Winnipeg

Water and Waste Department • Service des eaux et des déchets

DEC 12 2017

Client File No.: 963.20
Our File No(s): S-1021, EMS
020-17-08-11-00
020-17-08-11-0N

Manitoba Sustainable Development
Climate Change and Environmental Protection Division
Environmental Approvals Branch
Suite 160 – 123 Main Street (Box 80)
Winnipeg, MB R3C 1A5

Attention: Ms. Tracey Braun, M.Sc., Director

Dear Ms. Braun:

RE: Biosolids Field Storage Assessment Report
Environment Act Licence No. 1089 E RR

Please find attached the City of Winnipeg Biosolids Field Storage Assessment Report. This report has been prepared and submitted in accordance with the letter we received from your Department dated September 8, 2017, regarding the supplementary Notice of Alteration for Environment Act Licence No. 1089 E RR.

Should you have any questions on this report, please contact Mr. Duane Griffin, P. Eng. at 204-986-4483 or by email at dgriffin@winnipeg.ca.

Yours truly,

Chris Carroll, P. Eng., MBA
Manager of Wastewater Services Division

Attachment

AEW/jl

c: M.L. Geer, CPA, CA, Water and Waste Department (email)
G.K. Patton, P.Eng., Water and Waste Department (email)
D.E. Griffin, P.Eng., Water and Waste Department (email)
D. Keam, WSP Global Company (email)

CITY OF WINNIPEG
BIOSOLIDS LAND APPLICATION
FIELD STORAGE ASSESSMENT
SUMMARY REPORT

DECEMBER 2017

CITY OF WINNIPEG BIOSOLIDS LAND APPLICATION

FIELD STORAGE ASSESSMENT

SUMMARY REPORT

CITY OF WINNIPEG

PROJECT NO.: 17M-00008-00
DATE: DECEMBER 12, 2017

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1 INTRODUCTION

In the full City of Winnipeg Biosolids Land Application Program (Project) it is anticipated that approximately 20,000 wet tonnes of Class B biosolids will be land applied annually. The North End Sewage Treatment Plant (NEWPCC) produces nearly 4,000 wet tonnes monthly and can only house a minimum volume on-site. This requires the biosolids produced between May and September (start of land application program) to be hauled daily (between 6 and 12 trucks daily) from the NEWPCC to a temporary field storage site until land application can proceed after crop harvest in the late summer/fall of a given year.

During initial Project discussions held with the Manitoba Sustainable Development (MSD), Environmental Approvals Branch (EAB), odour management and the method of field storage containment were identified as key concerns for the Project. In order to address these issues, the City conducted an assessment of field storage options for biosolids in September through October, 2017.

1.1 OBJECTIVE

The objective of the field storage assessment was to aid in determining the feasibility of field storage for the City's annual biosolids land application program.

1.2 ENVIRONMENTAL APPROVAL AND PUBLIC NOTIFICATION

On August 1, 2017, the City applied to the MSD, EAB for a Supplementary Notice of Alteration to the Biosolids Land Application Pilot Program under Environment Act License (EAL) 1089E RR requesting approval to conduct an assessment of field storage options for biosolids. Approval for the field storage assessment was received from the EAB on September 8, 2017 (copy of the approval letter is provided in Appendix A).

Prior to the commencement of the trucking of biosolids to the field storage assessment site, a “good neighbour” practice was implemented whereby letters of notification were hand-delivered to all adjacent landowners. The letters provided an overview of the field storage assessment and advised adjacent landowners to visit the City’s project website for additional information regarding the overall biosolids land application project and to contact the WSP Public Engagement Lead with any concerns or comments. A log of all letters delivered and any comments received were also recorded. A copy of the letter of notification and delivery log is included in Appendix B. In addition, a warning sign was posted at the entrance to the assessment site, asking the public not to enter the area for health and safety purposes (Photograph 1).

Photograph 1. "Do not enter" sign posted at entrance to biosolids field storage assessment site.

2 METHODOLOGY

2.1 LOCATION OF STORAGE ASSESSMENT SITE

The field storage assessment was conducted on City-owned land located southwest of the West End Sewage Treatment Plant (WEWPCC) within the City of Winnipeg municipal boundary on River Lot 83 Parish of St. Charles at the west edge of field. The field site in this area is a permanent grass cover; there were no soil limitations associated with this site.

The biosolids field storage assessment complied with requirements outlined in the MSD Approval Letter (File No. 963.20 dated September 8, 2017 [refer to Appendix A]) as well as all applicable regulations, including the provincial *Nutrient Management Regulation*, the *Water Protection Act*, the *Environment Act*, the *Livestock Manure and Mortalities Management Regulation* and the *Workplace Safety and Health Act*. As per environmental regulatory requirements, siting of the storage assessment site met the following restrictions:

- The assessment site was located at least 100 m from any surface water course, sinkhole, and spring or well and in a manner that does not cause pollution of surface water, groundwater or soil.
- The assessment site as located in an agricultural field with the presence of clay and clay till to a depth of 1.5 metres (m).
- The assessment site was located at least 1,600 m from designated residential area, 300 m from a residence, at least 30 m from property line with residence and at least 15 m from property line without residence.

In addition, each of the individual field storage plots within the assessment site were located:

- Separation distances between each plot varied between 110 m and 230 m due to field conditions (e.g. hydro tower or low lying areas), the objective was to provide sufficient separation distance for odour assessment.
- In a north – south direction to limit prevailing winds (west) during odour assessments.

2.2 STORAGE OPTION DESIGN

The assessment site was set up with seven different plots of biosolids, each covered with different material for evaluation purposes.

The seven (7) storage plots (including one control) included in the assessment are listed below:

1. 12 x 1 tonne tote with plastic liner
2. Earth berm with straw cover
3. Earth berm with poly cover
4. Earth berm with hydro-mulch cover
5. Earth berm with ag-lime cover
6. Earth berm with wood chips
7. Earth berm with no cover (Control)

The 1 tonne totes with plastic liner were selected as a stand in example for a poly compost bag/tube, similar feature to a grain tube or bag.

Storage plots were pre-marked with wooden stakes in the field by WSP to an approximate size of 6 x 6 m. The land application contractor, Assiniboine Injections Ltd., (Assiniboine Injections) was responsible for the physical establishment of the storage plots including:

- The development of an earthen berm measuring approximately 0.6 m in height on all four sides of the plots that was then covered with a poly textile sheet to prevent mixing of the soil and biosolids (the one exception was the 1 tonne totes plot that were not bermed);
- Transportation of biosolids from the Brady Road Resource Management Facility (Brady Facility);
- Deposition of biosolids into the plots; and,
- Addition of the appropriate cover type onto the biosolids in the plots.

On September 12, one (1) truckload of biosolids material (approximately 20 tonnes) was deposited inside each of the 3-walled bermed storage plots. The appropriate cover type (i.e. straw, hydro-mulch, wood chips, lime and poly cover) was applied over the biosolids in the appropriate storage plot. Once this was complete, the fourth side (front) side of the earth berm was completed to fully contain each storage plot. Snow fencing was placed around each storage plot as an extra measure of protection to restrict human access to the plots. Table 1 provides a summary of the field storage options that were assessed as well as corresponding photographs.

Table 1. Field Storage Options

Field Storage Options	Design Criteria	Volume / Size	Pre-establishment requirements
Plot 1: 1 tonne tote with plastic liner	— Fill 12 x 1 tonne totes and tie off tight at top.	— Biosolids Volume: 1 tonne /1 m^3 x 12 totes (12 m^3) — Berm height: None — Estimated stockpile height: 1.0 m	
Plot 2: Earth berm with straw cover	— Earth berm to approximately 0.6 m above grade on three sides. — Leave one side open for stockpile access. After biosolids are unloaded, close off the fourth wall with earth. — Cover berms with poly textile cover to prevent mixing. — Cover biosolids with straw to a minimum of 0.1 m (used two full square bales at 3x4x8 feet [1x1.2x2.4 m]).	— Biosolids Volume: 20 tonnes/20 m^3 (1 truck) — Berm height: 0.6 m — Estimated stockpile height: 0.7 m — Area inside berm: 6 m x 6 m = 36 m^2	

Field Storage Options	Design Criteria	Volume / Size	Pre-establishment requirements
Plot 3: Earth berm with poly cover	— Earth berm to approximately 0.6 m above grade on three sides. — Leave one side open for stockpile access. After biosolids are unloaded, close off the fourth wall with earth. — Cover berms with poly textile cover to prevent mixing. — Cover biosolids with poly textile covering (used 25 x 25 foot [7.6x7.6 m] poly textile sheet).	— Biosolids Volume: 20 tonnes/20 m^3 (1 truck) — Berm height: 0.6 m — Estimated stockpile height: 0.7 m — Area inside berm: 6 m x 6 m = 36 m^2	
Plot 4: Earth berm with hydro-mulch cover	— Earth berm to approximately 0.6 m above grade on three sides. — Leave one side open for stockpile access. After biosolids are unloaded, close off the fourth wall with earth. — Cover berms with poly textile cover to prevent mixing. — Cover biosolids with a blow over of a hydro-mulch (used 10 yards [10 m^3]).	— Biosolids Volume: 20 tonnes/20 m^3 (1 truck) — Berm height: 0.6 m — Estimated stockpile height: 0.7 m — Area inside berm: 6 m x 6 m = 36 m^2	

Field Storage Options	Design Criteria	Volume / Size	Pre-establishment requirements
Plot 5: Earth berm with ag-lime cover	— Earth berm to approximately 0.6 m above grade on three sides. — Leave one side open for stockpile access. After biosolids are unloaded, close off the fourth wall with earth. — Cover berms with poly textile cover to prevent mixing. — Cover biosolids with ag-lime to sufficiently cover the storage pile (used 15 yards [12 m^3]).	— Biosolids Volume: 20 tonnes/20 m^3 (1 truck) — Berm height: 0.6 m — Estimated stockpile height: 0.7 m — Area inside berm: 6 m x 6 m = 36 m^2	
Plot 6: Earth berm with wood chips	— Earth berm to approximately 0.6 m above grade on three sides. — Leave one side open for stockpile access. After biosolids are unloaded, close off the fourth wall with earth. — Cover berms with poly textile cover to prevent mixing. — Cover biosolids with wood chips to visibly cover the pile (used 10 yards [8 m^3]).	— Biosolids Volume: 20 tonnes/20 m^3 (1 truck) — Berm height: 0.6 m — Estimated stockpile height: 0.7 m — Area inside berm: 6 m x 6 m = 36 m^2	

Field Storage Options	Design Criteria	Volume / Size	Pre-establishment requirements
Plot 7: Earth berm with no cover (Control)	— Earth berm to approximately 0.6 m above grade on three sides. — Cover berms with poly textile cover to prevent mixing. — Leave one side open for stockpile access. After biosolids are unloaded, close off the fourth wall with earth.	— Biosolids Volume: 20 tonne/20 m^3 (1 truck) — Berm height: 0.6 m — Estimated stockpile height: 0.7 m — Area inside berm: 6 m x 6 m = 36 m^2	

2.3 FIELD STORAGE ASSESSMENT

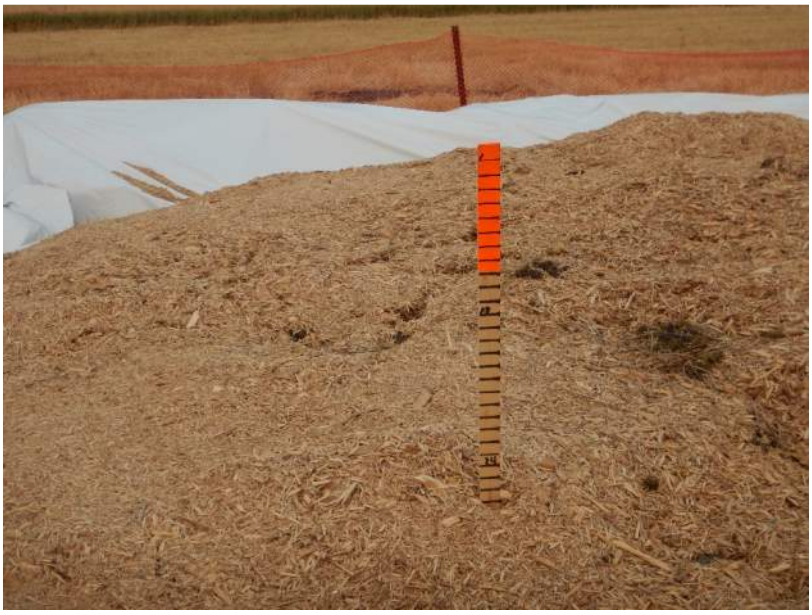
The biosolids were stored at the assessment site from September 12 to November 2, 2017. During this time, there were regular site assessments conducted by the project team, and other stakeholders. During the site assessments, the storage plots were evaluated for:

- Logistics of management of biosolids (Assiniboine Injections was asked to provide their opinion of the handling and storage of the biosolids during plot setup);
- Odour control;
- Leaching;
- Storm water management; and,
- Vector exposure and control

2.3.1 LOGISTICS OF MANAGEMENT

Upon completion of the field storage set-up, Assiniboine Injections was asked to provide their opinion on the handling and storage of biosolids for each storage option. Agricultural producers who attended the site assessments were also asked to provide any concerns they had regarding field storage options.

In addition, a marked wooden stake, demarcated with gradations in inches was placed at the front of the biosolids stockpile in each plot in order to assess the amount of slumping that occurred (Photograph 2).



Photograph 2. Wooden stake used to measure degree of slumping of biosolids stockpiles.

2.3.2 LEACHING

To evaluate potential leaching of nutrient and metals from the biosolids stockpiles to the underlying soil layer, soil samples were collected from the plots prior to the biosolids being added and after the removal of the biosolids from the plots. Soil samples were collected from 0-15 cm and 15-60 cm at each plot manually, using a JMC Backsaver Soil Sampler tube with a 2.0 cm diameter core. For each plot, twelve subsamples for a sample depth were collected and mixed in a bucket to create a composite sample and submitted to the laboratory. The JMC Backsaver soil core was wiped clean between sample depths and washed between plots. Nitrile gloves were worn throughout the sampling program and changed between the collections of each soil sample. Sample locations were GPS recorded for the November sampling event. In an attempt to safeguard against cross contamination between residual biosolids to soil sample, the soil surface face (~ 1 cm) was removed and then a sample was collected. All soil samples were placed in a cooler and maintained at a temperature below 10 °C, labels were completed with sample ID, date and time of sample collection. Samples were submitted to ALS Laboratories for analysis.

Soil samples collected from the topsoil 0-15 cm depth were analyzed for:

- pH
- Nitrate and nitrite nitrogen
- Total nitrogen
- Total Nitrogen
- Ammonia nitrogen
- sodium bicarbonate extractable phosphorous
- potassium
- arsenic
- cadmium
- chromium
- copper
- lead
- mercury
- nickel
- phosphorus (total)
- zinc

Soil samples collected from the 15-60 cm depths were analyzed for:

- Nitrite-N and Nitrate-N
- Ammonium-nitrogen
- Total Nitrogen

2.3.3 ODOUR CONTROL

A key component of the field storage assessment was the evaluation of the potential odour annoyance associated with each of the storage plots. To aid in the odour assessment an Odour Assessment Panel (Panel) was created that consisted of:

- City of Winnipeg staff associated with the Project / WSP staff working on the project (potential biased Panel members).
- MSD regulators (unbiased Panel members).
- Rural Municipality representatives and interested local agricultural producers (unbiased Panel members).

The intent was to have two to three consistent Panel members attend each odour assessment event.

The odour assessment was conducted over a period of five weeks (four times) by Panel members and included an evaluation of a background odour baseline (an area with no biosolids present) and evaluation of each of the seven storage plots. The odour assessment was completed by different Panel members and under variable weather conditions, when available.

METHOD OF ODOUR ASSESSMENT

At each odour assessment date, a Project Team Moderator (Moderator) assisted with the coordination and completion of the odour evaluation. The Panel members were asked to meet at the entrance to the assessment site. Each Panel member was provided with a field data recording sheet to record the degree of odouriferouness at each storage plot as well as a 3M 8247 Particulate Respirator R95 filtered mask (suitable for nuisance level organic vapour relief).

At each survey event the Panel visited a background odour baseline area (biosolids-free area), and each of the seven storage plots. The Panel evaluated the odour at each area/plot following the procedure outlined below that was adapted from the *Good Practices Guide for Odour Management in Alberta, 2015, Clean Air Strategic Alliance*:

1. At the background odour baseline area, the Moderator asked the Panel members to wear their carbon mask for about two minutes to clear their noses.
2. Panel members were then asked by the Moderator to remove their masks, breathe normally and to assign and record (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 odour scale outlined in Table 2.
3. The Moderator then had the Panel members move to Plot 1. Odour assessments occurred at each of 4 pre-determined distances from each of the plots -approximately 50 m, 25 m, 10 m and 5 m generally down wind of each plot. Note that during the first assessment date on September 19, the furthest distance used was 35 m due to tall grass cover that hindered the assessment. For all other assessment dates, the the 50 m furthest distance from each storage option plot was used. Panel members started at the farthest distance point (50 m) and moved forward to each distance point in descending sequence. At each distance point:
    a. The Panel members were asked to wear the carbon mask two minutes.
    b. The Panel members were then asked to remove their mask, breathe normally and to assign and record a level of annoyance to the odour based on a scale of 0 to 4 as per the odour scale outlined in Table 2.
4. This process was repeated for all of the remaining plots (1 through 7).

At each odour assessment date, climatic conditions were also recorded (temperature, wind speed, direction, humidity etc.) as well as any additional comments on odour by Panel members.

Table 2. Odour Scale

Numerical Value	Annoyance Level	Intensity Level[1]
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.

2.3.4 STORM WATER MANAGEMENT AND VECTOR CONTROL

Notes on storage option conditions were maintained during the field storage assessment including: the condition of cover, seepage, soil conditions and weather. Following some rainfall events, observations were made as to the condition of the plots, biosolids, ponding water, estimates of volume or extent and how wet the biosolids appear.

Observations were also made regarding the intensity of flies and other insects or rodents (vectors) present at the storage plots. Observations included; swarming, staging, sounds and other factors that may influence presence or absence.

2.4 DECOMMISSIONING OF THE FIELD STORAGE OPTIONS PLOTS

At the end of the assessment period, the storage options plots were decommissioned on November 2 and 3, 2017. The decommissioning of the plots simulates what would occur during the full scale biosolids land application program whereby the stockpiled biosolids would be removed from the field stockpile site(s) for land application after being stored from several days to months.

Decommissioning of the storage plots involved the removal of snow fencing and any poly textile materials; removal of the biosolids and cover material from each plot, which were transported to the Brady Facility for landfill disposal; collection of soils samples from the soil layer within all seven plots; and, re-grading of the plots to level out topsoil used in the creation of the berms for the plots. Photographs 3 through 5 depict the decommissioning of the plots.

[1] Adapted from: Good Practices Guide for Odour Management in Alberta, 2015, Clean Air Strategic Alliance.

Photograph 3. Decommissioning of Biosolids Pilot Odour Assessment - Plot 5, Removal of Biosolids.

Photograph 4. Decommissioning of Biosolids Pilot Odour Assessment - Plot 7, Levelling of Clay Berm.

Photograph 5. Soil Sampling Biosolids Odour Assessment Plots, After Decommissioning.

3 FINDINGS OF THE FIELD STORAGE ASSESSMENT

3.1 FIELD STORAGE LOGISTICS

Assiniboine Injections, the subcontractor that completed the setup and removal of the field storage plots provided the following comments regarding the storage options:

— Establishing the earth berms around the biosolids was difficult due to the permanent grass cover. To establish any useful height to the berms a lot of top soil would need to be collected from the site, and this would cause collection of storm water around the storage areas.

In addition the local agricultural producer that participated in the biosolids land application pilot program had the following comments regarding the storage options:

— Biosecurity is a concern for organic matter specifically straw as the cover for the biosolids storage areas. If the straw being used was sourced from the cooperating agricultural producers for their own fields, this will greatly reduce the risk of weed and disease transfer to agricultural fields.
— Utilizing topsoil from the agricultural fields to create the berm for field storage sites is not a viable option as there is concern that the topsoil in the storage areas will be disturbed and may result in decreased crop productivity in those areas.
— Field storage sites should be established at field entrances and equipment should travel along field edges in order to minimize soil compaction.

During each odour assessment date, the biosolids were assessed for slumping through visual observations of the biosolids stockpile height in relation to the graded stake in each plot. Visual observations indicted little to no slumping occurred in any of the plots between September 15 (3 days after stockpiling in the plots) and October 17 (the last odour assessment date). It appeared that most slumping occurred shortly after off-loading of the material.

3.2 ODOUR ASSESSMENT

A summary of the field storage odour assessment is provided in Section 3.2.1. Summary tables of each odour assessment date is provided in Appendix C.1. Note that the four assessments completed by the Odour Assessment Panel are provided as averages for each distance and each storage plot.

It should be noted an assessment of odour during delivery and stockpiling of the biosolids in the field was not conducted to provide a “day-one” comparison value. In addition, during the establishment of the storage plots, some smearing of biosolids occurred in the grassed area adjacent to plot 1 (1 tonne tote bags option), during filling of the bags. This may have resulted in higher odour valuations by the Panel members at this plot during the odour assessments.

3.2.1 SUMMARY OF RESULTS

Pre-Stockpiling Odour Assessment

— On September 7, 2017 field storage plots were measured out, the southwest corner of the 6x6 m plots were staked, and berms on three sides of the plots were developed by excavating soil from the outside of the determined plot area. It was perceived that by allowing the base of the storage area to remain in permanent grass cover this would allow for a suitable limit indicator for cleanup of the biosolids in the end and not provide a bowl effect for water ponding after biosolids removal. The following day (September 8) an informal odour assessment was completed by D. Keam with WSP and A. Wolfe with the City to evaluate background odour levels in the area prior to biosolids stockpiling (refer to Tables 1a and 1b, Appendix C.1).

- The pre-biosolids odour was evaluated as "0" (no odour - no offending odour observed) for the three plot areas assessed (plots 1, 5 and 7) at all distances (50 m, 25 m, 10 m and 5 m) as well as at the background level area (at field entrance). Main comment included "grassy, faint hay odour in area".

In-formal Odour Assessment One and Three Days Post Stockpiling

— An informal assessment of odour at the 5 m distance mark for all plots was completed by A. Wolfe with the City on September 13, one day-post biosolids stockpiling in the storage option plots (refer to Tables 2a and 2b, Appendix C.1).

- Odour levels for all plots were evaluated at a level 2 (annoying) with the exception of plot 6 - wood chip cover (odour level 1- a little annoying) and plot 1 – no cover (control [odour level 3 - very annoying]).
- Flies were observed to be present on the stockpiles in all plots.

— A second informal assessment of odour at the 5 m distance mark for all plots was completed by A. Wolfe with the City on September 15, three days-post biosolids stockpiling (refer to Tables 3a and 3b, Appendix C.1).

- Odour levels for all plots were evaluated at a level 1 (a little annoying) with the exception of plot 1 – 1 tonne tote bags and plot 7 – control; both of these plots were scored as odour levels of 2 (annoying).

Panel Odour Assessment – One, Two, Three and Five Weeks Post Stockpiling

— September 19, one (1)-week post stockpiling (refer to Tables 4a and 4b, Appendix C.1).

- During the first Panel assessment date, the highest average odours scored at all distances and for all plots was for plot 1 – 1 tonne tote bags and plot 7 – no cover (control). Note: the higher odour level detected for plot 1 may have been due to the previously mentioned smearing of biosolids on the grassed area adjacent to the plot.
- Average odour levels in all plots at all distances were evaluated at 2 or less with the exception of plot 7- no cover (average odour value of 2.1 and 2.6 at the 10 m and 5 m distances respectively).
- The highest odour values were recorded at the 5 m mark for all plots (averages ranging from a low of 0.8 in plot 6 - wood chip cover option, to 2.6 in plot 7 – no cover).
- Comments on odours typically included "faint to slight odour". Panel members often commented on detecting odours associated with the cover type which were described as "grass, straw, wood chip".
- No flies or other vectors were observed in any of the plots.
- No standing water was observed in any of the plots.

— September 27, two weeks post stockpiling (refer to Tables 5a and 5b, Appendix C.1).

- During the second Panel assessment date the highest average odours detected at all distances and for all plots was again for plot 1 – 1 tonne tote bags and plot 7 – no cover (control).
- Average odour levels in all plots at all distances were evaluated at 2 or less with the exception of plot 7- no cover which had an average odour level of 2.1 and 2.4 at the 10 m and 5 m distances, respectively.
- The highest odour values were recorded at the 5 m mark for all plots (averages ranging from low of 0.4 in plot 6 – wood chip cover option, to 2.4 in plot 7 – no cover).
- Comments on odours typically included "stronger odour". Panel members often commented on detecting odours associated with the cover type which were described as "grass, straw, wood chip".

— October 4, 2017, three weeks post stockpiling (refer to Tables 6a and 6b, Appendix C.1).
  - During the third Panel assessment date the only plot that was recorded to have an average odour level above 1 was plot 7 – no cover (control [average odour level of 1.3 and 1.7 at 10 m and 5m distances respectively]).
  - The highest odour values were again recorded at the 5 m mark for all plots (averages ranging from low of 0 [no odour] in plot 4 – hydro-mulch cover, to 1.7 [a little annoying to annoying] in plot 7 – no cover [control]).
  - Comments on odours typically included "faint to slight odour". Panel members often commented on detecting odours associated with the cover type which were described as "wood chip, earthy, straw".
— October 17, 2017, five weeks post stockpiling (refer to Tables 7a and 7b, Appendix C.1).
  - Results collected during the final Panel assessment date were similar to those collected during the third Panel assessment - the only plot that was recorded to have an average odour level above 1 was plot 7 – no cover (control).
  - Many of the plots and most distances were recorded as having average odour levels of at or near 0.
  - The highest odour values were again recorded at the 5 m mark for all plots (averages ranging from low of 0 [no odour] in plot 4 – wood chip cover, to 1.6 [a little annoying to annoying] in plot 7 – no cover [average odour level of 1.3 and 1.6 at 10 m and 5m distances respectively]).
  - Comments on odours typically included "faint; barely detectable". Panel members often commented on detecting odours associated with the cover type which were described as "earthy, straw".

In-formal Odour Assessment During Stockpile Removal and One Day Post Removal

— On November 2, 2017 the field storage assessment plots were decommissioned and an informal odour assessment was completed by D. Keam and D. Sahulka with WSP at the 5 and 10 m marks from plots 7- no cover, 6 – wood chip cover and 5 – ag-lime cover, as the biosolids were being removed from the plots.
— Odour levels at all three plots at the 10 m mark were recorded as 0 to 1 (no odour to a little annoying).
— Odour levels at all three plots at the 5 m mark were recorded as 1 (a little annoying). When standing downwind of plots and during wind gusts odour levels at the 5 m mark from the plots were evaluated as a 2 (annoying).

Overall, with the exception of 1-day post stockpiling of the biosolids (at the 5 m distance), the average odour levels in all of the plots (including the control – no cover) were evaluated at a level 3 (very annoying – primarily associated with no cover plot) or less, even during the plot decommissioning process.

Typically, at the furthest distances from the plots (35 m/50 m), most of the storage plots with the exception of the 1 tonne tote bags (again may be due to biosolid smearing on adjacent ground area) and the no cover (control) options, were recorded to have average odour levels below 1 (a little annoying).

The 5 m distance from the stockpiles had the highest average recorded odour levels for all storage plots and over all assessment dates (except the no cover [control]), however by the third week post-stockpiling, even the average odour levels at this distance had decreased to below 1 (no odour to a little annoying).

3.3 LEACHING POTENTIAL

A summary of the soil sampling data collected pre and post stockpiling for each plot is provided in Appendix C Table C.2-1 and C.2-2. A copy of the Certificate of Analysis for the soil samples is provided in Appendix D. A summary of soil nutrient and metal levels pre and post stockpiling is provided below.

In order to evaluate or compare the difference between the analytical sample values from the trial plots pre and post stockpiling the percent difference was calculated. When the pre-application value is greater than the post-application value then the percent difference is positive and the difference is assumed not to be attributable to biosolid leaching but rather to the heterogeneous nature of the soil environment. When the post-application value is greater than the pre-application value the percent difference is negative and the application of biosolids may be considered to be contributing

to the concentration of the analyte in the soil. The interpreted alert criteria for metals and general chemistries in soil is when the percent difference is > 30% implying they are different and when <30% implying they are similar or 0.3 pH units different (MOECC, Analytical Protocol, O.Reg. 153/04).

It is however important to note that the soil analytical data is not replicated, there is no scientific random design and therefore summary of findings are only based on observable and are not statistical difference. Both error and natural states may be a contributing factor to these observations. Error may be applied at each stage including sample collection (e.g. smearing of biosolids between sample depths, insufficient cleaning between sampling, and cross contamination in sample buckets), laboratory error analytical methods error (minor). Native states that contribute to differences primarily include soil heterogeneity, micro-topography, slope, soil moisture, and type of vegetation cover and vigor of growth.

3.3.1 SUMMARY OF FINDINGS

Outlined in Table C.2-1 and C.2-2 are the Pre and Post stockpile plot soil data.

- Only nickel in the post stockpile sample from the straw cover plot (2) exceed regulatory soil quality guidelines at the 0-15 cm depth. No exceedances of the applied guidelines were detected for any of the other analytical parameters assessed from pre and post stockpile sampling events, in both the 0-15 cm and 15-60 cm depths[2].
- Plot 1 does not demonstrate any analytical parameters within the 0-15 cm and 15-60 cm depths that is greater than the applied alert criteria.
- Plot 2 does not demonstrate any analytical parameters in the 0-15 cm profile that is greater than the applied alert criteria with the exception of nickel. In the 15-60 cm depth, no analytical parameter exceeded the applied alert criteria.
- Plot 3 does not demonstrate an analytical parameters in the 0-15 cm profile that is greater than the applied alert criteria except for available phosphate-phosphorus. In the 15-60 cm, plant available ammonium-nitrogen exceeds the applied alert criteria.
- Plot 4 does not demonstrate an analytical parameters in the 0-15 cm profile that is greater than the applied alert criteria. In the 15-60 cm, plant available ammonium-nitrogen exceeds the applied alert criteria.
- Plot 5 does not demonstrate an analytical parameters in the 0-15 cm profile that is greater than the applied alert criteria except for available phosphate-phosphorus and potassium. In the 15-60 cm, plant available ammonium-nitrogen and total nitrogen exceeds the applied alert criteria.
- Plot 6 does not demonstrate an analytical parameters in the 0-15 cm profile that is greater than the applied alert criteria. In the 15-60 cm, plant available ammonium-nitrogen exceeds the applied alert criteria.
- Plot 7 does demonstrate several analytical parameters in the 0-15 cm profile that is greater than the applied alert criteria including; available phosphate-phosphorus, arsenic, chromium and copper. In the 15-60 cm, both plant available ammonium-nitrogen and total nitrogen exceeds the applied alert criteria.

[2] CCME, 1997, Soil Quality Guidelines for Protection of the Environment and Human Health. Soil ingestion/contact, agricultural land use.

3.4 STORM WATER AND VECTOR MANAGEMENT

A summary of storm water and vector management observations recorded by Panel members during the odour assessment is provided below.

3.4.1 STORM WATER

- During the odour assessment conducted on September 27, ponding water was observed on top of the poly-tote bags of plot 1 and on the berms covered in poly textile for plots 3, 4 and 5. Note that during the previous 24 hours 7.2 millimetres (mm) of precipitation had fallen and in the previous week period (September 20-26), approximately 51.5 mm of precipitation had fallen (refer to Figure 1).
- During the odour assessment conducted on October 4, ponding water was observed on the berms covered in poly textile for plots 2, 6 and 7. Note that during the previous 24 hours 0.2 mm of precipitation had fallen and in the previous week period (September 27-October 3), approximately 3.3 mm of precipitation had fallen (refer to Figure 1).
- During the odour assessment conducted on October 17, ponding water was observed on top of the poly-tote bags of plot 1 and on the berms covered in poly textile for plots 2, 3, and 6. Note that during the previous 24 hours, no (0.0 mm) precipitation had occurred and in the previous week period (October 10-16), approximately 2.3 mm of precipitation had fallen (refer to Figure 1).

3.4.2 VECTORS

It should be noted that the field storage assessment was conducted in the fall season when temperatures are cooler and fly abundance is generally lower. During the summer season with hot weather and greater abundance of flies, biosolids stockpile may pose more of an attractant to vectors.

- On September 13, one-day post stockpiling of biosolids, flies were observed to be present on the stockpiles in all plots. The temperature on this day was 20^{0}C at the time of the assessment (refer to Figure 2).
- By the third day post stockpiling and throughout the remainder of the field storage options assessment pilot, little to no flies were observed on the stockpiles.
- On September 27, a small rodent (deer mouse or vole) was observed in the straw of plot 2.
- No other vectors were observed during the course of the odour assessment pilot in any of the plots.

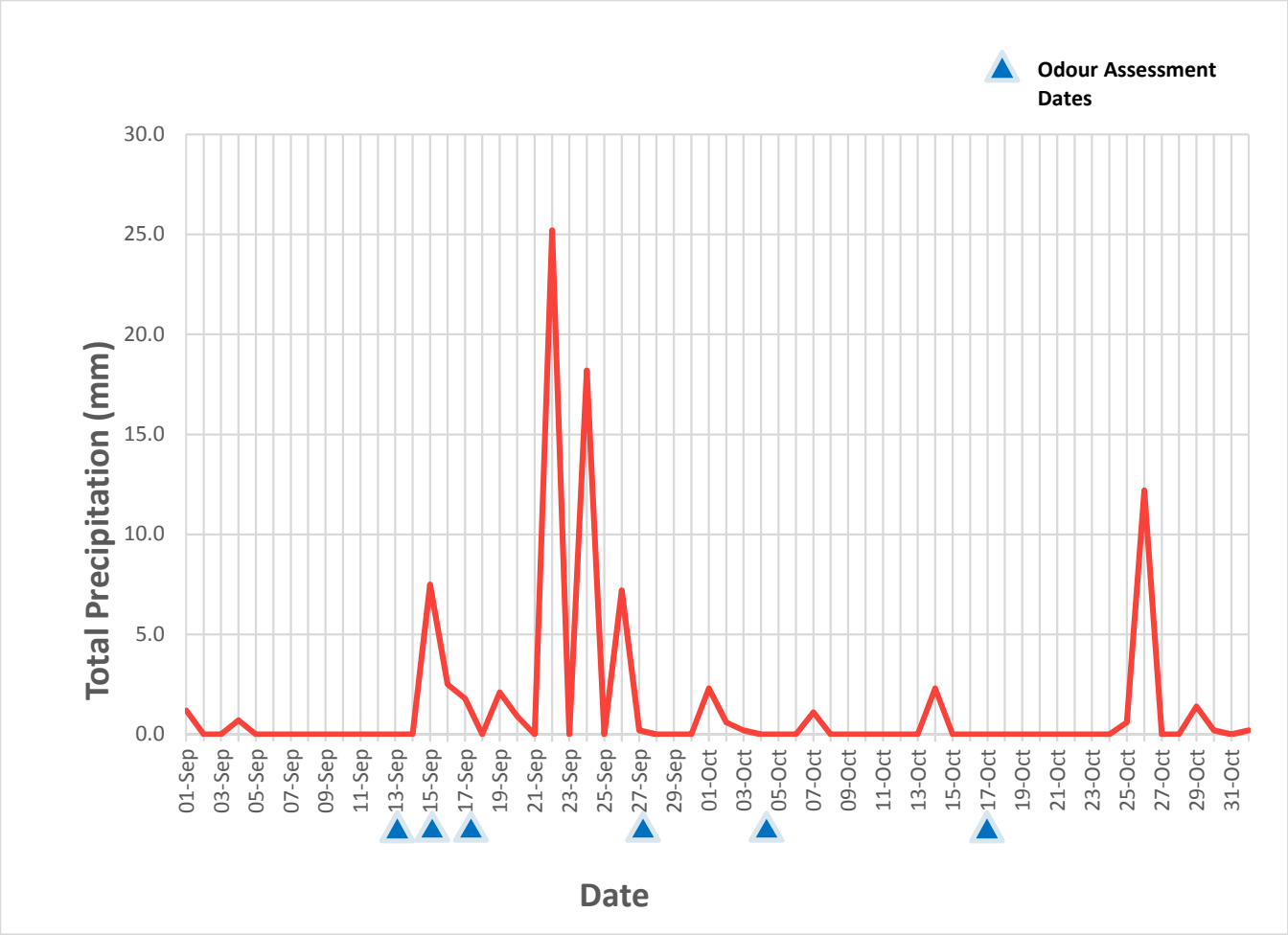


Figure 1. Field Storage Assessment - Precipitation Data Sept. 1- Nov. 2, 2017

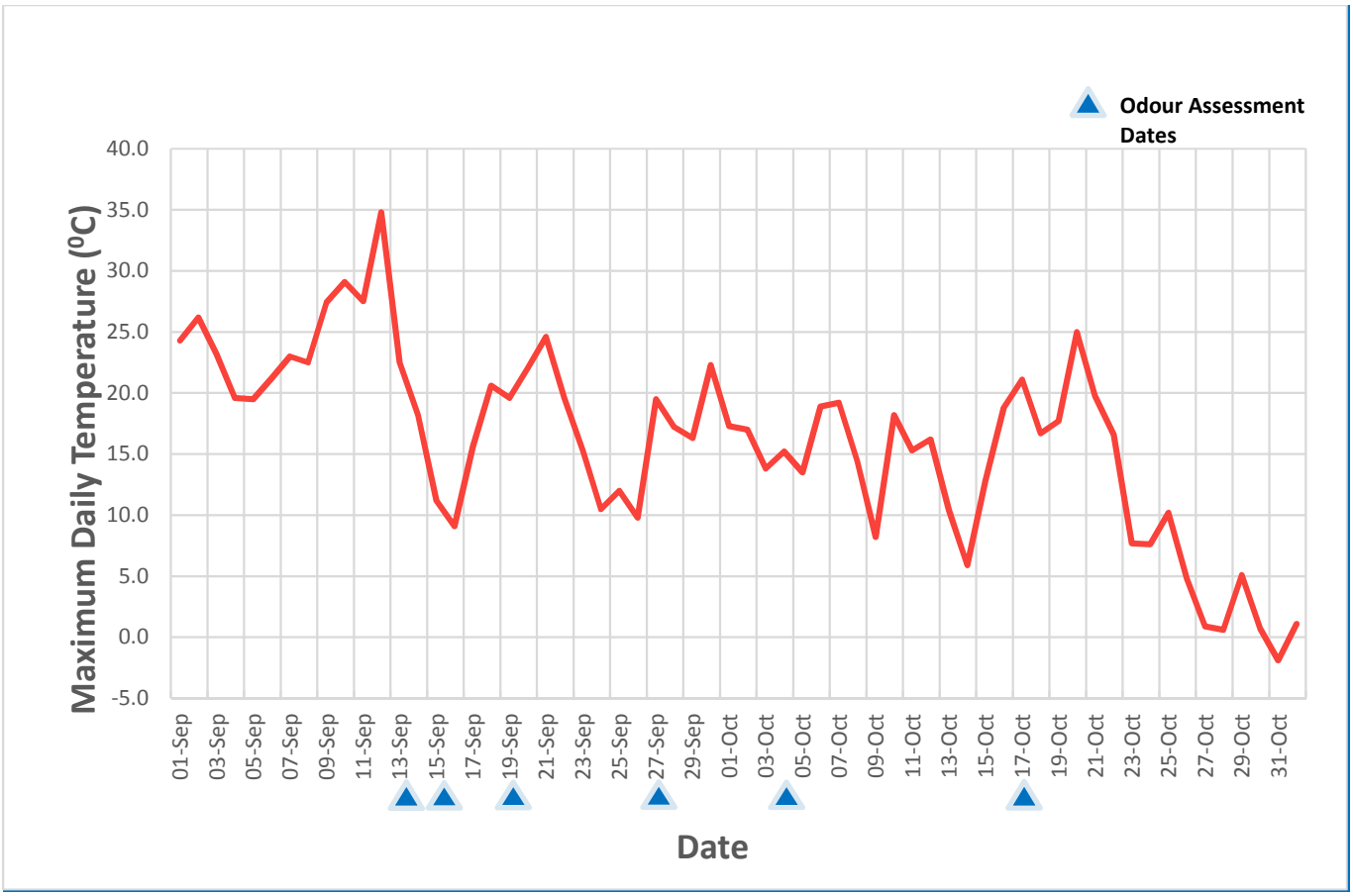


Figure 2. Field Storage Assessment - Maximum Daily Temperature Data Sept. 1- Nov. 2, 2017

4 EVALUATION OF STORAGE MERITS

4.1 FIELD STORAGE COVER TYPE

The following observations collected during the assessment, are provided in support of identifying three (3) feasible cover options for biosolids storage to control odour, leaching and vectors:

- All of the field storage options with cover (straw, wood chips, hydro-mulch, ag-lime and poly textile) were evaluated as having similar levels of odour control by the Odour Assessment Panel.
- It was also observed that even on moderate to high wind event days, no cover materials (straw, woodchips, hydro-mulch or ag-lime) was being eroded or blown away.
- All storage plots with cover appeared to demonstrate similar vector management.
- The organic cover materials appeared to demonstrate similar storm water management (some water ponding was observed on the poly textile surfaces of the berms) whereas the poly textile cover and poly-tote bags had some issues with water ponding on top of the cover after higher rainfall events.
- The 1 –tonne poly-tote bags proved somewhat challenging in ensuring biosolids material was not lost outside of the bags during filling.
- All covers, except the poly textile cover, were permeable to storm water and would not prevent water from leaching through the biosolids and mobilize soluble nutrients down to the soil. Rather, the cover materials would act as an absorbent to minor rainfall events and allow the material to dry promptly following a rainfall event.
- Only nickel in the post stockpile sample from the straw cover plot (2) exceed regulatory soil quality guidelines at the 0-15 cm depth. No exceedances of the applied guidelines were detected for any of the other analytical parameters assessed from pre and post stockpile sampling events, in both the 0-15 cm and 15-60 cm depths.

NON-FEASIBLE COVER OPTIONS

Environmental sustainability, handling challenges and the requirement of speciality equipment are associated with the use of poly textile cover and poly-tote bags. Organic covers can be land applied along with the biosolids materials but poly textile materials need to be removed and disposed (can't be recycled) and thus is not environmentally sustainable. In addition, the placing and removal of the poly textile cover and poly–tote bags require more handling and speciality equipment to roll out the poly textile over the storage area or to load and unload poly textile bags. Therefore these two options are likely not feasible for the land application program.

Ag-lime is also not likely a feasible option due to the high cost associated with purchasing ag-lime material and the difficulty in spreading the ag-lime on top of a field-scale biosolids storage area; organic material can be blown over the biosolids stockpiles whereas ag-lime material would need to be spread.

The no cover option is not feasible as it was not effective at mitigating odour and provided a greater attractant to vectors. Based on these observations, the following four (4) storage options are likely not feasible for the land application program:

1. Poly textile cover
2. Poly tote bags
3. Ag-lime
4. No cover

FEASIBLE COVER OPTIONS

The three field storage options that are the most feasible for the land application program therefore include:

1. Straw cover
2. Wood chip cover
3. Hydro-mulch cover

Table 3 provides a summary of these three options in terms of their advantages, disadvantages and costs.

Table 3. Evaluation of Preferred Field Biosolids Storage Options

Storage Option	Advantages	Disadvantages
Straw Cover	— Good odour, vector and storm water management control — Can be directly spread on field. — Renewable organic source. — Readily available. — Organic material that breaks down in the soil. — Can be sourced from agricultural producers participating in the land application program thereby minimizing biosecurity issues associated with weed and disease transfer. — Short transport distance to field storage sites.	— Will require pre-planning a year ahead of time to ensure straw cover is available throughout storage season (May through October). — Requires heavy equipment to move. — May be difficult to source quantity of straw required. — Biosecurity issues associated with using straw from other areas.
Wood chip Cover	— Good odour, vector and storm water management control. — Renewable organic source. — Organic material that breaks down in the soil.	— Source and quality may be limited. ▪ Only available from select sources (e.g. City of Winnipeg – chip it program). ▪ Dependent upon amount of wood material being recycled. — May have some concerns with biosecurity if other organic plant material is included (including transfer of forest-based disease and insects, e.g. emerald ash borer). — Need to transport materials to the biosolids field storage sites from further distances. — Requires heavy equipment to move.
Hydro-mulch Cover	— Good odour, vector and storm water management control. — Some what renewable organic source. — Organic material that breaks down in the soil.	— Source and quality may be limited. ▪ Only available from select sources (e.g. private contractor). — Scheduling may be a factor as subcontractors are required to bring material to the storage sites. — May have some concerns with biosecurity if other organic plant material is included. — Hydro-mulch cover showed signs of cracking during the assessment which may allow more water into the biosolids materials and result in increased leaching potential. — Need to transport materials to the biosolids field storage sites from further distances.

4.2 FIELD STORAGE BERM LOGISTICS

An important aspect of field storage of bisosolids is the control of storm water run-off and leachate from the storage piles thorough the use of berms. During the assessment, clay berms were established by utilizing the existing topsoil at each plot site. However, during a lessons learned debriefing conducted for a biosolids pilot land application project, the cooperating agricultural producer indicated that berms for the field storage of biosolids should not be developed from field topsoil resources as this will disturb the soil and may result in lower crop productivity in these areas for many years. Rather, berms should be developed from other materials.

Other viable sources of berm materials for biosolids storage were therefore assessed based on:

- Availability – berm materials need to be readily available and cost effective to use
- Impermeable/Absorbent – berms materials need to act as either an impermeable or absorbent barrier to control potential leaching
- Sustainability – berm materials need to be easily disposed of in an environmentally sustainable manner (e.g. biodegradable, use of poly textile material to "wrap" berms in would require disposal at landfill)
- Stability - berm materials need to be stable to accommodate required biosolids storage capacity within the available footprints
- Floor of the bermed area should be covered with an organic material (straw or wood chips) to further act as an absorbant of leachable nutrients and metals prior to stockpiling, this material would act as an absorbent interface between the biosolids and soil surface. This material can then be either land applied or disposed of at a landfill site.

Table 4 provides advantages and disadvantage associated with different berm materials.

Table 4. Evaluation of Berm Materials for Field Storage Sites

Berm Material	Advantage	Disadvantage
Large square straw bales	— Reduced biosecurity issues and transport costs if bales are sourced from cooperating agricultural producer. — Will act as a sponge and absorb leachate. — Biodegradable – can be spread on field during land application. — Large size allows for building of structurally firm wall and will resist the weight of slumping provided by biosolids. Can be further held in place by pinning to ground with wooden or metal stakes if necessary. — Stackable – will provide a visual barrier and limit exposure to wind.	— Additional costs may be incurred for specialized equipment to bail straw. — Susceptible to damage by heavy equipment and vandalism.
Concrete or plastic barriers (Jersey barrier)	— Large size allows for building of structurally firm wall and will resist the weight of slumping provided by biosolids. Can be further held in place by pinning to ground with wooden or metal stakes if necessary. — Can be easily lined with poly textile material along walls. — Will act as a barrier to water and allow reabsorption of water runoff. — Easily relocated to new sites with heavy equipment. — Low biosecurity concerns for different field sites if decontaminated prior to reuse.	— Costly to purchase and will likely require decontamination to be re-used due to biosecurity and health hazard concerns. Is not environmentally sustainable if lined with poly textile material (poly textile requires disposal at landfill). — Transportation to sites by subcontractor required — May create a pool effect with significant storm water events.
Topsoil brought in from other sources	— Can be spread on field after decommissioning of storage area. — Provide suitable resistance to slump weight of biosolids.	— Prohibitive costs to purchase. — Biosecurity issues. — Transportation to sites by subcontractor required. — Large volume of material required to achieve suitable berm height and area.

5 SUMMARY AND CONCLUSION

5.1 FIELD STORAGE LOGISTICS

Field storage of bisosolids includes the control of stormwater run-off and leachate from the storage piles thorough the use of berms. During the assessment, clay berms were established by utilizing the existing topsoil at each plot site. However, during a lessons learned debriefing conducted for a biosolids pilot land application project, the cooperating agricultural producer indicated that berms for the field storage of biosolids should not be developed from field topsoil resources as this will disturb the soil and may result in lower crop productivity in these areas for many years. Rather, berms should be developed from other materials that are readily available, impermeable/absorbent, sustainable, and stable. The recommended berm materials were observed to be straw bales or concrete/platic barriers (Jersey barrier).

It was further concluded that the floor of the bermed area should be covered with an organic material (straw or wood chips) to further act as an absorbant of leachable nutrients and metals prior to stockpiling, this material would act as an absorbent interface between the biosolids and soil surface. This material can then be either land applied or disposed of at a landfill site.

Based on the field storage cover evaluations it was concluded that the most feasible approach to the land cover application program would be straw, wood chip or hydro-mulch cover. They provide a respectable odour management and sustainable approach to logistics and management.

5.2 ODOUR ASSESSMENT

Based on the field storage assessment, the uncovered biosolids stockpile odour levels were recorded to be primarily at a level 3 (very annoying - strong - the odour is penetrating; you can't get away from it and it can easily be detected at all times) or less even at a distance of 5 m from the biosolids pile. By adding a cover material (straw, wood chips, ag-lime, hydro-mulch or poly textile), odour associated with field storage of biosolids can be reduced. The highest odour levels were recorded during the first week of storage and when disturbed for plot decommissioning. In addition, odour concerns can likely be further reduced by adhering to applicable best management practices and prescribed setback distances that include establishing field storage sites that are at least:

— 1,000 m from designated residential area
— 300 m from a residence

5.3 LEACHING POTENTIAL

Only nickel in the post stockpile sample from the straw cover plot (2) exceed regulatory soil quality guidelines at the 0-15 cm depth. No exceedances of the applied guidelines were detected for any of the other analytical parameters assessed from pre and post stockpile sampling events, in both the 0-15 cm and 15-60 cm depths.

5.4 STORM WATER AND VECTOR MANAGEMENT

Ponding of water in the storage plots after a rainfall event was primarily associated with the poly textile materials used to the cover the berms and on plot 3 (poly textile cover) and on the plot 1 – poly-tote bags.

The presence of flies one-day after stockpiling of biosolids may have been contributed to the "freshness" of the materials and the fact that on that day at the time of the assessment, the air temperature was quite warm (20^{0}C). However, it does appear that once the surface of the stockpiled biosolids materials are exposed to the air and allowed to dry for several days (as is the case for plot 7 –no cover) or are covered with organic or poly textile materials, the attraction of the biosolids materials to vectors is greatly reduced. However, it should be noted that the field storage assessment was also conducted in the fall season when temperatures are cooler and fly abundance is generally lower. A larger scale field storage program conducted during the summer season with hot weather and greater abundance of flies, may result in a higher attraction to vectors.

5.5 CONCLUSION

Overall, the three most feasible field biosolids storage options include: straw cover, wood chip cover and hydro-mulch cover. It must be kept in mind however that the field storage assessment was completed on a small scale trial level and these results may differ for larger field storage sites utilized during the future full-scale land application program.

In addition, the following logistical items should be included as part of a full-scale field biosolids storage program:

- Biosecurity is a concern for any organic matter (straw, wood chips, hydro-mulch) that is used as the cover for the field biosolid storage. If straw is used as the cover it should be sourced from the cooperating agricultural producer or trusted resource in order to reduce the risk of weed and disease transfer to agricultural fields.
- Utilizing topsoil from the participating agricultural fields to create the berm for field storage sites is not a viable option as there is concern that the topsoil in the storage area will be disturb and may result in decreased crop productivity in those areas.
- Field storage sites should be established at field entrances and equipment should travel along field edges in order to minimize soil compaction.

APPENDIX

A REGULATORY APPROVAL LETTER

Manitoba
Sustainable Development
Environmental Stewardship Division
Environmental Approvals Branch
123 Main Street, Suite 160, Winnipeg, Manitoba, Canada R3C 1A5
T 204 945-8321 F 204-945-5229
www.gov.mb.ca/conservation/eal

File: 963.20

September 8, 2017

Chris Carroll, P.Eng.
Manager of Wastewater Services Division
City of Winnipeg
109 – 1199 Pacific Avenue
Winnipeg, MB R3E 3S8

Dear Chris Carroll:

Re: City of Winnipeg Biosolids Land Application Pilot – Field Storage Assessment – Supplementary Notice of Alteration

Receipt of the August 1, 2017 letter regarding the City of Winnipeg's supplementary Notice of Alteration relative to the Biosolids Land Application Pilot regarding the City conducting pilot assessments of field storage options for biosolids that would be land applied is hereby acknowledged. As indicated in the letter, the purpose of this pilot assessment is to aid in determining the feasibility of field storage for the City's annual biosolids land application program that is under development. Environment Act Licence No. 1089E RR applies to these activities.

The Notice of Alteration and additional information received August 31, 2017 describe details of the Field Storage Assessment pilot including the quantity of biosolids that would be involved, legal description of the location, timelines, plans for odour and storm water monitoring, and soil sampling activities. It is understood that the biosolids materials will be transferred from the Brady Road Resource Management Facility (BRRMF) to the proposed City-owned site at SE 11-10-01 EPM for use in the this Field Storage Assessment pilot. There will be several in-field storage options assessed in the pilot. It is proposed that the Field Storage Assessment pilot would start in early September and continue for 4 to 6 weeks.

Due to biosolids transportation limitations, biosolids are proposed to be transferred from the North End Water Pollution Control Centre (NEWPCC) and temporarily stored in a dedicated area in the north portion of BRRMF, and then reloaded to trucks with end dump trailers for hauling to the City owned site at SE 11-10-01 EPM for use in the Field Storage Assessment pilot. It is estimated that 6 to 10 end dump trailer truckloads of biosolids would be transferred to the site for use during the Field Storage Assessment pilot and then returned to BRRFM upon completion of this pilot.

Upon consideration of the request for approval of this Field Storage Assessment pilot, I have decided, pursuant to Section 14(2) of The Environment Act, to approve the request subject to the following conditions:

1. Biosolids and all associated materials shall be transported between the BRRMF and the site of the Field Storage Assessment pilot in covered containers so as to prevent the loss of biosolids, soils that may be contaminated with biosolids, and associated liquids to the satisfaction of the assigned Environment Officer;

2. Biosolids materials other than those specifically involved with the Field Storage Assessment pilot shall not be stored at the site of this pilot;

3. Immediately upon successful establishment of all field storage areas of the Field Storage Assessment pilot, biosolids transferred from the NEWPCC to BRRMF for the purposes of this pilot that have not been transferred to the site of the pilot for use in the pilot shall be disposed of as waste at the BRRMF or as otherwise approved by the assigned Environment Officer;

4. Access to the site of the Field Storage Assessment pilot shall be limited to persons specifically participating in associated activities. General public access to the site shall not be permitted to the satisfaction of the assigned Environment Officer;

5. Surface water resulting from precipitation at the site of the Field Storage Assessment pilot during this pilot shall be controlled and managed to the satisfaction of the assigned Environment Officer;

6. The site of the Field Storage Assessment pilot shall be operated and maintained so as to control vector attraction and activity at the site to the satisfaction of the assigned Environment Officer;

7. A report summarizing all activities and results associated with the Field Storage Assessment pilot shall be submitted to the Environmental Approvals Branch, Manitoba Sustainable Development by not later than November 30, 2017; and

8. This approval shall terminate December 29, 2017.

All other previously approved proposed and imposed conditions, limitations and requirements remain in place during this pilot.

If you have any questions or would like to discuss matters pertaining to this Field Storage Assessment pilot, the continuing development of the land applications of biosolids program, or the Biosolids Master Plan in general, please contact Robert Boswick, Environmental Engineer, at 204-945-6030 or robert.boswick@gov.mb.ca.

Yours sincerely,

for Tracey Braun, M.Sc.
Director
Environmental Approvals Branch

c. Duane Griffin, P.Eng. – Water and Waste Department, City of Winnipeg
Don Labossiere/Donna Smiley – Environmental Compliance and Enforcement Branch, Manitoba Sustainable Development
Siobhan Burland Ross/Robert Boswick/Asit Dey – Environmental Approvals Branch, Manitoba Sustainable Development
Public Registries

APPENDIX

B ADJACENT LANDOWNER NOTIFICATION LETTER EXAMPLE AND LOG

Notice of Biosolids Field Storage Assessment

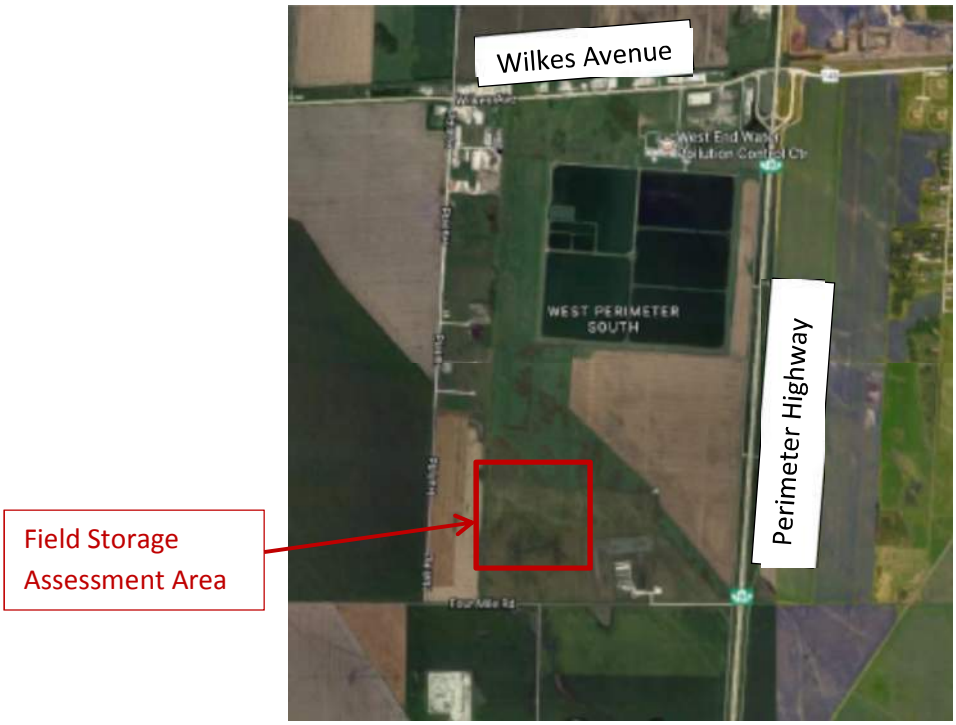
City of Winnipeg Biosolids Field Storage Assessment

The City of Winnipeg will begin an assessment of different storage options for treated wastewater biosolids in early September 2017. The storage assessment will include stockpiling approximately 150 tonnes of biosolids for a six week period on the City property west of the Perimeter Highway, south of the West End Sewage Treatment Plant (WEWPCC), outlined on the map below. Once the storage assessment is complete in October 2017, the biosolids will be transported off site to pre-approved local farmland for application as a fertilizer, or the Brady Road Resource Management Facility (landfill). The storage assessment is part of the City's Biosolids Land Application program.

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, also known as sludge, are further treated and dewatered. After treatment, the solids are called biosolids.

Approval from the Province of Manitoba will be received prior to starting the field storage assessment. Biosolids management is regulated by the Province of Manitoba through the Nutrient Management Regulation and a project specific Environment Act Licence.

The project team will visit the site regularly to assess odour.



For more information, please visit the project website: winnipeg.ca/BiosolidsLandApplication.

If you have any questions or comments about the program, please contact Brock Feenstra, Public Engagement Lead with WSP Global, the consulting firm for this project, at BiosolidsLandApplication@winnipeg.ca or 1-888-882-3391.

Notice of Biosolids Field Storage Assessment Delivery Log

Legal Land Location	Parcel Index Owner	Date/Time Notice Delivered	Initials
01-10-01E			
SW01-10-01E	CA & ND & HE&JG Froese		
02-10-01E			
B, 1-25570	Sharon D. Klassen		
35-09-01E			
G	Dallas V. & Malvenia Muir		
RM Headingly Hall Road	~~Hall Road~~		
700 Datomer Road.		Sept. 6/17 8:30	Bm.
	Dan New Anything	" "	BM
	Datomer Motor Sales	" 9:00	Bm.
	Saber Industries	" 9:00	Bm.
	M&M Teske Ltd.	" "	Bm
10 Datomer Rd.	Whitewater Logistics	" "	Bm.
6 Datomer Rd.	EWC	" 9:05	BM
2 Datomer Rd		" "	Bm.
17 Sabrina Way	Southend concrete.	" "	BM
6 Sabrina Way	Prairieview Terminals Ltd	" 9:10	Bm.
14 Wanda Way	Green Opportunities	" 9:15	Bm.
? Diedmann Way	Detailing?	" 9:15	Bm
? " "	? new	" "	Bm.
4 Diedmann	Evrane Cuys	locked, not delivered no access	
8316 Wilkes.	Superior Propane	Sept. 6/17 9:25	Bm.
5 005	? Vacant.	" 9:35	Bm.
4' 164	dog		
4 155	?	" 9:38	BM

APPENDIX

C SUMMARY DATA TABLES

APPENDIX

C.1 ODOUR ASSESSMENT TABLES

City of Winnipeg Biosolids Odour Assessment - September 7, 2017

Start Time:	9:48	**End Time:**	11:00
Weather Conditions:			
Cloud Cover:	0 - clear	Wind Speed:	Moderate wind - 5.1 m/s
Temperature (^{o}C):	12	Wind Direction:	NNE
Relative Humidity (%):	67%	Precipitation:	None
Barometric Pressure (kPa):	101		
Number of Surveyors:	3		

Table 1a. Odour Assessment Averages - Pre Stockpile Baseline

Plot Cover Options	Distance from Stockpile (m)			
	50	25	10	5
Background level (non-biosolid area)	-	-	-	0
1 - Poly-tote bag	0	0	0	0
2 - Straw	-	-	-	-
3 - Poly textile	-	-	-	-
4 - Hydromulch	-	-	-	-
5 - Lime mud	0	0	0	0
6 - Wood chip	-	-	-	-
7 - No Cover (Control)	0	0	0	0

Table 1b. Odour Assessment Comments - Pre Stockpile Baseline

Plot Cover Options	Distance from Stockpile (m)			
	50	20	10	5
Background level (non-biosolid area)	-	-	-	-
1 - Poly-tote bag	Grassy; faint hay odour	Grassy; faint hay odour	Grass	Earthy; grassy
2 - Straw	-	-	-	-
3 - Poly textile	-	-	-	-
4 - Hydromulch	-	-	-	-
5 - Lime mud	Grassy; faint hay odour	Grassy; faint hay odour	Grassy; faint hay odour	Earthy; grassy
6 - Wood chip	-	-	-	-
7 - No Cover (Control)	Grassy; faint hay odour	Mild grass; faint hay	Grassy	Grassy

Odour Scale

Numerical Value	Annoyance Level	Annoyance Level[1]
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.

City of Winnipeg Biosolids Odour Assessment - September 13, 2017

Start Time:	12:15	**End Time:**	-
Weather Conditions:			
Cloud Cover:	0 - clear, sunny	Wind Speed:	-
Temperature (°C):	20	Wind Direction:	NE
Relative Humidity (%):	-	Precipitation:	None
Barometric Pressure (kPa):	-		
Number of Surveyors:	1		

Table 2a. Odour Assessment - In-formal Assessment 1-day Post-Stockpile

Plot Cover Options	Distance from Stockpile (m)			
	50	25	10	5
Background level (non-biosolid area)	-	-	-	-
1 - Poly-tote bag	-	-	-	2
2 - Straw	-	-	-	2
3 - Poly textile	-	-	-	2
4 - Hydromulch	-	-	-	2
5 - Lime mud	-	-	-	2
6 - Wood chip	-	-	-	1
7 - No Cover (Control)	-	-	-	3

Table 2b. Odour Assessment Comments - In-formal Assessment 1-day Post-Stockpile

Plot Cover Options	Distance from Stockpile (m)			
	50	20	10	5
Background level (non-biosolid area)	-	-	-	-
1 - Poly-tote bag	-	-	-	some flies present
2 - Straw	-	-	-	faint hay odour; some flies present
3 - Poly textile	-	-	-	some flies present
4 - Hydromulch	-	-	-	some cracking on hydromulch; some flies present
5 - Lime mud	-	-	-	slight cracking in lime cover; some flies present
6 - Wood chip	-	-	-	faint wood chip odour; some flies present
7 - No Cover (Control)	-	-	-	some flies present

Odour Scale

Numerical Value	Annoyance Level	Annoyance Level[1]
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.

City of Winnipeg Biosolids Odour Assessment - September 15, 2017

Start Time:	12:15	**End Time:**	-
Weather Conditions:			
Cloud Cover:	4 - overcast	Wind Speed:	windy
Temperature (°C):	10	Wind Direction:	NE
Relative Humidity (%):	-	Precipitation:	light rain
Barometric Pressure (kPa):	-		
Number of Surveyors:	1		

Table 3a. City of Winnipeg Biosolids Odour Assessment - In-formal Assessment 3-days Post-Stockpile

Plot Cover Options	Distance from Stockpile (m)			
	50	25	10	5
Background level (non-biosolid area)	-	-	-	-
1 - Poly-tote bag	-	-	-	2
2 - Straw	-	-	-	1
3 - Poly textile	-	-	-	1
4 - Hydromulch	-	-	-	1
5 - Lime mud	-	-	-	1
6 - Wood chip	-	-	-	1
7 - No Cover (Control)	-	-	-	2

Table 3b.Odour Assessment - In-formal Assessment - 3-days Post-Stockpile

Plot Cover Options	Distance from Stockpile (m)			
	50	20	10	5
Background level (non-biosolid area)	-	-	-	-
1 - Poly-tote bag	-	-	-	no flies present
2 - Straw	-	-	-	faint hay odour; no flies present; no standing water
3 - Poly textile	-	-	-	no flies present; no standing water
4 - Hydromulch	-	-	-	some cracking on hydromulch; no flies present; no standing water
5 - Lime mud	-	-	-	no flies present; no standing water
6 - Wood chip	-	-	-	faint wood chip odour; no flies present; no standing water
7 - No Cover (Control)	-	-	-	-

Odour Scale

Numerical Value	Annoyance Level	Annoyance Level[1]
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.

City of Winnipeg Biosolids Odour Assessment - September 19, 2017

Start Time:	14:00	**End Time:**	16:15
Weather Conditions:			
Cloud Cover:	1 - partly cloudy	Wind Speed:	Strong wind - 9.4 m/s
Temperature (°C):	17	Wind Direction:	SSE
Relative Humidity (%):	81	Precipitation:	None
Barometric Pressure (kPa):	100.2		
Number of Surveyors:	8		

Table 4a. Odour Assessment Averages - Panel 1

Plot Cover Options	Distance from Stockpile (m)			
	35	20	10	5
Background level (non biosolids area)	-	-	-	0
1 - Poly-tote bag	1.8	1.4	1.7	2.0
2 - Straw	0.5	0.4	0.8	0.9
3 - Poly textile	0.3	0.4	0.4	0.9
4 - Hydromulch	0.1	0.3	0.9	1.0
5 - Lime mud	0.4	0.6	1.1	1.6
6 - Wood chip	0.4	0.5	0.5	0.8
7 - No Cover (Control)	1.4	1.6	2.1	2.6

Table 4b. Odour Assessment Comments - Panel 1

Plot Cover Options	Distance from Stockpile (m)			
	35	20	10	5
Background level (non biosolids ar	-	-	-	Grassy/mildew to no odour
1 - Poly-tote bag	Mild, noticeable biosolid odour; earthy	Grass, earthy; slight biosolid odour; similar to less than 35 m	Stronger but not overpowering; grassy, earthy	Similar to 10 m; No vectors; no standing water
2 - Straw	No blowing straw; Primarily straw/grass odour	Primarily straw smell; slight biosolid odour	Primarily straw; mild biosolids	Mostly straw smell with very faint biosolid odour; No vectors or standing water observed
3 - Poly textile	Grassy, faint biosolids odour	Grassy, earthy, faint biosolids	Grassy, faint biosolids	Slight odour; minimal odour; ponding of water on polytextile; no vectors
4 - Hydromulch	Slightly mouldy/straw/grassy odour	Slight mouldy, background grass odour/hay; very faint biosolid odour	Very faint biosolid odour, not annoying; earthy	Slight biosolid odour, earthy; cracking on surface; no vectors or standing water observed
5 - Lime mud	Faint biosolids, grassy, straw	Slight straw, grass odour; faint biosolids	Very slight biosolids; grassy, slight straw scent	Earthy, slighty stronger biosolids odour; no vectors or standing water
6 - Wood chip	Wood chip scent only	Wood chip scent primarily; slight biosolid odour	Wood chip scent primarily; faint biosolid odour	Slight biosolid odour, dominant wood chip odour; slight mouldy odour; no movement, good cover; no vectors or standing water
7 - No Cover (Control)	Biosolids odour mild, slight and faint; wind dependent	Biosolids odour wind dependent; stronger	Biosolids odour stronger	Strongest; no flies, birds or standing water observed

City of Winnipeg Biosolids Odour Assessment - September 27, 2017

Start Time:	14:15	**End Time:**	16:00
Weather Conditions:			
Cloud Cover:	0 - clear	Wind Speed:	Moderate wind - 2.9 m/s
Temperature (°C):	17	Wind Direction:	NE
Relative Humidity (%):	-	Precipitation:	None
Barometric Pressure (kPa):	-		
Number of Surveyors:	8		

Table 5a. Odour Assessment Averages - Panel 2

Plot Cover Options	Distance from Stockpile (m)			
	50	25	10	5
Background level (non biosolids area)	-	-	-	0
1 - Poly-tote bag	0.9	1.3	0.9	1.8
2 - Straw	0.1	0.4	0.8	0.9
3 - Poly textile	0	0	0.6	0.6
4 - Hydromulch	0.1	0.4	0.8	1.6
5 - Lime mud	0	0.9	1.1	1.5
6 - Wood chip	0	0.1	0.1	0.4
7 - No Cover (Control)	0.5	0.5	2.1	2.4

Table 5b. Odour Assessment Comments - Panel 2

Plot Cover Options	Distance from Stockpile (m)			
	50	20	10	5
Background level (non biosolids area)	-	-	-	Grassy, pleasant earthy smell; dry grass
1 - Poly-tote bag	Somewhat noticeable, slight odour; Biosolid odour noticeable in wind	More pungent than from 35 m; Biosolid odour is consistent but faint	Biosolids odour, similar to 20 m	Stronger odour than previous; standing water on poly cover and some insects
2 - Straw	No scent; Very faint straw	Mouldy straw; Dry grass from surrounding area; No biosolid odour	Mouldy straw; Intermittent; Faint whiff on wind; Straw	Primarily straw; Intermittent; Bird observed; Mouse observed in straw; Standing water on poly berms
3 - Poly textile	No odour	No odour	Grassy; Intermittent, very faint	Grassy; water ponding on poly surface; some insects
4 - Hydromulch	Sweet; very faint	Mild, mouldy, wet earth odour; Faint	Very faint; primarily with wind gusts	Organic; Very faint biosolid odour; Cracks on surface; Standing water on berms; Some insects
5 - Lime mud	None to very faint odour	Earthy; Intermittent, faint with wind gusts;	Slight biosolid odour; earthy	Strong pungent odour to earthy; Stronger on wind gusts; no vectors or standing water apparent
6 - Wood chip	Grassy; no odour	Slight wood odour	Wood odour	Wood chip smell; faint biosolid odour; No standing water, some insects
7 - No Cover (Control)	Noticeable biosolid odour; intermittent/wind gusts	Similar to 35 m	Defined biosolid odour; sweet, pungent odour	Moderate odour; appears dry; no vectors apparent/some insects; no standing water

Odour Scale

Numerical Value	Annoyance Level	Annoyance Level[1]
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.

City of Winnipeg Biosolids Odour Assessment - October 4, 2017

Start Time:	-	**End Time:**	-
Weather Conditions:			
Cloud Cover:	0 -clear	Wind Speed:	Strong wind - 7.4 més
Temperature (°C):	14	Wind Direction:	W
Relative Humidity (%):	-	Precipitation:	None
Barometric Pressure (kPa):	-		
Number of Surveyors:	7		

Table 6a. Odour Assessment Averages - Panel 3

Plot Cover Options	Distance from Stockpile (m)			
	50	25	10	5
Background level (non biosolids	-	-	-	0
1 - Poly-tote bag	0.4	0.1	0.4	0.4
2 - Straw	0.0	0.3	0.3	0.6
3 - Poly textile	0	0	0.0	0.0
4 - Hydromulch	0	0	0	0
5 - Lime mud	0	0	0	0.1
6 - Wood chip	0	0	0	0.3
7 - No Cover (Control)	0.1	0.9	1.3	1.7

Table 6b. Odour Assessment Comments - Panel 3

Plot Cover Options	Distance from Stockpile (m)			
	50	20	10	5
Background level (non biosolids area)	-	-	-	-
1 - Poly-tote bag	Biosolid odour present; very mild	Biosolid odour present; very mild	Biosolid odour present; very mild	Biosolid odour present
2 - Straw	Earthy, grassy	Straw smell	Straw smell	Straw smell; no standing water or flies
3 - Poly textile	Grassy	Grassy	Earthy; no biosolid odour	Earthy; no biosolid odour; birds on snow fencing; standing water on poly
4 - Hydromulch	-	Sweet smell; smoke?	Sweet smell, smoky?; Biosolid odour/earthy	Biosolid odour maybe present; smoky; no standing water, no flies
5 - Lime mud	Grassy	-	Earthy/biosolids; sweet smell/smoky	Dry/moist patches; no standing water, bird on fence; very faint odour
6 - Wood chip	Grassy; sweet smell/smoky	Woody	Woody	Very light, primarily wood smell; standing water on poly; no flies
7 - No Cover (Control)	Biosolid odour present; grassy	No odour to biosolid odour present	Faint biosolid odour	Biosolid odour present, faint; no flies, standing water on poly berm

Odour Scale

Numerical Value	Annoyance Level	Annoyance Level[1]
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.

City of Winnipeg Biosolids Odour Assessment - October17, 2017

Start Time:	13:30	**End Time:**	15:30
Weather Conditions:			
Cloud Cover:	0 - clear	Wind Speed:	Moderate wind
Temperature (°C):	20	Wind Direction:	SW
Relative Humidity (%):	-	Precipitation:	None
Barometric Pressure (kPa):	-		
Number of Surveyors:	7		

Table 7a. Odour Assessment Averages - Panel 4

Plot Cover Options	Distance from Stockpile (m)			
	50	25	10	5
Background level (non biosolids area)	-	-	-	0
1 - Poly-tote bag	0.1	0.1	0.1	0.4
2 - Straw	0.1	0.0	0.1	0.1
3 - Poly textile	0.0	0.0	0.0	0.1
4 - Hydromulch	0.0	0.0	0.1	0.3
5 - Lime mud	0.0	0.0	0.0	0.1
6 - Wood chip	0.0	0.0	0.0	0.0
7 - No Cover (Control)	0.1	0.9	1.3	1.6

Table 7b. Odour Assessment Comments - Panel 4

Plot Cover Options	Distance from Stockpile (m)			
	50	20	10	5
Background level (non biosolids area)	-	-	-	Earthy
1 - Poly-tote bag	Warm air, earthy; faint biosolids	Warm air, earthy; faint biosolids	Warm air, earthy; faint biosolids	Faint biosolids; some pooling of water on tote bags
2 - Straw	Grassy; straw; faint biosolid but could be from PL-3	Barely detectable, not annoying; straw	Straw	Primarily straw; standing water on berm; no flies
3 - Poly textile	-	-	-	Earthy; Standing water on poly; faint biosolids
4 - Hydromulch	Grassy	-	Grassy; Very slight biosolid odour	Earthy; faint biosolid odour; no standing water or vectors; cracking on surface; wet/moist areas
5 - Lime mud	-	-	-	Dry, no moist or wet areas; Earthy; Barely detectable; Some areas exposed; No standing water or flies
6 - Wood chip	Woody	-	-	Some areas exposed; No standing water or flies
7 - No Cover (Control)	Grassy; barely detectable; faint	Minor odour; Detectable; Faint; Mild	Minor but present	Minor but present; Not overpowering; Some standing water on pile; some flies

Odour Scale

Numerical Value	Annoyance Level	Annoyance Level[1]
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.

APPENDIX

C.2 SOIL SAMPLE RESULTS TABLES FOR LEACHING POTENTIAL

Table C 2-1. Pre and post stockpile plot soil data for 0-15 cm in depth.

Analytes	Units	Applicable Criteria	PL1-Totes			PL2-Straw Cover			PL3-Poly Cover			PL4-Hydro-mulch Cover			PL5-Ag-lime Cover			PL6-Wood Chip Cover			PL7-No Cover		
			Pre stockpile (Sept 5)	Post stockpile (Nov 3)	Difference[F]	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	Difference[F]	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	Difference[F]	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	Difference[F]	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	Difference[F]	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	Difference[F]	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	Difference[F]
Physical																							
pH (1:2 soil:water)	pH	6-8	6.62	6.89	0.27	7.08	7.71	0.63	6.80	6.81	0.01	7.44	7.87	0.43	7.66	7.03	-0.63	7.54	7.78	0.24	7.42	7.31	-0.11
Nutrients																							
Nitrite-N	mg/kg		<1.0	0.45		<1.0	0.61		<1.0	0.55		<1.0	0.53		<1.0	0.62		<1.0	0.61		<1.0	0.56	
Nitrate+Nitrite-N			<2.0	<2.0		<2.0	<2.0		<2.0	4.9		<2.0	<2.0		<2.0	3.9		<2.0	2.1		<2.0	7.5	
Nitrate-N			<2.0	<2.0		<2.0	<2.0		<2.0	4.4		<2.0	<2.0		<2.0	3.2		<2.0	<2.0		<2.0	6.9	
Available Ammonium-N			9.9	-		10.8	-		9.8	-		8.5	-		8.5	-		10.2	-		8.8	-	
Available Phosphate-P		60[E]	11.3	13.9	-20.6%	8.7	2.5		5.7	10.8	-61.8%	7.6	9.4	-21.2%	3.5	9.1	-88.9%	6.0	3.6		4.3	9.7	-77.1%
Available Potassium			440	577	-26.9%	407	477	-15.8%	421	499	-17.0%	439	574	-26.7%	380	522	-31.5%	345	450	-26.4%	474	582	-20.5%
Total Nitrogen by LECO	%		0.292	0.248		0.239	0.155		0.241	0.250	-3.7%	0.212	0.164		0.201	0.238	-16.9%	0.219	0.187		0.185	0.238	-25.1%
Metals																							
Arsenic (As)	mg/kg	12[A]	8.11	8.02		9.85	10.5	-6.4%	9.49	9.31		9.72	9.10		9.22	9.75	-5.6%	9.23	10.7	-14.8%	5.89	10.5	-56.3%
Cadmium (Cd)		1.4[B]	0.176	0.145		0.147	0.099		0.133	0.118		0.123	0.088		0.143	0.126		0.141	0.123		0.096	0.109	-12.7%
Chromium (Cr)		64[B]	45.6	40.1		43.4	54.1	-21.9%	47.3	50.7	-6.9%	48.4	53.4	-9.8%	48.6	49.5	-1.8%	47.4	51.3	-7.9%	34.5	51.0	-38.6%
Copper (Cu)		63[B]	30.6	30.1		30.0	33.8	-11.9%	30.8	30.8		32.4	32.6	-0.6%	31.2	30.8		31.5	31.8	-0.9%	22.1	31.6	-35.4%
Lead (Pb)		70[C]	16.2	15.0		15.3	16.0	-4.5%	16.5	16.8	-1.8%	16.1	17.3	-7.2%	16.6	16.5		15.3	16.2	-5.7%	13.3	16.9	-23.8%
Mercury (Hg)		6.6[C]	0.0357	0.0240		0.0403	0.0407	-	0.0378	0.0385	-1.8%	0.0418	0.0333		0.0351	0.0299		0.0367	0.0355		0.0299	0.0354	-16.8%
Nickel (Ni)		50[D]	36.8	38.9	-5.5%	38.2	53.3	-33.0%	45.0	47.4	-5.2%	44.3	47.0	-5.9%	39.5	41.2	-4.2%	47.7	48.4	-1.5%	37.6	46.3	-20.7%
Phosphorous (P)		-	560	450		480	460		420	450	-6.9%	490	450		450	470	-4.3%	460	460		370	480	-25.9%
Zinc (Zn)		200[A]	89	82		79	91	-14.1%	85	89	-4.6%	81	96	-16.9%	83	86	-3.6%	89	89		63	83	-27.4%

Notes:

"-" = analysis not determined

[A] CCME. 1997. Soil Quality Guidelines for the Protection of the Environmental and Human Health. Human Health guidelines/check values (SQG_{HH}) Soil Ingestion. Agricultural land use.

[B] CCME. 1999. Soil Quality Guidelines for the Protection of the Environmental and Human Health. Environmental Health guidelines/check values (SQG_{E}) Soil contact guideline. Agricultural land use.

[C] CCME. 2015. Soil Quality Guidelines for the Protection of the Environmental and Human Health. Environmental Health guidelines/check values (SQG_{E}) Soil contact guideline. Agricultural land use.

[D] CCME. 1991. Interim Soil Quality Guidelines for the Protection of the Environmental and Human Health. 2015 CCME Nickel Environmental Health guidelines/check values (SQG_{E}) is 45 mg/kg for soil contact guideline. Agricultural land use.

[E] Manitoba Water Protection Act, Nutrient Management Regulation, 2017.

F Ministry of Ontario, Protocol for Analytical Methods, Table 5-14: Performance Criteria - Boron, Hotwater Soluble; Calcium, Magnesium; Sodium; Metals (30%), Sample Duplicate Required Performance Standard;
Table 5-15 Performance Criteria - pH in Soil (0.3 pH units.

% Difference

% Difference = (X-Y)/Average(X, Y) * 100%

X – Soil sample collected pre biosolid application

Y – Soil sample collected post biosolid application

The % difference is utilized to compare two experimental values, in this case, samples collected from a specific location and depth at two different times, prior to and post biosolid land application.

Interpretation: When the pre-application (X) value is greater than the post-application (Y) value than the percent difference is positive and the application of biosolid materials is likely not a contributing factor to the concentration of the analyte in the soil. When the post-application (Y) value is greater than the pre-application (X) value the percent difference is negative and the application of biosolid materials may be contributing to the concentration of the analyte in the soil.

Based on Maxxam Analytics QA/QC interpretation guide, the recommended alert criteria for metals and general chemistries in soil is when the percent difference is greater than 30%. Specific for this evaluation only negative values are reported as this demonstrates the possible contribution due to biosolids stockpile.

Exceeded the applied regulatory guideline.

Exceeded the applied alert criteria.

Table C2-2. Pre and post stockpile plot soil data for 15-60 cm in depth.

Analytes	Units	PL1-Totes			PL2-Straw Cover			PL3-Poly Cover			PL4-Hydro-mulch cover			PL5-Ag-lime Cover			PL6-Wood Chip Cover			PL7-No Cover		
		Pre stockpile (Sept 5)	Post stockpile (Nov 3)	% Difference	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	% Difference	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	% Difference	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	% Difference	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	% Difference	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	% Difference	Pre stockpile (Sept 5)	Post stockpile (Nov 3)	% Difference
Nutrients																						
Nitrite-N	mg/kg	<1.0	<0.4	-	<1.0	0.96	-	<1.0	0.67	-	<1.0	0.77	-	<1.0	0.72	-	<1.0	0.67	-	<1.0	0.6	-
Nitrate+Nitrite-N		<2.0	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-	<2.0	2.3	-	<2.0	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-
Nitrate-N		<2.0	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-	<2.0	<2.0	-
Available Ammonium-N		7.9	7.4		6.6	8.4	-24.0%	7.2	10.3	-35.4%	5.6	9.7	-53.6%	5.0	8.8	-55.1%	6.0	8.9	-38.9%	6.3	10.9	-53.5%
Total Nitrogen by LECO	%	0.147	0.142		0.100	0.116	-14.8%	0.100	0.114	-13.1%	0.097	0.104	-7.0%	0.089	0.132	-38.9%	0.100	0.134	-29.1%	0.084	0.141	-50.7%

Notes:

"-" = analysis not determined

% Difference

% Difference = (X-Y)/Average(X, Y) * 100%

X – Soil sample collected pre biosolid application

Y – Soil sample collected post biosolid application

The % difference is utilized to compare two experimental values, in this case, samples collected from a specific location and depth at two different times, prior to and post biosolid land application.

Interpretation: When the pre-application (X) value is greater than the post-application (Y) value than the percent difference is positive and the application of biosolid materials is likely not a contributing factor to the concentration of the analyte in the soil. When the post-application (Y) value is greater than the pre-application (X) value the percent difference is negative and the application of biosolid materials may be contributing to the concentration of the analyte in the soil.

Based on Maxxam Analytics QA/QC interpretation guide, the recommended alert criteria for metals and general chemistries in soil is when the percent difference is greater than 30%. Specific for this evaluation only negative values are reported as this demonstrates the possible contribution due to biosolids stockpile.

Exceeded the applied alert criteria.

APPENDIX

D SOIL SAMPLE CERTIFICATES OF ANALYSIS

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

Date Received: 06-SEP-17
Report Date: 15-SEP-17 15:19 (MT)
Version: FINAL

Client Phone: 204-259-1488

Certificate of Analysis

Lab Work Order #: L1986233

Project P.O. #: NOT SUBMITTED
Job Reference: 17M-00008-00
C of C Numbers:
Legal Site Desc:

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L1986233-1 PL1-TC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 12:30									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	9.9	+/-1.5		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Available Phosphate-P	11.3	-		1.0	mg/kg	-	11-SEP-17	11-SEP-17	R3828856
Available Potassium	440	+/-55		20	mg/kg	-11.8%	12-SEP-17	12-SEP-17	R3827268
Mercury (Hg)	0.0357	+/-0.0098		0.0050	mg/kg	0	14-SEP-17	15-SEP-17	R3829621
Total Nitrogen by LECO	0.292	+/-0.052		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
pH (1:2 soil:water)	6.62	+/-0.18		0.10	pH	0	11-SEP-17	11-SEP-17	R3823927
Metals									
Arsenic (As)	8.11	+/-1.0		0.10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Cadmium (Cd)	0.176	+/-0.031		0.020	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Chromium (Cr)	45.6	+/-8.2		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Copper (Cu)	30.6	+/-4.6		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Lead (Pb)	16.2	+/-3.2		0.20	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Nickel (Ni)	36.8	+/-4.6		0.50	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Zinc (Zn)	89	+/-11		10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	9.9	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-2 PL2-SC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 12:50									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	10.8	+/-1.7		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Available Phosphate-P	8.7	-		1.0	mg/kg	-	11-SEP-17	11-SEP-17	R3828856
Available Potassium	407	+/-51		20	mg/kg	-11.8%	12-SEP-17	12-SEP-17	R3827268
Mercury (Hg)	0.0403	+/-0.011		0.0050	mg/kg	0	14-SEP-17	15-SEP-17	R3829621
Total Nitrogen by LECO	0.239	+/-0.043		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
pH (1:2 soil:water)	7.08	+/-0.18		0.10	pH	0	11-SEP-17	11-SEP-17	R3823927
Metals									
Arsenic (As)	9.85	+/-1.3		0.10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Cadmium (Cd)	0.147	+/-0.026		0.020	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Chromium (Cr)	43.4	+/-7.8		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Copper (Cu)	30.0	+/-4.5		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Lead (Pb)	15.3	+/-3.0		0.20	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Nickel (Ni)	38.2	+/-4.8		0.50	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Zinc (Zn)	79	+/-10		10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	10.8	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-3 PL3-PC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:00									
Matrix: SOIL									
Miscellaneous Parameters									

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L1986233-3 PL3-PC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:00									
Matrix: SOIL									
Available Ammonium-N	9.8	+/-1.5		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Available Phosphate-P	5.7	-		1.0	mg/kg	-	11-SEP-17	11-SEP-17	R3828856
Available Potassium	421	+/-53		20	mg/kg	-11.8%	12-SEP-17	12-SEP-17	R3827268
Mercury (Hg)	0.0378	+/-0.010		0.0050	mg/kg	0	14-SEP-17	15-SEP-17	R3829621
Total Nitrogen by LECO	0.241	+/-0.044		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
pH (1:2 soil:water)	6.80	+/-0.18		0.10	pH	0	11-SEP-17	11-SEP-17	R3823927
Metals									
Arsenic (As)	9.49	+/-1.2		0.10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Cadmium (Cd)	0.133	+/-0.024		0.020	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Chromium (Cr)	47.3	+/-8.6		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Copper (Cu)	30.8	+/-4.6		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Lead (Pb)	16.5	+/-3.2		0.20	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Nickel (Ni)	45.0	+/-5.6		0.50	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Zinc (Zn)	85	+/-11		10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	9.8	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-4 PL4-HM-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:30									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	8.5	+/-1.3		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Available Phosphate-P	7.6	-		1.0	mg/kg	-	11-SEP-17	11-SEP-17	R3828856
Available Potassium	439	+/-55		20	mg/kg	-11.8%	12-SEP-17	12-SEP-17	R3827268
Mercury (Hg)	0.0418	+/-0.011		0.0050	mg/kg	0	14-SEP-17	15-SEP-17	R3829621
Total Nitrogen by LECO	0.212	+/-0.039		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
pH (1:2 soil:water)	7.44	+/-0.18		0.10	pH	0	11-SEP-17	11-SEP-17	R3823927
Metals									
Arsenic (As)	9.72	+/-1.2		0.10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Cadmium (Cd)	0.123	+/-0.022		0.020	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Chromium (Cr)	48.4	+/-8.8		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Copper (Cu)	32.4	+/-4.9		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Lead (Pb)	16.1	+/-3.1		0.20	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Nickel (Ni)	44.3	+/-5.6		0.50	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Zinc (Zn)	81	+/-10		10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	8.5	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-5 PL5-WC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:50									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	8.5	+/-1.3		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L1986233-5 PL5-WC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:50									
Matrix: SOIL									
Available Phosphate-P	3.5	-		1.0	mg/kg	-	11-SEP-17	11-SEP-17	R3828856
Available Potassium	380	+/-48		20	mg/kg	-11.8%	12-SEP-17	12-SEP-17	R3827268
Mercury (Hg)	0.0351	+/-0.0097		0.0050	mg/kg	0	14-SEP-17	15-SEP-17	R3829621
Total Nitrogen by LECO	0.201	+/-0.037		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
pH (1:2 soil:water)	7.66	+/-0.18		0.10	pH	0	11-SEP-17	11-SEP-17	R3823927
Metals									
Arsenic (As)	9.22	+/-1.2		0.10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Cadmium (Cd)	0.143	+/-0.026		0.020	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Chromium (Cr)	48.6	+/-8.8		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Copper (Cu)	31.2	+/-4.7		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Lead (Pb)	16.6	+/-3.2		0.20	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Nickel (Ni)	39.5	+/-5.0		0.50	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Zinc (Zn)	83	+/-11		10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	8.5	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-6 PL6-LC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 14:15									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	10.2	+/-1.6		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Available Phosphate-P	6.0	-		1.0	mg/kg	-	11-SEP-17	11-SEP-17	R3828856
Available Potassium	345	+/-44		20	mg/kg	-11.8%	12-SEP-17	12-SEP-17	R3827268
Mercury (Hg)	0.0367	+/-0.010		0.0050	mg/kg	0	14-SEP-17	15-SEP-17	R3829621
Total Nitrogen by LECO	0.219	+/-0.040		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
pH (1:2 soil:water)	7.54	+/-0.18		0.10	pH	0	11-SEP-17	11-SEP-17	R3823927
Metals									
Arsenic (As)	9.23	+/-1.2		0.10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Cadmium (Cd)	0.141	+/-0.025		0.020	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Chromium (Cr)	47.4	+/-8.6		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Copper (Cu)	31.5	+/-4.7		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Lead (Pb)	15.3	+/-3.0		0.20	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Nickel (Ni)	47.7	+/-6.0		0.50	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Zinc (Zn)	89	+/-11		10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	10.2	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-7 PL7-NC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 14:45									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	8.8	+/-1.4		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Available Phosphate-P	4.3	-		1.0	mg/kg	-	11-SEP-17	11-SEP-17	R3828856

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L1986233-7 PL7-NC-PRE (0-15CM)									
Sampled By: CLIENT on 05-SEP-17 @ 14:45									
Matrix: SOIL									
Available Potassium	474	+/-59	DLHC	40	mg/kg	-11.8%	12-SEP-17	12-SEP-17	R3827268
Mercury (Hg)	0.0299	+/-0.0086		0.0050	mg/kg	0	14-SEP-17	15-SEP-17	R3829621
Total Nitrogen by LECO	0.185	+/-0.035		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
pH (1:2 soil:water)	7.42	+/-0.18		0.10	pH	0	11-SEP-17	11-SEP-17	R3823927
Metals									
Arsenic (As)	5.89	+/-0.75		0.10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Cadmium (Cd)	0.096	+/-0.017		0.020	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Chromium (Cr)	34.5	+/-6.2		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Copper (Cu)	22.1	+/-3.3		1.0	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Lead (Pb)	13.3	+/-2.6		0.20	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Nickel (Ni)	37.6	+/-4.7		0.50	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Zinc (Zn)	63	+/-8		10	mg/kg	0	14-SEP-17	14-SEP-17	R3829093
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	8.8	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-8 PL1-TC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 12:30									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	7.9	+/-1.3		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Total Nitrogen by LECO	0.147	+/-0.029		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	7.9	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-9 PL2-SC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 12:50									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	6.6	+/-1.1		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Total Nitrogen by LECO	0.100	+/-0.022		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	6.6	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-10 PL3-PC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:00									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	7.2	+/-1.2		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Total Nitrogen by LECO	0.100	+/-0.022		0.020	%	0	13-SEP-17	13-SEP-17	R3828916

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Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L1986233-10 PL3-PC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:00									
Matrix: SOIL									
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	7.2	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-11 PL4-HM-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:30									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	5.6	+/-0.9		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Total Nitrogen by LECO	0.097	+/-0.021		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	5.6	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-12 PL5-WC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 13:50									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	5.0	+/-0.9		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Total Nitrogen by LECO	0.089	+/-0.020		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	5.0	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-13 PL6-LC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 14:15									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	6.0	+/-1.0		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497
Total Nitrogen by LECO	0.100	+/-0.022		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	6.0	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
L1986233-14 PL7-NC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 14:45									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	6.3	+/-1.0		1.0	mg/kg	0	09-SEP-17	09-SEP-17	R3824497

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L1986233-14 PL7-NC-PRE (15-60CM)									
Sampled By: CLIENT on 05-SEP-17 @ 14:45									
Matrix: SOIL									
Total Nitrogen by LECO	0.084	+/-0.019		0.020	%	0	13-SEP-17	13-SEP-17	R3828916
Total Available N & NO3-N, NO2-N & NH4									
Available Ammonium-N - Calculation									
Total Available Nitrogen	6.3	-		2.2	mg/kg	-		12-SEP-17	
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL									
Nitrite-N	<1.0	-		1.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131
Nitrate-N	<2.0	-		2.0	mg/kg	-	09-SEP-17	09-SEP-17	R3823131

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

Reference Information

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Internal Reference Material	Available Ammonium-N	DLHC	L1986233-1, -10, -11, -12, -13, -14, -2, -3, -4, -5, -6, -7, -8, -9

Sample Parameter Qualifier Key:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).

Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**
ETL-N-TOT-AVAIL-SK	Soil	Available Ammonium-N - Calculation		Soil Methods of Analysis (1993) CSSS
HG-200.2-CVAF-WP	Soil	Mercury in Soil by CVAFS		EPA 200.2/1631E (mod)
Soil samples are digested with nitric and hydrochloric acids, followed by analysis by CVAFS.				
K-AVAIL-SK	Soil	Available Potassium		Comm. Soil Sci. Plant, 25 (5&6)
Plant available potassium is extracted from the soil using Modified Kelowna solution. Potassium in the soil extract is determined by flame emission at 770 nm.				
MET-200.2-MS-WP	Soil	Metals		EPA 200.2/6020A
Samples for analysis are homogenized, dried at 60 degrees Celsius, sieved through a 2 mm (10 mesh) sieve, and a representative subsample of the dry material is weighed. The sample is then digested by block digester (EPA 200.2). Instrumental analysis is by inductively coupled plasma - mass spectrometry (EPA Method 6020A). Method Limitation: This method is not a total digestion technique. It is a very strong acid digestion that is intended to dissolve those metals that may become "environmentally available." By design, elements bound in silicate structures are not normally dissolved by this procedure as they are not usually mobile in the environment.				
N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method		CSSS (2008) 22.4
The sample is ignited in a combustion analyzer where nitrogen in the reduced nitrous oxide gas is determined using a thermal conductivity detector.				
N2/N3-AVAIL-KCL-SK	Soil	Nitrate, Nitrite & Nitrate+Nitrite-N(KCL		CSSS (1993) p. 26-28
Plant available nitrate and nitrite are extracted from the sample with 2N KCl. Nitrate and Nitrite in the filtered extract are determined colorimetrically by Technicon auto-analyzer or flow injection analyzer at 520 nm.				
NH4-AVAIL-SK	Soil	Available Ammonium-N		Comm Soil Sci 19(6)
Ammonium (NH4-N) is extracted from the soil using 2 N KCl. Ammonium in the extract is mixed with hypochlorite and salicylate to form indophenol blue, which is determined colorimetrically by auto analysis at 660 nm.				
PH-1:2-SK	Soil	pH (1:2 Soil:Water Extraction)		AB Ag (1988) p.7
1 part dry soil and 2 parts de-ionized water (by volume) is mixed. The slurry is allowed to stand with occasional stirring for 30 - 60 minutes. After equilibration, pH of the slurry is measured using a pH meter.				
PO4-AVAIL-OLSEN-SK	Soil	Available Phosphate-P by Olsen		CSSS (2008) 8.2
Plant available phosphorus is extracted from the sample with sodium bicarbonate. PO4-P in the filtered extract is determined colorimetrically at 880 nm.				

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

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

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

Chain of Custody Numbers:

Reference Information

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

Workorder: L1986233 Report Date: 15-SEP-17

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-CVAF-WP	**Soil**							
Batch R3829621								
WG2616176-4 CRM		**PACS-3**						
Mercury (Hg)			103.4		%		70-130	15-SEP-17
WG2616176-5 CRM		**CANMET TILL-1**						
Mercury (Hg)			0.0990		mg/kg		0.048-0.148	15-SEP-17
WG2616176-6 DUP		**L1986958-6**						
Mercury (Hg)		0.897	0.730		mg/kg	21	40	15-SEP-17
WG2616176-2 LCS								
Mercury (Hg)			99.3		%		80-120	15-SEP-17
WG2616176-1 MB								
Mercury (Hg)			<0.0050		mg/kg		0.005	15-SEP-17
K-AVAIL-SK	**Soil**							
Batch R3827268								
WG2611286-3 IRM		**FARM2005**						
Available Potassium			97.3		%		70-130	12-SEP-17
WG2611286-2 MB								
Available Potassium			<20		mg/kg		20	12-SEP-17
MET-200.2-MS-WP	**Soil**							
Batch R3829093								
WG2616165-4 CRM		**PACS-3**						
Arsenic (As)			98.1		%		70-130	14-SEP-17
Cadmium (Cd)			97.7		%		70-130	14-SEP-17
Chromium (Cr)			103.6		%		70-130	14-SEP-17
Copper (Cu)			100.7		%		70-130	14-SEP-17
Lead (Pb)			95.3		%		70-130	14-SEP-17
Nickel (Ni)			104.1		%		70-130	14-SEP-17
Zinc (Zn)			99.4		%		70-130	14-SEP-17
WG2616165-5 CRM		**CANMET TILL-1**						
Arsenic (As)			103.8		%		70-130	14-SEP-17
Cadmium (Cd)			105.3		%		70-130	14-SEP-17
Chromium (Cr)			103.4		%		70-130	14-SEP-17
Copper (Cu)			105.8		%		70-130	14-SEP-17
Lead (Pb)			106.9		%		70-130	14-SEP-17
Nickel (Ni)			104.8		%		70-130	14-SEP-17
Zinc (Zn)			102.4		%		70-130	14-SEP-17
WG2616165-7 DUP		**WG2616165-6**						
Arsenic (As)		4.53	4.80		mg/kg	5.7	30	14-SEP-17

Quality Control Report

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-MS-WP	**Soil**							
Batch R3829093								
WG2616165-7 DUP		**WG2616165-6**						
Cadmium (Cd)		0.296	0.308		mg/kg	4.1	30	14-SEP-17
Chromium (Cr)		48.7	49.1		mg/kg	0.8	30	14-SEP-17
Copper (Cu)		26.5	27.4		mg/kg	3.4	30	14-SEP-17
Lead (Pb)		16.0	15.9		mg/kg	0.5	40	14-SEP-17
Nickel (Ni)		31.1	31.9		mg/kg	2.7	30	14-SEP-17
Zinc (Zn)		85	87		mg/kg	2.9	30	14-SEP-17
WG2616165-2 LCS								
Arsenic (As)			106.3		%		80-120	14-SEP-17
Cadmium (Cd)			101.5		%		80-120	14-SEP-17
Chromium (Cr)			104.4		%		80-120	14-SEP-17
Copper (Cu)			99.5		%		80-120	14-SEP-17
Lead (Pb)			102.4		%		80-120	14-SEP-17
Nickel (Ni)			100.9		%		80-120	14-SEP-17
Zinc (Zn)			99.1		%		80-120	14-SEP-17
WG2616165-1 MB								
Arsenic (As)			<0.10		mg/kg		0.1	14-SEP-17
Cadmium (Cd)			<0.020		mg/kg		0.02	14-SEP-17
Chromium (Cr)			<1.0		mg/kg		1	14-SEP-17
Copper (Cu)			<1.0		mg/kg		1	14-SEP-17
Lead (Pb)			<0.20		mg/kg		0.2	14-SEP-17
Nickel (Ni)			<0.50		mg/kg		0.5	14-SEP-17
Zinc (Zn)			<10		mg/kg		10	14-SEP-17
N-TOT-LECO-SK	**Soil**							
Batch R3828916								
WG2611863-1 DUP		**L1986958-1**						
Total Nitrogen by LECO		8.69	8.57		%	1.3	20	13-SEP-17
WG2611863-2 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			0.096		%		0.085-0.135	13-SEP-17
WG2611863-3 MB								
Total Nitrogen by LECO			<0.020		%		0.02	13-SEP-17
N2/N3-AVAIL-KCL-SK	**Soil**							
Batch R3823131								
WG2611266-1 DUP		**L1986233-8**						
Nitrite-N		<1.0	<1.0	RPD-NA	mg/kg	N/A	30	09-SEP-17

Quality Control Report

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N2/N3-AVAIL-KCL-SK	**Soil**							
Batch R3823131								
WG2611266-1 DUP		**L1986233-8**						
Nitrate+Nitrite-N		<2.0	<2.0	RPD-NA	mg/kg	N/A	30	09-SEP-17
WG2611266-4 IRM		**SAL814**						
Nitrate+Nitrite-N			107.5		%		70-130	09-SEP-17
WG2611266-2 MB								
Nitrite-N			<1.0		mg/kg		1	09-SEP-17
Nitrate+Nitrite-N			<2.0		mg/kg		2	09-SEP-17
NH4-AVAIL-SK	**Soil**							
Batch R3824497								
WG2611271-1 DUP		**L1986233-14**						
Available Ammonium-N		6.3	6.1		mg/kg	3.1	20	09-SEP-17
WG2611271-3 IRM		**SAL814**						
Available Ammonium-N			109.1		%		70-130	09-SEP-17
WG2611271-2 MB								
Available Ammonium-N			<1.0		mg/kg		1	09-SEP-17
PH-1:2-SK	**Soil**							
Batch R3823927								
WG2611284-1 DUP		**L1986233-3**						
pH (1:2 soil:water)		6.80	6.83	J	pH	0.03	3	11-SEP-17
WG2611284-3 IRM		**SAL814**						
pH (1:2 soil:water)			7.85		pH		7.65-8.25	11-SEP-17
PO4-AVAIL-OLSEN-SK	**Soil**							
Batch R3828856								
WG2611283-1 DUP		**L1986233-4**						
Available Phosphate-P		7.6	7.6		mg/kg	0.8	30	11-SEP-17
WG2611283-3 IRM		**FARM2005**						
Available Phosphate-P			102.3		%		80-120	11-SEP-17
WG2611283-2 MB								
Available Phosphate-P			<1.0		mg/kg		1	11-SEP-17

Quality Control Report

Workorder: L1986233 Report Date: 15-SEP-17

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

Legend:

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

Sample Parameter Qualifier Definitions:

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

Quality Control Report

Workorder: L1986233 Report Date: 15-SEP-17

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

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Plant Available Nutrients							
Nitrate, Nitrite & Nitrate+Nitrite-N(KCL							
	1	05-SEP-17 12:30	09-SEP-17 13:55	3	4	days	EHT
	2	05-SEP-17 12:50	09-SEP-17 13:55	3	4	days	EHT
	3	05-SEP-17 13:00	09-SEP-17 13:55	3	4	days	EHT
	4	05-SEP-17 13:30	09-SEP-17 13:55	3	4	days	EHT
	5	05-SEP-17 13:50	09-SEP-17 13:55	3	4	days	EHT
	6	05-SEP-17 14:15	09-SEP-17 13:55	3	4	days	EHT
	7	05-SEP-17 14:45	09-SEP-17 13:55	3	4	days	EHT
	8	05-SEP-17 12:30	09-SEP-17 13:55	3	4	days	EHT
	9	05-SEP-17 12:50	09-SEP-17 13:55	3	4	days	EHT
	10	05-SEP-17 13:00	09-SEP-17 13:55	3	4	days	EHT
	11	05-SEP-17 13:30	09-SEP-17 13:55	3	4	days	EHT
	12	05-SEP-17 13:50	09-SEP-17 13:55	3	4	days	EHT
	13	05-SEP-17 14:15	09-SEP-17 13:55	3	4	days	EHT
	14	05-SEP-17 14:45	09-SEP-17 13:55	3	4	days	EHT

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L1986233 were received on 06-SEP-17 08:10.

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

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

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

Chain of Custody (COC) / Analytical Request Form

ALS Environmental
www.alsglobal.com

Canada Toll Free: 1 800 668 9878

L1986233-COFC

COC Number: 14 -

Page 1 of 2

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

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

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q63821	Approver ID:	Cost Center:
Job #:	17M-00008-00	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only): L1986233 **ALS Contact:** **Sampler:**

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	pH, EC (2:1)	PO4-Avail-Olsen-SK	N2/N3 Avail	N-Tot-LECO	Ammonia-nitrogen	K-Avail	Metals-200.2 MS-WP (As, Cd, Cr, Cu, Ni, P	Total Phosphorus	HG-200.2 CVAF	Number of Containers
1	PL1-TC-Pre (0-15cm) PL1 0-15	05-Sep-19	12:30	Soil	X	X	X	X	X	X	X	X	X	2
2	PL2-SC-Pre(0-15cm) PL2 0-15		12:50	Soil	X	X	X	X	X	X	X	X	X	2
3	PL3-PC-Pre(0-15cm) PL3 0-15		13:00	Soil	X	X	X	X	X	X	X	X	X	2
4	PL4-HM-Pre(0-15cm) PL4 0-15		13:30	Soil	X	X	X	X	X	X	X	X	X	2
5	PL5-WC-Pre(0-15cm) PL5 0-15		13:50	Soil	X	X	X	X	X	X	X	X	X	2
6	PL6-LC-Pre(0-15cm) PL6 0-15		14:15	Soil	X	X	X	X	X	X	X	X	X	2
7	PL7-NC-Pre(0-15cm) PL7 0-15		14:45	Soil	X	X	X	X	X	X	X	X	X	2

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

SAMPLE CONDITION AS RECEIVED (lab use only)

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

INITIAL COOLER TEMPERATURES °C		FINAL COOLER TEMPERATURES °C	
4.4			

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	29-Aug-19	8:05	DRI	6-9-19	8:10			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-03766 v09 Front004 January 2014

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

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

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L1986233-COFC

COC Number: 14 -

Page 2 of 2

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

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

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q63821	Approver ID:	Cost Center:
Job #:	17M-00008-00	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only): L1986233 | **ALS Contact:** | **Sampler:**

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

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	N2/N3 Avail	N-Tot-LECO	Ammonia-nitrogen	Number of Containers
8	PL1-TC-Pre (15-60cm) PL1 15-60	05-Sep-17	12:30	Soil	X	X	X	1
9	PL2-SC-Pre(15-60cm) PL2 15-60		12:50	Soil	X	X	X	1
10	PL3-PC-Pre(15-60cm) PL3 15-60		13:00	Soil	X	X	X	1
11	PL4-HM-Pre(15-60cm) PL4 15-60		13:30	Soil	X	X	X	1
12	PL5-WC-Pre(15-60cm) PL5 15-60		13:50	Soil	X	X	X	1
13	PL6-LC-Pre(15-60cm) PL6 15-60		14:15	Soil	X	X	X	1
14	PL7-NC-Pre(15-60cm) PL7 15-60		14:45	Soil	X	X	X	1

Drinking Water (DW) Samples[1] (client use)

Are samples taken from a Regulated DW System? ☐ Yes ☐ No

Are samples for human drinking water use? ☐ Yes ☐ No

Special Instructions / Specify Criteria to add on report (client Use)

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations Yes ☐ No ☐

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

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
4.4					

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Brian Nioms	Date: 2017-09-06	Time: 8:05	Received by: DRI	Date: 6-9-17	Time: 8:10	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

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

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

WSP Canada Group Limited
ATTN: BRIAN MOONS
1600 Buffalo Place
Winnipeg MB R3T 6B8

Date Received: 03-NOV-17
Report Date: 15-NOV-17 15:07 (MT)
Version: FINAL

Client Phone: 204-477-6650

Certificate of Analysis

Lab Work Order #: L2018054

Project P.O. #: 17M-00008-00/PLT/EXP
Job Reference: 17M-00008-00/PLT/EXP
C of C Numbers:
Legal Site Desc:

Comments: ADDITIONAL 14-NOV-17 14:10

Hua Wo
Chemistry Laboratory Manager

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2018054-1 PL1 15-60									
Sampled By: BM on 03-NOV-17 @ 13:45									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	7.4	+/-1.2		1.0	mg/kg	0	15-NOV-17	15-NOV-17	R3885626
Total Nitrogen by LECO	0.142	+/-0.028		0.020	%	0	09-NOV-17	09-NOV-17	R3880461
Nitrate, Nitrite and Nitrate+Nitrite-N									
Nitrite-N	<0.40	-		0.40	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
Nitrate-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
L2018054-2 PL2 15-60									
Sampled By: BM on 03-NOV-17 @ 14:00									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	8.4	+/-1.3		1.0	mg/kg	0	15-NOV-17	15-NOV-17	R3885626
Total Nitrogen by LECO	0.116	+/-0.024		0.020	%	0	09-NOV-17	09-NOV-17	R3880461
Nitrate, Nitrite and Nitrate+Nitrite-N									
Nitrite-N	0.96	+/-0.25		0.40	mg/kg	0	10-NOV-17	10-NOV-17	R3884613
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
Nitrate-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
L2018054-3 PL3 15-60									
Sampled By: BM on 03-NOV-17 @ 14:15									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	10.3	+/-1.6		1.0	mg/kg	0	15-NOV-17	15-NOV-17	R3885626
Total Nitrogen by LECO	0.114	+/-0.024		0.020	%	0	09-NOV-17	09-NOV-17	R3880461
Nitrate, Nitrite and Nitrate+Nitrite-N									
Nitrite-N	0.67	+/-0.20		0.40	mg/kg	0	10-NOV-17	10-NOV-17	R3884613
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
Nitrate-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
L2018054-4 PL4 15-60									
Sampled By: BM on 03-NOV-17 @ 14:30									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	9.7	+/-1.5		1.0	mg/kg	0	15-NOV-17	15-NOV-17	R3885626
Total Nitrogen by LECO	0.104	+/-0.022		0.020	%	0	09-NOV-17	09-NOV-17	R3880461
Nitrate, Nitrite and Nitrate+Nitrite-N									
Nitrite-N	0.77	+/-0.22		0.40	mg/kg	0	10-NOV-17	10-NOV-17	R3884613
Nitrate+Nitrite-N	2.3	+/-1.4		2.0	mg/kg	0	10-NOV-17	10-NOV-17	R3884613
Nitrate-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
L2018054-5 PL5 15-60									
Sampled By: BM on 03-NOV-17 @ 14:45									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	8.8	+/-1.4		1.0	mg/kg	0	15-NOV-17	15-NOV-17	R3885626
Total Nitrogen by LECO	0.132	+/-0.026		0.020	%	0	09-NOV-17	09-NOV-17	R3880468
Nitrate, Nitrite and Nitrate+Nitrite-N									
Nitrite-N	0.72	+/-0.21		0.40	mg/kg	0	10-NOV-17	10-NOV-17	R3884613
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
Nitrate-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
L2018054-6 PL6 15-60									
Sampled By: BM on 03-NOV-17 @ 15:00									
Matrix: SOIL									

ALS ENVIRONMENTAL ANALYTICAL REPORT

Sample Details/Parameters	Result	MU	Qualifier*	D.L.	Units	Bias	Extracted	Analyzed	Batch
L2018054-6 PL6 15-60									
Sampled By: BM on 03-NOV-17 @ 15:00									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	8.9	+/-1.4		1.0	mg/kg	0	15-NOV-17	15-NOV-17	R3885626
Total Nitrogen by LECO	0.134	+/-0.027		0.020	%	0	09-NOV-17	09-NOV-17	R3880468
Nitrate, Nitrite and Nitrate+Nitrite-N									
Nitrite-N	0.67	+/-0.20		0.40	mg/kg	0	10-NOV-17	10-NOV-17	R3884613
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
Nitrate-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
L2018054-7 PL7 15-60									
Sampled By: BM on 03-NOV-17 @ 15:15									
Matrix: SOIL									
Miscellaneous Parameters									
Available Ammonium-N	10.9	+/-1.7		1.0	mg/kg	0	15-NOV-17	15-NOV-17	R3885626
Total Nitrogen by LECO	0.141	+/-0.028		0.020	%	0	09-NOV-17	09-NOV-17	R3880468
Nitrate, Nitrite and Nitrate+Nitrite-N									
Nitrite-N	0.60	+/-0.19		0.40	mg/kg	0	10-NOV-17	10-NOV-17	R3884613
Nitrate+Nitrite-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613
Nitrate-N	<2.0	-		2.0	mg/kg	-	10-NOV-17	10-NOV-17	R3884613

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

Reference Information

Report Comments: ADDITIONAL 14-NOV-17 14:10

QC Samples with Qualifiers & Comments:

QC Type Description	Parameter	Qualifier	Applies to Sample Number(s)
Internal Reference Material	Available Ammonium-N	DLHC	L2018054-1, -2, -3, -4, -5, -6, -7

Test Method References:

ALS Test Code	Matrix	Test Description	Preparation Method Reference	Method Reference**
N-TOT-LECO-SK	Soil	Total Nitrogen by combustion method		CSSS (2008) 22.4

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

N2/N3-AVAIL-SK	Soil	Nitrate, Nitrite and Nitrate+Nitrite-N		APHA 4500 NO3F

Available Nitrate and Nitrite are extracted from the soil using a dilute calcium chloride solution. Nitrate plus Nitrite is quantitatively reduced to nitrite by passage of the sample through a copperized cadmium column. The nitrite (reduced nitrate plus original nitrite) is then determined by diazotizing with sulfanilamide followed by coupling with N-(1-naphthyl) ethylenediamine dihydrochloride. The resulting water soluble dye has a magenta color which is measured at colorimetrically at 520nm. Nitrite is determined on the same extract by following the same instrumental procedure without a cadmium column.
Reference: Recommended Methods of Soil Analysis for Canadian Prairie Agricultural Soils. Alberta Agriculture (1988) p. 19 and 28

NH4-AVAIL-SK	Soil	Available Ammonium-N		Comm Soil Sci 19(6)

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

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

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

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

Chain of Custody Numbers:

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOT-LECO-SK	**Soil**							
Batch R3880461								
WG2659491-1 DUP		**L2018561-10**						
Total Nitrogen by LECO		<0.020	<0.020	RPD-NA	%	N/A	20	09-NOV-17
WG2659491-2 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			0.102		%		0.085-0.135	09-NOV-17
WG2659491-3 MB								
Total Nitrogen by LECO			<0.020		%		0.02	09-NOV-17
Batch R3880468								
WG2658380-1 DUP		**L2019029-1**						
Total Nitrogen by LECO		8.70	8.73		%	0.3	20	09-NOV-17
WG2658380-2 IRM		**08-109_SOIL**						
Total Nitrogen by LECO			0.110		%		0.085-0.135	09-NOV-17
WG2658380-4 MB								
Total Nitrogen by LECO			<0.020		%		0.02	09-NOV-17
N2/N3-AVAIL-SK	**Soil**							
Batch R3884613								
WG2660862-1 DUP		**L2018054-4**						
Nitrite-N		0.77	0.62		mg/kg	23	50	10-NOV-17
Nitrate+Nitrite-N		2.3	<2.0	RPD-NA	mg/kg	N/A	30	10-NOV-17
WG2660862-3 IRM		**SAL814**						
Nitrate+Nitrite-N			113.9		%		70-130	10-NOV-17
WG2660862-2 MB								
Nitrite-N			<0.40		mg/kg		0.4	10-NOV-17
Nitrate+Nitrite-N			<2.0		mg/kg		2	10-NOV-17
NH4-AVAIL-SK	**Soil**							
Batch R3885626								
WG2663535-4 DUP		**L2018054-7**						
Available Ammonium-N		10.9	10.8		mg/kg	1.0	20	15-NOV-17
WG2663535-6 IRM		**SAL814**						
Available Ammonium-N			80.8		%		70-130	15-NOV-17
WG2663535-5 MB								
Available Ammonium-N			<1.0		mg/kg		1	15-NOV-17

Quality Control Report

Workorder: L2018054 Report Date: 15-NOV-17

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

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
DLHC	Detection Limit Raised: Dilution required due to high concentration of test analyte(s).
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Workorder: L2018054 Report Date: 15-NOV-17

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

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Plant Available Nutrients							
Nitrate, Nitrite and Nitrate+Nitrite-N							
	1	03-NOV-17 13:45	10-NOV-17 17:55	3	7	days	EHT
	2	03-NOV-17 14:00	10-NOV-17 17:55	3	7	days	EHT
	3	03-NOV-17 14:15	10-NOV-17 17:55	3	7	days	EHT
	4	03-NOV-17 14:30	10-NOV-17 17:55	3	7	days	EHT
	5	03-NOV-17 14:45	10-NOV-17 17:55	3	7	days	EHT
	6	03-NOV-17 15:00	10-NOV-17 17:55	3	7	days	EHT
	7	03-NOV-17 15:15	10-NOV-17 17:55	3	7	days	EHT

Legend & Qualifier Definitions:

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

Notes*:
Where actual sampling date is not provided to ALS, the date (& time) of receipt is used for calculation purposes.
Where actual sampling time is not provided to ALS, the earlier of 12 noon on the sampling date or the time (& date) of receipt is used for calculation purposes. Samples for L2018054 were received on 03-NOV-17 16:00.

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

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

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

ALS Environmental

www.alsglobal.com

Chain of Custody (COC) / Request For

Canada Toll Free: 1 80

L2018054-COFC

label here

COC Number: 14 -

Page 1 of 1

L2018054

03-Nov-17

Report To			
Company:	WSP Group Canada Limited	Select Report Format: ☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Contact:	Brian Moons	Quality Control (QC) Report with Report ☐ Yes ☑ No	R ☑ Regular (Standard TAT if received by 3 pm - business days)
Address:	1600 Buffalo Place	☐ Criteria on Report - provide details below if box checked	P ☐ Priority (2-4 bus. days if received by 3pm) 50% surcharge - contact ALS to confirm TAT
		Select Distribution: ☑ EMAIL ☐ MAIL ☐ FAX	E ☐ Emergency (1-2 bus. days if received by 3pm) 100% surcharge - contact ALS to confirm TAT
Phone:	204-477-6650	Email 1 or Fax brian.moons@wsp.com	E2 ☐ Same day or weekend emergency - contact ALS to confirm TAT and surcharge
		Email 2 darren.keam@wsp.com	Specify Date Required for E2,E or P:

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

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q63821	Approver ID:	Cost Center:
Job #:	17M-00008-00 | PLT | EXP	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only)	ALS Contact: Judy D	Sampler: Brian Moons

ALS Sample # (lab use only)	Sample Identification and/or Coordinates (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	N2/N3 Avail	N-Tot-LECO	Ammonia nitrogen	Number of Containers
	PL1 15-60	03-Nov-17	13:45	Soil	R	R	R	1
	PL2 15-60	03-Nov-17	14:00	Soil	R	R	R	1
	PL3 15-60	03-Nov-17	14:15	Soil	R	R	R	1
	PL4 15-60	03-Nov-17	14:30	Soil	R	R	R	1
	PL5 15-60	03-Nov-17	14:45	Soil	R	R	R	1
	PL6 15-60	03-Nov-17	15:00	Soil	R	R	R	1
	PL7 15-60	03-Nov-17	15:15	Soil	R	R	R	1

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

SAMPLE CONDITION AS RECEIVED (lab use only)

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

INITIAL COOLER TEMPERATURES °C			FINAL COOLER TEMPERATURES °C		
			3.6		

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by:	Date:	Time:	Received by:	Date:	Time:	Received by:	Date:	Time:
	2017/11/03	16:05		03-Nov-17	4:25			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326e v09 Front/04 January 2014

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

APPENDIX

E STANDARD LIMITATIONS

STANDARD LIMITATIONS
ENVIRONMENTAL INVESTIGATIONS and CHARACTERIZATION PROGRAMS

These Standard Limitations form part of the Report to which they are appended and any use of the Report is subject to them.

1. Exclusive Use By Client

This Report was prepared for the exclusive use of the client identified as the intended recipient. Any use of the Report by any other party without the written consent of WSP Canada Group Limited is the sole responsibility of such party. WSP Canada Group Limited accepts no responsibility for damages that may be suffered by any third party as a result of decisions made or actions taken based on the Report.

2. Scope, Terms and Conditions of Contract

The observations and investigations (hereinafter referred to as the "Work") upon which this Report is based were carried out in accordance with the scope, terms and conditions of the contract or the proposal pursuant to which the Work was commissioned. The conclusions presented in the Report are based solely upon the scope of services described in the contract or the proposal and governed by the time and budgetary constraints imposed by them.

3. Standard of Care

The principles, procedures and standards relevant to the nature of the services performed are not universally the same. The Work has been carried out in accordance with generally accepted environmental study and/or professional practices, industry standards and environmental regulations, where applicable. No other warranties are either expressed or implied with respect to the professional services provided under the terms of the contract or the proposal and represented in this Report.

4. Scope of the Work

This Report may be based in part on information obtained at discrete sampling and/or monitoring locations. The conditions reported herein were those encountered at the subject property at the time the Work was performed and as present at the discrete sampling/monitoring locations, if any. Conditions between sampling/monitoring locations may be different than those encountered at the sampling/monitoring locations and WSP Canada Group Limited is not responsible for such differences.

5. Reasonable Conclusions

The conclusions contained in this Report are based on the Work and may also consider a review of information from other sources as identified in the Report. The accuracy of information from other sources was not verified unless specifically noted in the Report, nor was it determined if the reviewed information constituted all information that exists and pertains to the subject property.

The conclusions made are based on reasonable and professional interpretation of the information considered. If additional information concerning conditions of relevance to this Report is obtained during future work at the subject property, WSP Canada Group Limited should be notified in order that we may determine if modifications to the conclusions presented in this Report are necessary.

6. Report as a Complete Document

This Report must be read as a whole and sections taken out of context may be misleading. If discrepancies occur between the preliminary (draft) and final versions of the Report, the final version of the report shall take precedence.

7. Limits of Liability

WSP Canada Group Limited's liability with respect to the Work is limited to re-performing, without cost, any part of the Work that is unacceptable solely as a result of failure to comply with industry standards. WSP Canada Group Limited's maximum liability is limited in accordance with terms in the original contract, provided that notice of claim is made within regulated timelines as of the date of delivery of the Report.