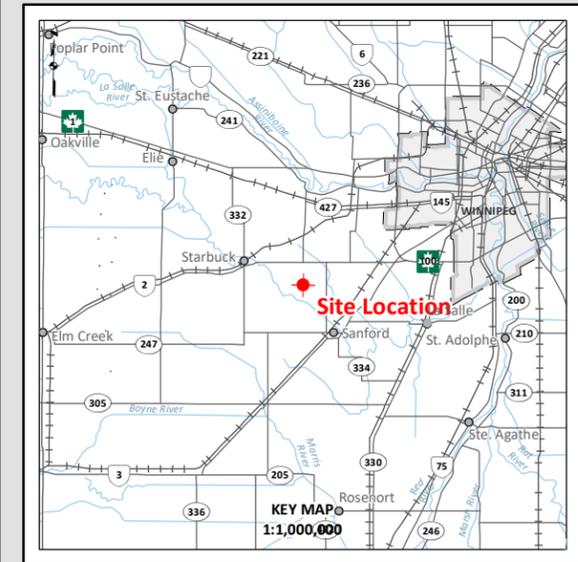
City of Winnipeg
Biosolids Land Application
Program, 2021
Figure 2

Field 1 & Field 2
Rural Municipality of Macdonald
Manitoba



Report By: DS WSP Job #: 17M-00008-04
Drawn by: JH Date: December 15, 2021
Reviewed By: DS Office: Winnipeg

Notes: Imagery Source: ESRI Imagery Service



Legend

Land Application Area

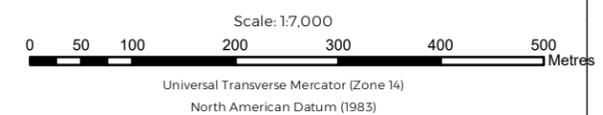
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City of Winnipeg
Biosolids Land Application
Program, 2021

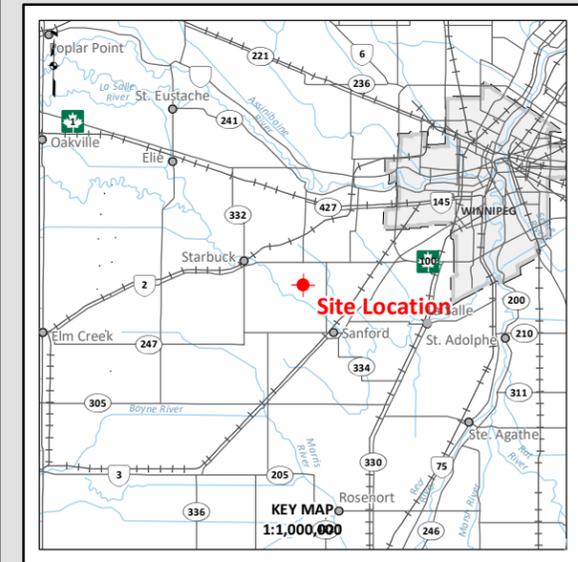
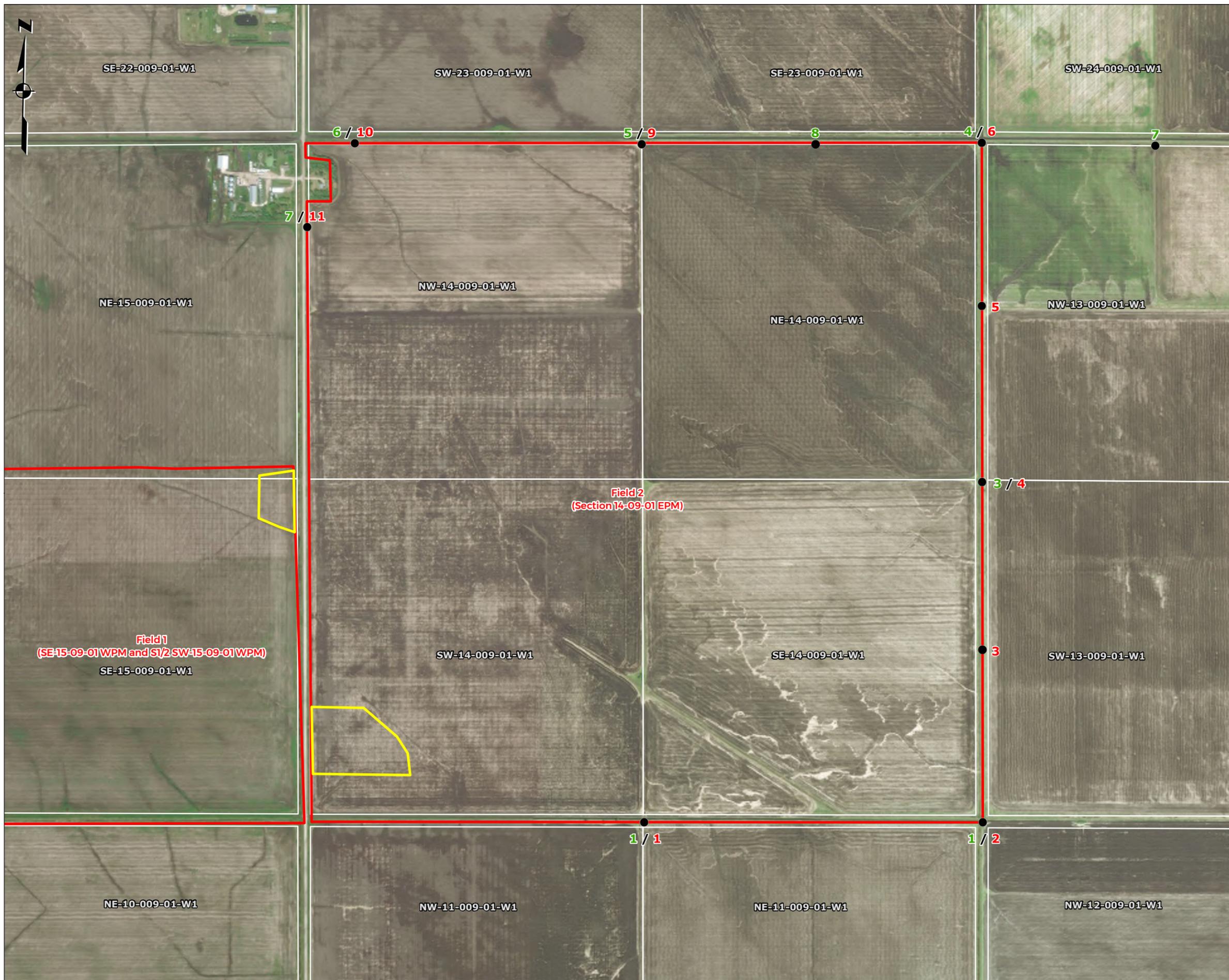
Figure 3

Field 3
Rural Municipality of Macdonald
Manitoba



Report By: DS WSP Job #: 17M-00008-04
Drawn by: JH Date: December 15, 2021
Reviewed By: DS Office: Winnipeg

Notes: Imagery Source: ESRI Imagery Service

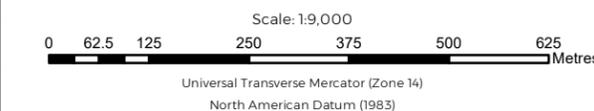


- Legend**
- Land Application Area
 - Storage Site
 - Odour Assessment Sample Locations
 - September 14, 2021
 - 3 / 4 — October 22, 2021

Draft

City of Winnipeg
 Biosolids Land Application
 Program, 2021
Figure 4

Odour Assessment Sample Locations
Rural Municipality of Macdonald
Manitoba



Report By: DS WSP Job #: 17M-00008-04
 Drawn by: JH Date: December 15, 2021
 Reviewed By: DS Office: Winnipeg

Notes: Imagery Source: ESRI Imagery Service

APPENDIX

B

PHOTOGRAPHS



Photo 1. Field 2 storage site setup (looking southeast).



Photo 2. Field 2 storage site setup (looking northeast).



Date Taken: April 30, 2021

Taken by: DKeam

Project No.: 17M-00008-04

Client: City of Winnipeg

Location: RM of Macdonald,
Manitoba



Photo 3. Biosolids stockpile with straw cover at Field 2 storage site. (June 21).



Photo 4. Field 2 storage site odour assessment (July 24).



Date Taken: June 21/July 24, 2021

Taken by: DKeam

Project No.: 17M-00008-04

Client: City of Winnipeg

Location: RM of Macdonald,
Manitoba



Photo 5. Field 2 land application (loading of biosolids spreader).



Photo 6. Field 2 land application (spreading of biosolids).l



Date Taken: Sept. 14, 2021

Taken by: DKeam

Project No.: 17M-00008-04

Client: City of Winnipeg

Location: RM of Macdonald,
Manitoba

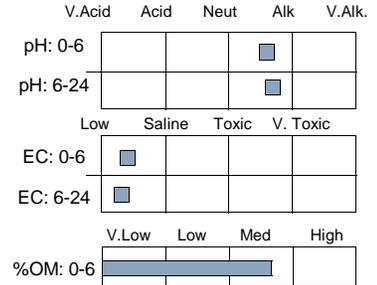
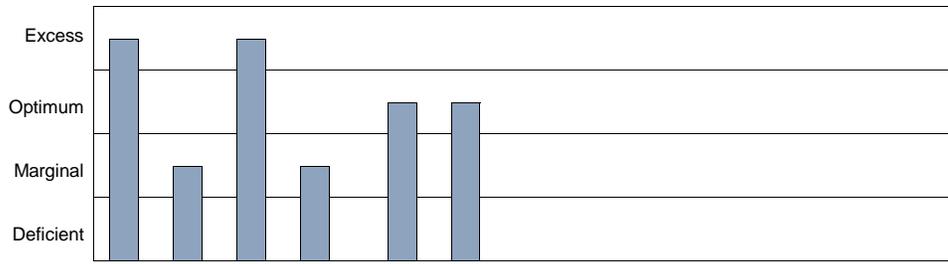
APPENDIX

C

CHAIN OF
ANALYSIS
REPORTS

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W037 Reference Field Name: Legal Location: N 1/2 NW 14-9-1 W1 Total Acres: Sampler:	Lot Number: 210907_029 Date Sampled: 2021/09/03 Received Date: 2021/09/07 Date Reported: 2021/09/08
Attention: Darren Keam Client ID: 18-0013		

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210907_029-01	0-6	74	23.0	440	5	5300	1500	63							7.6	0.78	6.7
210907_029-02	6-24	25			4										7.7	0.60	



	N	P	K	S	CEC (meq/100g): 39.8	Ca Base Sat. (%): 66.0	Mg Base Sat. (%): 31.0
0-6 lb/Ac:	148	46	880	10	Base Saturation (%): 100.0	K Base Sat. (%): 2.8	Na Base Sat. (%): 0.7
6-24 lb/Ac:	150			21			
Total lb/Ac measured:	298	46	880	31	Sand (%):	Silt (%):	Clay (%):
Estimated lb/Ac to 24 inch:	298			31	Texture:		

Lab Comments: _____
* Bicarbonate-Extractable (Olsen) Phosphate

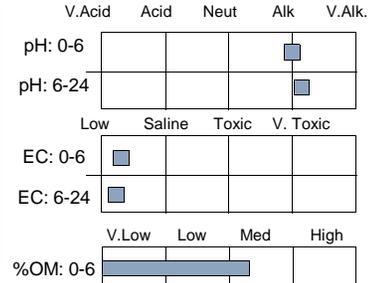
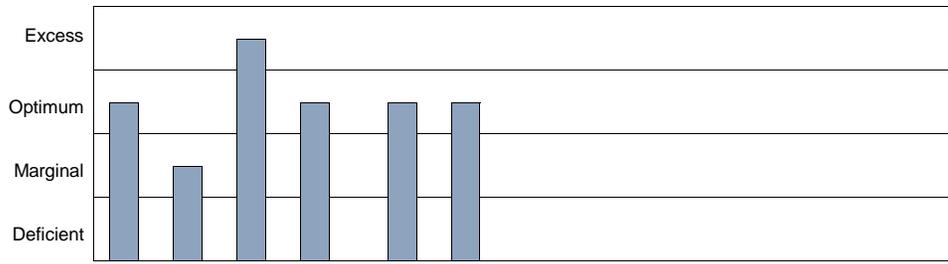
Fertility Recommendation Previous Crop: Wheat, CPS Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.9 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	47 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	35 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	21 bu	0	0	15	0	10						
Soybeans													
*Customer Yield	8.3 (Average)	35 bu	0	0	15	0	0						
Calculated Yield	10.2 (Wet)	47 bu	0	0	20	0	0						
Calculated Yield	7.9 (Average)	33 bu	0	0	15	0	0						
Calculated Yield	4.5 (Dry)	18 bu	0	0	15	0	0						



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W038 Reference Field Name: Legal Location: S 1/2 NW 14-9-1 W1 Total Acres: Sampler:	Lot Number: 210907_030 Date Sampled: 2021/09/03 Received Date: 2021/09/07 Date Reported: 2021/09/08
Attention: Darren Keam Client ID: 18-0013		

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm		dS/m	%
210907_030-01	0-6	30	16.0	460	11	6000	2000	80							8.0	0.58	5.3
210907_030-02	6-24	9			9										8.3	0.44	



	N	P	K	S
0-6 lb/Ac:	60	32	920	22
6-24 lb/Ac:	53			55
Total lb/Ac measured:	113	32	920	77
Estimated lb/Ac to 24 inch:	112			76

CEC (meq/100g): 47.6 Ca Base Sat. (%): 63.0 Mg Base Sat. (%): 34.0
 Base Saturation (%): 100.0 K Base Sat. (%): 2.5 Na Base Sat. (%): 0.7

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

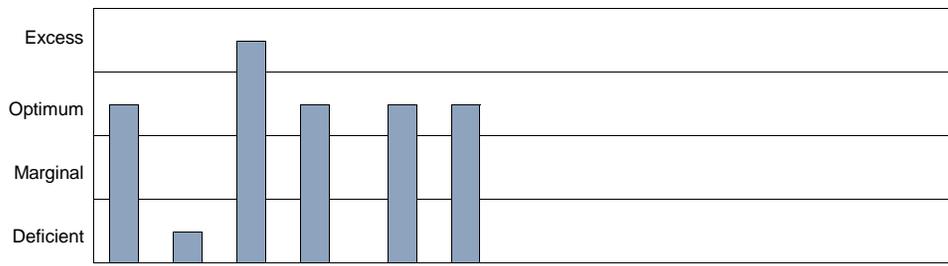
Fertility Recommendation Previous Crop: Wheat, CPS Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.9 (Wet)	45 bu	0	30	20	0	10						
Calculated Yield	10.2 (Wet)	47 bu	0	35	20	0	10						
Calculated Yield	7.9 (Average)	35 bu	0	10	15	0	10						
Calculated Yield	4.5 (Dry)	21 bu	0	0	15	0	10						
Soybeans													
*Customer Yield	8.3 (Average)	35 bu	0	0	15	0	0						
Calculated Yield	10.2 (Wet)	47 bu	0	0	20	0	0						
Calculated Yield	7.9 (Average)	33 bu	0	0	15	0	0						
Calculated Yield	4.5 (Dry)	18 bu	0	0	15	0	0						



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W039 Reference Field Name: Legal Location: SW 14-9-1 W1 Total Acres: Sampler:	Lot Number: 210907_031 Date Sampled: 2021/09/03 Received Date: 2021/09/07 Date Reported: 2021/09/08
Attention: Darren Keam Client ID: 18-0013		

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm		dS/m	%
210907_031-01	0-6	27	6.0	450	8	5500	2700	170							8.5	0.54	3.9
210907_031-02	6-24	13			7										8.7	0.50	



	V. Acid	Acid	Neut	Alk	V. Alk.
pH: 0-6					■
pH: 6-24					■
	Low	Saline	Toxic	V. Toxic	
EC: 0-6	■				
EC: 6-24	■				
	V. Low	Low	Med	High	
%OM: 0-6	■				

	N	P	K	S	CEC (meq/100g): 51.5	Ca Base Sat. (%): 53.0	Mg Base Sat. (%): 43.0
0-6 lb/Ac:	54	12	900	16	Base Saturation (%): 100.0	K Base Sat. (%): 2.3	Na Base Sat. (%): 1.5
6-24 lb/Ac:	78			44			
Total lb/Ac measured:	132	12	900	60	Sand (%):	Silt (%):	Clay (%):
Estimated lb/Ac to 24 inch:	133			60	Texture:		

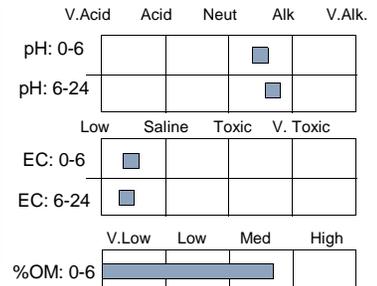
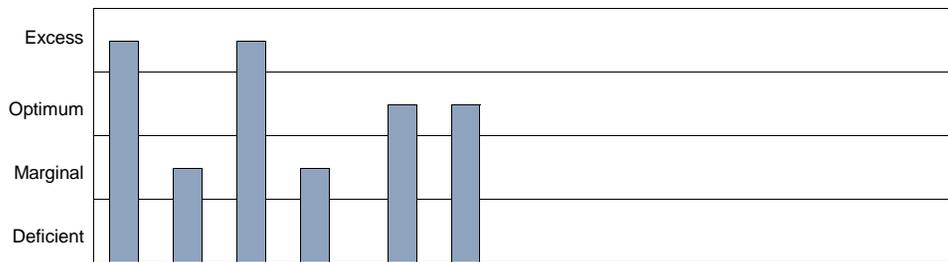
Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

Fertility Recommendation Previous Crop: Wheat, CPS Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.9 (Wet)	45 bu	0	30	30	0	10						
Calculated Yield	10.2 (Wet)	47 bu	0	35	30	0	10						
Calculated Yield	7.9 (Average)	35 bu	0	5	25	0	10						
Calculated Yield	4.5 (Dry)	21 bu	0	0	15	0	10						
Soybeans													
*Customer Yield	8.3 (Average)	35 bu	0	0	25	0	0						
Calculated Yield	10.2 (Wet)	47 bu	0	0	30	0	0						
Calculated Yield	7.9 (Average)	33 bu	0	0	25	0	0						
Calculated Yield	4.5 (Dry)	18 bu	0	0	15	0	0						

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W040 Reference Field Name: Legal Location: SW 14-9-1 W1 Total Acres: Sampler:	Lot Number: 210907_032 Date Sampled: 2021/09/03 Received Date: 2021/09/07 Date Reported: 2021/09/08
Attention: Darren Keam Client ID: 18-0013		

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm		dS/m	%
210907_032-01	0-6	72	19.0	450	8	5500	1800	130							7.5	0.88	6.8
210907_032-02	6-24	32			5										7.7	0.75	



	N	P	K	S	CEC (meq/100g): 43.9	Ca Base Sat. (%): 63.0	Mg Base Sat. (%): 34.0
0-6 lb/Ac:	144	38	900	16	Base Saturation (%): 100.0	K Base Sat. (%): 2.6	Na Base Sat. (%): 1.2
6-24 lb/Ac:	192			31			
Total lb/Ac measured:	336	38	900	47	Sand (%):	Silt (%):	Clay (%):
Estimated lb/Ac to 24 inch:	335			47	Texture:		

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

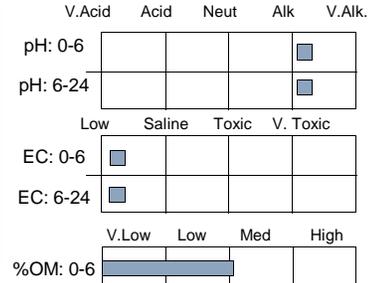
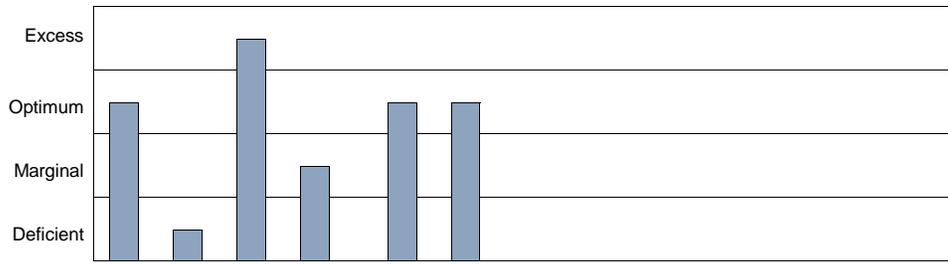
Fertility Recommendation Previous Crop: Wheat, CPS Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.9 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	47 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	35 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	21 bu	0	0	15	0	10						
Soybeans													
*Customer Yield	8.3 (Average)	35 bu	0	0	15	0	0						
Calculated Yield	10.2 (Wet)	47 bu	0	0	20	0	0						
Calculated Yield	7.9 (Average)	33 bu	0	0	15	0	0						
Calculated Yield	4.5 (Dry)	18 bu	0	0	15	0	0						



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W044 Reference Field Name:	Lot Number: 210907_033 Date Sampled: 2021/09/03 Received Date: 2021/09/07 Date Reported: 2021/09/08
Attention: Darren Keam Client ID: 18-0013	Legal Location: SE 14-9-1 W1 Total Acres: 32 Sampler:	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210907_033-01	0-6	32	5.6	660	4	5900	2200	110							8.4	0.48	4.3
210907_033-02	6-24	18			7										8.4	0.46	



	N	P	K	S	CEC (meq/100g):	50.0	Ca Base Sat. (%):	59.0	Mg Base Sat. (%):	37.0
0-6 lb/Ac:	64	11	1320	8	Base Saturation (%):	100.0	K Base Sat. (%):	3.4	Na Base Sat. (%):	0.9
6-24 lb/Ac:	108			41						
Total lb/Ac measured:	172	11	1320	49	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	171			50	Lab Comments:					

* Bicarbonate-Extractable (Olsen) Phosphate

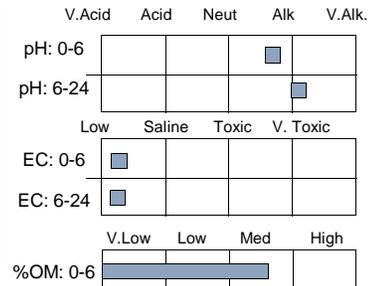
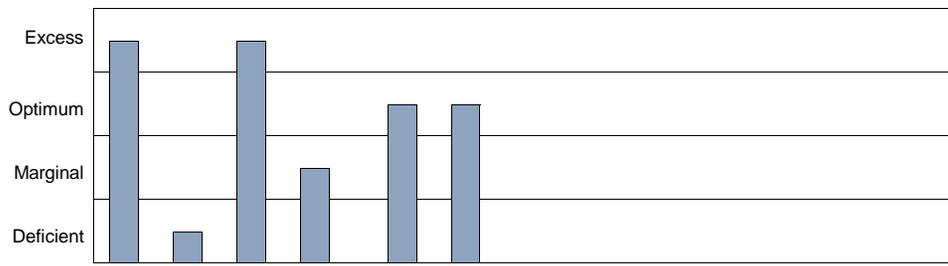
Fertility Recommendation Previous Crop: Wheat, CPS Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.9 (Wet)	45 bu	0	0	30	0	10						
Calculated Yield	10.2 (Wet)	47 bu	0	0	30	0	10						
Calculated Yield	7.9 (Average)	35 bu	0	0	25	0	10						
Calculated Yield	4.5 (Dry)	21 bu	0	0	15	0	10						
Soybeans													
*Customer Yield	8.3 (Average)	35 bu	0	0	25	0	0						
Calculated Yield	10.2 (Wet)	47 bu	0	0	30	0	0						
Calculated Yield	7.9 (Average)	33 bu	0	0	25	0	0						
Calculated Yield	4.5 (Dry)	18 bu	0	0	15	0	0						



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W043 Reference Field Name:	Lot Number: 210907_034 Date Sampled: 2021/09/03 Received Date: 2021/09/07 Date Reported: 2021/09/08
Attention: Darren Keam Client ID: 18-0013	Legal Location: SE 14-9-1 W1 Total Acres: 32 Sampler:	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm		dS/m	%
210907_034-01	0-6	46	8.4	520	4	3800	2100	120							7.7	0.52	6.5
210907_034-02	6-24	31			6										8.2	0.48	



	N	P	K	S
0-6 lb/Ac:	92	17	1040	9
6-24 lb/Ac:	186			38
Total lb/Ac measured:	278	17	1040	47
Estimated lb/Ac to 24 inch:	281			46

CEC (meq/100g): 37.6 Ca Base Sat. (%): 50.0 Mg Base Sat. (%): 45.0
 Base Saturation (%): 100.0 K Base Sat. (%): 3.6 Na Base Sat. (%): 1.3

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

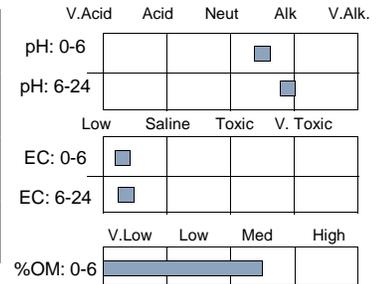
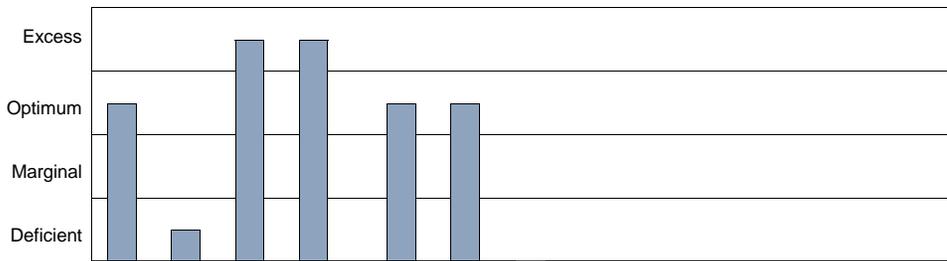
Fertility Recommendation Previous Crop: Wheat, CPS Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.9 (Wet)	45 bu	0	0	30	0	10						
Calculated Yield	10.2 (Wet)	47 bu	0	0	30	0	10						
Calculated Yield	7.9 (Average)	35 bu	0	0	25	0	10						
Calculated Yield	4.5 (Dry)	21 bu	0	0	15	0	10						
Soybeans													
*Customer Yield	8.3 (Average)	35 bu	0	0	25	0	0						
Calculated Yield	10.2 (Wet)	47 bu	0	0	30	0	0						
Calculated Yield	7.9 (Average)	33 bu	0	0	25	0	0						
Calculated Yield	4.5 (Dry)	18 bu	0	0	15	0	0						



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W036 Reference Field Name:	Lot Number: 210908_104 Date Sampled: 2021/09/08 Received Date: 2021/09/08 Date Reported: 2021/09/09
Attention: Darren Keam	Legal Location: SE 5-10-1 E1 Total Acres: 32	
Client ID: 18-0013	Sampler: Pimlott	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm		dS/m	%
210908_104-01	0-6	20	8.6	470	22	5200	2000	110							7.5	0.59	6.0
210908_104-02	6-24	17			15										7.9	0.68	



	N	P	K	S	CEC (meq/100g):	44.2	Ca Base Sat. (%):	59.0	Mg Base Sat. (%):	37.0
0-6 lb/Ac:	40	17	940	44	Base Saturation (%):	100.0	K Base Sat. (%):	2.7	Na Base Sat. (%):	1.0
6-24 lb/Ac:	102			90						
Total lb/Ac measured:	142	17	940	134	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	139			133	Lab Comments:					

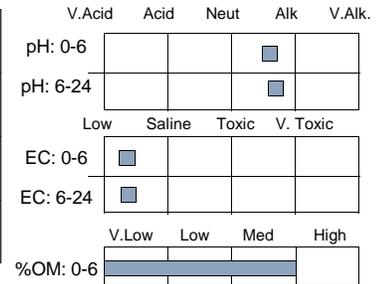
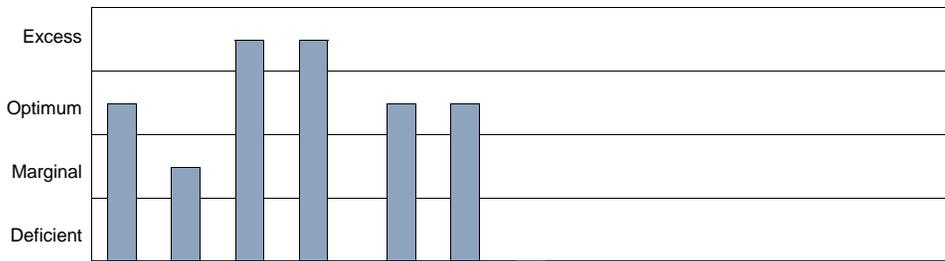
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.3 (Wet)	45 bu	0	5	30	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	25	30	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	25	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W034 Reference Field Name:	Lot Number: 210908_105 Date Sampled: 2021/09/08 Received Date: 2021/09/08 Date Reported: 2021/09/09
Attention: Darren Keam	Legal Location: SE 5-10-1 E1 Total Acres: 32	
Client ID: 18-0013	Sampler: Pimlott	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210908_105-01	0-6	32	13.0	680	16	5300	1400	43							7.6	0.68	8.7
210908_105-02	6-24	30			14										7.7	0.74	



	N	P	K	S	CEC (meq/100g):	39.7	Ca Base Sat. (%):	67.0	Mg Base Sat. (%):	29.0
0-6 lb/Ac:	64	26	1360	32	Base Saturation (%):	100.0	K Base Sat. (%):	4.4	Na Base Sat. (%):	0.5
6-24 lb/Ac:	180			84	Sand (%):		Silt (%):		Clay (%):	Texture:

Total lb/Ac measured: 244 26 1360 116
 Estimated lb/Ac to 24 inch: 243 115

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

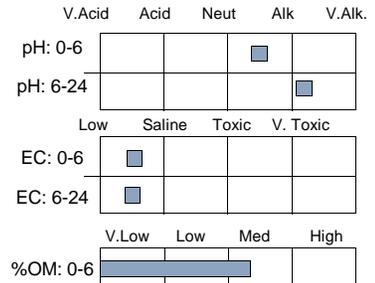
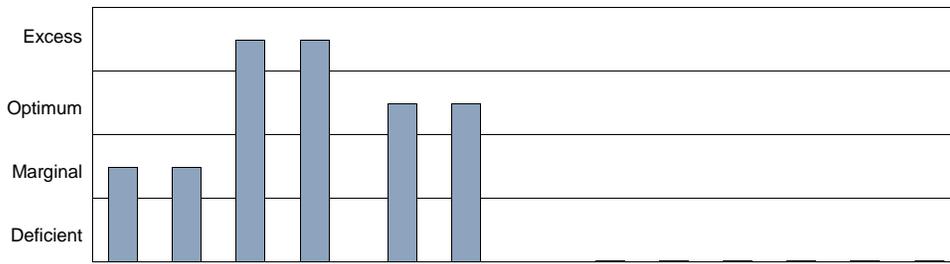
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.3 (Wet)	45 bu	0	0	25	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	25	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	20	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W041 Reference Field Name:	Lot Number: 210929_002 Date Sampled: 2021/09/27 Received Date: 2021/09/29 Date Reported: 2021/10/01
Attention: Darren Keam Client ID: 18-0013	Legal Location: NE 14-9-1 W1 Total Acres: 32 Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210929_002-01	0-6	15	19.0	370	21	6900	1300	14							7.5	1.02	5.4
210929_002-02	6-24	8			27										8.4	0.95	



	N	P	K	S	CEC (meq/100g):	45.8	Ca Base Sat. (%):	75.0	Mg Base Sat. (%):	23.0
0-6 lb/Ac:	30	38	740	42	Base Saturation (%):	100.0	K Base Sat. (%):	2.1	Na Base Sat (%):	0.1
6-24 lb/Ac:	46			162						
Total lb/Ac measured:	76	38	740	204	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	76			202	Lab Comments:					

Fertility Recommendation Previous Crop: Soybeans Straw Removed Continuous Cropping Irrigated

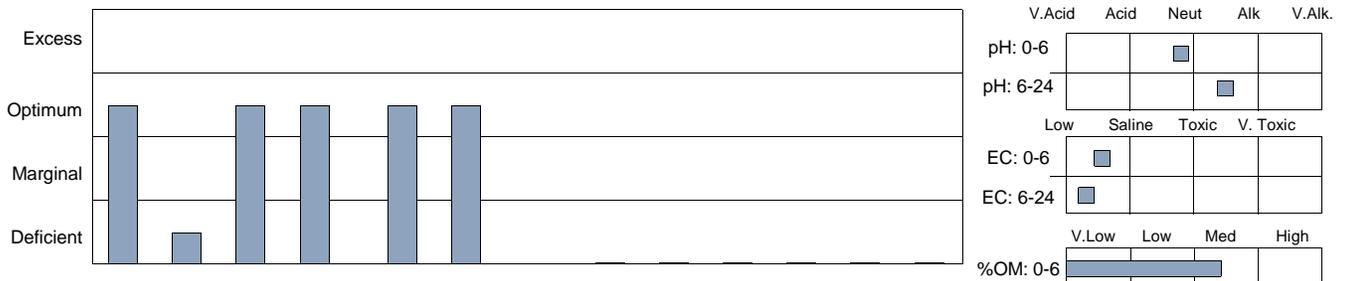
Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	45	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	65	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	45	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement. Nitrogen recommendations were reduced to account for the nitrogen contribution from the preceding legume crop.



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W042 Reference Field Name:	Lot Number: 210929_003 Date Sampled: 2021/09/27 Received Date: 2021/09/29 Date Reported: 2021/10/01
Attention: Darren Keam	Legal Location: NE 14-9-1- W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210929_003-01	0-6	35	9.8	230	13	6000	1000	14							6.8	1.06	5.7
210929_003-02	6-24	23			10										7.5	0.59	



	N	P	K	S	CEC (meq/100g):	41.0	Ca Base Sat. (%):	74.0	Mg Base Sat. (%):	21.0
0-6 lb/Ac:	70	20	460	26	Base Saturation (%):	96.0	K Base Sat. (%):	1.4	Na Base Sat (%):	0.2
6-24 lb/Ac:	138			60						
					Sand (%):		Silt (%):		Clay (%):	Texture:

Total lb/Ac measured: 208 N, 20 P, 460 K, 86 S
 Estimated lb/Ac to 24 inch: 211 N, 86 S

Lab Comments: Bicarbonate-Extractable (Olsen) Phosphate

Fertility Recommendation Previous Crop: Soybeans Straw Removed Continuous Cropping Irrigated

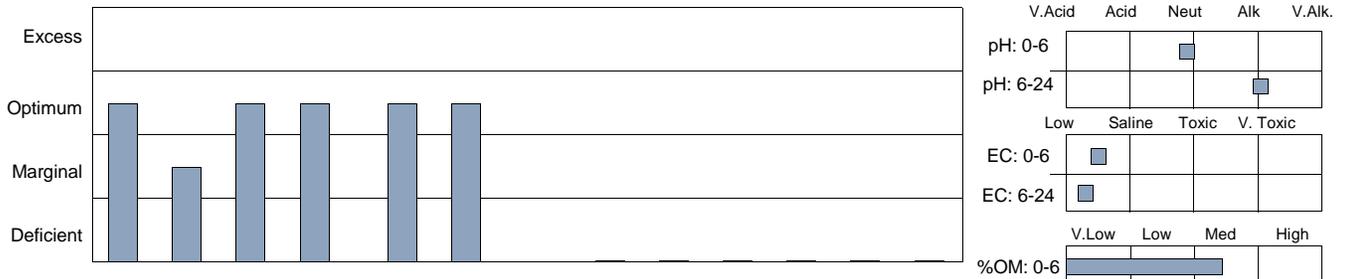
Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	30	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	30	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	25	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W045 Reference Field Name:	Lot Number: 210929_004 Date Sampled: 2021/09/27 Received Date: 2021/09/29 Date Reported: 2021/10/01
Attention: Darren Keam	Legal Location: SE 15-9-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210929_004-01	0-6	44	11.0	260	10	5300	1700	19							6.9	0.95	5.8
210929_004-02	6-24	27			7										8.1	0.58	



	N	P	K	S	CEC (meq/100g):	42.1	Ca Base Sat. (%):	63.0	Mg Base Sat. (%):	33.0
0-6 lb/Ac:	88	22	520	20	Base Saturation (%):	98.0	K Base Sat. (%):	1.6	Na Base Sat (%):	0.2
6-24 lb/Ac:	162			43						
Total lb/Ac measured:	250	22	520	63	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	249			62	Lab Comments:					
					* Bicarbonate-Extractable (Olsen) Phosphate					

Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

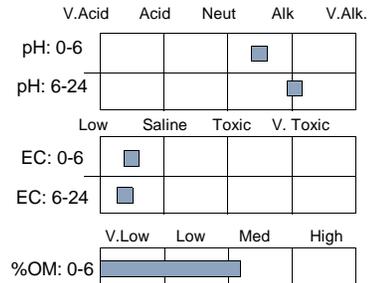
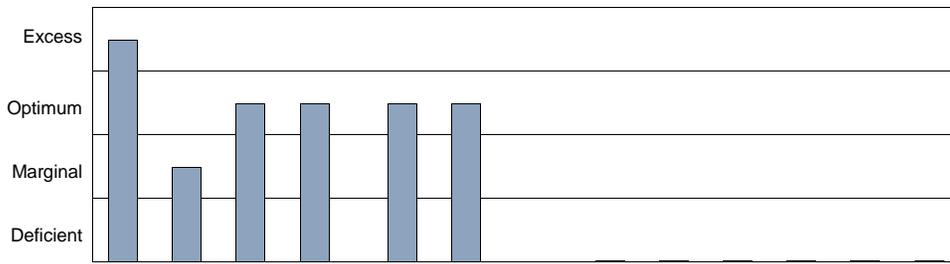
Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	25	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	25	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	20	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W046 Reference Field Name:	Lot Number: 210929_005 Date Sampled: 2021/09/27 Received Date: 2021/09/29 Date Reported: 2021/10/01
Attention: Darren Keam	Legal Location: SE 15-9-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210929_005-01	0-6	72	17.0	280	9	5700	1600	16							7.5	0.92	4.8
210929_005-02	6-24	30			6										8.1	0.74	



	N	P	K	S	CEC (meq/100g):	42.3	Ca Base Sat. (%):	67.0	Mg Base Sat. (%):	31.0
0-6 lb/Ac:	144	34	560	17	Base Saturation (%):	100.0	K Base Sat. (%):	1.7	Na Base Sat (%):	0.2
6-24 lb/Ac:	180			38						
Total lb/Ac measured:	324	34	560	55	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	321			55	Lab Comments:					

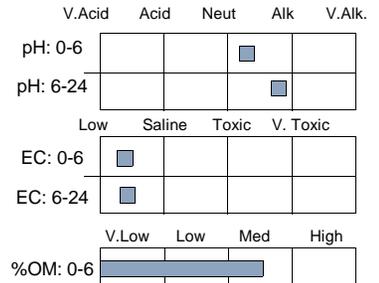
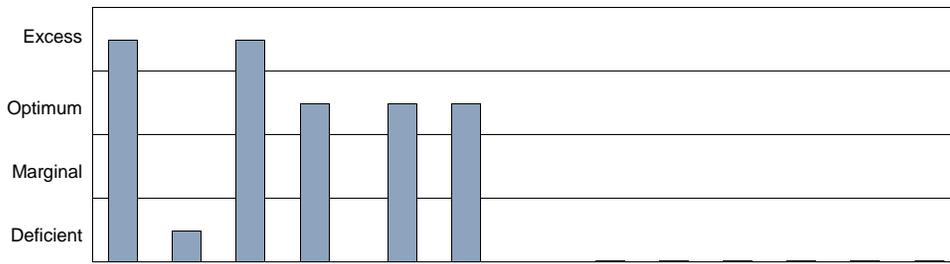
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W047 Reference Field Name:	Lot Number: 210929_006 Date Sampled: 2021/09/27 Received Date: 2021/09/29 Date Reported: 2021/10/01
Attention: Darren Keam Client ID: 18-0013	Legal Location: NE 15-9-1 W1 Total Acres: 32 Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210929_006-01	0-6	53	8.4	390	8	5600	1600	18							7.3	0.74	6.2
210929_006-02	6-24	26			7										7.8	0.82	



	N	P	K	S	CEC (meq/100g):	42.7	Ca Base Sat. (%):	66.0	Mg Base Sat. (%):	32.0
0-6 lb/Ac:	106	17	780	15	Base Saturation (%):	100.0	K Base Sat. (%):	2.4	Na Base Sat (%):	0.2
6-24 lb/Ac:	156			42						
Total lb/Ac measured:	262	17	780	57	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	263			57	Lab Comments:					

* Bicarbonate-Extractable (Olsen) Phosphate

Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	30	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	30	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	25	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

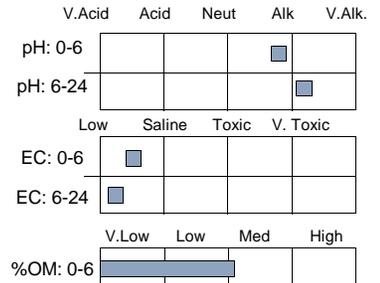
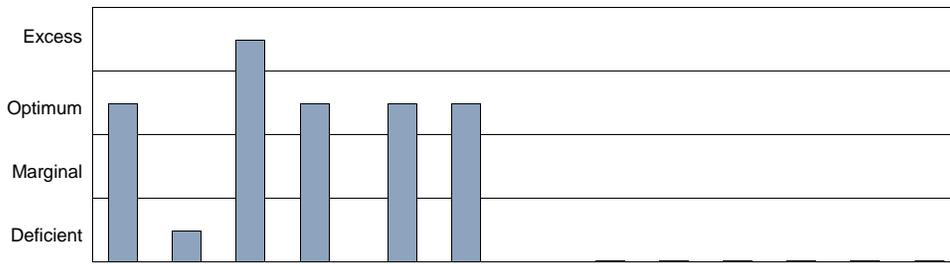


Interpretive Guidelines and Class Limits are based on accepted guidelines. The client is advised to consult with an agronomic professional for detailed interpretation. Farmer's Edge Laboratories limits liability to the cost of the analysis.



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W048 Reference Field Name:	Lot Number: 210929_007 Date Sampled: 2021/09/27 Received Date: 2021/09/29 Date Reported: 2021/10/01
Attention: Darren Keam Client ID: 18-0013	Legal Location: NE 15-9-1 W1 Total Acres: 32 Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210929_007-01	0-6	38	6.4	320	9	5800	1300	17							7.8	0.99	4.4
210929_007-02	6-24	13			9										8.4	0.46	



	N	P	K	S	CEC (meq/100g):	40.3	Ca Base Sat. (%):	72.0	Mg Base Sat. (%):	26.0
0-6 lb/Ac:	76	13	640	18	Base Saturation (%):	100.0	K Base Sat. (%):	2.0	Na Base Sat (%):	0.2
6-24 lb/Ac:	78			52						
Total lb/Ac measured:	154	13	640	70	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	155			70	Lab Comments:					

Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

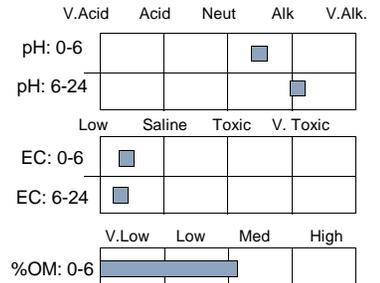
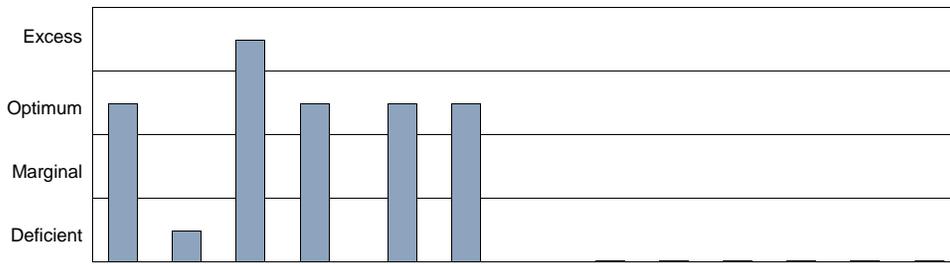
Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	30	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	20	30	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	25	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W049 Reference Field Name: Legal Location: SW 1/2 15 Total Acres: 32 Sampler: Jeremiah Kevin	Lot Number: 210929_008 Date Sampled: 2021/09/27 Received Date: 2021/09/29 Date Reported: 2021/10/01
Attention: Darren Keam Client ID: 18-0013		

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
210929_008-01	0-6	28	7.8	370	10	6200	1500	17							7.5	0.78	4.6
210929_008-02	6-24	14			10										8.2	0.62	



	N	P	K	S	CEC (meq/100g):	44.2	Ca Base Sat. (%):	69.0	Mg Base Sat. (%):	28.0
0-6 lb/Ac:	56	16	740	20	Base Saturation (%):	100.0	K Base Sat. (%):	2.1	Na Base Sat (%):	0.2
6-24 lb/Ac:	84			60	Sand (%):		Silt (%):		Clay (%):	Texture:

Total lb/Ac measured:	140	16	740	80	Lab Comments:
Estimated lb/Ac to 24 inch:	141			82	

Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	10	30	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	30	30	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	25	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.





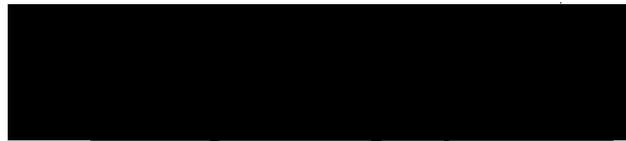
WSP Canada Group Limited
ATTN: DARREN KEAM
1600 Buffalo Place
Winnipeg MB R3T 6B8

Date Received: 01-OCT-20
Report Date: 16-OCT-20 14:25 (MT)
Version: FINAL

Client Phone: 204-259-1488

Certificate of Analysis

Lab Work Order #: L2510942
Project P.O. #: 17M-00008-03
Job Reference: 17M-00008-03
C of C Numbers:
Legal Site Desc:



Judy Dalmaijer
Account Manager

[This report shall not be reproduced except in full without the written authority of the Laboratory.]

ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
ALS CANADA LTD Part of the ALS Group An ALS Limited Company

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2510942-1 WO 34 Sampled By: CLIENT on 01-OCT-20 @ 10:00 Matrix: SOIL Miscellaneous Parameters Mercury (Hg)	0.0343	+/-0.0081		0.0050	mg/kg	0	09-OCT-20	15-OCT-20	R5255800
Metals in Soil by CRC ICPMS Arsenic (As) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Nickel (Ni) Zinc (Zn)	8.63 0.442 43.6 30.7 16.3 36.5 99.2	+/-1.1 +/-0.064 +/-5.7 +/-3.9 +/-2.5 +/-4.7 +/-14		0.10 0.020 0.50 0.50 0.50 0.50 2.0	mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg	0 0 0 0 0 0 0	09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20	09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20	R5253339 R5253339 R5253339 R5253339 R5253339 R5253339 R5253339
L2510942-2 WO 35 Sampled By: CLIENT on 01-OCT-20 @ 11:00 Matrix: SOIL Miscellaneous Parameters Mercury (Hg)	0.0318	+/-0.0075		0.0050	mg/kg	0	09-OCT-20	15-OCT-20	R5255800
Metals in Soil by CRC ICPMS Arsenic (As) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Nickel (Ni) Zinc (Zn)	8.41 0.268 43.1 30.5 16.1 35.8 90.7	+/-1.1 +/-0.039 +/-5.7 +/-3.8 +/-2.4 +/-4.7 +/-12		0.10 0.020 0.50 0.50 0.50 0.50 2.0	mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg	0 0 0 0 0 0 0	09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20	09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20	R5253339 R5253339 R5253339 R5253339 R5253339 R5253339 R5253339
L2510942-3 WO 36 Sampled By: CLIENT on 01-OCT-20 @ 12:00 Matrix: SOIL Miscellaneous Parameters Mercury (Hg)	0.0342	+/-0.0081		0.0050	mg/kg	0	09-OCT-20	15-OCT-20	R5255800
Metals in Soil by CRC ICPMS Arsenic (As) Cadmium (Cd) Chromium (Cr) Copper (Cu) Lead (Pb) Nickel (Ni) Zinc (Zn)	9.52 0.365 46.2 32.3 18.1 39.3 96.0	+/-1.2 +/-0.053 +/-6.1 +/-4.1 +/-2.7 +/-5.1 +/-13		0.10 0.020 0.50 0.50 0.50 0.50 2.0	mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg mg/kg	0 0 0 0 0 0 0	09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20	09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20 09-OCT-20	R5253339 R5253339 R5253339 R5253339 R5253339 R5253339 R5253339
* Refer to Referenced Information for Qualifiers (if any) and Methodology.									

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
---------------------	-----------	-----------	-----------------------------

Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**
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HG-200.2-CVAA-WP	Soil	Mercury in Soil		EPA 200.2/1631E (mod)
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Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAAS.

MET-200.2-CCMS-WP	Soil	Metals in Soil by CRC ICPMS		EPA 200.2/6020B (mod)
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Soil/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

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

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

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

Laboratory Definition Code	Laboratory Location
----------------------------	---------------------

WP	ALS ENVIRONMENTAL - WINNIPEG, MANITOBA, CANADA
----	--

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surr - Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

MU: Measurement Uncertainty. The reported uncertainty is an expanded uncertainty calculated using a coverage factor of 2 which gives a level of confidence of approximately 95%.

Bias: The reported method bias is the average long term deviation from the target value for a long term reference or control sample, measured in percent.

Zero values indicate no detectable method bias.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L2510942

Report Date: 16-OCT-20

Page 1 of 3

Client: WSP Canada Group Limited
 1600 Buffalo Place
 Winnipeg MB R3T 6B8

Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-200.2-CVAA-WP								
	Soil							
Batch	R5255800							
WG3425459-4	CRM	TILL2						
Mercury (Hg)			106.3		%		70-130	15-OCT-20
WG3425459-5	DUP	L2510942-2						
Mercury (Hg)		0.0318	0.0310		mg/kg	2.5	40	15-OCT-20
WG3425459-2	LCS							
Mercury (Hg)			102.7		%		80-120	15-OCT-20
WG3425459-1	MB							
Mercury (Hg)			<0.0050		mg/kg		0.005	15-OCT-20
MET-200.2-CCMS-WP								
	Soil							
Batch	R5253339							
WG3422049-4	CRM	TILL2						
Arsenic (As)			103.1		%		70-130	09-OCT-20
Cadmium (Cd)			97.3		%		70-130	09-OCT-20
Chromium (Cr)			98.5		%		70-130	09-OCT-20
Copper (Cu)			99.1		%		70-130	09-OCT-20
Lead (Pb)			107.7		%		70-130	09-OCT-20
Nickel (Ni)			100.8		%		70-130	09-OCT-20
Zinc (Zn)			99.3		%		70-130	09-OCT-20
WG3422049-5	DUP	L2510942-2						
Arsenic (As)		8.41	8.52		mg/kg	1.3	30	09-OCT-20
Cadmium (Cd)		0.268	0.301		mg/kg	12	30	09-OCT-20
Chromium (Cr)		43.1	42.1		mg/kg	2.4	30	09-OCT-20
Copper (Cu)		30.5	29.9		mg/kg	2.1	30	09-OCT-20
Lead (Pb)		16.1	16.0		mg/kg	0.8	40	09-OCT-20
Nickel (Ni)		35.8	36.1		mg/kg	0.8	30	09-OCT-20
Zinc (Zn)		90.7	86.9		mg/kg	4.3	30	09-OCT-20
WG3422049-2	LCS							
Arsenic (As)			102.5		%		80-120	09-OCT-20
Cadmium (Cd)			101.2		%		80-120	09-OCT-20
Chromium (Cr)			98.8		%		80-120	09-OCT-20
Copper (Cu)			97.5		%		80-120	09-OCT-20
Lead (Pb)			104.4		%		80-120	09-OCT-20
Nickel (Ni)			96.5		%		80-120	09-OCT-20
Zinc (Zn)			95.8		%		80-120	09-OCT-20
WG3422049-1	MB							
Arsenic (As)			<0.10		mg/kg		0.1	09-OCT-20



Quality Control Report

Workorder: L2510942

Report Date: 16-OCT-20

Page 2 of 3

Client: WSP Canada Group Limited
1600 Buffalo Place
Winnipeg MB R3T 6B8

Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-WP	Soil							
Batch	R5253339							
WG3422049-1	MB							
Cadmium (Cd)			<0.020		mg/kg		0.02	09-OCT-20
Chromium (Cr)			<0.50		mg/kg		0.5	09-OCT-20
Copper (Cu)			<0.50		mg/kg		0.5	09-OCT-20
Lead (Pb)			<0.50		mg/kg		0.5	09-OCT-20
Nickel (Ni)			<0.50		mg/kg		0.5	09-OCT-20
Zinc (Zn)			<2.0		mg/kg		2	09-OCT-20

Quality Control Report

Workorder: L2510942

Report Date: 16-OCT-20

Client: WSP Canada Group Limited
1600 Buffalo Place
Winnipeg MB R3T 6B8

Page 3 of 3

Contact: DARREN KEAM

Legend:

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

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.



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

Date Received: 03-SEP-21
Report Date: 10-SEP-21 11:26 (MT)
Version: FINAL

Client Phone: 204-259-1488

Certificate of Analysis

Lab Work Order #: L2635635
Project P.O. #: 17M-00008-04
Job Reference: 17M-00008-04
C of C Numbers:
Legal Site Desc:



Hua Wo
Chemistry Laboratory Manager

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ADDRESS: 1329 Niakwa Road East, Unit 12, Winnipeg, MB R2J 3T4 Canada | Phone: +1 204 255 9720 | Fax: +1 204 255 9721
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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2635635-1 W037 0-15CM Sampled By: CLIENT on 03-SEP-21 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0282	+/-0.010		0.0050	mg/kg	0	08-SEP-21	09-SEP-21	R5581125
pH (1:2 soil:water)	6.65	-		0.10	pH	-		09-SEP-21	R5581651
Metals in Soil by CRC ICPMS									
Arsenic (As)	10.1	+/-2.4		0.10	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Cadmium (Cd)	0.329	+/-0.085		0.020	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Chromium (Cr)	49.3	+/-9.9		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Copper (Cu)	33.3	+/-7.3		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Lead (Pb)	16.8	+/-4.2		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Nickel (Ni)	43.9	+/-8.0		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Phosphorus (P)	655	+/-130		50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Zinc (Zn)	102	+/-20		2.0	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
L2635635-2 W038 0-15CM Sampled By: CLIENT on 03-SEP-21 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0311	+/-0.011		0.0050	mg/kg	0	08-SEP-21	09-SEP-21	R5581125
pH (1:2 soil:water)	7.31	-		0.10	pH	-		09-SEP-21	R5581651
Metals in Soil by CRC ICPMS									
Arsenic (As)	9.10	+/-2.1		0.10	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Cadmium (Cd)	0.214	+/-0.055		0.020	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Chromium (Cr)	47.9	+/-9.6		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Copper (Cu)	31.0	+/-6.8		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Lead (Pb)	14.6	+/-3.6		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Nickel (Ni)	38.9	+/-7.1		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Phosphorus (P)	466	+/-91		50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Zinc (Zn)	90.2	+/-17		2.0	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
L2635635-3 W039 0-15CM Sampled By: CLIENT on 03-SEP-21 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0296	+/-0.011		0.0050	mg/kg	0	08-SEP-21	09-SEP-21	R5581125
pH (1:2 soil:water)	8.20	-		0.10	pH	-		09-SEP-21	R5581651
Metals in Soil by CRC ICPMS									
Arsenic (As)	10.5	+/-2.5		0.10	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Cadmium (Cd)	0.303	+/-0.078		0.020	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Chromium (Cr)	54.2	+/-11		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Copper (Cu)	32.9	+/-7.2		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Lead (Pb)	14.2	+/-3.5		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Nickel (Ni)	47.0	+/-8.6		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Phosphorus (P)	560	+/-110		50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Zinc (Zn)	92.0	+/-18		2.0	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
L2635635-4 W040 0-15CM Sampled By: CLIENT on 03-SEP-21 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0300	+/-0.011		0.0050	mg/kg	0	08-SEP-21	09-SEP-21	R5581125
pH (1:2 soil:water)	6.89	-		0.10	pH	-		09-SEP-21	R5581651
Metals in Soil by CRC ICPMS									
Arsenic (As)	10.3	+/-2.4		0.10	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Cadmium (Cd)	0.337	+/-0.087		0.020	mg/kg	0	08-SEP-21	10-SEP-21	R5582072

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2635635-4 W040 0-15CM Sampled By: CLIENT on 03-SEP-21 Matrix: SOIL									
Metals in Soil by CRC ICPMS									
Chromium (Cr)	47.0	+/-9.4		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Copper (Cu)	33.8	+/-7.4		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Lead (Pb)	16.1	+/-4.0		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Nickel (Ni)	44.1	+/-8.0		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Phosphorus (P)	561	+/-110		50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Zinc (Zn)	98.9	+/-19		2.0	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
L2635635-5 W043 0-15CM Sampled By: CLIENT on 03-SEP-21 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0287	+/-0.010		0.0050	mg/kg	0	08-SEP-21	09-SEP-21	R5581125
pH (1:2 soil:water)	6.14	-		0.10	pH	-		09-SEP-21	R5581651
Metals in Soil by CRC ICPMS									
Arsenic (As)	8.05	+/-1.9		0.10	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Cadmium (Cd)	0.234	+/-0.060		0.020	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Chromium (Cr)	39.0	+/-7.8		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Copper (Cu)	28.7	+/-6.3		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Lead (Pb)	14.5	+/-3.6		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Nickel (Ni)	32.9	+/-6.0		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Phosphorus (P)	408	+/-80		50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Zinc (Zn)	81.6	+/-16		2.0	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
L2635635-6 W044 0-15CM Sampled By: CLIENT on 03-SEP-21 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0285	+/-0.010		0.0050	mg/kg	0	08-SEP-21	09-SEP-21	R5581125
pH (1:2 soil:water)	7.64	-		0.10	pH	-		09-SEP-21	R5581651
Metals in Soil by CRC ICPMS									
Arsenic (As)	9.49	+/-2.2		0.10	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Cadmium (Cd)	0.320	+/-0.082		0.020	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Chromium (Cr)	46.7	+/-9.4		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Copper (Cu)	30.3	+/-6.7		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Lead (Pb)	15.1	+/-3.7		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Nickel (Ni)	39.6	+/-7.2		0.50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Phosphorus (P)	550	+/-110		50	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
Zinc (Zn)	80.7	+/-16		2.0	mg/kg	0	08-SEP-21	10-SEP-21	R5582072
* Refer to Referenced Information for Qualifiers (if any) and Methodology.									

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
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Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**
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HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAAS		EPA 200.2/1631E (mod)
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Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS		EPA 200.2/6020A (mod)
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Soil/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

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

PH-1:2-VA	Soil	pH in Soil (1:2 Soil:Water Extraction)		BC WLAP METHOD: PH, ELECTROMETRIC, SOIL
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This analysis is carried out in accordance with procedures described in "pH, Electrometric in Soil and Sediment - Prescriptive Method", Rev. 2005, Section B Physical, Inorganic and Misc. Constituents, BC Environmental Laboratory Manual. The procedure involves mixing the dried (at <60°C) and sieved (No. 10 / 2mm) sample with deionized/distilled water at a 1:2 ratio of sediment to water. The pH of the solution is then measured using a standard pH probe.

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

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

Laboratory Definition Code	Laboratory Location
----------------------------	---------------------

VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA
----	---

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surr - Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

MU: Measurement Uncertainty. The reported uncertainty is an expanded uncertainty calculated using a coverage factor of 2 which gives a level of confidence of approximately 95%.

Bias: The reported method bias is the average long term deviation from the target value for a long term reference or control sample, measured in percent.

Zero values indicate no detectable method bias.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L2635635

Report Date: 10-SEP-21

Page 1 of 3

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-200.2-CVAF-VA								
	Soil							
Batch	R5581125							
WG3613668-4	CRM	SCP SS-2						
Mercury (Hg)			92.8		%		70-130	09-SEP-21
WG3613668-2	DUP	L2635635-2						
Mercury (Hg)		0.0311	0.0328		mg/kg	5.3	40	09-SEP-21
WG3613668-3	LCS							
Mercury (Hg)			100.9		%		80-120	09-SEP-21
WG3613668-1	MB							
Mercury (Hg)			<0.0050		mg/kg		0.005	09-SEP-21
MET-200.2-CCMS-VA								
	Soil							
Batch	R5582072							
WG3613668-4	CRM	SCP SS-2						
Arsenic (As)			98.5		%		70-130	10-SEP-21
Cadmium (Cd)			108.9		%		70-130	10-SEP-21
Chromium (Cr)			103.9		%		70-130	10-SEP-21
Copper (Cu)			102.2		%		70-130	10-SEP-21
Lead (Pb)			100.1		%		70-130	10-SEP-21
Nickel (Ni)			100.6		%		70-130	10-SEP-21
Phosphorus (P)			97.5		%		70-130	10-SEP-21
Zinc (Zn)			100.3		%		70-130	10-SEP-21
WG3613668-2	DUP	L2635635-2						
Arsenic (As)		9.10	9.00		mg/kg	1.1	30	10-SEP-21
Cadmium (Cd)		0.214	0.257		mg/kg	18	30	10-SEP-21
Chromium (Cr)		47.9	44.2		mg/kg	8.2	30	10-SEP-21
Copper (Cu)		31.0	30.0		mg/kg	3.3	30	10-SEP-21
Lead (Pb)		14.6	14.0		mg/kg	4.4	40	10-SEP-21
Nickel (Ni)		38.9	43.0		mg/kg	9.9	30	10-SEP-21
Phosphorus (P)		466	517		mg/kg	10	30	10-SEP-21
Zinc (Zn)		90.2	81.0		mg/kg	11	30	10-SEP-21
WG3613668-3	LCS							
Arsenic (As)			93.8		%		80-120	10-SEP-21
Cadmium (Cd)			95.3		%		80-120	10-SEP-21
Chromium (Cr)			91.3		%		80-120	10-SEP-21
Copper (Cu)			92.6		%		80-120	10-SEP-21
Lead (Pb)			96.7		%		80-120	10-SEP-21
Nickel (Ni)			93.5		%		80-120	10-SEP-21



Quality Control Report

Workorder: L2635635

Report Date: 10-SEP-21

Page 2 of 3

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA								
	Soil							
Batch	R5582072							
WG3613668-3	LCS							
Phosphorus (P)			98.8		%		80-120	10-SEP-21
Zinc (Zn)			93.1		%		80-120	10-SEP-21
WG3613668-1	MB							
Arsenic (As)			<0.10		mg/kg		0.1	10-SEP-21
Cadmium (Cd)			<0.020		mg/kg		0.02	10-SEP-21
Chromium (Cr)			<0.50		mg/kg		0.5	10-SEP-21
Copper (Cu)			<0.50		mg/kg		0.5	10-SEP-21
Lead (Pb)			<0.50		mg/kg		0.5	10-SEP-21
Nickel (Ni)			<0.50		mg/kg		0.5	10-SEP-21
Phosphorus (P)			<50		mg/kg		50	10-SEP-21
Zinc (Zn)			<2.0		mg/kg		2	10-SEP-21
PH-1:2-VA								
	Soil							
Batch	R5581651							
WG3613668-2	DUP	L2635635-2						
pH (1:2 soil:water)		7.31	7.24	J	pH	0.07	0.2	09-SEP-21

Quality Control Report

Workorder: L2635635

Report Date: 10-SEP-21

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

Page 3 of 3

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.

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.



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

Date Received: 28-SEP-21
Report Date: 07-OCT-21 13:14 (MT)
Version: FINAL

Client Phone: 204-259-1488

Certificate of Analysis

Lab Work Order #: L2645041
Project P.O. #: 17M-00008-04
Job Reference: 17M-00008-04
C of C Numbers:
Legal Site Desc:



Hua Wo
Chemistry Laboratory Manager

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ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2645041-1 W041 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 13:00 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0287	+/-0.010		0.0050	mg/kg	0	04-OCT-21	07-OCT-21	R5612978
Metals in Soil by CRC ICPMS									
Arsenic (As)	10.4	+/-2.4		0.10	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Cadmium (Cd)	0.424	+/-0.11		0.020	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Chromium (Cr)	52.7	+/-11		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Copper (Cu)	33.2	+/-7.3		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Lead (Pb)	15.2	+/-3.8		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Nickel (Ni)	42.8	+/-7.8		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Phosphorus (P)	654	+/-130		50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Zinc (Zn)	96.6	+/-19		2.0	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
L2645041-2 W042 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 13:40 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0262	+/-0.0095		0.0050	mg/kg	0	04-OCT-21	07-OCT-21	R5612978
Metals in Soil by CRC ICPMS									
Arsenic (As)	9.70	+/-2.3		0.10	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Cadmium (Cd)	0.353	+/-0.091		0.020	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Chromium (Cr)	50.5	+/-10		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Copper (Cu)	32.7	+/-7.2		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Lead (Pb)	15.2	+/-3.8		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Nickel (Ni)	42.2	+/-7.7		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Phosphorus (P)	580	+/-110		50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Zinc (Zn)	108	+/-21		2.0	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
L2645041-3 W045 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 14:15 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0295	+/-0.011		0.0050	mg/kg	0	04-OCT-21	07-OCT-21	R5612978
Metals in Soil by CRC ICPMS									
Arsenic (As)	10.7	+/-2.5		0.10	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Cadmium (Cd)	0.324	+/-0.084		0.020	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Chromium (Cr)	45.0	+/-9.0		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Copper (Cu)	31.4	+/-6.9		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Lead (Pb)	14.7	+/-3.6		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Nickel (Ni)	40.7	+/-7.4		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Phosphorus (P)	562	+/-110		50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Zinc (Zn)	90.4	+/-17		2.0	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
L2645041-4 W046 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 14:45 Matrix: SOIL									
Miscellaneous Parameters									
Mercury (Hg)	0.0289	+/-0.010		0.0050	mg/kg	0	04-OCT-21	07-OCT-21	R5612978
Metals in Soil by CRC ICPMS									
Arsenic (As)	9.86	+/-2.3		0.10	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Cadmium (Cd)	0.219	+/-0.056		0.020	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Chromium (Cr)	49.2	+/-9.9		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Copper (Cu)	32.5	+/-7.1		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Lead (Pb)	15.5	+/-3.8		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Nickel (Ni)	40.3	+/-7.4		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2645041-4 W046 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 14:45 Matrix: SOIL Metals in Soil by CRC ICPMS									
Phosphorus (P)	611	+/-120		50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Zinc (Zn)	94.7	+/-18		2.0	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
L2645041-5 W047 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 15:25 Matrix: SOIL Miscellaneous Parameters									
Mercury (Hg)	0.0265	+/-0.0096		0.0050	mg/kg	0	04-OCT-21	07-OCT-21	R5612978
Metals in Soil by CRC ICPMS									
Arsenic (As)	9.56	+/-2.3		0.10	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Cadmium (Cd)	0.371	+/-0.095		0.020	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Chromium (Cr)	49.5	+/-9.9		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Copper (Cu)	31.6	+/-7.0		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Lead (Pb)	14.6	+/-3.6		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Nickel (Ni)	39.9	+/-7.3		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Phosphorus (P)	614	+/-120		50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Zinc (Zn)	101	+/-19		2.0	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
L2645041-6 W048 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 16:10 Matrix: SOIL Miscellaneous Parameters									
Mercury (Hg)	0.0292	+/-0.011		0.0050	mg/kg	0	04-OCT-21	07-OCT-21	R5612978
Metals in Soil by CRC ICPMS									
Arsenic (As)	10.8	+/-2.6		0.10	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Cadmium (Cd)	0.354	+/-0.091		0.020	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Chromium (Cr)	54.8	+/-11		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Copper (Cu)	32.6	+/-7.2		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Lead (Pb)	15.5	+/-3.8		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Nickel (Ni)	42.1	+/-7.7		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Phosphorus (P)	517	+/-100		50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Zinc (Zn)	97.2	+/-19		2.0	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
L2645041-7 W049 0-15CM Sampled By: CLIENT on 27-SEP-21 @ 17:00 Matrix: SOIL Miscellaneous Parameters									
Mercury (Hg)	0.0295	+/-0.011		0.0050	mg/kg	0	04-OCT-21	07-OCT-21	R5612978
Metals in Soil by CRC ICPMS									
Arsenic (As)	10.1	+/-2.4		0.10	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Cadmium (Cd)	0.363	+/-0.094		0.020	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Chromium (Cr)	55.2	+/-11		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Copper (Cu)	32.6	+/-7.2		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Lead (Pb)	14.8	+/-3.7		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Nickel (Ni)	44.4	+/-8.1		0.50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Phosphorus (P)	568	+/-110		50	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
Zinc (Zn)	102	+/-20		2.0	mg/kg	0	04-OCT-21	06-OCT-21	R5613756
* Refer to Referenced Information for Qualifiers (if any) and Methodology.									

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Laboratory Control Sample	Phosphorus (P)	MES	L2645041-1, -2, -3, -4, -5, -6, -7

Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**
HG-200.2-CVAF-VA	Soil	Mercury in Soil by CVAAS		EPA 200.2/1631E (mod)

Soil samples are digested with hot nitric and hydrochloric acids, followed by CVAAS analysis. This method is fully compliant with the BC SALM strong acid leachable metals digestion method.

MET-200.2-CCMS-VA	Soil	Metals in Soil by CRC ICPMS		EPA 200.2/6020A (mod)
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Soil/sediment is dried, disaggregated, and sieved (2 mm). Strong Acid Leachable Metals in the <2mm fraction are solubilized by heated digestion with nitric and hydrochloric acids. Instrumental analysis is by Collision / Reaction Cell ICPMS.

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

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

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

Laboratory Definition Code	Laboratory Location
VA	ALS ENVIRONMENTAL - VANCOUVER, BRITISH COLUMBIA, CANADA

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

Surr - Surrogates are compounds that are similar in behaviour to target analyte(s), but that do not normally occur in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery. In reports that display the D.L. column, laboratory objectives for surrogates are listed there.

mg/kg - milligrams per kilogram based on dry weight of sample

mg/kg wwt - milligrams per kilogram based on wet weight of sample

mg/kg lwt - milligrams per kilogram based on lipid-adjusted weight

mg/L - unit of concentration based on volume, parts per million.

< - Less than.

D.L. - The reporting limit.

N/A - Result not available. Refer to qualifier code and definition for explanation.

MU: Measurement Uncertainty. The reported uncertainty is an expanded uncertainty calculated using a coverage factor of 2 which gives a level of confidence of approximately 95%.

Bias: The reported method bias is the average long term deviation from the target value for a long term reference or control sample, measured in percent. Zero values indicate no detectable method bias.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Analytical results in unsigned test reports with the DRAFT watermark are subject to change, pending final QC review.



Quality Control Report

Workorder: L2645041

Report Date: 07-OCT-21

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
HG-200.2-CVAF-VA								
	Soil							
Batch	R5612978							
WG3631146-4	CRM	SCP SS-2						
Mercury (Hg)			95.7		%		70-130	07-OCT-21
WG3631146-2	DUP	L2645041-1						
Mercury (Hg)		0.0287	0.0283		mg/kg	1.4	40	07-OCT-21
WG3631146-3	LCS							
Mercury (Hg)			100.4		%		80-120	07-OCT-21
WG3631146-1	MB							
Mercury (Hg)			<0.0050		mg/kg		0.005	07-OCT-21
MET-200.2-CCMS-VA								
	Soil							
Batch	R5613756							
WG3631146-4	CRM	SCP SS-2						
Arsenic (As)			107.7		%		70-130	06-OCT-21
Cadmium (Cd)			105.2		%		70-130	06-OCT-21
Chromium (Cr)			109.3		%		70-130	06-OCT-21
Copper (Cu)			101.5		%		70-130	06-OCT-21
Lead (Pb)			104.0		%		70-130	06-OCT-21
Nickel (Ni)			104.1		%		70-130	06-OCT-21
Phosphorus (P)			109.8		%		70-130	06-OCT-21
Zinc (Zn)			105.3		%		70-130	06-OCT-21
WG3631146-2	DUP	L2645041-1						
Arsenic (As)		10.4	10.1		mg/kg	2.6	30	06-OCT-21
Cadmium (Cd)		0.424	0.394		mg/kg	7.4	30	06-OCT-21
Chromium (Cr)		52.7	50.4		mg/kg	4.5	30	06-OCT-21
Copper (Cu)		33.2	32.3		mg/kg	2.7	30	06-OCT-21
Lead (Pb)		15.2	15.0		mg/kg	1.6	40	06-OCT-21
Nickel (Ni)		42.8	40.5		mg/kg	5.7	30	06-OCT-21
Phosphorus (P)		654	663		mg/kg	1.4	30	06-OCT-21
Zinc (Zn)		96.6	93.1		mg/kg	3.6	30	06-OCT-21
WG3631146-3	LCS							
Arsenic (As)			107.8		%		80-120	06-OCT-21
Cadmium (Cd)			104.8		%		80-120	06-OCT-21
Chromium (Cr)			106.8		%		80-120	06-OCT-21
Copper (Cu)			105.3		%		80-120	06-OCT-21
Lead (Pb)			106.0		%		80-120	06-OCT-21
Nickel (Ni)			105.0		%		80-120	06-OCT-21



Quality Control Report

Workorder: L2645041

Report Date: 07-OCT-21

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

Contact: DARREN KEAM

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-200.2-CCMS-VA	Soil							
Batch	R5613756							
WG3631146-3	LCS							
Phosphorus (P)			120.2	MES	%		80-120	06-OCT-21
Zinc (Zn)			106.7		%		80-120	06-OCT-21
WG3631146-1	MB							
Arsenic (As)			<0.10		mg/kg		0.1	06-OCT-21
Cadmium (Cd)			<0.020		mg/kg		0.02	06-OCT-21
Chromium (Cr)			<0.50		mg/kg		0.5	06-OCT-21
Copper (Cu)			<0.50		mg/kg		0.5	06-OCT-21
Lead (Pb)			<0.50		mg/kg		0.5	06-OCT-21
Nickel (Ni)			<0.50		mg/kg		0.5	06-OCT-21
Phosphorus (P)			<50		mg/kg		50	06-OCT-21
Zinc (Zn)			<2.0		mg/kg		2	06-OCT-21

Quality Control Report

Workorder: L2645041

Report Date: 07-OCT-21

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

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Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
MES	Data Quality Objective was marginally exceeded (by < 10% absolute) for < 10% of analytes in a Multi-Element Scan / Multi-Parameter Scan (considered acceptable as per OMOE & CCME).

Hold Time Exceedances:

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

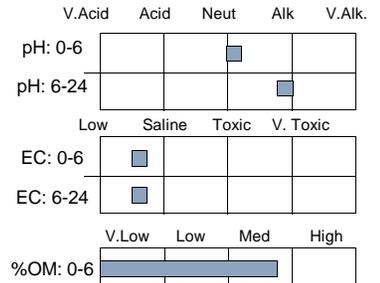
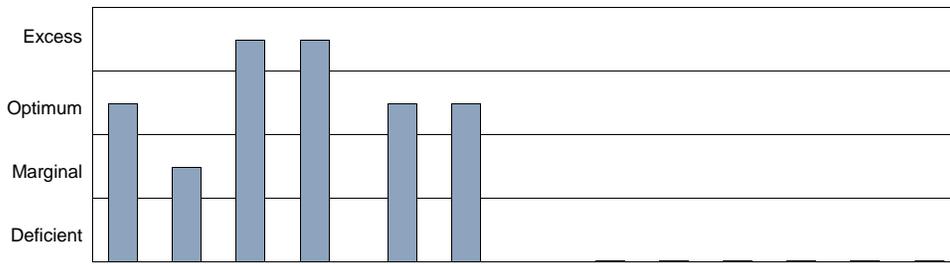
ALS recommended hold times may vary by province. They are assigned to meet known provincial and/or federal government requirements. In the absence of regulatory hold times, ALS establishes recommendations based on guidelines published by the US EPA, APHA Standard Methods, or Environment Canada (where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

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W022 Reference Field Name:	Lot Number: 211004_146 Date Sampled: 2021/09/30 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SW 28-12-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_146-01	0-6	29	19.0	450	31	4000	2600	61							7.1	1.17	7.1
211004_146-02	6-24	11			22										7.9	1.16	



	N	P	K	S	CEC (meq/100g):	42.8	Ca Base Sat. (%):	47.0	Mg Base Sat. (%):	50.0
0-6 lb/Ac:	58	38	900	62	Base Saturation (%):	100.0	K Base Sat. (%):	2.7	Na Base Sat (%):	0.6
6-24 lb/Ac:	66			132						
Total lb/Ac measured:	124	38	900	194						
Estimated lb/Ac to 24 inch:	126			193						

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

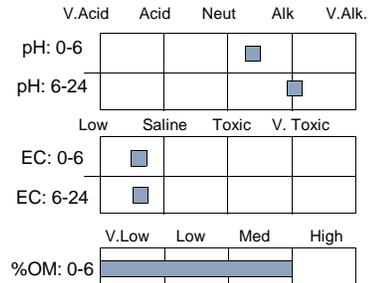
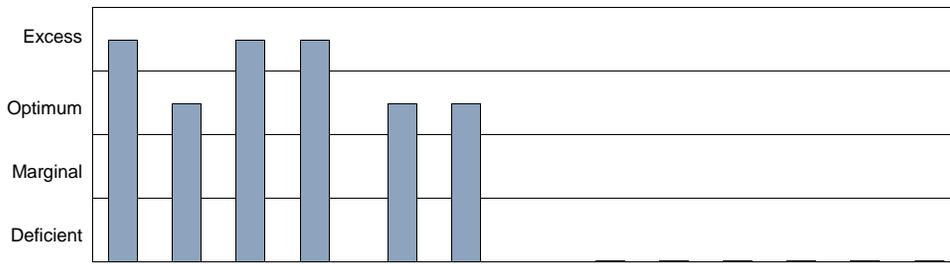
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	15	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	35	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	10	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W021 Reference Field Name:	Lot Number: 211004_147 Date Sampled: 2021/09/30 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SW 28-12-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_147-01	0-6	59	33.0	470	50	3800	2900	110							7.4	1.15	8.2
211004_147-02	6-24	26			59										8.1	1.19	



	N	P	K	S	CEC (meq/100g):	44.5	Ca Base Sat. (%):	43.0	Mg Base Sat. (%):	53.0
0-6 lb/Ac:	118	66	940	100	Base Saturation (%):	100.0	K Base Sat. (%):	2.7	Na Base Sat (%):	1.0
6-24 lb/Ac:	156			354						
Total lb/Ac measured:	274	66	940	454	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	272			450	Lab Comments:					

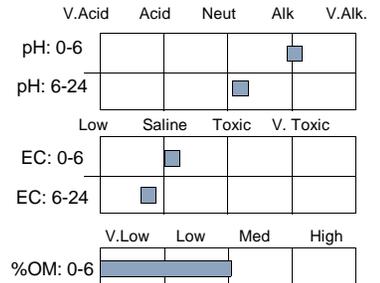
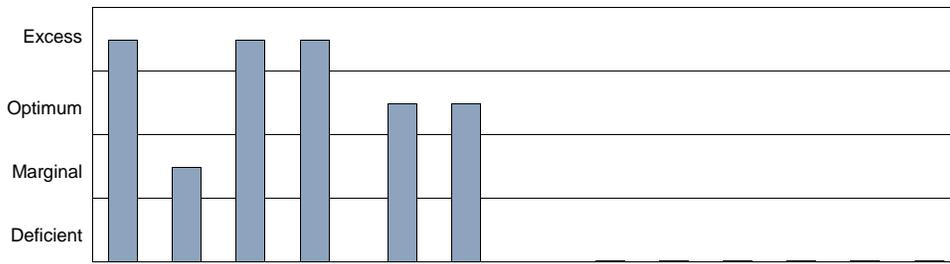
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	15	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	15	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W019 Reference Field Name:	Lot Number: 211004_149 Date Sampled: 2021/09/30 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SE 1/2 NE 28-12-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_149-01	0-6	28	15.0	300	110	4400	3400	590							8.1	2.24	4.2
211004_149-02	6-24	67			37										7.2	1.42	



	N	P	K	S	CEC (meq/100g):	52.9	Ca Base Sat. (%):	41.0	Mg Base Sat. (%):	52.0
0-6 lb/Ac:	56	30	600	220	Base Saturation (%):	100.0	K Base Sat. (%):	1.5	Na Base Sat (%):	4.9
6-24 lb/Ac:	402			222						
Total lb/Ac measured:	458	30	600	442	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	457			445	Lab Comments:					

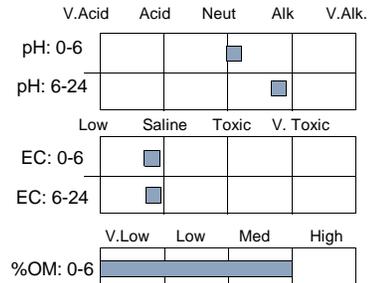
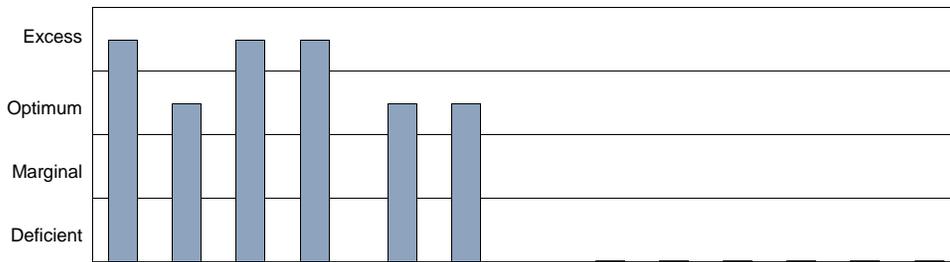
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W026 Reference Field Name:	Lot Number: 211004_142 Date Sampled: 2021/09/30 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam Client ID: 18-0013	Legal Location: NE 29-12-1 W1 Total Acres: 32 Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_142-01	0-6	80	31.0	410	41	3200	2000	88							7.1	1.53	8.3
211004_142-02	6-24	45			59										7.8	1.57	



	N	P	K	S	CEC (meq/100g):	34.4	Ca Base Sat. (%):	47.0	Mg Base Sat. (%):	49.0
0-6 lb/Ac:	160	62	820	82	Base Saturation (%):	100.0	K Base Sat. (%):	3.1	Na Base Sat (%):	1.1
6-24 lb/Ac:	270			354						
Total lb/Ac measured:	430	62	820	436	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	432			436	Lab Comments:					

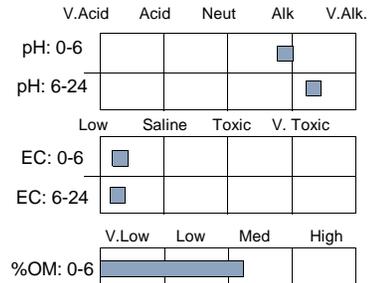
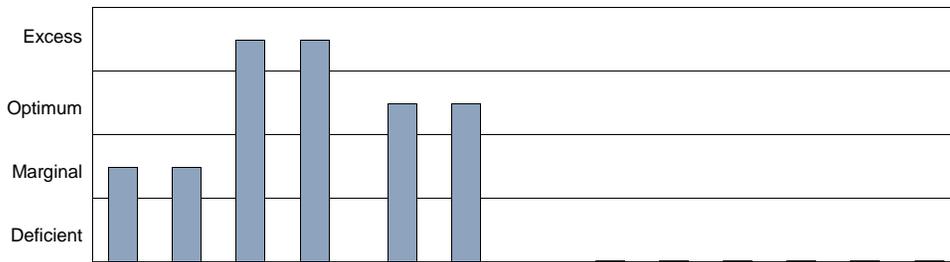
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	15	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	15	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W025 Reference Field Name:	Lot Number: 211004_143 Date Sampled: 2021/09/30 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: NE 29-12-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_143-01	0-6	27	16.0	370	18	2600	2500	110							7.9	0.59	5.0
211004_143-02	6-24	6			18										8.7	0.52	



	N	P	K	S	CEC (meq/100g):	35.4	Ca Base Sat. (%):	37.0	Mg Base Sat. (%):	59.0
0-6 lb/Ac:	54	32	740	36	Base Saturation (%):	100.0	K Base Sat. (%):	2.7	Na Base Sat (%):	1.3
6-24 lb/Ac:	38			108						
Total lb/Ac measured:	92	32	740	144	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	93			144	Lab Comments:					

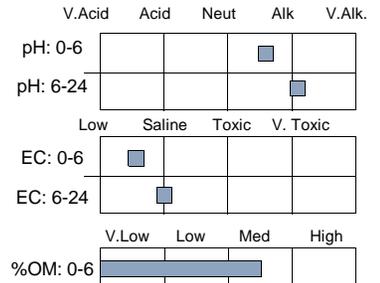
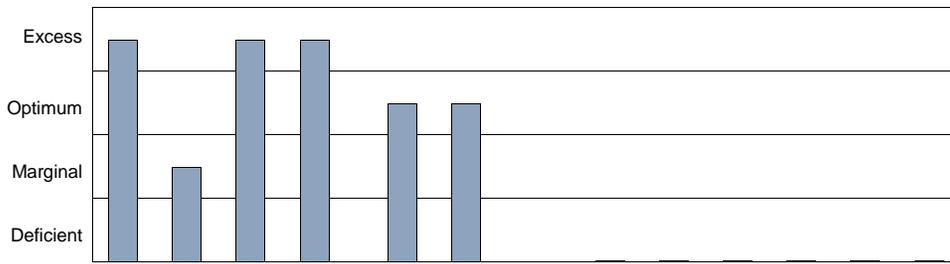
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	45	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	65	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	45	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W024 Reference Field Name:	Lot Number: 211004_144 Date Sampled: 2021/09/30 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SE 29-12-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_144-01	0-6	52	23.0	350	54	2800	2900	230							7.6	1.06	6.1
211004_144-02	6-24	27			190										8.2	2.02	



	N	P	K	S
0-6 lb/Ac:	104	46	700	108
6-24 lb/Ac:	162			1140
Total lb/Ac measured:	266	46	700	1248
Estimated lb/Ac to 24 inch:	266			1252

CEC (meq/100g): 39.7 Ca Base Sat. (%): 35.0 Mg Base Sat. (%): 60.0
 Base Saturation (%): 100.0 K Base Sat. (%): 2.3 Na Base Sat (%): 2.6

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments:

* Bicarbonate-Extractable (Olsen) Phosphate

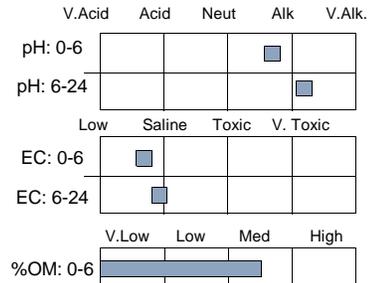
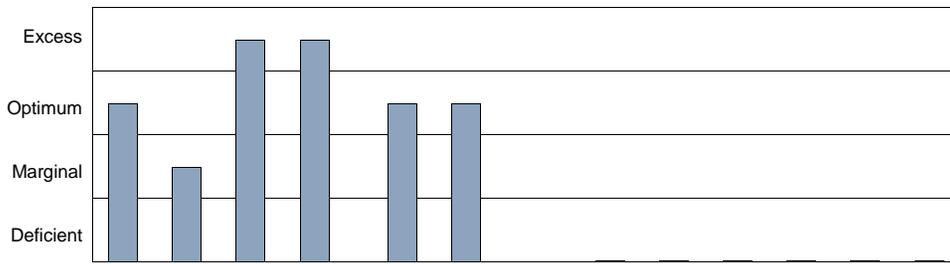
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.3 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W023 Reference Field Name:	Lot Number: 211004_145 Date Sampled: 2021/09/30 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SE 29-12-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_145-01	0-6	37	19.0	350	50	3600	2900	210							7.7	1.30	6.1
211004_145-02	6-24	13			120										8.4	1.75	



	N	P	K	S	CEC (meq/100g):	44.0	Ca Base Sat. (%):	41.0	Mg Base Sat. (%):	55.0
0-6 lb/Ac:	74	38	700	100	Base Saturation (%):	100.0	K Base Sat. (%):	2.0	Na Base Sat (%):	2.1
6-24 lb/Ac:	78			720						
Total lb/Ac measured:	152	38	700	820	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	151			840	Lab Comments:					

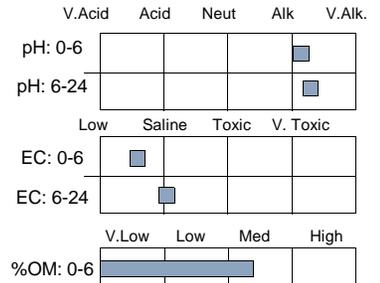
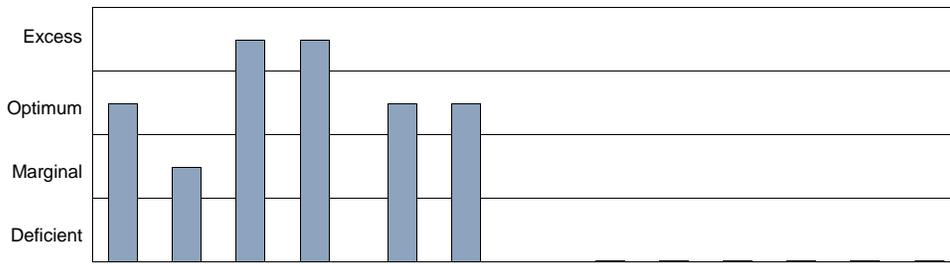
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	15	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W017 Reference Field Name:	Lot Number: 211004_137 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam Client ID: 18-0013	Legal Location: SW 31-12-1 W1 Total Acres: 32 Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_137-01	0-6	40	16.0	350	55	4400	3200	410							8.3	1.11	5.6
211004_137-02	6-24	13			150										8.6	2.08	



	N	P	K	S	CEC (meq/100g):	50.9	Ca Base Sat. (%):	43.0	Mg Base Sat. (%):	52.0
0-6 lb/Ac:	80	32	700	110	Base Saturation (%):	100.0	K Base Sat. (%):	1.8	Na Base Sat (%):	3.5
6-24 lb/Ac:	78			900						
Total lb/Ac measured:	158	32	700	1010						
Estimated lb/Ac to 24 inch:	160			992						

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: _____

* Bicarbonate-Extractable (Olsen) Phosphate

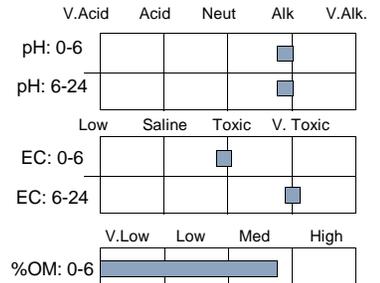
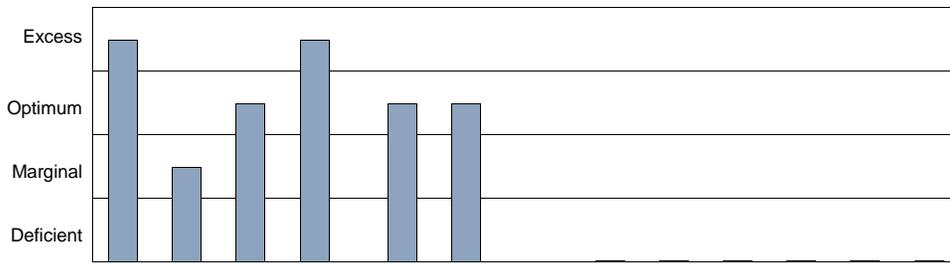
Fertility Recommendation Previous Crop: Soybeans Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W018 Reference Field Name:	Lot Number: 211004_138 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SW 31-12-1 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_138-01	0-6	65	26.0	290	430	5700	2700	910							7.9	3.68	7.1
211004_138-02	6-24	51			1300										7.9	8.24	



	N	P	K	S	CEC (meq/100g):	55.5	Ca Base Sat. (%):	51.0	Mg Base Sat. (%):	40.0
0-6 lb/Ac:	130	52	580	860	Base Saturation (%):	100.0	K Base Sat. (%):	1.3	Na Base Sat (%):	7.1
6-24 lb/Ac:	306			7800	Sand (%):		Silt (%):		Clay (%):	Texture:

Total lb/Ac measured: 436 N, 52 P, 580 K, 8660 S
 Estimated lb/Ac to 24 inch: 436 N, 8542 S

Lab Comments:
 ' Bicarbonate-Extractable (Olsen) Phosphate

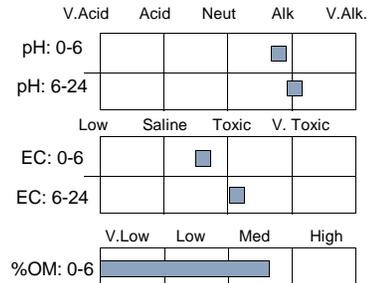
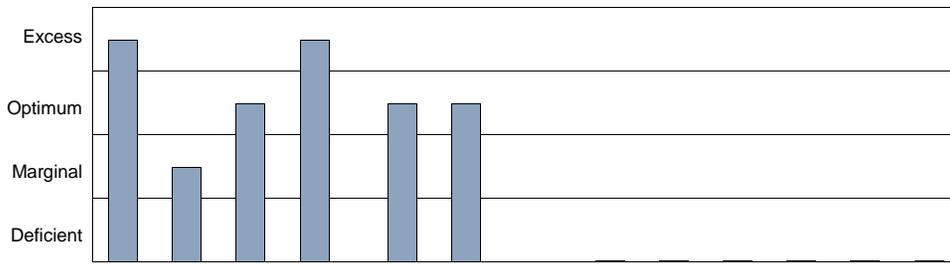
Fertility Recommendation Previous Crop: Soybeans Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9 (Very Wet)	45 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	34 bu	10	0	15	0	10						
Calculated Yield	4.5 (Dry)	21 bu	10	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. Crop yield is likely to be reduced due to salinity levels in this field. Producer-targeted yield goals are not reduced in cases of salinity. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W007 Reference Field Name:	Lot Number: 211004_130 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam Client ID: 18-0013	Legal Location: NW 36-12-2 W1 Total Acres: 32 Sampler:	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_130-01	0-6	81	25.0	240	180	4600	3300	620							7.8	3.10	6.6
211004_130-02	6-24	26			370										8.1	4.52	



	N	P	K	S
0-6 lb/Ac:	162	50	480	360
6-24 lb/Ac:	156			2220
Total lb/Ac measured:	318	50	480	2580
Estimated lb/Ac to 24 inch:	316			2575

CEC (meq/100g): 53.1 Ca Base Sat. (%): 43.0 Mg Base Sat. (%): 51.0
 Base Saturation (%): 100.0 K Base Sat. (%): 1.1 Na Base Sat (%): 5.1

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

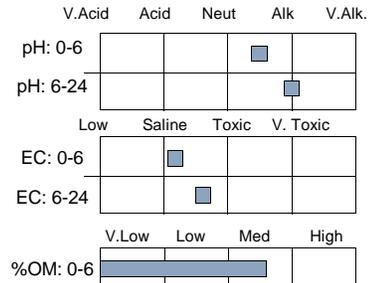
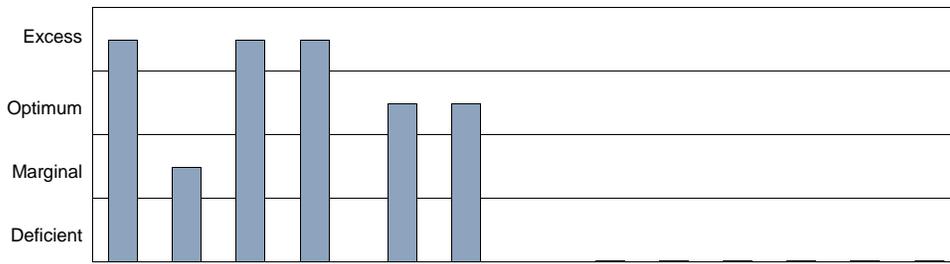
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9 (Very Wet)	45 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	34 bu	10	0	15	0	10						
Calculated Yield	4.5 (Dry)	21 bu	10	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. Crop yield is likely to be reduced due to salinity levels in this field. Producer-targeted yield goals are not reduced in cases of salinity. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W005 Reference Field Name:	Lot Number: 211004_131 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam Client ID: 18-0013	Legal Location: NE 36-12-2 W1 Total Acres: 32 Sampler:	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_131-01	0-6	81	29.0	310	76	4400	2600	330							7.5	2.32	6.4
211004_131-02	6-24	20			300										8.0	3.10	



	N	P	K	S
0-6 lb/Ac:	162	58	620	152
6-24 lb/Ac:	120			1800
Total lb/Ac measured:	282	58	620	1952
Estimated lb/Ac to 24 inch:	284			1976

CEC (meq/100g): 45.7 Ca Base Sat. (%): 49.0 Mg Base Sat. (%): 47.0
 Base Saturation (%): 100.0 K Base Sat. (%): 1.7 Na Base Sat (%): 3.1

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

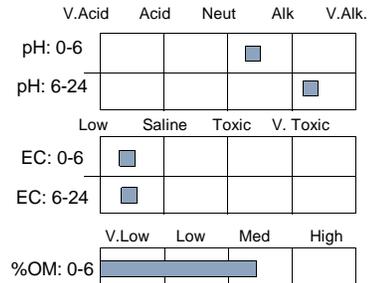
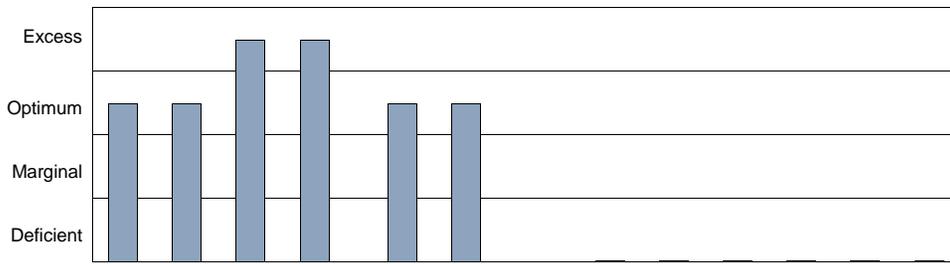
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9.3 (Wet)	45 bu	0	0	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W006 Reference Field Name:	Lot Number: 211004_132 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam Client ID: 18-0013	Legal Location: NE 36-12-2 W1 Total Acres: 32 Sampler:	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_132-01	0-6	42	47.0	470	21	4700	2900	180							7.4	0.80	5.8
211004_132-02	6-24	14			39										8.6	0.86	



	N	P	K	S
0-6 lb/Ac:	84	94	940	42
6-24 lb/Ac:	84			234
Total lb/Ac measured:	168	94	940	276
Estimated lb/Ac to 24 inch:	168			280

CEC (meq/100g): 49.1 Ca Base Sat. (%): 48.0 Mg Base Sat. (%): 48.0
 Base Saturation (%): 100.0 K Base Sat. (%): 2.5 Na Base Sat (%): 1.6

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

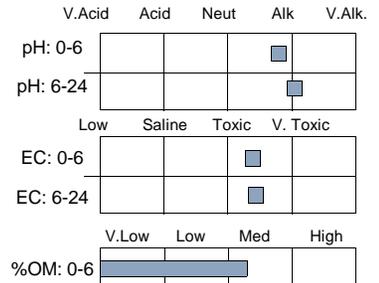
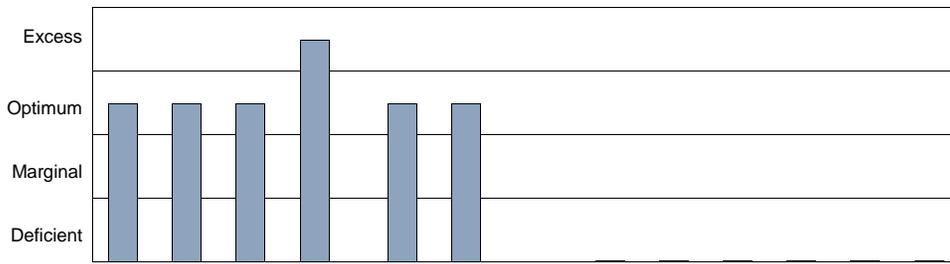
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	0	15	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	0	15	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W009 Reference Field Name:	Lot Number: 211004_133 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam Client ID: 18-0013	Legal Location: SW 36-12-2 W1 Total Acres: 32 Sampler:	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_133-01	0-6	40	39.0	250	620	5000	3100	730							7.8	5.40	5.2
211004_133-02	6-24	18			500										8.1	5.56	



	N	P	K	S
0-6 lb/Ac:	80	78	500	1240
6-24 lb/Ac:	108			3000
Total lb/Ac measured:	188	78	500	4240
Estimated lb/Ac to 24 inch:	190			4253

CEC (meq/100g): 54.5 Ca Base Sat. (%): 46.0 Mg Base Sat. (%): 47.0
 Base Saturation (%): 100.0 K Base Sat. (%): 1.2 Na Base Sat (%): 5.8

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

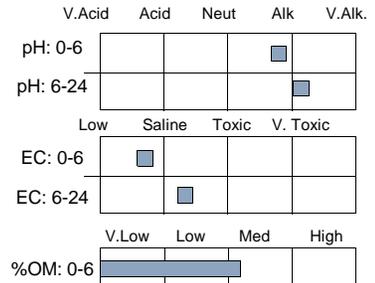
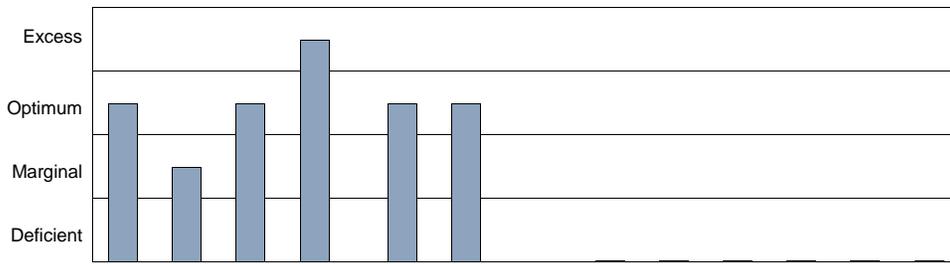
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
Canola, Hybrid													
*Customer Yield	9 (Very Wet)	45 bu	0	0	15	0	10						
Calculated Yield	10.2 (Wet)	35 bu	30	0	15	0	10						
Calculated Yield	7.9 (Average)	27 bu	30	0	15	0	10						
Calculated Yield	4.5 (Dry)	17 bu	30	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. Crop yield is likely to be reduced due to salinity levels in this field. Producer-targeted yield goals are not reduced in cases of salinity. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W010 Reference Field Name:	Lot Number: 211004_134 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SW 36-12-2 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_134-01	0-6	24	28.0	290	49	3700	2700	280							7.8	1.33	4.8
211004_134-02	6-24	12			210										8.3	2.60	



	N	P	K	S
0-6 lb/Ac:	48	56	580	98
6-24 lb/Ac:	72			1260
Total lb/Ac measured:	120	56	580	1358
Estimated lb/Ac to 24 inch:	121			1360

CEC (meq/100g): 42.5 Ca Base Sat. (%): 44.0 Mg Base Sat. (%): 52.0
 Base Saturation (%): 100.0 K Base Sat. (%): 1.7 Na Base Sat (%): 2.9

Sand (%): Silt (%): Clay (%): Texture:

Lab Comments: * Bicarbonate-Extractable (Olsen) Phosphate

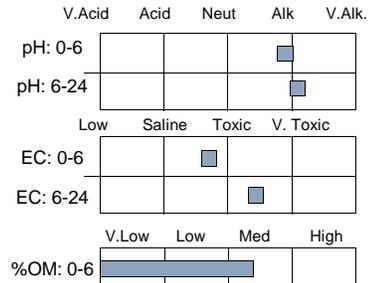
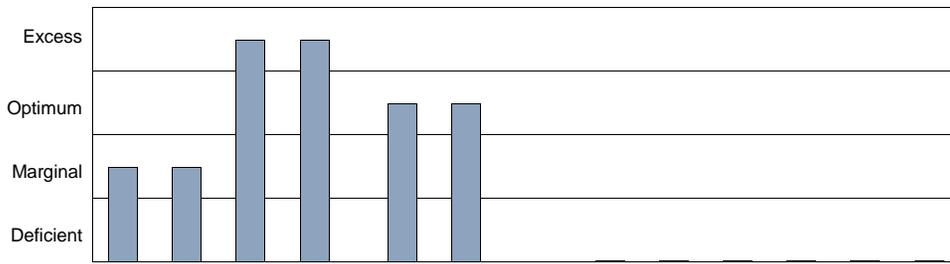
Fertility Recommendation Previous Crop: Canola, Hybrid Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	25	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	45	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	20	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement.

Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W011 Reference Field Name:	Lot Number: 211004_135 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam	Legal Location: SE 36-12-2 W1 Total Acres: 32	
Client ID: 18-0013	Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_135-01	0-6	26	14.0	300	260	4400	3100	640							7.9	3.26	5.6
211004_135-02	6-24	7			800										8.2	5.56	



	N	P	K	S	CEC (meq/100g):	51.6	Ca Base Sat. (%):	43.0	Mg Base Sat. (%):	50.0
0-6 lb/Ac:	52	28	600	520	Base Saturation (%):	100.0	K Base Sat. (%):	1.5	Na Base Sat (%):	5.4
6-24 lb/Ac:	44			4800						
Total lb/Ac measured:	96	28	600	5320	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	96			5315	Lab Comments:					

Fertility Recommendation Previous Crop: Soybeans Straw Removed Continuous Cropping Irrigated

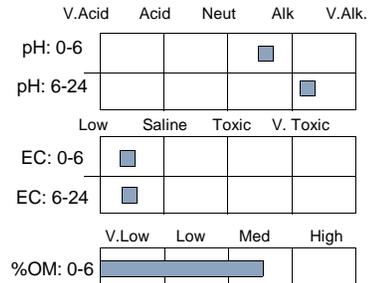
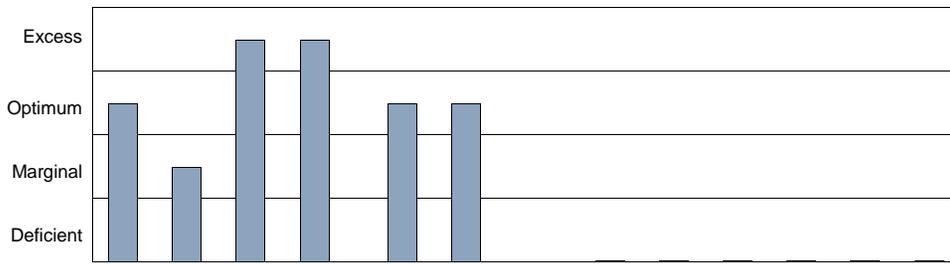
Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9 (Very Wet)	45 bu	0	20	25	0	10						
Calculated Yield	7.9 (Average)	34 bu	10	5	20	0	10						
Calculated Yield	4.5 (Dry)	21 bu	10	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. Crop yield is likely to be reduced due to salinity levels in this field. Producer-targeted yield goals are not reduced in cases of salinity. The rate of P2O5 application is higher than the maximum recommended seed-placed P2O5 rate for the first crop (> 20 lbs/acre). The remaining may be banded. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement. Nitrogen recommendations were reduced to account for the nitrogen contribution from the preceding legume crop.



Report To: WSP Canada Group Ltd 1600 Buffalo Place Winnipeg, MB R3T 6B8	Grower: City of Wpg Grower Field Name: W012 Reference Field Name:	Lot Number: 211004_136 Date Sampled: 2021/09/29 Received Date: 2021/10/04 Date Reported: 2021/10/06
Attention: Darren Keam Client ID: 18-0013	Legal Location: SE 36-12-2 W1 Total Acres: 32 Sampler: Jeremiah Kevin	

Sample ID	Depth	N	P*	K	S	Ca	Mg	Na	B	Cu	Fe	Mn	Zn	Cl	pH	EC	OM
		ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	dS/m	%	
211004_136-01	0-6	38	18.0	320	34	4300	2600	170							7.6	0.82	6.2
211004_136-02	6-24	7			44										8.5	0.88	



	N	P	K	S	CEC (meq/100g):	44.5	Ca Base Sat. (%):	48.0	Mg Base Sat. (%):	49.0
0-6 lb/Ac:	76	36	640	68	Base Saturation (%):	100.0	K Base Sat. (%):	1.8	Na Base Sat (%):	1.6
6-24 lb/Ac:	43			264						
Total lb/Ac measured:	119	36	640	332	Sand (%):		Silt (%):		Clay (%):	Texture:
Estimated lb/Ac to 24 inch:	118			330	Lab Comments:					

Fertility Recommendation Previous Crop: Soybeans Straw Removed Continuous Cropping Irrigated

Yield Type	Rain Required (Inch)	Yield	% Yield Reduction	N	P2O5	K2O	S	B	Cu	Fe	Mn	Zn	Cl
*Customer Yield	9.3 (Wet)	45 bu	0	10	20	0	10						
Calculated Yield	10.2 (Wet)	50 bu	0	30	20	0	10						
Calculated Yield	7.9 (Average)	38 bu	0	0	15	0	10						
Calculated Yield	4.5 (Dry)	24 bu	0	0	15	0	10						

Fertility recommendations are based on spring banding of N, S and seed placement of P, K. Consider total seed row fertilizer with regard to seedling damage. The rate of Phosphorus application is based on seed-placement. Broadcasting and incorporation requirement on the average is 2.5 times that of seed-placement. Nitrogen recommendations were reduced to account for the nitrogen contribution from the preceding legume crop.



APPENDIX

D

BIOSOLIDS LAND
APPLICATION
PRESCRIPTION
RATES

Field Prescription Application Rate, City of Winnipeg

Date Modified: Oct. 12, 2021

Field ID:	NE14-9-1W	
Land Area Available (ha):	90	
2022 Crop	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	50	56
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	55	62
2 x P2O5 Crop Removal @ target Yield:	110	123
3 x P2O5 Crop Removal @ target Yield:	165	185
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data

	W041	W041	210929_002			
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	15.0	8	70			-
Available Phosphate-P	19.0		34			-
Available Potassium	370		666			-
Available Sulfate-S	021	27	204			-
EC (dS/m)	1.02	0.95				
Organic Matter (%)	5.4					
	W042	W042	210929-003			
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha-1	mg kg ⁻¹		kg ha-1
Total Nitrogen						
Available Nitrate-N	35.0	23	187			-
Available Phosphate-P	09.8		18			-
Available Potassium	230.0		414			-
Available Sulfate-S	13.0	10	86			-
EC (dS/m)	01.06	0.59				
Organic Matter (%)	5.70					

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis Pilot Project
Estimated Biosolid Volume	In-field	m ³	2,944
Specific Gravity	As Received	g cm ⁻³	1.00
Estimated Biosolids		tonnes	2,944
Dry tonnes biosolids available (tonnes x %solids)	Dried Basis	tonnes	801
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N		kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻¹	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen			Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	187 Ha
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	461 Ac
P ₂ O ₅ Application check		%	
Application Rate based on Phosphorous (1xCR)			Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	141 Ha
	Dried Basis	kg ha ⁻¹	348 Ac
Amount of Nitrogen applied		lb ac ⁻¹	66
		kg ha ⁻¹	18
Additional Nitrogen required		lb ac ⁻¹	16
Application Rate based on Phosphorous (2xCR)			Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	71 Ha
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	174 Ac
Additional Nitrogen required		kg ha ⁻¹	92

Selected Application rate based on:		2x CR P
Selected Application Rate	Dried Basis	tonnes ha ⁻¹
		tons ac ⁻¹
Estimated Biosolids Volume Applied	Wet Basis	tonnes ha ⁻¹
		tons ac ⁻¹
Estimated Biosolids Volume Remaining	Wet	Tonnes
		Tonnes

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

Field Prescription Application Rate, City of Winnipeg

Date Modified: Oct. 18, 2021

Field ID:	NE15-9-01EPM	
Land Area Available (ha):	59	
2022 Crop	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	0	0
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	57	64
2 x P2O5 Crop Removal @ target Yield:	114	128
3 x P2O5 Crop Removal @ target Yield:	171	192
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data						
	W047		210929-006	W048		210929-006
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	53.0	26	236	38.0	13	139
Available Phosphate-P	08.4		15	06.4		12
Available Potassium	390		702	320		576
Available Sulfate-S	008	7	58	009	9	72
EC (dS/m)	0.74	0.82		0.99	0.46	
Organic Matter (%)	6.2			4.4		

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis
Estimated Biosolid Volume	In-field	m ³	
Specific Gravity	As Received	g cm ⁻³	
Estimated Biosolids		tonnes	
Dry tonnes biosolids available (tonnes x %solids)	Dried Basis	tonnes	
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N	Dried Basis	kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

2,714
1.00
2,714
738

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻²	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen				Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	-	#DIV/0! Ha
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	-	#DIV/0! Ac
P ₂ O ₅ Application check		%	-	
Application Rate based on Phosphorous (1xCR)				Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	6	125 Ha
	Dried Basis	kg ha ⁻¹	77	310 Ac
Amount of Nitrogen applied		lb ac ⁻¹	68	
Additional Nitrogen required		kg ha ⁻¹	77	
		lb ac-1	68	
Application Rate based on Phosphorous (2xCR)				Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	12	63 Ha
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	154	155 Ac
Additional Nitrogen required		kg ha ⁻¹	154	

Selected Application rate based on:			
Selected Application Rate	Dried Basis	tonnes ha ⁻¹	12
		tons ac ⁻¹	5
	Wet Basis	tonnes ha ⁻¹	46
		tons ac ⁻¹	21
Estimated Biosolids Volume Applied	Wet	Tonnes	2,709
Estimated Biosolids Volume Remaining	Wet	Tonnes	5

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

Field Prescription Application Rate, City of Winnipeg

Date Modified:

Sept. 9, 2021

Field ID:	N1/2 NW14-9-01WPM	
Land Area Available (ha):	32	
2022 Crop	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	0	0
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	55	62
2 x P2O5 Crop Removal @ target Yield:	110	123
3 x P2O5 Crop Removal @ target Yield:	165	185
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data

	W037		210907-029			
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	74.0	25	268			-
Available Phosphate-P	23.0		41			-
Available Potassium	440		792			-
Available Sulfate-S	5	4	34			-
EC (dS/m)	0.78	0.60				
Organic Matter (%)	6.7					

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis Pilot Project
Estimated Biosolid Volume	In-field	m ³	1,472
Specific Gravity	As Received	g cm ⁻¹	1.00
Estimated Biosolids		tonnes	1,472
Dry tonnes biosolids available (= tonnes x %solids)	Dried Basis	tonnes	400
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N		kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 48 hours		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻²	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen				Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	-	#DIV/0! Ha
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	-	#DIV/0! Ac
P ₂ O ₅ Application check		%	-	
Application Rate based on Phosphorous (1xCR)				Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	6	71 Ha
	Dried Basis	kg ha ⁻¹	74	174 Ac
Amount of Nitrogen applied		lb ac ⁻¹	66	
		kg ha ⁻¹	74	
Additional Nitrogen required		lb ac-1	66	
Application Rate based on Phosphorous (2xCR)				Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	11	35 Ha
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	148	87 Ac
Additional Nitrogen required		kg ha ⁻¹	148	

Selected Application rate based on:			
Selected Application Rate	Dried Basis	2x CR P	
		tonnes ha ⁻¹	11
	tons ac ⁻¹	5	
	Wet Basis	tonnes ha ⁻¹	44
tons ac ⁻¹		20	
Estimated Biosolids Volume Applied	Wet	Tonnes	1,419
Estimated Biosolids Volume Remaining	Wet	Tonnes	53

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

Field Prescription Application Rate, City of Winnipeg

Date Modified: Sept. 9, 2021

Field ID:	S1/2 NW & SW14-9-1WPM	
Land Area Available (ha):	95	
2022 Crop:	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	50	56
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	55	62
2 x P2O5 Crop Removal @ target Yield:	110	123
3 x P2O5 Crop Removal @ target Yield:	165	185
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data

	W038		210907_030	W039		210907_031
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	30.0	9	103	27.0	13	119
Available Phosphate-P	16.0		29	06.0		11
Available Potassium	460		828	450		810
Available Sulfate-S	011	9	76	008	7	58
EC (dS/m)	0.58	0.44		0.54	0.50	
Organic Matter (%)	5.3			3.9		
	W040		210907_032			
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	72.0	32	302			-
Available Phosphate-P	19.0		34			-
Available Potassium	450.0		810			-
Available Sulfate-S	08.0	5	46			-
EC (dS/m)	00.88	0.75				
Organic Matter (%)	6.80					

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis Pilot Project
Estimated Biosolid Volume	In-field	m ³	4,400
Specific Gravity	As Received	g cm ⁻³	1.00
Estimated Biosolids		tonnes	4,400
Dry tonnes biosolids available (= tonnes x %solids)	Dried Basis	tonnes	1,197
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N		kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻²	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen				Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	4	279 Ha
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	47	689 Ac
P ₂ O ₅ Application check		%	83	
Application Rate based on Phosphorous (1xCR)				Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	6	211 Ha
	Dried Basis	kg ha ⁻¹	74	521 Ac
Amount of Nitrogen applied		lb ac ⁻¹	66	
		kg ha ⁻¹	18	
Additional Nitrogen required		lb ac ⁻¹	16	
Application Rate based on Phosphorous (2xCR)				Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	11	105 Ha
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	148	260 Ac
Additional Nitrogen required		kg ha ⁻¹	92	

Selected Application rate based on:		2x CR P	
Selected Application Rate	Dried Basis	tonnes ha ⁻¹	11
		tons ac ⁻¹	5
Estimated Biosolids Volume Applied	Wet Basis	tonnes ha ⁻¹	44
		tons ac ⁻¹	20
Estimated Biosolids Volume Applied	Wet	Tonnes	4,212
Estimated Biosolids Volume Remaining	Wet	Tonnes	188

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

Field Prescription Application Rate, City of Winnipeg

Date Modified:

Sept. 9, 2021

Field ID:	SE5-10-01EPM	
Land Area Available (ha):	18	
2022 Crop	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	0	0
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	55	62
2 x P2O5 Crop Removal @ target Yield:	110	123
3 x P2O5 Crop Removal @ target Yield:	165	185
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data

	W034		210908_105	W036		210908_104
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	32.0	30	220	20.0	17	128
Available Phosphate-P	13.0		23	08.6		15
Available Potassium	680		1,224	470		846
Available Sulfate-S	016	14	116	022	15	134
EC (dS/m)	0.68	0.74		0.59	0.68	
Organic Matter (%)	8.7			6		

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis Pilot Project
Estimated Biosolid Volume	In-field	m ³	792
Specific Gravity	As Received	g cm ⁻¹	1.00
Estimated Biosolids		tonnes	792
Dry tonnes biosolids available (= tonnes x %solids)	Dried Basis	tonnes	215
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N		kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻²	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen				Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	-	#DIV/0! Ha
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	-	#DIV/0! Ac
P ₂ O ₅ Application check		%	-	
Application Rate based on Phosphorous (1xCR)				Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	6	38 Ha
	Dried Basis	kg ha ⁻¹	74	94 Ac
Amount of Nitrogen applied		lb ac ⁻¹	66	
		kg ha ⁻¹	74	
Additional Nitrogen required		lb ac-1	66	
Application Rate based on Phosphorous (2xCR)				Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	11	19 Ha
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	148	47 Ac
Additional Nitrogen required		kg ha ⁻¹	148	

Selected Application rate based on:			
Selected Application Rate	Dried Basis	2x CR P	
		tonnes ha ⁻¹	11
		tons ac ⁻¹	5
	Wet Basis	tonnes ha ⁻¹	44
tons ac ⁻¹		20	
Estimated Biosolids Volume Applied	Wet	Tonnes	798
Estimated Biosolids Volume Remaining	Wet	Tonnes	6

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

Field Prescription Application Rate, City of Winnipeg

Date Modified:

Sept. 9, 2021

Field ID:	SE14-9-01WPM	
Land Area Available (ha):	63	
2022 Crop	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	0	0
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	55	62
2 x P2O5 Crop Removal @ target Yield:	110	123
3 x P2O5 Crop Removal @ target Yield:	165	185
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data

	W043	15-60 cm	210907_34	W044	15-60 cm	210907_33
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	46.0	31	250	32.0	18	155
Available Phosphate-P	08.4		15	05.6		10
Available Potassium	520		936	660		1,188
Available Sulfate-S	004	6	44	004	7	50
EC (dS/m)	0.52	0.48		0.48	0.46	
Organic Matter (%)	6.5				4.3	

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis Pilot Project
Estimated Biosolid Volume	In-field	m ³	2,945
Specific Gravity	As Received	g cm ⁻¹	1.00
Estimated Biosolids		tonnes	2,945
Dry tonnes biosolids available (= tonnes x %solids)	Dried Basis	tonnes	801
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N		kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻²	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen				Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	-	#DIV/0! Ha
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	-	#DIV/0! Ac
P ₂ O ₅ Application check		%	-	
Application Rate based on Phosphorous (1xCR)				Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	6	141 Ha
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	74	349 Ac
		lb ac ⁻¹	66	
Additional Nitrogen required		kg ha ⁻¹	74	
		lb ac ⁻¹	66	
Application Rate based on Phosphorous (2xCR)				Land Area Required
Total Phosphorus Based Application Rate	Dried Basis	tonnes ha ⁻¹	11	71 Ha
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	148	174 Ac
Additional Nitrogen required		kg ha ⁻¹	148	

Selected Application rate based on:		2x CR P	
Selected Application Rate	Dried Basis	tonnes ha ⁻¹	11
		tons ac ⁻¹	5
	Wet Basis	tonnes ha ⁻¹	44
		tons ac ⁻¹	20
Estimated Biosolids Volume Applied	Wet	Tonnes	2,793
Estimated Biosolids Volume Remaining	Wet	Tonnes	152

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

Field Prescription Application Rate, City of Winnipeg

Date Modified: Oct. 18, 2021

Field ID:	SE15-9-01EPM	
Land Area Available (ha):	64	
2022 Crop	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	0	0
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	57	64
2 x P2O5 Crop Removal @ target Yield:	114	128
3 x P2O5 Crop Removal @ target Yield:	171	192
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data						
	W045		210929-004	W046		210929-005
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	44.0	27	225	72.0	30	292
Available Phosphate-P	11.0		20	17.0		31
Available Potassium	260		468	280		504
Available Sulfate-S	010	7	62	009	6	54
EC (dS/m)	0.95	0.58		0.92	0.74	
Organic Matter (%)	5.8			4.8		

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis
Estimated Biosolid Volume	In-field	m ³	2,926
Specific Gravity	As Received	g cm ⁻³	1.00
Estimated Biosolids		tonnes	2,926
Dry tonnes biosolids available (tonnes x %solids)	Dried Basis	tonnes	796
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N	Dried Basis	kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻²	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen			Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	#DIV/0! Ha
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	#DIV/0! Ac
P ₂ O ₅ Application check		%	-
Application Rate based on Phosphorous (1xCR)			Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	135 Ha
	Dried Basis	kg ha ⁻¹	334 Ac
Amount of Nitrogen applied		lb ac ⁻¹	68
Additional Nitrogen required		kg ha ⁻¹	77
		lb ac-1	68
Application Rate based on Phosphorous (2xCR)			Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	12
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	154
Additional Nitrogen required		kg ha ⁻¹	154

Selected Application rate based on:		2x CR P	
Selected Application Rate	Dried Basis	tonnes ha ⁻¹	12
		tons ac ⁻¹	5
Estimated Biosolids Volume Applied	Wet Basis	tonnes ha ⁻¹	46
		tons ac ⁻¹	21
Estimated Biosolids Volume Remaining	Wet	Tonnes	2,938
		Tonnes	12

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

Field Prescription Application Rate, City of Winnipeg

Date Modified: 18-Oct-21

Field ID:	SW15-9-01EPM	
Land Area Available (ha):	15	
2022 Crop	Canola	
2022 Target Yield:	45 bu/ac	
	lb/ac	kg/ha
Target Nitrogen total less soil residual:	0	0
Fertilizer Phosphate (P2O5) total less soil residual:	50	56
1 x P2O5 Crop Removal @ target Yield:	55	62
2 x P2O5 Crop Removal @ target Yield:	110	123
3 x P2O5 Crop Removal @ target Yield:	165	185
Sulfate-S target:	20	22

Plant Available Nutrients Soil Test Data

	W049		210929-008			
Sample Depth	0-15 cm	15-60 cm	Total Available	0-15 cm	15-60 cm	Total Available
Units	mg kg ⁻¹		kg ha ⁻¹	mg kg ⁻¹		kg ha ⁻¹
Total Nitrogen						
Available Nitrate-N	28.0	14	126			-
Available Phosphate-P	07.8		14			-
Available Potassium	370		666			-
Available Sulfate-S	010	10	80			-
EC (dS/m)	0.78	0.62				
Organic Matter (%)	4.6					

City of Winnipeg Biosolids Characteristics and Analysis

Parameter Name	Parameter Description	Unit	Biosolid Analysis
Estimated Biosolid Volume	In-field	m ³	690
Specific Gravity	As Received	g cm ⁻³	1.00
Estimated Biosolids		tonnes	690
Dry tonnes biosolids available (tonnes x %solids)	Dried Basis	tonnes	188
Moisture	As Received	%	73.4
Total Solids	As Received	%	27.2
Organic Matter	Dry Basis	%	50.23
Total Organic Carbon	Dry Basis	%	30.49
C:N Ratio	Dry Basis	x:1	7.8
C:P Ratio	Dry Basis	x:1	16.2
N:P Ratio	Dry Basis	x:1	2.08
pH	Saturated Paste		6.07
Total N	Dried Basis	%	3.9
	Dried Basis	mg kg ⁻¹	39,328
	Dried Basis	kg Tonne ⁻¹	39.3
Ammonium - N (NH4-N)	Dried Basis	mg kg ⁻¹	5,372.29
	Dried Basis	kg Tonne ⁻¹	5.37
Available Nitrate-N	Dried Basis	mg kg ⁻¹	2.04
Available Nitrate-N	Dried Basis	kg Tonne ⁻¹	0.002
Total Phosphorous (average)	Dried Basis	mg kg ⁻¹	18,874

Amount of Biosolids Nutrient Available to Crop

Organic N (=TN - Ammonium N)	Dried Basis	mg kg ⁻¹	33,956
Organic N	Dried Basis	kg Tonne ⁻¹	34.0
Method of Application:			Incorporated
Anticipated Weather			Cool/dry
Anticipated Volatilization (%)	within 1 day		15
Available Organic N (@ 25%)	Dried Basis	kg Tonne ⁻¹	8.5
Ammonium-nitrogen Available	Dried Basis	kg Tonne ⁻²	4.57
Plant Available Nitrogen (PAN) (Year 1)	Dried Basis	kg Tonne ⁻¹	13.1
PAN Year 2 (@12% mineralization)	Dried Basis	kg Tonne ⁻¹	4.1
PAN Year 3 (@6% mineralization)	Dried Basis	kg Tonne ⁻¹	2.0
Phosphorous	Dried Basis	kg Tonne ⁻¹	18.9
P ₂ O ₅ equivalent	Dried Basis	kg Tonne ⁻¹	43.4
Total Available P ₂ O ₅	Dried Basis	kg Tonne ⁻¹	10.9

Application Rate based on Nitrogen			Land Area Required
Nitrogen Based Application Rate	Dried Basis	tonnes ha ⁻¹	-
Amount of Available P2O5 applied	Dried Basis	kg ha ⁻¹	-
P ₂ O ₅ Application check		%	-
Application Rate based on Phosphorous (1xCR)			Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	6
	Dried Basis	kg ha ⁻¹	74
Amount of Nitrogen applied		lb ac ⁻¹	66
Additional Nitrogen required		kg ha ⁻¹	74
		lb ac-1	66
Application Rate based on Phosphorous (2xCR)			Land Area Required
Total Phosphorous Based Application Rate	Dried Basis	tonnes ha ⁻¹	11
Amount of Nitrogen applied	Dried Basis	kg ha ⁻¹	148
Additional Nitrogen required		kg ha ⁻¹	148

Selected Application rate based on:		2x CR P	
Selected Application Rate	Dried Basis	tonnes ha ⁻¹	11
		tons ac ⁻¹	5
Estimated Biosolids Volume Applied	Wet Basis	tonnes ha ⁻¹	44
		tons ac ⁻¹	20
Estimated Biosolids Volume Remaining	Wet	Tonnes	665
		Tonnes	25

Notes:

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

Organic N - TKN - Ammonium N

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

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

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

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

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

Soil Phosphorous Olsen method.

City of Winnipeg Biosolids and Application Field Trace Element Content

Analyte	Biosolids Trace Elements				N1/2 NW14-09-01WPM				Application Rate (T/ha, dry)	Cumulative Metal Concentration	Cumulative Weight Allowed by Guideline ²		Applications Events Permitted before meeting applied Criteria based on Average Metal Concentrations	
	Minimum	Maximum	Mean	Mean	(W037, 0-15cm)		Mean				(mg/kg)	(kg/ha)		Count
	(mg/kg)	(kg/ha)	(kg/T)	(mg/kg)	(kg/ha)	(mg/kg)	(kg/ha)	(kg/ha)			(kg/ha)	(mg/kg)		(kg/ha)
Arsenic	0.1	6.3	4.0	0.004	10.1	18.18	10.10	4.55	0.05	4.591	12	21.6	75	
Cadmium	10.7	2.4	5.0	0.005	0.329	0.59	0.33	0.15	0.06	0.205	1.4	2.5	34	
Copper	143.0	954.0	570.8	0.571	33.3	59.94	33.30	14.99	6.48	21.465	63	113.4	8	
Chromium	33.1	118.7	118.7	0.119	49.3	88.74	49.30	22.19	0.00	22.185	64	115.2	20	
Lead	3.5	325.0	57.5	0.057	16.8	30.24	16.80	7.56	0.00	7.560	70	126	147	
Mercury	0.1	1.8	0.9	0.001	0.0282	0.05	0.03	0.01	0.00	0.013	6.6	11.9	1225	
Nickle	7.1	121.0	44.5	0.044	43.90	79.02	43.90	19.76	0.00	19.755	50	90	22	
Zinc	626.0	5080.0	1366.2	1.366	102.00	183.60	102.00	45.90	0.00	45.900	200	360	11	

Analyte	Biosolids Trace Elements				S1/2 NW & SW14-09-01WPM				Application Rate (T/ha, dry)	Cumulative Metal Concentration	Cumulative Weight Allowed by Guideline ²		Applications Events Permitted before meeting applied Criteria based on Average Metal Concentrations				
	Minimum	Maximum	Mean	Mean	(W038, 0-15cm)		Mean				(mg/kg)	(kg/ha)		Count			
	(mg/kg)	(kg/ha)	(kg/T)	(mg/kg)	(kg/ha)	(mg/kg)	(kg/ha)	(mg/kg)			(kg/ha)	(kg/ha)		(mg/kg)	(kg/ha)		
Arsenic	0.1	6.3	4.0	0.004	9.1	16.38	10.5	18.90	10.30	18.54	9.97	13.46	0.05	13.501	12	21.6	114
Cadmium	10.7	2.4	5.0	0.005	0.214	0.39	0.303	0.55	0.337	0.61	0.28	0.38	0.06	0.441	1.4	2.5	38
Copper	143.0	954.0	570.8	0.571	31	55.80	32.9	59.22	33.80	60.84	32.57	43.97	0.00	43.965	63	113.4	9
Chromium	33.1	118.7	118.7	0.119	47.9	86.22	54.2	97.56	47.00	84.60	49.70	67.10	0.00	67.095	64	115.2	21
Lead	3.5	325.0	57.5	0.057	14.6	26.28	14.2	25.56	16.10	28.98	14.97	20.21	0.00	20.205	70	126	153
Mercury	0.1	1.8	0.9	0.001	0.0311	0.06	0.0296	0.05	0.03	0.05	0.03	0.04	0.00	0.041	6.6	11.9	1225
Nickle	7.1	121.0	44.5	0.044	38.90	70.02	47.00	84.60	44.10	79.38	43.33	58.50	0.00	58.500	50	90	40
Zinc	626.0	5080.0	1366.2	1.366	90.20	162.36	92.00	165.60	98.90	178.02	93.70	126.50	0.00	126.495	200	360	13

Analyte	Biosolids Trace Elements				SE14-09-01WPM				Application Rate (T/ha, dry)	Cumulative Metal Concentration	Cumulative Weight Allowed by Guideline ²		Applications Events Permitted before meeting applied Criteria based on Average Metal Concentrations		
	Minimum	Maximum	Mean	Mean	(W043, 0-15cm)		Mean				(mg/kg)	(kg/ha)		Count	
	(mg/kg)	(kg/ha)	(kg/T)	(mg/kg)	(kg/ha)	(mg/kg)	(kg/ha)	(mg/kg)			(kg/ha)	(kg/ha)		(mg/kg)	(kg/ha)
Arsenic	0.1	6.3	4.0	0.004	8.05	14.49	0.0285	0.05	4.04	3.64	0.05	3.681	12	21.6	156
Cadmium	10.7	2.4	5.0	0.005	0.234	0.42	0.32	0.58	0.28	0.25	0.00	0.249	1.4	2.5	37
Copper	143.0	954.0	570.8	0.571	28.7	51.66	30.3	54.54	29.50	26.55	0.00	26.550	63	113.4	10
Chromium	33.1	118.7	118.7	0.119	39	70.20	46.7	84.06	42.85	38.57	0.00	38.565	64	115.2	33
Lead	3.5	325.0	57.5	0.057	14.5	26.10	15.1	27.18	14.80	13.32	0.00	13.320	70	126	153
Mercury	0.1	1.8	0.9	0.001	0.0287	0.05	0.0285	0.05	0.03	0.03	0.00	0.026	6.6	11.9	1225
Nickle	7.1	121.0	44.5	0.044	32.90	59.22	39.60	71.28	36.25	32.63	0.00	32.625	50	90	61
Zinc	626.0	5080.0	1366.2	1.366	81.60	146.88	80.70	145.26	81.15	73.04	0.00	73.035	200	360	14

Analyte	Biosolids Trace Elements				SE5-10-01WPM				Application Rate (T/ha, dry)	Cumulative Metal Concentration	Cumulative Weight Allowed by Guideline ²		Applications Events Permitted before meeting applied Criteria based on Average Metal Concentrations				
	Minimum	Maximum	Mean	Mean	(W034, 0-15cm)		Mean				(mg/kg)	(kg/ha)		Count			
	(mg/kg)	(kg/ha)	(kg/T)	(mg/kg)	(kg/ha)	(mg/kg)	(kg/ha)	(mg/kg)			(kg/ha)	(kg/ha)		(mg/kg)	(kg/ha)		
Arsenic	0.1	6.3	4.0	0.004	8.63	15.53	8.41	15.14	9.52	17.14	8.85	11.95	0.00	11.952	12	21.6	133
Cadmium	10.7	2.4	5.0	0.005	0.442	0.80	0.268	0.48	0.37	0.66	0.36	0.48	0.00	0.484	1.4	2.5	30
Copper	143.0	954.0	570.8	0.571	30.7	55.26	30.5	54.90	32.30	58.14	31.17	42.08	0.00	42.075	63	113.4	9
Chromium	33.1	118.7	118.7	0.119	43.6	78.48	43.1	77.58	46.20	83.16	44.30	59.81	0.00	59.805	64	115.2	27
Lead	3.5	325.0	57.5	0.057	16.3	29.34	16.1	28.98	18.10	32.58	16.83	22.73	0.00	22.725	70	126	148
Mercury	0.1	1.8	0.9	0.001	0.0343	0.06	0.0318	0.06	0.0342	0.06	0.03	0.05	0.00	0.045	6.6	11.9	1224
Nickle	7.1	121.0	44.5	0.044	36.50	65.70	35.80	64.44	39.30	70.74	37.20	50.22	0.00	50.220	50	90	48
Zinc	626.0	5080.0	1366.2	1.366	99.20	178.56	90.70	163.26	96.00	172.80	95.30	128.66	0.00	128.655	200	360	12

Notes:

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

Inputs/Assumptions

Soil Bulk Density	1,200	kg/m3	
Sample Depth	0.15	m	
Hectare	10,000	m2/ha	
Soil Mass	1,000,000	mg/kg	
Anticipated Application Rate	11	T/ha - dry	N1/2 NW14-09-01WPM
Anticipated Application Rate	11	T/ha - dry	S1/2NW & SW14-09-01WPM
Anticipated Application Rate	11	T/ha - dry	SE14-09-01WPM

APPENDIX

E

DATA TABLE – A.
SOIL MONITORING
RESULTS

Table A. Summary of Residual Nitrogen and Phosphorus Post-Biosolids Application Monitoring

Benchmark Sampling Analysis: (Olsen-P, Nitrate-N, metals: 0-15cm), (Nitrate-N: 15-60cm)
 Annual Monitoring Analysis: (Olsen-P, Nitrate-N: 0-15cm), (Nitrate-N: 15-60cm)

Legal Land Location					Sample Site ID	Application Year	Soil Monitoring					Soil Benchmark		Application Rate			Post Monitoring																		
Quarter	Section	Twp	Range	Field size (ha)			2017	2018	2019	2020	2021	Nitrate N (mg/kg)		Olsen P (mg/kg)	wet T/ha	PAN (kg/ha)	Target P205 (kg/ha)	1st Year		2nd Year		3rd Year													
												(0-15 cm)	(15-60 cm)	(0-15 cm)				(0-15 cm)	(15-60 cm)	(0-15 cm)	(0-15 cm)	(15-60 cm)	(0-15 cm)	(0-15 cm)	(15-60 cm)										
NE	31	8	01E	68	W001	Benchmark	1st Year	2nd Year	3rd Year	Done	2.6		12.6	48	102	123	19.4	7.7	20.4	38	18	29	11.00	3.00	16										
					W002	Benchmark	1st Year	2nd Year	3rd Year	Done	2		7																						
					W002a	Benchmark	1st Year	2nd Year	3rd Year	Done																									
					W002b	Benchmark	Biosolids plus Commercial	2nd Year	3rd Year	Done																									
					W002c	-	1st Year	2nd Year	3rd Year	Done																									
SE	31	8	01E	16	W003	Benchmark	1st Year	n/a	n/a	Done	2		9	48	102	123	16.3	5.6	14.7	29	10	25	16	6	13										
					W004	Benchmark	1st Year	n/a	n/a	Done	2		17.3																						
					W004a	Benchmark	1st Year	2nd Year	3rd Year	Done																									
NE	36	12	02W	60	W005	Benchmark	1st Year	2nd Year	3rd Year	14.4		13.2	47	129	121	19	14	37	28	24	20	81	20	29											
NW	36	12	02W	63	W007	Benchmark	1st Year	2nd Year	3rd Year	26.6		13.1				23	26	65	31	34	19	81	26	25											
SW	36	12	02W	61	W009	Benchmark	1st Year	2nd Year	3rd Year	42		13																							
					W010	Benchmark	1st Year	2nd Year	3rd Year	37		18																							
					W013	Benchmark	1st Year	2nd Year	3rd Year	42		13																							
					W014	Benchmark	1st Year	2nd Year	3rd Year	37		18																							
SE	36	12	02W	58	W012	Benchmark	1st Year	2nd Year	3rd Year	23.6		15.8																							
NW	31	12	01W	90	W015	Benchmark	1st Year	2nd Year	3rd Year	5		2				47	150	123	23	5	29														
					W016	Benchmark	1st Year	2nd Year	3rd Year	34		29																							
					SW	31	12	01W	90	W017	Benchmark	1st Year	2nd Year	3rd Year	31					5.5															
										W018	Benchmark	1st Year	2nd Year	3rd Year	12					7.9															
					S1/2	28	12	01W	129	W019	Benchmark	1st Year	2nd Year	3rd Year	27					18	38	137	112	33	13	18	28	67	15						
										W020	Benchmark	1st Year	2nd Year	3rd Year	17					18															
										W021	Benchmark	1st Year	2nd Year	3rd Year	22					11															
										W022	Benchmark	1st Year	2nd Year	3rd Year	26					15															
					E1/2	29	12	01W	116	W023	Benchmark	1st Year	2nd Year	3rd Year	25					9.2	38	137	112	16	7	8	37	13	19						
										W024	Benchmark	1st Year	2nd Year	3rd Year	35					15															
W025	Benchmark	1st Year	2nd Year	3rd Year						18		11																							
W026	Benchmark	1st Year	2nd Year	3rd Year						17		7.8																							
N1/2	32	9	1EPM	127	W027	Benchmark	1st Year	2nd Year	3rd Year	3	14	7	46	152	123	64	46	25																	
					W028	Benchmark	1st Year	2nd Year	3rd Year	25	10	9.6				71	47	10																	
					W029	Benchmark	1st Year	2nd Year	3rd Year	15	5	8.6				120	95	32																	
					W030	Benchmark	1st Year	2nd Year	3rd Year	12	4	8.4				64	50	24																	
					W031	Benchmark	1st Year	2nd Year	3rd Year	25	10	15				46	34	15																	
E1/2 of SE	32	9	1EPM	32	W032	Benchmark	1st Year	2nd Year	3rd Year	11	6	21																							
W1/2 of SE	32	9	1EPM	31	W033	N/A	1st Year	2nd Year	3rd Year																										
SE	5	10	1EPM	50	W034	Benchmark	1st Year	2nd Year	3rd Year	32	30	13	44	148	123																				
					W035	Benchmark	1st Year	2nd Year	3rd Year	67	56	13																							
					W036	Benchmark	1st Year	2nd Year	3rd Year																										
					N1/2, NW	14	9	1WPM	32	W037	Benchmark	1st Year				2nd Year	3rd Year	74	25	23															
					S1/2, NW	14	9	1WPM	32	W038	Benchmark	1st Year				2nd Year	3rd Year	30	9	16															
										W039	Benchmark	1st Year				2nd Year	3rd Year	27	13	6															
					SW	14	9	1WPM	63.2	W040	Benchmark	1st Year				2nd Year	3rd Year	72	32	19															
										W041	Benchmark	1st Year				2nd Year	3rd Year	15	6	19															
					NE	14	9	1WPM	64	W042	Benchmark	1st Year				2nd Year	3rd Year	35	23	9.8															
										W043	Benchmark	1st Year				2nd Year	3rd Year	48	31	8.4															
					SE	14	9	1WPM	62.8	W044	Benchmark	1st Year				2nd Year	3rd Year	32	18	5.6															
										W045	Benchmark	1st Year				2nd Year	3rd Year	44	27	11															
					SE	15	9	1WPM	64	W046	Benchmark	1st Year				2nd Year	3rd Year	72	30	17	46	154	128												
										W047	Benchmark	1st Year				2nd Year	3rd Year	53	26	8.4															
					NE	15	9	1WPM	59	W048	Benchmark	1st Year				2nd Year	3rd Year	38	13	6.4															
										W049	Benchmark	1st Year				2nd Year	3rd Year	28	14	7.8															
S1/2_SW	15	9	1WPM	31	W049	Benchmark	1st Year	2nd Year	3rd Year				44	148	123																				