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CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY LONG-TERM MONITORING PROGRAM
2018 PROGRAM A – ANNUAL REPORT
DELIVERABLE D6

FINAL – REV 0

KGS Group 16-0300-002
December 2018

PROVINCE OF MANITOBA
M.A.F. HAMM
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REGISTERED PROFESSIONAL GEOSCIENTIST

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Science | Imagination | Collaboration

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December 20, 2018 File No: 16-0300-002

Manitoba Infrastructure
2nd Floor - 280 Broadway
Winnipeg, Manitoba
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ATTENTION: Mr. Paul Graveline
Project Manager

RE: Red River Floodway Long-Term Monitoring Program
2018 Program A – Annual Report, Final Rev 0

Dear Mr. Graveline:

KGS Group is pleased to provide two (2) paper copies and electronic copies on DVD of the 2018 Program A – Annual Report Rev 0, which is part of the Red River Floodway Long-Term Monitoring Program. This report summarizes activities for 2018.

We appreciate the opportunity to provide on-going services to Manitoba Infrastructure.

Sincerely,

J. Bert Smith, P.Eng.
Principal

MFH/jr
Enclosure

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1.0 INTRODUCTION

1.1 ENVIRONMENT ACT LICENCE REQUIREMENTS

This 2018 Program A Annual Report is submitted in response to the requirements for annual monitoring in accordance with Clause 27 and Clause 30 of Environmental Licence No. 2691 dated July 8, 2005 and described in the Manitoba Floodway Authority memorandum HM72 Rev 1 Post-construction and Long-term Monitoring Program, issued April 2013. Revisions to the Long-term Monitoring Program were given in HM99, the 2013 to 2014 Post-construction Monitoring Program Comprehensive Annual Report February 2015. Background information and historic data that are not included in this report can be found in the annual groundwater Monitoring Data Analysis Reports 2005 through 2017. There was no monitoring program in 2012.

1.2 SCOPE OF WORK

The objectives of the project are to carry out long-term monitoring, testing and reporting on groundwater conditions within and adjacent to the Red River Floodway (Floodway) in accordance with the Provincial commitment to flood protection and as required under the Red River Floodway's Operating License (Environment Act License No. 2691). The original work program, overseen through Manitoba Infrastructure (MI) included a monitoring period from spring 2016 through fall 2018, outlined in KGS Group proposal 15-000-1555. In March 2018 MI approved a three year extension to the work with a revised budget and work plan for 2018 as well as 2019 through 2021. The Project Scope of Work includes the following annual activities:

- Spring and Summer Flood Monitoring Program A (or B if required);
- Inspection of Treated Groundwater Springs;
- Annual Well Disinfection, Inspection/Maintenance/Repair Programs and Channel Inspections;
- Reporting.

Previous deliverables for the current MI work program included:

- Deliverable D1 Red River Floodway Long-Term Monitoring Program 2017 Program A-Annual Report Deliverable D1.
- Deliverable D2 Red River Floodway Long-Term Monitoring Program 2016 Annual Inspection and Maintenance Report- Deliverable D2.
- Deliverable D3 Red River Floodway Long-Term Monitoring Program Deliverable D3-2017 Program A-Task 14 Notification Report 01.
- Deliverable D4 Red River Floodway Long-Term Monitoring Program 2017 Program A-Annual Report Deliverable D4.
- Deliverable D5 Red River Floodway Long-Term Monitoring Program 2017 Annual Inspection and Maintenance Report- Deliverable D5.

This report (Deliverable D6) contains reporting for Program A Annual Report (Task 1), which also includes the inspection of treated groundwater springs and the annual well disinfection. In 2017 MI approved a scope change for the spring inspections and channel bottom survey to be conducted by boat in the Low Flow Channel at the same time. The 2018 Annual Inspection and Maintenance Report (Task 2) was submitted as Deliverable D7. Tables and Figures are labelled using the deliverable numbers to create unique products. For example, Appendix D6-A indicates Appendix A of the Deliverable D6 report.

In 2018, the Red River Floodway was not operated, nor was there any Red River flow into the Floodway Channel. The requirements for Long-term Monitoring Program A (Task 1) (as outlined in proposal 15-000-1555) were initiated in Spring 2018. This included sampling of 5 instrumented wells for inorganic parameters and bacteria two times: at the peak flow of the Red River at the Inlet Control Structure; and post-melt (several weeks after peak flow) along with sampling of 7 additional core monitoring wells once during the peak flow of the Red River. Sampling of surface water is required once at two locations (PTH 59N Bridge and PTH 44 Bridge) during the peak flow in the Red River; however an additional sample was taken after the melt to help interpret the post-melt groundwater data.

In addition to the Spring Flood Monitoring Program A (Task 1) in 2018, KGS Group conducted an inspection of treated groundwater springs and an annual well disinfection program as described in this report. The 2018 Annual Inspection and Maintenance Report (Deliverable D7)

has been submitted separately and also includes a discussion of the channel bottom inspection, which was conducted at the same time as the springs inspection.

The Red River peaked on May 1, 2018 at Station G05OC021 (Red River above the Floodway Control Structure) at El. 227.913 m as discussed in Section 3.0.

The detailed 2018 program was as follows:

- Pre-melt monitoring was conducted on March 28 to 30, 2018 before the rise in the Red River.
- Spring melt monitoring was conducted on April 30 to May 1, 2018.
- Surface water monitoring at locations near the PTH 44 Bridge and PTH 59N Bridge was conducted from April 30, 2018 to May 1, 2018 and Post-melt surface water monitoring was conducted on June 7, 2018.
- Post-melt groundwater monitoring was conducted on June 7, 2018.
- Annual groundwater springs inspection and channel bottom inspection was conducted on August 28 and 29, 2018.
- Annual well disinfection program was conducted on October 19, 2018.

The 2018 program represents the fourth year of the Long-term Monitoring Program, and the third year falling under MI direction. The 2018 Long-term Monitoring Program used monitoring wells designated in the monitoring program for Program A Task 1 as shown on Figure D6-1.

1.3 AQUIFER CHARACTERIZATION

The carbonate aquifer found along the Floodway Channel is part of a regional groundwater flow system from eastern Manitoba. The confined carbonate bedrock aquifer has natural variations in water quality, with the conductivity ranging from moderate to high (1,000 to 2,000 µS/cm). Conductivity is a measure of dissolved solids, such as calcium, magnesium, chloride, sodium and sulphate. Near the Floodway Inlet, local mixing with saline groundwater found west of the Red River, results in higher conductivity groundwater (greater than 3,000 µS/cm) with increased chloride and sodium.

Lower conductivity values are found in the bedrock aquifer where it is influenced by the Birds Hill surficial granular aquifer, from CPR Keewatin Bridge to Church Road. The Birds Hill sand and gravel surficial aquifer is a local unconfined aquifer near PTH 59N Bridge. The bedrock aquifer beneath and surrounding the Birds Hill deposit has lower groundwater conductivity due to the freshwater recharge through the sand and gravel.

Natural variations in groundwater quality by location and with the seasons must be considered when the baseline and ongoing water quality results are evaluated during construction activities and Floodway operation events. One way to detect whether there is surface water intrusion into the groundwater aquifer is to monitor an indicator parameter such as conductivity which, along with other major ions, can be used to evaluate this contrast. In the vicinity of the Birds Hill sand and gravel surficial aquifer, recharge from precipitation results in groundwater with lower conductivity (500 µS/cm to 1,000 µS/cm) than is found in other areas of the carbonate aquifer.

The intrusion of surface water into the groundwater is most readily detected when there is a contrast between the chemistry of the samples. Most groundwater conductivity values were found to be greater than surface water conductivity values measured during annual spring Floodway operation. Red River conductivity values are historically lowest during spring Floodway operation events, such as in the spring of 2005, 2006, 2007, 2009, 2010, 2011, 2013, 2014 and 2017, which were measured in previous programs. In this situation, groundwater conductivity would be expected to decrease, if surface water intruded.

During summer Floodway operation in 2005, summer Floodway use in 2007, and summer Floodway operation in 2010 and 2011, conductivity values of surface water from the Red River diverted in the Floodway were slightly higher than in the spring, and higher than the natural groundwater conductivity levels in some areas near the CPR Keewatin Bridge, PTH 59N Bridge and Church Road. These areas have naturally low groundwater conductivity in the bedrock aquifer. Floodway Channel surface water conductivity was also higher during the summer precipitation events in June 2008, than during the spring melt, with no Floodway operation in April 2008. An increase in groundwater conductivity might occur in summer, if surface water intrudes into the groundwater at this time.

In the spring 2015 flood, one time sampling in the Floodway Channel during the spring melt on April 6, 2015 (no Floodway flow or Floodway operation) showed that the conductivity of the local surface water in the Floodway Channel was low in April, and increased in May as the surface water input decreased and the groundwater base flow became a greater percentage of the flow system.

In the spring of 2016, the conductivity during the spring melt on March 28 to 30, 2016 (no Floodway flow or Floodway operation) showed a low conductivity for the local surface water in the Floodway channel. An increase was seen in June 2016 as the percentage of groundwater base flow increased.

2.0 METHODOLOGY

2.1 SURFACE WATER

Surface water samples in 2018 were taken in the Floodway Channel at the PTH 44 and PTH 59 Bridges. Grab samples were collected from the channel. Samples were taken directly into sample bottles attached to an extension pole. KGS Group recorded field parameters (dissolved oxygen, specific conductivity, temperature and pH) using the YSI Pro meter. Results for the field parameters are shown in Table D6-1. Laboratory analysis data are shown in Table D6-2 and Table D6-3. Original laboratory reports are given in Appendix D6-E. Laboratory results are given in mg/L unless indicated otherwise.

2.2 WELL PUMPING METHOD MODIFICATIONS

In 2018, monitoring wells were purged using a combination of small diameter submersible pumps (either dedicated to the well or portable) and dedicated inertial pumps (Waterra tubing with foot valves). Monitoring wells K13-12321, K09-12012, K11-12014 and K11-12015 contain Waterra tubing. Monitoring well K09-12316 contains a dedicated inertial pump. These pumps were initially intended to be long term monitors; however, they have not functioned long term and have been replaced with Waterra tubing.

After the well disinfection program on October 19, 2018, as approved by MI, the remaining dedicated well pump was removed for inside storage at KGS Group over the winter, to protect against long-term precipitation of carbonate groundwater within the pump during submergence over the winter months, prior to the next spring pre-melt event.

2.3 GROUNDWATER

Monitoring well groundwater samples were taken from the 5 instrumented wells (of 12 total monitoring wells) on March 28 to 30, 2018. Subsequently all 12 monitoring wells were sampled on April 30 to May 2, 2018. The 5 instrumented wells sampled in March were also sampled on June 7, 2018. All monitoring wells were located within the Floodway Right-of-Way. One of the monitoring wells sampled is a water supply well for Inlet Control Structure (G05OC006). Water

samples are taken from an inside tap, however the water is not used for drinking. Well locations are shown on Figure D6-1. Monitoring wells are not used for drinking water supply.

In order to ensure groundwater samples were representative of the natural formation water, the monitoring wells were purged a minimum of three (3) well volumes, or until groundwater parameters (conductivity and temperature) stabilized. Field measurements were taken at the start of purging and at set intervals of 5 to 10 minutes. Stable groundwater parameters were achieved at all sample locations within 20 minutes.

Field measurements for pH, conductivity and dissolved oxygen were taken during each sampling period. Groundwater samples were stored in a cooler chest at 4°C for transport to the laboratory. The samples were analyzed at ALS Laboratory in Winnipeg, Manitoba. Metal samples were filtered and acidified in the laboratory, since iron and manganese were not analyzed.

Results for the field parameters are shown in Table D6-1. Laboratory analysis data are shown in Table D6-2 and Table D6-3. Original laboratory reports are given in Appendix D6-E. Laboratory results are given in mg/L, unless otherwise noted.

2.4 TRANSDUCER GROUNDWATER LEVEL AND QUALITY PROGRAM

Continuous measurements of groundwater elevation and temperature were collected from the previous December 2017 download, to October 2018 in the 5 instrumented monitoring wells. Transducers were installed at depth so that the tips were in the open bedrock or screened zone. Transducers and pumps installed in these monitoring wells are owned by MI. Transducer results are shown in Appendix D6-B. Historical transducer data (prior to 2016), reported in the most recent previous Red River Floodway 2015 Long-term Monitoring Program Report (HM101) is compiled in Appendix D6-C. Transducer monitoring in spring 7A1 (Kildare) is discussed in Section 6.0.

2.5 WELL DISINFECTION PROGRAM

The methodology employed for the well disinfection program included the following for each location:

- Recorded water level measurement from the top of the PVC well casing;
- Temporarily removed the dedicated transducer;
- For monitoring wells with dedicated submersible pumps, the pumps were removed, labelled and placed in dedicated bags for winter storage at KGS Group;
- Added a calculated amount of household bleach to the well to raise the chlorine level in the well water to 200 ppm;
- Operated a temporary submersible well and pumped the well until discharge water had a chlorine odour (approximately 10 minutes);
- Removed the temporary inertial pump from the well;
- Closed and locked each well.

2.6 QUALITY ASSURANCE / QUALITY CONTROL (QA/QC)

Standardized sampling procedures and protocols were used during the sampling event to ensure representative samples were collected in a controlled manner so that scientifically defensible comparisons can be made.

Chain of Custody – KGS Group ensured all Chain-of-Custody procedures were properly undertaken and holding times were not exceeded.

Sample Collection – Samples were collected directly from the dedicated pump outlet, which is sealed in the well. Disposable latex gloves were worn when handling each piece of equipment and groundwater sample, using a new pair for each sample collection. Samples were collected in clean containers (supplied by the lab) and stored at the appropriate temperature using the proper preservatives. Any equipment replacement in the five instrumented monitoring wells was disinfected prior to installation.

Laboratory Qualification – ALS Environmental of Winnipeg, Manitoba, is a Canadian Association for Laboratory Accreditation Inc. (CALA) accredited analytical testing laboratory. Criteria and guidelines used for assessment of analytical data were clearly established with the laboratory to ensure the appropriate detection limits were used.

Duplicate Samples – Duplicate groundwater samples were submitted at a frequency of 10% for the total samples submitted to assess the quality of the laboratory analysis. The field duplicates

were labelled such that the laboratory did not know the samples were duplicates. Laboratory standards and duplicates are run regularly by ALS and are on file.

Field Equipment – Field equipment such as field chemistry meters and transducers (if they include conductivity) are calibrated prior to use or installation.

3.0 SURFACE WATER RESULTS AND ASSESSMENT

3.1 2018 SPRING MELT

The Floodway was not operated in 2018 and there was no flow over the lip of the Floodway (El. 228.6 m – 750 ft). The previous Floodway operation flows are summarized in Appendix Table D6-A-1. The 2018 spring melt monitoring was timed to coincide with the peak of the Red River flow which occurred on May 1, 2018 at Station G05OC021 (Red River above the Floodway Control Structure) at El. 227.913 as shown on the hydrograph in Appendix D6-A-2. The April 30, 2018 flood report and daily flood sheet for April 29, 2018 is given in Appendix D6-A-3, summarizing conditions just prior to the crest of the flood.

Real time data for elevation, temperature and water quality available on-line from the USGS (United States Geological Survey) for the Red River at Grand Forks is presented in Appendix D6-A-4. This data is used as a general reference since the Floodway Long-term Monitoring Program does not include monitoring in the Red River. The profile shows the spring peak, which occurred prior to the spring peak in Manitoba.

During the 9 Post-Construction and Long-Term Monitoring periods (2010 through 2018), there were three previous years where the Floodway was not operated (2012, 2015 and 2016). There was no monitoring in 2012, therefore 2015 and 2016 would represent the years with conditions most similar to the 2018 spring melt (Table D6-A-1).

3.2 2018 MONITORING LOCATIONS AND DATA

Surface water monitoring locations in 2018 were as follows:

- Floodway Channel at PTH 59N Bridge.
- Floodway Channel at PTH 44 Bridge.

Surface water quality data is shown in Table D6-1 for field data and Table D6-2 for laboratory data.

3.3 2018 TEMPERATURE

Based on historical data collected, the cold temperature of the Red River at the beginning of the spring melt is generally useful as an indicator of surface water infiltration when the river or overland surface water runoff temperature is a few degrees above freezing and the groundwater temperature is higher. As the spring melt advances over time, water from the spring melt starts to warm, increasing in temperature as the peak passes. Historically, a decrease in temperature has been observed in groundwater with the initial onset of spring melt.

In 2018 the first surface water samples (temperatures between 8.1 and 12.6 °C) were measured in the Floodway Channel on April 30, 2018 and May 1, 2018. The range of sampled monitoring well groundwater temperatures at the time measured from 6.0 to 7.4 °C for most wells as shown on Table D6-1. The low groundwater temperature at Church Rd. (4.4 °C) and higher temperature at the Inlet Control Structure domestic well 9.9 °C were exceptions. The June 7, 2018 surface water samples had temperatures of 18.8 and 23°C and were taken after the spring melt, representing groundwater baseflow combined with surface flow from local sources.

3.4 2018 BACTERIOLOGICAL QUALITY

Bacteria results in the Floodway Channel surface water during the 2018 spring melt monitoring are shown in Table D6-2. Total coliform at PTH 59N Bridge was 866 MPN / 100 mL on May 1 and increased to 6200 MPN / 100 mL on June 7, 2018. The *E. coli* count at PTH 59N Bridge was 94 MPN/100 mL on May 1, 2018 and decreased to 6 MPN / 100 mL on June 7, 2018.

Total coliform at PTH 44 Bridge was 649 MPN / 100 mL at on April 30, 2018 and increased to 2420 MPN / 100 mL on June 7, 2018. The *E. coli* count at PTH 59N Bridge was 5 MPN / 100 mL on April 30, 2018 increased to 66 MPN / 100 mL on June 7, 2018. With the exception of *E. coli* at PTH 59N Bridge, the increase in bacteria counts between May and June reflect a combination of increasing exposure to point sources, lower flow of local runoff sources within the channel and warmer temperatures.

3.5 2018 NITRATE PLUS NITRITE (AS NITROGEN) AND OTHER NUTRIENTS

The spring melt nitrate plus nitrite (as N) concentration at the PTH 59N Bridge was 0.0156 mg/L on April 30, 2018 and decreased to <0.01 mg/L in post melt monitoring on June 7, 2018. The spring melt nitrate plus nitrite (as N) concentration at the PTH 44N Bridge was <0.0051 mg/L on May 1, 2018 and increased to 0.046 mg/L in post melt monitoring on June 7, 2018. All concentrations were below the Health Canada Canadian Drinking Quality Objectives of 10 mg/L, which are used for comparison. The concentrations during and after the spring melt are lower than typical concentrations measured during Floodway operation, such as in 2017 when the maximum nitrate plus nitrite (as N) concentration was closer to 1 mg/L.

The spring melt ammonia concentration at the PTH 59N Bridge was 0.054 mg/L on April 30, 2018 and decreased to 0.017 mg/L in post melt monitoring on June 7, 2018. The spring melt ammonia concentration at the PTH 44N Bridge was <0.01 mg/L on April 30, 2018 and increased to 0.02 mg/L in post melt monitoring on June 7, 2018. The concentrations during and after the spring melt are lower than typical concentrations measured during Floodway operation, such as in 2017 when the maximum ammonia concentration was 0.137 mg/L.

None of the unionized ammonia concentrations calculated in surface water in 2018 exceeded the CCME Freshwater Aquatic Life guideline of 0.019 mg/L (Table D6-2, note 3).

The spring melt Total Kjehdahl Nitrogen (TKN) concentration at the PTH 59N Bridge was 0.66 mg/L on May 1, 2018 and decreased to 0.58 mg/L in post melt monitoring on June 7, 2018. The spring melt TKN concentration at the PTH 44N Bridge was 0.84 mg/L on April 30, 2018 and decreased to 0.6 mg/L in post melt monitoring on June 7, 2018. The concentrations during and after the spring melt are lower than typical concentrations measured during Floodway operation, such as in 2017 when the maximum ammonia concentration was 1.2 mg/L. There are no CCME Guidelines for TKN.

The spring melt total phosphorous concentration at the PTH 59N Bridge was 0.174 mg/L on May 1, 2018 and decreased to 0.0531 mg/L in post melt monitoring on June 7, 2018. The spring melt total phosphorous concentration at the PTH 44N Bridge was 0.175 mg/L on April 30, 2018 and decreased to 0.111 mg/L in post melt monitoring on June 7, 2018. The concentrations

during and after the spring melt are lower than typical concentrations measured during Floodway operation, such as in 2017 when the maximum phosphorous concentration was 0.52 mg/L. The phosphorous concentrations measured are in the hypereutrophic to eutrophic range used for evaluation of river water quality in the CCME Environmental Quality Guidelines for Freshwater Aquatic Life. Phosphorous concentrations above 0.1 mg/L are considered hypereutrophic in rivers. Phosphorous concentrations between 0.035 and 0.050 mg/L are considered eutrophic in rivers.

The spring melt Total Suspended Solids (TSS) concentration at the PTH 59N Bridge was 24.9 mg/L on May 1, 2018 and decreased to 2 mg/L in post melt monitoring on June 7, 2018. The spring melt TSS concentration at the PTH 44N Bridge was 34.8 mg/L on April 30, 2018 and decreased to 2.9 mg/L in post melt monitoring on June 7, 2018. The concentrations during and after the spring melt are lower than typical concentrations measured during Floodway operation, such as in 2017 when the maximum TSS concentration was 176 mg/L. CCME guidelines for TSS relate to exposure events not baseflow, and so are not applicable.

3.6 2018 CONDUCTIVITY AND MAJOR IONS

Conductivity during the spring melt was 496 to 578 µS/cm on April 30 to May 1, 2018 increasing to 983 and 1070 µS/cm on June 7 at PTH 59N and PTH 44 Bridge respectively. This increase reflects the increase in total dissolved solids, hardness (as $CaCO_3$), alkalinity, sodium, chloride and sulphate.

3.7 2018 DISSOLVED OXYGEN

Dissolved oxygen ranged from 10 to 12 mg/L in the spring melt surface water sampled and slightly higher from 7 to 9.5 mg/L in the post-melt sampling. The dissolved oxygen in the groundwater was compared to the surface water to try to detect any areas of surface water infiltration (Table D6-1); however, a correlation between higher dissolved oxygen and changes in groundwater water quality was not established.

3.8 RELATIONSHIP AMONG PARAMETERS

Conductivity and major ions were lower during the spring melt than in the post melt period. Bacteria counts were also lower (except for *E. coli* at one location) reflecting the dilution from the spring melt. Nutrient concentrations and total suspended solids; however, were higher in the spring melt than the post melt, reflecting the initial local runoff into the channel. Post–flood conditions are characterized by an increased contribution of groundwater baseflow.

It is important to note that surface water in the floodway channel varies widely over the course of the year as was shown by extensive surface water monitoring program during the floodway expansion program.

4.0 GROUNDWATER RESULTS

Groundwater results from 2018 are compared to 2016 since both are years with no operation of the Red River Floodway. Groundwater quality results from monitoring wells measured in 2018 are discussed below. Results for samples collected during the spring melt are compared to samples collected post-melt. In general, lower concentrations of dissolved solids observed during the spring Floodway melt period versus the post-melt period would reflect possible surface water influence on groundwater within the monitoring wells sampled. As flow from the spring melt in the Floodway decreases, parameter concentrations (excluding nutrients) in the Floodway tend to increase, reflecting a return to greater contribution of groundwater from the surrounding aquifer to the baseflow of the Floodway at these locations.

4.1 FLOODWAY OUTLET AND PTH 44

At the Floodway Outlet, the monitoring well located 350 m (K13-12321) north of the expanded channel within the Right-of-Way, showed some evidence of surface water intrusion during the spring melt; however the closer monitoring well only 65 m north of the channel (K09-12316) did not, as discussed below. Hydrographs showed a rise in groundwater elevation during the spring melt. At monitoring well K09-12316 (Appendix D6-B-1 and D6-C - Figure HM66-3) and monitoring well K13-12321 (Appendix D6-B-5 and D6-C - Figure HM66-45) the elevation increase in 2018 was much smaller than the 2016 spring melt response, with no decrease in temperature, reflecting the more limited run-off from spring snowmelt in 2016.

At the Rockhaven Road well K13-12321 an increase in conductivity was seen which is not indicative of surface water intrusion. However slight decreases were seen in TDS, and associated alkalinity, hardness, chloride, calcium and magnesium, indicating that the conductivity measurements may not be representative. Nitrate plus nitrite as nitrogen also decreased at K13-12321 between the March pre-melt and May spring melt, which is an indication of surface water intrusion in wells near the outlet which have elevated nitrate in pre-melt monitoring. The increase may be due to local recharge sources north of Rockhaven Road or the influence of the Red River, since the well closest to the Floodway does not show these changes.

Well K09-12316, closest to the channel, showed a slight increase in conductivity from 885 µS/cm in March pre-melt sampling to 908 µS/cm during spring melt sampling as shown on Table D6-3, which is not indicative of surface water intrusion. The increase in conductivity reflects the increase in hardness. Nitrate as nitrate (as N) concentrations are similar during and after the melt.

Total coliform and *E. coli* were not detected at either well in pre-melt, spring melt or post-melt monitoring in 2018. Dissolved oxygen concentrations did not correlate with water quality changes at well K13-12321 at Rockhaven Road and higher dissolved oxygen readings may be due to the use of the Waterra pump.

4.2 HAY ROAD TO DUNNING ROAD

At the bedrock well within the Right-of-Way at Church Road (K09-12012) a change in conductivity was not seen. The increase in groundwater elevation during the spring 2018 melt was much less than in 2016 and there was little change in temperature (Appendix D6-B-2 and D6-C - Figure HM66-13). Nitrate plus nitrite (as N) remained below detection. Higher dissolved oxygen readings in 2018 may be due to the use of the Waterra pump.

At the PTH 44 Bridge (U09-13571), parameter concentrations decreased during the spring melt compared with historic pre-melt measurements indicating potential surface water intrusion. Nitrate plus nitrite (as N) was elevated in the pre-melt sample and decreased during the spring melt. The dissolved oxygen value was low (below 1 mg/L).

At Hay Road (K11-12018) and Ludwick Road (K09-12011) there were no noticeable changes in parameter concentrations during the spring Floodway melt compared with the historic pre-melt measurements.

At Dunning Road (K11-12017), parameter concentrations decreased during the spring melt compared with historic pre-melt measurements indicating potential surface water intrusion. No change was seen in nitrate plus nitrite (as N) values. The dissolved oxygen value was low (at or below 0.75 mg/L).

Total coliform and *E. coli* were not detected in these wells at either well in pre-melt, spring melt or post-melt monitoring in 2018.

4.3 PTH 59N BRIDGE AREA

Near Bray Road, north of the PTH 59N Bridge, well K11-12016 showed a decrease in water quality parameters between the historic pre-melt concentrations and the spring melt, but with no change in nitrate plus nitrite (as N).

At the bedrock well located upstream of the PTH 59N bridge, and 250 m west of the expanded channel at the west Right-of-Way boundary (K11-12014) the increase in groundwater elevation was much less than the 2016 spring melt and temperatures were stable (Appendix D6-B-3 and D6-C - Figure HM66-37). Parameter concentrations including nitrate plus nitrite (as nitrogen) did not change during the spring melt from pre-melt concentrations. Dissolved oxygen was below 1 mg/L in spring melt monitoring.

At the bedrock well located upstream of the PTH 59N bridge and 60 m west of the west channel slope within the Right-of-Way (K11-12015) the increase in groundwater elevation was much less than the 2016 spring melt with stable temperature (Appendix D6-B-4 and D6-C - Figure HM66-38). Parameter concentrations including nitrate plus nitrite (as nitrogen) did not change during the spring melt from pre-melt concentrations. Dissolved oxygen was below 1 mg/L in spring melt monitoring.

Total coliform and *E. coli* were not detected in these wells at either well in pre-melt, spring melt or post-melt monitoring in 2018 except for a total coliform count of 1 MPN/100 mL at well K11-12014 in the post melt sampling.

Near McGregor Farm Road at K13-12322 parameter concentrations decreased during the spring melt from historic pre-melt concentrations indicating potential surface water intrusion; however, nitrate plus nitrite (as nitrogen) decreased, which does not indicate surface water intrusion at this location. Dissolved oxygen was low, at 0.1 mg/L.

4.4 KEEWATIN BRIDGE AND AREA TO THE SOUTH

There is no monitoring from the Keewatin Bridge south to the inlet structure for Program A. These wells are monitored only in Program B.

At the inlet control structure (GO50C006) parameter concentrations decreased during the spring melt from historic pre-melt concentrations indicating potential surface water intrusion. Nitrate plus nitrite as nitrogen did not show a change. Dissolved oxygen was low at 0.75 mg/L. Total coliform bacteria 3 MPN/100mL was detected at the Floodway Inlet Control Structure domestic well (washrooms), which is not used for potable water. MI was informed of this sample result.

5.0 GROUNDWATER RESULTS AND ASSESSMENT

5.1 CONDUCTIVITY CHANGES

Conductivity changes are being used as an indicator of surface water influence on groundwater quality, as conductivity is a parameter that is readily measured. Conductivity changes reflect the changes in major ions contributing to the dissolved solids.

If surface water intrudes into the aquifer, the mixing would result in changes observed in groundwater conductivity. Groundwater conductivity decreases with the addition of surface waters in most areas. Changes are most readily observed in areas where groundwater is more mineralized and thus has higher conductivity than surface water, which is typically the case during the spring. Conversely, increases in groundwater conductivity would be seen in areas where baseline groundwater conductivity is less than that of surface waters.

In addition to the Floodway, potential surface water infiltration sources in the area include ponds and open sand and gravel quarries, creeks, and the Red River (primarily near the Floodway Outlet).

The magnitude of the water quality change is described by a range in the percentage change in conductivity as follows: Type A (>50% change); Type B (25 to 50% change); Type C (10 to 25% change); Type D (5 to 10% change). Tables D6-4 and D6-5 show the 2018 water quality assessment based on changes in conductivity. For instrumented wells (Table D6-4), pre-melt samples (March) were compared with samples taken during the spring melt (April 30 to May 1 2018). For the remaining 7 non-instrumented monitoring wells (Table D6-5), spring melt samples were compared with recent historical pre-melt samples. The monitoring wells selected for sampling for the Long-Term monitoring program were in areas with higher potential for surface water intrusion due to hydrogeologic conditions, or locations near other surface water sources (such as the Floodway Outlet).

In 2018, 5 monitoring wells (with installed transducers) were sampled in three events for water chemistry and bacteria (pre-melt, spring melt, post melt). From the pre-melt period to the spring melt and post-melt period in 2018, a change in groundwater quality was not seen in any of the

wells based on the conductivity data (0 wells sampled %) sampled. However, a change is interpreted in well K13-12321 based on the TDS and other parameters. All of these monitoring wells are within the Floodway Right-of-Way.

For the remaining 7 core monitoring wells, which only required measurement during the spring Floodway operation period, 5 of the 7 monitoring wells (71%) showed an observable change as follows:

- Type B (25 to 50% change) for 1 well (14% of the total) located inside of the Right-of-Way at the Floodway Inlet (G050C006).
- Type C (10 to 25% change) for 4 monitoring wells (57% of the total) located inside of the Right-of-Way at the Outlet - the PTH44 bridge (U09-13571), Dunning Road (K11-12017), and just south of the PTH59N Bridge at McGregor Farm Road (K13-12322).

5.2 BACTERIA

Total coliform and *E. coli* were not detected in these wells at either well in pre-melt, spring melt or post-melt monitoring in 2018 except for a total coliform count of 1 MPN/100 mL at well K11-12014 in the post melt sampling. Total coliform bacteria 3 MPN/100 mL was detected at the Floodway Inlet Control Structure domestic well (washrooms), which is not used for potable water. MI was informed of this sample result.

Notification to Manitoba Infrastructure

KGS Group sent the following notification to MI on May 8, 2018.

> *KGS Group is reporting on bacteria concentrations during the Floodway monitoring event on May 8, 2018. No total coliform or E. coli were found in the monitoring wells sampled.*
>
> *Total coliform (3 CFU/100 mL) were found in the sample from the Floodway Inlet Control Structure washroom tap sample (well) G050C006 taken on May 2, 2018. No E. coli bacteria were detected. Total coliforms have been found in this well in past years (2016 most recently). The results for the Inlet Control well are attached.*
>
> *We recommend you forward them to MI staff in charge of this well for possible actions by MI. Re-sampling of a domestic well with this level of bacteria would generally be recommended to the well owner, followed by well disinfection if the bacteria persists. In*

either event, the water should not be used for potable purposes. Additional guidance on domestic wells can be obtained by contacting the Office of Drinking Water.

No other actions or reporting is required under the monitoring protocols for the Floodway monitoring project.

The MI project manager indicated this information was forwarded.

5.3 NITRATE PLUS NITRITE AS (NITROGEN)

Nitrate plus nitrite (as N) concentrations were below the Canadian Drinking Water Quality Guidelines (CDWQG) of 10 mg/L at all monitoring wells tested. Eight (8) of the 12 sample locations had concentrations below detection (<0.0051 to <0.051 mg/L) in 2018, either for spring melt sampling only, or spring melt, pre-melt and post-melt events.

There were no wells where higher concentrations of nitrate plus nitrite (as N) were observed during the spring melt sampling than during the pre-melt sampling.

In contrast, one sample within the Right-of-Way at Rockhaven Road (K13-12321) showed a decrease in nitrate plus nitrite (as N) during the spring Floodway operation compared with both pre-melt and post-flood values, which have higher background values. The reduction in observed values demonstrates the potential influence of surface water with lower nitrate plus nitrite (as N) values relative to background.

5.4 RELATIONSHIP BETWEEN PARAMETERS

One instrumented well had lower conductivity values during the May 2018 spring melt sampling than during the pre-melt sampling; however, bacteria was not detected at this location. Bacteria sampling was not conducted in the 5 non-instrumented wells that showed lower conductivity values in 2018.

Changes in nitrate plus nitrite (as N) correlated with changes in Floodway water quality at 20% (1) of 5 core monitoring wells with dedicated transducers sampled within the Right-of-Way (K13-12321 at Rockhaven Road), and 14% (1) of 7 remaining core monitoring wells (U09-13571). Higher nitrate plus nitrite (as N) concentrations were not observed during the spring melt

compared with pre-melt and post flood samples for the area near the PTH 59N Bridge. Where groundwater is locally affected by elevated nitrate plus nitrite (as N) near Rockhaven Road, the Floodway outlet and PTH44 Bridge (U09-13571), a decrease in concentrations with the spring Floodway operation was observed, as expected. Nitrate plus nitrite (as N) concentrations in all monitoring wells tested were well below the Canadian Drinking Water Quality Guideline of 10 mg/L nitrate plus nitrite (as N).

Many of the monitoring wells are located on the shoulder of the Floodway Channel, or in the spoil pile, and would be expected to experience any water quality changes more quickly than domestic wells located further away, beyond the Floodway Right-of Way. Domestic wells (with the exception of the Floodway Inlet well) are not monitored in the Long-term monitoring program. Travel times from the Floodway surface water to the monitoring wells vary, depending on Floodway Channel water elevations, piezometric water elevations, the surface water/groundwater interconnection pathway which depends on clay and till thickness, and the hydraulic conductivity of the bedrock, which ranges from highly fractured to massive.

In general, groundwater gradients will be greater and travel rates will be faster closer to the Floodway. Gradients will decrease and travel times will lengthen further from the Floodway or in years where there is no Floodway operation, drier conditions, or limited channel flow.

5.5 SUMMARY ASSESSMENT OF CHANGES

The 2018 monitoring event flood represented a year with no Floodway operation. Of the years 2005 to 2018 when Floodway Monitoring has taken place, the 2018 year was the fifth year with no Floodway operation (2008, 2012, 2015, 2016) (Table D6-A-1). Groundwater quality changes observed from monitoring wells located within the Floodway Right-of-Way in 2018 were less than similar to years with no Floodway operation since the expansion was complete (2015, 2016).

Bacteria (total coliform and *E. coli*) were not detected in spring melt monitoring, whereas bacteria was detected in other years where the Floodway was not operated.

All monitoring wells which showed groundwater quality changes in 2018 also showed changes in previous years when the Floodway was not operated. Inorganic groundwater quality parameters seen in monitoring wells in 2018 did not exceed the Canadian Water Quality Guidelines for Drinking Water.

As required in the monitoring plan, procedures were implemented to notify Manitoba Infrastructure (e-mail and notification reports) when bacteria were detected in monitoring wells. Notification to Manitoba Water Stewardship Water Quality was not required as water quality changes within the monitoring wells were within those observed historically for years with no spring Floodway operation.

6.0 SPRING TREATMENT AREAS

The Spring Treatment Program mitigates surface water infiltration in the bedrock aquifer. This is accomplished by providing sand filtration of any migrating fines, by decreasing the amount of flow into the springs at the filter locations for a given flood, by reducing the potential for expansion of spring areas through piping, and by improving the bacterial quality of any infiltrating water. The constructed fine sand filters have a much lower hydraulic conductivity than an open bedrock fracture; therefore, the initial flow rate from the surface water into the aquifer is decreased. As the low permeability silt fraction builds up above the sand filter layer during surface water discharge into the aquifer, the infiltration rate is reduced further. The fine sand also meets criteria for slow sand filters designed to reduce bacteria passage through the filter. After the Floodway operation, when the flow direction reverses to groundwater discharge, the sand filter protects against upward piping of the foundation material (silt, sand) which otherwise could have increased the size of a fracture/hole. In addition, during the upward flow process, silt fraction buildup and bacteria will be flushed out of the sand filter.

Sealing the groundwater discharge areas completely is not desirable, as a pressure build-up and uncontrolled discharge in another area would likely develop. The treatments provide pressure relief, but in a controlled fashion and with a flow rate lower than was present before treatment.

Previous sampling in 2009 through 2011 (HM99, 2013 to 2014 Post Construction Monitoring Report) showed that total coliform and *E. coli* bacteria are generally present and at higher levels above the filter. The filter has been effectively reducing total coliform concentrations. *E. coli* has not been detected beneath the filter. Soon after the Floodway drains, surface water infiltration is flushed out quickly from the system as shown by a return to groundwater quality and an absence of bacteria. A return to groundwater quality (as shown by conductivity) was seen towards the end of the Floodway operation period as shown by the transducer data in 2009, 2011 and 2013, with more limited change seen in 2014 Appendix D4-B-6.

In 2016, monitoring of spring locations with a transducer was not included in the program. In 2015 one spring discharge location was monitored with a transducer during the spring melt when there was no Floodway operation. The results from 2015 (Appendix D4-C Figure HM66-

43) showed no infiltration and no drop in conductivity or temperature during the spring melt. The water level during the spring melt monitoring in 2015 was at the top of the Low Flow Channel. Monitoring in prior years showed that higher channel flows typical of Floodway operation will temporarily reverse the discharge groundwater gradient allowing surface water to recharge with a flow direction from the channel to the bedrock beneath the spring. There is a return to groundwater quality beneath the spring as the Floodway begins to drain and groundwater is again discharged into the channel. Since there was no Red River flow into the channel in 2015, these conditions did not occur and would not have occurred in 2016, which was also a year with no Floodway operation. The total flow and water depth in the channel was insufficient to reverse the gradient during the spring melt in 2015 and would have been similar in 2016.

A groundwater pressure and temperature transducer was installed at spring 7A1 (Kildare) as shown on Figure D6-1 in 2017 to monitor the 2017 spring Floodway operation. The plot of the transducer data is included in Appendix D6-B on Figure D6-B-6 spring 7A1 (Kildare). The plot shows a steep rise in groundwater elevation coincident with Floodway operation with a steep drop in groundwater temperature to nearly 1º C in the initial days of the operation as surface water intruded beneath the spring filter. The transducer installed in 2017 was not equipped to measure conductivity and was removed. A new transducer installed on May 1, 2018 at the same location was equipped to measure conductivity and groundwater pressure and temperature. Groundwater elevation data on May 1, 2018 coincides with peak groundwater elevations at the monitoring wells sampled, however no peak is observed at the spring location. No conductivity changes were observed during the May to November 2018 monitoring period. Temperature data was stable indicating continued groundwater discharge to the channel during the spring melt period.

A summer inspection of 23 spring locations was conducted in August 2018 as summarized in Appendix D6-D including description (Appendix D6-D-1, Table D6-D-1) and field documentation sketches and photos (Appendix D6-D-2). A plan view of these locations is included in Deliverable D7 (Appendix B) Long-Term Monitoring Program 2018 Annual Inspection and Maintenance Report. These plans have not been updated for 2018, since inspection locations remained the same and no new spring locations were found. Springs noted in 2018 are the same as those identified in 2017. Additional photos and video (Appendix D6-D-3) are provided on a separate DVD included with this report. This work documents conditions in the Long-Term

monitoring period and can be compared with surveys completed in 2013 through 2015 (HM99 2013 to 2014 Post Construction Monitoring Report), 2016 (Deliverable D1) and 2017 (Deliverable D4).

The constructed filters were found to be in good condition and were working as designed. Flow appeared to be coming up through the filter and discharging through the granular layer overlying the sand filter bed. No settlement or heaving of the filters was observed. No required repairs were identified.

The discharge trenches were constructed as shallow excavated trenches that were filled with riprap to grade or slightly above grade. As in previous years, it was observed that at 11 of the treated spring sites, the rip rap within the discharge trenches was infilling with sediment and spring discharge was finding alternate flow paths to the Low Flow Channel (Appendix D6-D-1, Table D6-D-1). This resulted in overland flow toward the Low Flow Channel or flow into low areas near the filter, creating wet and soft areas. No significant erosion channels were observed at any of these locations. The discharge trenches were constructed as ditches in a few locations (5A1 and 7A1). This method appeared to be more effective in directing discharge flows along the design discharge flow path, versus other trenches. Modifying the 11 identified discharge trenches to create more pronounced ditches would improve control of flow towards the Low Flow Channel.

Both high level and low level sampling pipes were found to be in good condition, with no damage observed. The covers for the low level sampling pipes at 5A1 and 7A1 were replaced by MI in 2018 after the inspection.

In 2016 and 2017, additional eroded discharge areas were observed in a small area along the discharge trench at 9B2. Construction of a graded sand filter would minimize potential for direct groundwater and surface water flow interconnections to develop at this location.

No new discharge areas were located in 2018. Five new discharge locations were identified in 2017 between Hay Road and the CEMR Bridge. One location had been observed previously in 2016. Two of the locations are near a Beaver Dam in the Low Flow Channel and may represent

surface water. Source areas were found at two of the 5 locations. Flow rates were low and in most cases diffuse as they entered the Low Flow Channel.

- ***AD17-1*** – No change in 2018.
- ***AD17-2*** – No change in 2018.
- ***AD17-3*** – Observed in 2016, 2017 and 2018 at similar flow rates.
- ***AD17-4*** – Observed in 2017. In 2018 this area appeared dry in comparison, with only a small amount of soft soil along the bank.
- ***AD17-5*** – Observed in 2017. In 2018 this area appeared dry.

Additional discharge areas AD17-1 through AD17-5 should be re-inspected in 2019 including field conductivity and temperature and source identification. Additional discharge locations AD17-1, AD17-2 and AD17-5 are adjacent to the channel; therefore, remediation may not be practical. Discharge areas AD17-3 and AD 17-4 should be assessed for potential remediation.

Remediation Items

- Modifying the 11 identified discharge trenches to create more pronounced ditches should be considered to improve control of flow towards the low flow channel.
- Construction of a graded sand filter at additional discharge areas at 9B2 should be considered.
- Additional discharge areas AD17-1 through AD17-5 should be re-inspected in 2019 including field conductivity and temperature and source identification.
- Discharge areas AD17-3 and AD 17-4 should be assessed for potential remediation.

7.0 WELL DISINFECTION

The purpose of the well disinfection program is to prepare instrumented monitoring wells that are used for bacteria analysis for the pre-melt (typically March) and flood (typically March/April) monitoring programs. The program in 2018 was conducted in the fall, as several months are required between disinfection and sampling. Disinfection was completed at the five core monitoring wells with dedicated transducers, which are used for bacteria analysis.

On October 19, 2018 KGS Group personnel disinfected 5 monitoring wells (K11-12316, K09-12012, K13-12321, K11-12014 and K11-12015) along the Red River Floodway at PTH 59N Bridge, Church Road, Rockhaven Road and at the Floodway Outlet following the procedure outlined in Section 2.5.

Any dedicated submersible pumps were removed from the monitoring wells at the time of disinfection for winter storage at KGS Group.

8.0 LONG-TERM MONITORING

The current work program, overseen by Manitoba Infrastructure includes a monitoring period from spring 2016 through fall 2021. The Scope of Work should be continued for 2019, to include the following annual activities:

- Spring and Summer Flood Monitoring Program A (or B if required);
- Inspection of Treated Groundwater Springs and Channel Inspections by boat;
- Annual Well Disinfection, Inspection/Maintenance/Repair Programs
- Reporting.

9.0 STATEMENT OF LIMITATIONS AND CONDITIONS

9.1 THIRD PARTY USE OF REPORT

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

9.2 GEO-ENVIRONMENTAL STATEMENT OF LIMITATIONS

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

TABLES

TABLE D6-1
2016-2018 MONITORING WELL AND SURFACE WATER FIELD PARAMETERS

Location	Well No.	Date	E.C. (µS/cm)	Temp. (°C)	pH (Units)	DO (mg/L)	Comments
Ground Water Samples							
Rockhaven Rd.	K13-12321	28-Mar-16	950	6.7	7.07	4.37	(1), (2), (3)
		21-Apr-16	1,100	6.8	7.25	3.13	-
		02-Jun-16	1,741	7.5	7.02	5.04	-
		02-Mar-17	-	6.8	6.97	4.77	-
		20-Apr-17	1032	7.0	6.99	6.02	
		11-May-17	1508	6.9	7.04	6.04	
		15-Mar-18	1222	3.4	6.9	9.19	(8)
		30-Apr-18	1084	7.2	6.91	7.71	
		07-Jun-18	1186	7.5	6.92	4.5	
Outlet Structure	K09-12316	28-Mar-16	752	7.0	7.21	3.68	(1), (2), (3)
		21-Apr-16	823	6.9	7.43	1.96	-
		02-Jun-16	851	7.0	7.15	2.50	-
		03-Mar-17	-	6.9	7.1	2.76	
		05-Apr-17	600.4	7.0	7.16	1.75	(1)
		20-Apr-17	688.4	7.0	7.31	3.84	
		11-May-17	881	6.9	7.2	2.99	
		15-Mar-18	908	7.0	7.09	3.09	
		30-Apr-18	943	7.1	6.97	3.56	(1), (6)
		07-Jun-18	944	7.2	7.01	2.55	
PTH 44 Bridge	U09-13571	28-Mar-16	909	7.7	7.18	1.04	(5)
		05-Apr-17	705.7	7.8	7.11	0.92	(6)
		30-Apr-18	1072	7.4	6.98	0.48	
Hay Rd.	K11-12018	28-Mar-16	1,103	6.1	7.36	0.99	(5)
		05-Apr-17	866	6.3	6.88	0.49	(6)
		30-Apr-18	1153	6.7	6.67	2.33	(8)
Church Rd.	K09-12012	29-Mar-16	1,036	6.2	7.39	0.18	(1), (2), (3)
		21-Apr-16	1,249	6.2	7.35	0.02	-
		02-Jun-16	1,005	6.4	7.23	0.15	-
		02-Mar-17	-	6.2	7.17	0.43	
		05-Apr-17	769.4	6.5	7.15	0.49	
		07-Apr-17	704.1	6.3	7.15	0.72	(1)
		20-Apr-17	947	6.2	7.26	1.13	
		11-May-17	1128	6.2	7.23	0.95	
		15-Mar-18	999	6.4	7.16	4.42	(1), (8)
		30-Apr-18	1066	4.7	7.68	4.17	(1), (10)
		07-Jun-18	958	6.5	7.33	3.94	
Ludwick Rd.	K09-12011	29-Mar-16	441	6.8	7.41	1.52	(5)
		06-Apr-17	349.6	6.9	7.29	0.52	(6)
		01-May-18	471.6	6.5	7.26	0.70	(8)
Dunning Rd.	K11-12017	29-Mar-16	1,037	6.10	7.25	0.19	(5)
		06-Apr-17	737.6	6.3	7.22	0.51	(6)
		01-May-18	1,052	6.1	7.16	0.74	(8)
Bray Rd.	K11-12016	29-Mar-16	952	6.3	6.70	0.17	(5)
		06-Apr-17	766.9	6.3	7.19	0.4	(6)
		01-May-18	1,005	6.0	7.36	1.48	(8)
PTH59N Bridge	K11-12014	30-Mar-16	557	7.30	7.51	0.90	(1), (2), (5)
		21-Apr-16	606	7.40	7.51	1.14	(4)
		02-Jun-16	688	7.90	7.32	4.71	-
		03-Mar-17	-	6.4	7.2	3.72	
		06-Apr-17	397.2	7.6	7.47	2.61	
		20-Apr-17	595.7	7.5	7.3	1.49	
		11-May-17	681.1	7.8	7.24	0.78	(1), (8)
		15-Mar-18	630	6.2	6.67	1.38	
		01-May-18	622.3	7.1	7.38	0.71	
		07-Jun-18	694.6	8.7	7.62	3.44	

TABLE D6-1
2016-2018 MONITORING WELL AND SURFACE WATER FIELD PARAMETERS

Location	Well No.	Date	E.C. (µS/cm)	Temp. (°C)	pH (Units)	DO (mg/L)	Comments
PTH59N Bridge Continued	K11-12015	30-Mar-16	521	7.2	7.70	1.12	(1), (2), (5)
		21-Apr-16	565	7.2	7.76	0.99	(3)
		02-Jun-16	583	7.4	7.44	1.49	-
		02-Mar-17	-	7.2	7.39	0.45	(1)
		06-Apr-17	370.1	7.3	7.51	3.84	
		20-Apr-17	580.6	7.3	7.44	1.43	
		11-May-17	659.5	7.3	7.39	0.89	
		15-Mar-18	647	7.4	7.04	0.71	(1), (6)
		01-May-18	608.1	7.0	7.51	0.91	(1), (2), (8)
		07-Jun-18	696.6	9	7.75	0.18	
McGregor Farm Rd.	K13-12322	30-Mar-16	737	6.2	7.56	0.09	(5)
		06-Apr-17	605.4	6.6	7.30	0.57	(6)
		02-May-18	858	6.3	7.18	0.10	(8)
Inlet Control Structure	G050C006	30-Mar-16	2,340	9.90	8.02	1.07	-
		07-Apr-17	1,709	14.1	7.72	0.53	(7)
		02-May-18	2,339	9.9	6.93	0.75	(7)
Surface Water Samples							
PTH 44 Bridge	PTH 44	28-Mar-16	415	9.30	7.77	13.80	-
		02-Jun-16	553	14.40	7.61	8.37	-
		05-Apr-17	305.1	5.1	7.95	11.57	-
		12-Apr-17	591	7.5	6.64	10.25	-
		19-Apr-17	709	7.7	7.09	10.03	-
		26-Apr-17	919	3.6	6.82	14.82	-
		11-May-17	743	12.7	6.94	10.08	-
		30-Apr-18	545.7	12.6	6.99	12.29	-
		07-Jun-18	1126	18.8	7.04	7.03	(11)
PTH59N Bridge	PTH 59N	30-Mar-16	608	6.30	7.36	8.11	-
		02-Jun-16	767	17.60	7.81	9.38	-
		05-Apr-17	312.8	6.2	7.8	9.32	-
		12-Apr-17	607.1	7.7	6.66	9.42	-
		19-Apr-17	800	7.3	6.64	9.06	-
		26-Apr-17	737.5	3.8	7.61	15.21	-
		11-May-17	657	14.8	7.93	9.29	-
		01-May-18	627.4	8.1	6.84	9.98	-
		07-Jun-18	1054	23.0	8.35	9.51	(11)

Notes:

"-" = No Data

E.C. = Electrical Conductivity

1. Well contains dedicated transducers.
2. Original Dedicated Well Pump Failed
3. New Dedicated Well Pump Installed
4. New Dedicated Waterra Tubing and Foot Valve
5. Sampled with Portable Pump.
6. Purged and sampled with tornado pump.
7. Washroom tap, not used for drinking.
8. Purged and sampled with Waterra pump.
9. Conductivity results for March 3, 2017 anomalous due to meter/calibration. See laboratory conductivity results Tables D-6-2 and D-6-3.
10. Not enough water in well to use tornado or Waterra pumps. Bailer used to take grab sample. Well dry after one bailer.
11. No Floodway Operation in 2018. Red River peaked on May 1, 2018 at Station 05-OC021 (EL. 227.913 m) - Red River Above Floodway Contr

TABLE D6-2
2016-2018 GENERAL SURFACE WATER QUALITY DATA FLOODWAY CHANNEL

Sample Location [1]	Location	Event	Duplicate	Date	Parameter [2]																										
					Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride - Soluble	Sulphate - Soluble	Ammonia (NH_3) [3]	Nitrate+ Nitrite-N	Nitrate-N	Nitrite-N	Calcium	Magnesium	Potassium	Sodium	Total Phosphorus	T.D.S. (Calc.)	T.S.S.	T.K.N.	Anion Sum	Cation Sum	Cation - Anion Balance	Ion Balance (%)	Total Coliform MPN/100mL	E.coli MPN/100mL
CCME [4]																															
Freshwater Aquatic Life					[5]	6.5-9.0	-	-	-	-	-	-	120 [6a]/640	-	[3a]	-	-	-	-	-	-	-	[9]	-	[7]	-	-	-	-	-	-	-
RRF at PTH 59 N																															
Event - Spring Melt/Spring Flood Monitoring																															
PTH59	RRF at PTH 59 N Spring Hill Ski	Spring Melt		30-Mar-16	21	8.13	549	193	236	<0.60	<0.34	231	45.6	39.1	0.072	0.414	0.405	0.0093	50.2	25.7	6.63	28.7	0.196	314	9	0.75	6	6.04	0.4	101	2790	630
		Spring Melt		2-Jun-16	17	8.24	718	210	256	<0.60	<0.34	352	46.2	93.2	0.014	4.68	4.620	0.0606	64.4	46.4	6.53	30.4	0.285	434	15	1.87	7.77	8.52	4.6	110	26100	1440
		Spring Flood		5-Apr-17	163	7.86	403	135	165	<0.60	<0.34	195	12.8	55.9	0.134	0.945	0.896	0.0490	44.0	20.6	9.19	15.5	0.505	239	172	1.19	4.3	4.81	5.6	112	2430	3
		Spring Flood		12-Apr-17	112	7.96	534	163	199	<0.60	<0.34	239	19.3	99	0.048	0.885	0.863	0.022	54.7	24.9	8.26	22.6	0.336	327	62	1.19	5.9	6.0	0.4	101	1550	9
		Spring Flood		19-Apr-17	26	8.03	696	198	241	<0.60	<0.34	298	45.3	123	-	0.522	0.517	0.0056	63.6	33.7	7.26	43.4	0.176	437	<20	0.66	7.8	8.0	1.2	102	34	<1
		Spring Flood		26-Apr-17	22.3	8.38	649	285	336	6	<0.34	350	24.3	63	-	0.0233	0.0221	0.0011	71.5	41.7	4.15	20.7	0.092	396	18	<0.20	7.7	8.0	1.9	104	308	6
		Spring Melt		01-May-18	42.7	8.42	578	209	239	7.44	<0.34	251	33.1	73.4	0.054	0.0156	0.0118	0.0038	51.8	29.5	6.21	23.7	0.174	343	24.9	0.66	6.6	6.2	-3.3	93.6	866	94
Event - Post Melt/Post Flood Monitoring																															
PTH59	RRF at PTH 59 N Spring Hill Ski	Spring Flood		11-May-17	12	8.45	634	283	328	8.4	<0.34	340	21.7	51.9	<0.010	<0.0051	<0.0050	<0.0010	74	37.8	3.65	20.7	0.077	387	9	0.75	7.5	7.8	2	104	1050	78
		Spring Flood	SW100	11-May-17	11.6	8.45	632	283	328	8.52	<0.34	345	21.7	59.2	<0.010	<0.0051	<0.0050	<0.0010	75.2	38.1	3.77	21	0.077	389	10	0.78	7.5	7.9	2.6	105	1200	73
		Spring Melt		07-Jun-18	1.31	**9.46**	983	150	109	36.6	<0.34	314	**156**	140	0.017	<0.010	<0.010	<0.0020	41.3	51.3	6.98	105	0.0531	590	<2.0	0.58	10.3	11.0	3.3	107	6200	6
RRF at PTH 44																															
Event - Spring Melt/Spring Flood Monitoring																															
PTH 44	NW side of PTH44 bridge	Spring Melt		28-Mar-2016	42.5	7.96	407	175	213	<0.60	<0.34	198	13.5	26.2	0.054	1.28	1.25	0.0263	45.3	20.7	7.82	9.41	0.356	233	24.0	0.79	4.51	4.58	0.8	102	980[8]	139[8]
		Spring Melt		2-Jun-2016	10.0	8.03	665	227	277	<0.60	<0.34	329	38.4	81.0	<0.010	0.727	0.704	0.0234	62.8	41.7	4.84	27.8	0.108	396	13.0	1.32	7.36	7.9	3.5	107	41100	1210
		Spring Flood		5-Apr-17	171	7.84	394	134	164	<0.60	<0.34	195	12.5	54.0	0.137	0.943	0.890	0.0521	44.3	20.4	9.13	15.1	0.520	236	173	1.19	4.23	4.79	6.2	113	2090	8
		Spring Flood	SW100	5-Apr-17	172	7.83	398	135	164	<0.60	<0.34	194	12.4	54.1	0.145	0.943	0.892	0.0513	43.8	20.6	9.51	15.1	0.519	236	176	1.22	4.23	4.79	6.2	113	1450	4
		Spring Flood		12-Apr-17	107	7.97	524	160	195	<0.60	<0.34	228	18.6	95.8	0.048	0.893	0.87	0.0226	53.6	22.8	7.85	21.3	0.329	316	124	1.1	5.78	5.68	-0.8	98.3	1300	6
		Spring Flood		19-Apr-17	54	8.53	644	205	230	9.96	<0.34	309	27.4	124	-	0.597	0.586	0.0109	69.3	33	7.61	36.4	0.219	423	52	0.85	7.5	7.95	2.9	106	236	4
		Spring Flood		26-Apr-17	24	8.33	704	283	337	3.96	<0.34	362	38.1	71.9	-	0.0552	0.0536	0.0016	73.2	43.6	4.69	29.3	0.1	431	26	0.56	8.23	8.64	2.4	105	548	30
		Spring Melt		30-Apr-18	27.6	8.44	496	182	210	5.76	<0.34	231	30.4	56.5	<0.010	<0.0051	<0.0050	<0.0010	44.5	29.2	6.42	24.7	0.175	301	29.2	0.84	5.86	5.67	1.7	103	649	5
		Spring Melt	SW100	30-Apr-18	28.3	8.46	496	182	208	6.48	<0.34	217	30.5	56.5	<0.010	<0.0051	<0.0050	0.002	45.9	25	6.04	22.4	0.18	295	34.8	0.74	5.48	5.66	-1.7	96.7	866	5
Event - Post Melt/Post Flood Monitoring																															
PTH 44	NW side of PTH44 bridge	Spring Flood		11-May-17	9.3	8.34	679	293	349	4.44	<0.34	357	23.5	65.9	<0.010	0.0116	0.0116	<0.0010	76.3	40.3	3.95	22.1	0.065	408	9	0.65	7.9	8.19	1.8	104	411	12
		Spring Melt		07-Jun-18	1.65	8.61	1070	236	260	13.6	<0.34	468	84.2	246	0.02	0.046	0.044	0.0023	58.3	78.4	7.33	78.2	0.111	694	2.9	0.6	12.2	13	2.9	106	5900	73
		Spring Melt	SW100	07-Jun-18	1.81	8.61	1070	238	263	13.9	<0.34	471	77.7	219	0.02	0.045	0.045	<0.0020	59.1	78.5	7.52	79.9	0.109	665	<2.0	0.62	11.5	13.1	6.3	113	2420	66

Notes:

"-" = No Data
"*" = Detection Limit Adjusted For Sample Matrix Effects
E.C. = Electrical Conductivity
T.K.N. = Total Kjeldahl Nitrogen
T.D.S. = Total Dissolved Solids
T.S.S. = Total Suspended Solids

1. See Figure HM95-1 for sample locations.
2. All values are expressed in milligrams per litre (mg/L) unless indicated otherwise.
3. Guideline for un-ionized ammonia is 0.019 mg/L, which is equivalent to 16 µg ammonia-N /L (=19*14.0067 / 17.35052, rounded t
   Guideline for total ammonia is temperature and pH dependent, See below table.

	pH							
Temp (^{o}C)	**6**	**6.5**	**7**	**7.5**	**8**	**8.5**	**9**	**10**
0	231	73	23.1	7.32	2.33	0.749	0.25	0.042
5	153	48.3	15.3	4.84	1.54	0.502	0.172	0.034
10	102	32.4	10.3	3.26	1.04	0.343	0.121	0.029
15	69.7	22	6.98	2.22	0.715	0.239	0.089	0.026
20	48	15.2	4.82	1.54	0.499	0.171	0.067	0.024
25	33.5	10.6	3.37	1.08	0.354	0.125	0.053	0.022
30	23.7	7.5	2.39	0.767	0.256	0.094	0.043	0.021

4. Canadian Council of Ministers of the Environment. Canadian Environmental Quality Guidelines, 1999. Update 2012.
   Chapter 4 -Aquatic Life

BOLD - Exceedance of Criteria

5. Turbidity Guidelines Narrative (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 8 NTUs from background levels for a short-term exposure (e.g. 24 hr period).
   Maximum average increase of 2 NTUs from background levels for a longer exposure (e.g. 30 d period).
   High Flow or Turbid Waters:
   Maximum increase of 8 NTUs from background levels at any one time when background levels are between 8 and 80 NTUs.
   Should not increase more than 10% of background levels when background is >80 NTUs.
6. Chloride toxicity to freshwater organisms was evaluated using tests with both $CaCl_2$ and NaCl salts.
   a. Long-term exposure - May not be protective of certain species of endangered and special concern freshwater mussels. Refer to fact sheet for more explanation
   b. Short-term exposure - derived with severe-effect data (such as lethality) and are not intended to protect all components of aquatic ecosystem structure and function but rather to protect most species against lethality during severe but transient events. Refer to fact sheet for more information.
7. Suspended Sediments Guidelines (see fact sheet for complete details):
   Clear Flow:
   Maximum increase of 25 mg/L from background levels for any short-term exposure (e.g.. 24 hr period).
   Maximum average increase of 5 mg/L from background levels for longer term exposures (e.g.. Inputs lasting between 24 hrs and 30 days).
   High Flow:
   Maximum increase of 25 mg/L from background levels at any time when background levels are between 25 and 250 mg/L.
   Should not increase more than 10% of background levels when background is >250 mg/L.
8. Bacteria sample taken on March 29, 2016
9. If trigger ranges for total phosphorous are exceeded, the potential exists for an environmental impact. If trigger range is not exceeded, but TP is more than 50% above baseline values, the potential exists for an environmental impact.

Trigger ranges (mg/L):				
	ultra-oligotrophic	<0.004	meso-eutrophic	0.020-0.035
	oligotrophic	0.004-0.010	eutrophic	0.035-0.10
	mesotrophic	0.010-0.020	hyper-eutrophic	>0.10

TABLE D6-3
2016-2018 GENERAL GROUNDWATER QUALITY DATA

Location	Well ID	Duplicate	Date	Parameter [1]																								Comments
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Sulphate	Nitrate & Nitrite as N	Nitrate as N	Nitrite as N	Calcium	Magnesium	Potassium	Sodium	T.D.S. (calc.) [8]	Total Cation	Total Anion	Cation-Anion Balance (%) [9,10]	Ion Balance	Total Coliform (MPN/100 mL) [6, 11]	E.coli (MPN/100 mL) [6,11]	
			EQL	*0.05*	*0.01*	*0.4*	*1*	*2*	*0.6*	*0.4*	*0.07*	*9*	*9*	*0.005-0.01*			*0.05*	*0.01*	*0.05*	*0.02*	*5*	-	-	-	-	*0*	*0*	
			HC-CDWQ [2]																									
			Drinking Water [3]	0.3/ 1.0/ 0.1 [4]	7.0 - 10.5 (AO)	-	-	-	-	-	80-100 [5] (AO)	250 (AO)	500 (AO)	-	10 [7]	1.0 [7]	-	-	-	200 (AO)	500 (AO)	-	-	-	-	0 per 100 mL	0 per 100 mL	-
Rockhaven Rd.	K13-12321	-	28-Mar-2016	3.11	7.39	974	408	498	<0.60	<0.34	497	44.6	79.2	2.33	2.33	<0.0010	74.2	75.9	4.88	27.3	561	11.3	11.2	0.1	100	11	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	<1	-
		-	2-Jun-2016	0.41	7.30	1710	506	617	<0.60	<0.34	882	243	93.7	3.25	3.25	<0.0020	113	146	6.55	69.8	990	20.9	19.1	4.3	109	<1	<1	-
		-	2-Mar-2017	0.30	7.17	1780	576	703	<0.60	<0.34	938	236	87.2	4.48	4.48	<0.0050	122	154	6.32	67.8	1020	21.9	20.3	3.7	108	<1	<1	-
		-	5-Apr-2017	0.33	7.57	1030	445	542	<0.60	<0.34	552	40.4	75.6	2.89	2.89	<0.0020	78.2	86.6	4.89	27.6	580	12.4	11.8	2.3	105	2	<1	-
		-	20-Apr-2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-
		-	11-May-2017	16	7.3	1440	542	661	<0.60	<0.34	792	141	86.9	3.31	3.31	<0.0050	105	129	6.13	42.9	836	17.9	16.9	2.9	106	<1	<1	-
		-	15-Mar-2018	43	7.55	1030	546	666	<0.60	<0.34	693	63.3	82.1	6.83	6.83	0.0074	92.8	112	5.18	30.6	714	15.3	14.9	1.4	103	<1	<1	-
		-	30-Apr-2018	3	7.37	1100	500	610	<0.60	<0.34	613	50.1	80.6	3.78	3.78	0.0011	83.6	98.1	5.11	30.2	648	13.7	13.4	1.2	102	<1	<1	-
		-	7-Jun-2018	5	7.55	1150	510	622	<0.60	<0.34	670	55.4	98.9	5.55	5.55	<0.0020	89.6	108	5.16	29.4	717	14.2	14.8	1.9	104	<1	<1	-
Outlet Structure	K09-12316	-	28-Mar-2016	0.27	7.51	775	312	381	<0.60	<0.34	372	30.6	75.6	1.56	1.56	<0.0010	62.8	52.3	4.33	24.5	444	8.61	8.79	-1	98	22	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	2	-
		-	2-Jun-2016	0.17	7.63	853	359	438	<0.60	<0.34	482	30.6	64.1	1.57	1.57	<0.0010	74.8	71.7	4.47	21.6	490	10.7	9.49	5.9	113	1	<1	-
		-	3-Mar-2017	<0.10	7.32	893	432	527	<0.60	<0.34	523	29.5	59.0	1.8	1.80	<0.0010	77.8	79.8	4.60	21.3	539	11.5	10.8	3	106	<1	<1	-
		MW100	3-Mar-2017	0.11	7.32	900	430	524	<0.60	<0.34	521	29.5	58.8	1.81	1.81	<0.0010	77.8	79.3	4.49	21.2	537	11.4	10.8	3	106	<1	<1	-
		-	5-Apr-2017	0.28	7.72	804	323	393	<0.60	<0.34	398	34.5	73.2	0.832	0.832	<0.0020	64.3	57.6	4.42	28.8	456	9.32	9	1.7	104	2	1	-
		MW-100	5-Apr-2017	0.19	7.61	802	324	395	<0.60	<0.34	406	34.7	73.0	0.838	0.836	0.0021	64.3	59.6	4.53	29.9	460	9.53	9.03	2.7	106	1	<1	-
		-	20-Apr-2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	<1	-
		-	11-May-2017	0.25	7.5	844	381	465	<0.60	<0.34	452	28.5	63.4	1.49	1.48	0.008	74.2	64.8	4.46	21.7	486	10.1	9.85	1.2	102	<1	<1	-
		-	15-Mar-2018	0.19	7.62	790	428	522	<0.60	<0.34	509	30.4	60.9	2.29	2.29	0.0022	77.2	76.7	4.22	23.2	529	11.3	10.8	2	104	<1	<1	-
		-	30-Apr-2018	0.96	7.43	885	421	513	<0.60	<0.34	494	35.7	61.5	2.24	2.24	0.0013	75.8	74.1	4.29	24.8	528	11.1	10.9	1	102	<1	<1	-
		-	7-Jun-2018	0.12	7.53	908	414	505	<0.60	<0.34	512	33	60.8	2.29	2.29	<0.0020	78	77	4.26	23.5	535	10.6	11.4	3.3	107	<1	<1	-
PTH 44 Bridge	U09-13571	-	28-Mar-2016	0.14	7.43	940	347	423	<0.60	<0.34	427	58.2	95.4	1.64	1.64	<0.0010	69.3	61.7	4.89	38.1	543	10.3	10.7	-1.7	96.6	-	-	-
		-	5-Apr-2017	0.50	7.44	952	353	431	<0.60	<0.34	466	46.9	105	1.03	1.03	<0.0020	71.9	69.5	5.01	41.5	552	11.2	10.6	2.7	106	-	-	-
		-	30-Apr-2018	0.54	7.42	1010	400	488	<0.60	<0.34	509	62.1	102	1.85	1.85	<0.0010	76.8	77.2	4.83	44.6	607	12.2	12	1	102	-	-	-
Hay Rd.	K11-12018	-	28-Mar-2016	8.20	7.23	1130	593	723	<0.60	<0.34	636	2.29	102	<0.0051	<0.0050	<0.0010	92.4	98.5	5.19	27.8	683	14.1	14	0.1	100	-	-	-
		-	5-Apr-2017	2.88	7.19	1180	608	741	<0.60	<0.34	657	1.8	107	<0.010	<0.010	<0.0020	87.7	106	5.31	31.0	704	14.6	14.4	0.6	101	-	-	-
		-	30-Apr-2018	8.06	7.20	1090	603	736	<0.60	<0.34	654	2.5	102	<0.0051	<0.0050	<0.0010	89.6	105	5.03	28.9	695	14.5	14.3	0.8	102	-	-	-
Church Rd.	K09-12012	-	29-Mar-2016	73.3	7.44	1060	350	427	<0.60	<0.34	531	23.0	237	<0.0051	<0.0050	<0.0010	94.9	71.3	4.50	45.2	686	12.7	12.6	0.4	101	<1	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-
		-	2-Jun-2016	12.8	7.56	1020	311	379	<0.60	<0.34	530	21.0	238	<0.0051	<0.0050	<0.0010	86.3	76.5	4.50	46.8	660	12.8	11.8	4.1	108	<1	<1	-
		-	2-Mar-2017	226	7.36	1140	392	478	<0.60	<0.34	609	23.5	277	<0.010	<0.010	<0.0020	98.4	88.1	4.81	52.4	779	14.6	14.3	1	102	<1	<1	-
		-	7-Apr-2017	16.5	7.55	934	324	395	<0.60	<0.34	430	23.6	180	<0.010	<0.010	<0.0020	71.0	61.3	3.83	40.7	575	10.5	10.9	-2	96	1	<1	-
		-	20-Apr-2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	<1	-
		-	11-May-2017	0.5	7.47	1090	387	473	<0.60	<0.34	589	19.2	242	<0.010	<0.010	<0.0020	97.9	83.7	4.85	47.9	728	14	13.3	2.4	105	<1	<1	-
		-	15-Mar-2018	0.3	7.77	976	356	435	<0.60	<0.34	539	24.5	214	<0.010	<0.010	<0.0020	88.4	77.4	4.48	49	672	13	12.3	3	106	<1	<1	-
		S100	15-Mar-2018	0.3	7.66	902	361	440	<0.60	<0.34	528	24.5	216	<0.010	<0.010	<0.0020	85.7	76.2	4.49	48.9	672	12.8	12.4	1.6	103	<1	<1	-
		-	1-May-2018	10.8	7.52	953	337	411	<0.60	<0.34	462	24.4	192	<0.0051	<0.0050	<0.0010	74.4	67.2	4.33	45.9	611	11.4	11.4	-0.3	99.4	<1	<1	-
		-	7-Jun-2018	0.1	7.66	987	340	415	<0.60	<0.34	510	22.8	175	<0.010	<0.010	<0.0020	82.8	73.6	4.45	48	610	11.1	12.4	5.6	112	<1	<1	-
Ludwick Rd.	K09-12011	-	29-Mar-2016	0.82	8.02	454	235	286	<0.60	<0.34	230	7.98	15.4	<0.0051	<0.0050	<0.0010	47.4	27.1	2.62	9.54	251	5.08	5.23	-1.5	97	-	-	-
		MW100	29-Mar-2016	0.77	8.08	459	227	277	<0.60	<0.34	229	7.99	15.4	<0.0051	<0.0050	<0.0010	47.7	26.8	2.70	9.51	246	5.07	5.09	-0.2	99.7	-	-	-
		-	6-Apr-2017	1.13	7.73	463	241	294	<0.60	<0.34	239	7.12	14.9	<0.0051	<0.0050	0.0014	48.1	28.7	2.67	8.67	255	5.21	5.33	-1.2	97.7	-	-	-
		-	1-May-2018	1.18	7.67	449	236	288	<0.60	<0.34	235	7.56	14.8	0.0135	0.0135	<0.0010	47.1	28.5	2.60	9.01	251	5.15	5.24	-0.8	98.3	-	-	-
Dunning Rd.	K11-12017	-	29-Mar-2016	3.62	7.83	1080	265	324	<0.60	<0.34	520	21.9	305	<0.0051	<0.0050	<0.0010	95.3	68.4	3.93	48.0	702	12.6	12.3	1.2	102	-	-	-
		-	6-Apr-2017	2.55	7.56	970	262	320	<0.60	<0.34	476	20.0	255	<0.0051	<0.0050	<0.0010	82.6	65.5	3.86	45.0	630	11.6	11.1	2	104	-	-	-
		-	1-May-2018	2.38	7.52	995	264	322	<0.60	<0.34	479	20.0	282	<0.0051	<0.0050	<0.0010	79.9	67.9	3.81	47.2	659	11.7	11.7	0.1	100	-	-	-
Bray Rd.	K11-12016	-	29-Mar-2016	0.11	7.75	990	299	364	<0.60	<0.34	500	16.1	236	<0.0051	<0.0050	<0.0010	94.4	64.1	4.49	33.8	629	11.6	11.3	1	102	-	-	-
		-	6-Apr-2017	0.33	7.50	1010	300	366	<0.60	<0.34	522	14.6	254	<0.0051	<0.0050	<0.0010	92.7	70.5	4.45	37.5	654	12.2	11.7	2	104	-	-	-
		-	1-May-2018	1.04	7.52	967	307	375	<0.60	<0.34	519	21.5	230	<0.0051	<0.0050	<0.0010	88.7	72.2	4.73	39.2	641	12.2	11.5	2.8	106	-	-	-

TABLE D6-3
2016-2018 GENERAL GROUNDWATER QUALITY DATA

Location	Well ID	Duplicate	Date	Parameter (1)																								
				Turbidity (NTU)	pH (units)	E.C. (µS/cm)	Alkalinity as $CaCO_3$	Bicarbonate as HCO_3	Carbonate as CO_3	Hydroxide as OH	Hardness as $CaCO_3$	Chloride	Sulphate	Nitrate & Nitrite as N	Nitrate as N	Nitrite as N	Calcium	Magnesium	Potassium	Sodium	T.D.S. (calc.) (8)	Total Cation	Total Anion	Cation-Anion Balance (%) (9,10)	Ion Balance	Total Coliform (MPN/100 mL) (6, 11)	E.coli (MPN/100 mL) (6,11)	Comments
			EQL	*0.05*	*0.01*	*0.4*	*1*	*2*	*0.6*	*0.4*	*0.07*	*9*	*9*	*0.005-0.01*			*0.05*	*0.01*	*0.05*	*0.02*	*5*	-	-	-	-	*0*	*0*	
			HC-CDWQ (2)																									
			Drinking Water (3)	0.3/ 1.0/ 0.1 (4)	7.0 - 10.5 (AO)	-	-	-	-	-	80-100 (5) (AO)	250 (AO)	500 (AO)	-	10 (7)	1.0 (7)	-	-	-	200 (AO)	500 (AO)	-	-	-	-	0 per 100 mL	0 per 100 mL	-
PTH59N Bridge	K11-12014	-	30-Mar-2016	<0.10	7.63	573	247	301	<0.60	<0.34	299	13.6	57.6	0.252	0.252	<0.0010	59.9	36.3	3.82	6.53	327	6.36	6.53	-1.4	97.3	9	<1	-
		MW-101	30-Mar-2016	<0.10	7.67	575	249	304	<0.60	<0.34	309	13.6	57.7	0.249	0.249	<0.0010	63.2	36.6	3.85	6.57	332	6.55	6.58	-0.3	99.5	12	<1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<1	1	-
		-	2-Jun-2016	0.49	7.60	625	256	312	<0.60	<0.34	363	16.1	60.9	0.211	0.211	<0.0010	72.4	44.3	4.25	7.40	360	7.69	6.85	5.8	112	10	<1	-
		-	3-Mar-2017	0.71	7.39	687	320	391	<0.60	<0.34	397	12.6	67.6	0.159	0.159	<0.0010	80.3	47.7	4.44	7.14	413	8.36	8.18	1.1	102	<1	<1	-
		-	6-Apr-2017	2.35	7.73	531	208	254	<0.60	<0.34	269	11.7	64.7	0.372	0.372	<0.0010	52.7	33.4	4.35	9.19	301	5.89	5.87	0.2	100	17	1	-
		-	20-Apr-2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	<1	-
		-	11-May-2017	1.50	7.52	672	303	370	<0.60	<0.34	379	12.3	65.4	0.314	0.314	<0.0010	75.6	46.3	4.48	7.98	394	8.04	7.79	1.6	103	<1	<1	-
		K11-100	11-May-2017	1.60	7.48	678	302	368	<0.60	<0.34	385	12.2	65.9	0.321	0.321	<0.0010	76.8	47	4.58	8.11	396	8.17	7.77	2.5	105	<1	<1	-
		-	15-Mar-2018	2.66	7.77	582	283	345	<0.60	<0.34	356	18.3	55.1	0.112	0.112	<0.0010	69.6	44.3	4.12	8.84	370	7.61	7.33	1.9	104	<1	<1	-
		-	1-May-2018	0.76	7.63	600	272	332	<0.60	<0.34	338	15.6	52.1	0.1	0.099	0.0012	60	45.8	4.46	8.09	350	7.23	6.97	1.8	104	<1	<1	-
		MW-100	1-May-2018	1.13	7.64	599	269	329	<0.60	<0.34	332	16	51.4	0.0954	0.0954	<0.0010	60.8	43.7	4.16	7.52	346	7.06	6.92	1	102	<1	<1	-
		-	7-Jun-2018	0.55	7.61	689	311	379	<0.60	<0.34	408	13.3	61.5	0.146	0.145	0.001	76.6	52.7	4.39	7.73	403	7.88	8.61	4.4	109	1	<1	-
	K11-12015	-	30-Mar-2016	0.32	7.78	532	222	270	<0.60	<0.34	269	16.7	50.5	0.207	0.207	<0.0010	54.2	32.4	3.89	6.72	298	5.76	5.96	-1.7	96.7	9	1	-
		-	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4	<1	-
		MW-100	21-Apr-2016	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5	<1	-
		-	2-Jun-2016	0.93	7.72	596	236	288	<0.60	<0.34	337	16.9	64.6	0.076	0.0733	0.0027	66.2	41.7	4.22	7.36	343	7.16	6.55	4.5	109	5	<1	-
		-	2-Mar-2017	0.22	7.64	614	267	326	<0.60	<0.34	349	14.6	58.3	0.0486	0.0486	<0.0010	68.8	43.0	4.16	6.43	355	7.36	6.97	2.7	106	<1	<1	-
		-	6-Apr-2017	1.44	7.79	489	191	233	<0.60	<0.34	249	12.6	55.4	0.474	0.474	<0.0010	49.3	30.5	3.96	9.14	276	5.47	5.36	1	102	12	2	-
		-	20-Apr-2017	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3	<1	-
		-	11-May-2017	0.21	7.68	615	248	302	<0.60	<0.34	331	14.9	78.9	0.143	0.128	0.0153	63.9	41.7	4.44	8.94	361	7.12	7.02	0.7	101	<1	<1	-
		-	15-Mar-2018	0.23	7.77	594	276	336	<0.60	<0.34	364	17.9	68.4	0.0641	0.0627	0.0014	73.1	44.1	4.28	8.09	381	7.74	7.44	2	104	<1	<1	-
		-	1-May-2018	0.56	7.62	590	252	307	<0.60	<0.34	310	18.7	54	0.0527	0.0527	<0.0010	59.7	39.1	4.13	7.56	334	6.63	6.69	-0.4	99.2	<1	<1	-
		-	7-Jun-2018	0.23	7.64	677	277	338	<0.60	<0.34	382	16	77.5	0.042	0.042	<0.0020	77.2	46	4.15	8.43	396	7.61	8.11	3.2	107	<1	<1	-
		K11-100	7-Jun-2018	0.22	7.71	673	283	345	<0.60	<0.34	387	16	78	0.0348	0.0348	<0.0010	78.7	46.3	4.25	8.48	401	7.73	8.22	3	106	<1	<1	-
McGregor Farm Rd.	K13-12322	-	30-Mar-2016	0.84	7.60	741	247	302	<0.60	<0.34	356	16.1	148	<0.0051	<0.0050	<0.0010	61.9	48.8	3.36	23.3	450	8.2	8.48	-1.7	96.7	-	-	-
		-	6-Apr-2017	0.75	7.62	796	264	322	<0.60	<0.34	400	16.1	162	<0.0051	<0.0050	<0.0010	68.5	55.7	3.79	27.8	492	9.31	9.1	1.1	102	-	-	-
		-	2-May-2018	1.50	7.67	816	261	318	<0.60	<0.34	416	16.9	184	<0.0051	<0.0050	<0.0010	71.5	57.6	3.80	28.9	519	9.66	9.52	0.7	102	-	-	-
Inlet Control Structure	G050C006	-	30-Mar-2016	38.4	7.84	2340	206	252	<0.60	<0.34	477	539	295	<0.051	<0.050	<0.010	95.5	57.9	12.8	325	1450	24	25.5	-3	94.1	1	0	-
		-	7-Apr-2017	37.0	7.75	2240	233	285	<0.60	<0.34	467	422	282	<0.051	<0.050	<0.010	89.2	59.4	12.3	304	1310	22.9	22.4	1	102	0	0	-
		-	2-May-2018	38.8	7.84	2230	223	272	<0.60	<0.34	459	451	278	<0.025	<0.025	<0.0050	91.5	56.0	12.0	326	1350	23.7	23	1.4	103	3	0	-

Notes:
EQL = Estimated Quantitation Limit = The lowest level of the parameter that can be quantified with confidence
E.C. = Electrical Conductivity
"-" = No Data

1. All values are expressed in milligrams per litre (mg/L) unless indicated otherwise.
2. Health Canada - Canadian Drinking Water Quality Guidelines (HC-CDWQ). Updated February 2017.
3. Guidelines for Canadian Drinking Quality, February 2017. Water and Air Quality Bureau, Healthy Environments and Consumer Safety Branch, Health Canada, Ottawa, Ontario. Prepared by the Federal-Provincial-Territorial Committee on Drinking Water.
   MAC = Maximum Acceptable Concentration = The maximum concentration of a parameter that is designed to protect those individuals most at risk, such as children and the elderly.
   AO = Aesthetic Objective = A guideline which addresses a parameter that may affect consumer acceptance of drinking water, such as taste, odour, and colour.
4. Waterworks systems that use a surface water source or a groundwater source under the direct influence of surface water should filter the source water to meet the following health-based turbidity limits, as defined for specific treatment technologies.
   Where possible, filtration systems should be designed and operated to reduce turbidity levels as low as possible, with a treated water turbidity target of less than 0.1 NTU at all times. Where this is not achievable, the treated water turbidity levels from individual filters:
   a) For chemically assisted filtration, shall be less than or equal to 0.3 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 1.0 NTU at any time.
   b) For slow sand or diatomaceous earth filtration, shall be less than or equal to 1.0 NTU in at least 95% of the measurements made, or at least 95% of the time each calendar month, and shall not exceed 3.0 NTU at any time.
   c) For membrane filtration, shall be less than or equal to 0.1 NTU in at least 99% of the measurements made, or at least 99% of the time each calendar month, and shall not exceed 0.3 NTU at any time. If membrane filtration is the sole treatment technology employed, some form of virus inactivation* should follow the filtration process.
5. Public acceptance of hardness varies considerably. Generally, hardness levels between 80 and 100 mg/L (as CaCO3) provide acceptable balance between corrosion and incrustation;
   Where water is softened by sodium ion exchange, it is recommended that a separate, unsoftened supply be retained for culinary and drinking purposes.
6. Total Coliform and E.coli analyzed by Low Level Quantitray Method TC/EC QT97.
7. Systems using chloramine disinfection or that have naturally occurring ammonia should monitor the level of nitrate/nitrite in the distribution system. Homeowners with a well should test the concentration of nitrate/nitrite in their water supply.
8. ALS Laboratory reports total dissolved solids (calculated) as the sum of cations plus anions using the following formula (mg/L).
9. Cation Anion balance = $\frac{\text{sum of meq of Cations - sum of meq of Anions}}{\text{sum of meq of Cations + sum of meq Anions}} \times 100 = \%$
10. Cation-anion balances greater than the absolute 10% are highlighted for reference only.
11. Detection of total coliforms should be investigated in consecutive samples from the same site, or from more than 10% of collected samples in a given sampling period.

-Exceedance of HC- CDWQ Drinking Water

TABLE D6-4
2018 WATER QUALITY ASSESSMENT - INSTRUMENTED WELLS

WELL ID	PROGRAM	CONDUCTIVITY							NITRATE			E. COLI	
		PRE-MELT CONDUCTIVITY (March 15, 2018)	SPRING MELT CONDUCTIVITY (April 30, 2018)	% CHANGE [3]	CHANGE IS GREATER THAN 5%[2]	MAGNITUDE OF WATER QUALITY CHANGE [1]	WELL HAS PRE-MELT GROUNDWATER CONDUCTIVITY VALUES SIMILAR TO THE FLOODWAY CHANNEL SURFACE WATER DURING THE FLOOD	CONDUCTIVITY VALUES FOR GROUNDWATER DO NOT CHANGE ASSOCIATED WITH THE SPRING MELT EVENT	PRE-MELT NITRATE PLUS NITRITE (as N) (March 15, 2018)	SPRING FLOOD NITRATE PLUS NITRITE (as N) (April 30, 2018)	% CHANGE [3]	E.COLI DETECTED IN A DISINFECTED WELL IN PRE-MELT SAMPLING	E. COLI DETECTED IN A DISINFECTED WELL IN SPRING FLOOD PEAK SAMPLING
K13-12321[4]	Program A	1030	1100	-6	No	N/A	No	Yes	6.83	3.78	81	No	No
K09-12316	Program A	790	885	-11	No	N/A	No	Yes	2.29	2.24	2	No	No
K09-12012	Program A	976	953	2	No	N/A	No	Yes	<0.01	<0.005	0	No	No
K11-12014	Program A	582	600	-3	No	N/A	No	Yes	0.112	0.1	12	No	No
K11-12015	Program A	594	590	1	No	N/A	No	Yes	0.0641	0.0527	22	No	No

Notes:
1. Magnitude of water quality change: Type A (>50% change), Type B (25% to 50% change). Type C (10% to 25% change), Type D (5% to 10%) change
2. Changes of ≤ 5% are considered to be within the accuracy of the analysis and are considered "no change" for purposes of this analysis.
3. Negative % change values indicate higher concentrations for spring melt peak vs pre-melt sampling. Increasing conductivity is not an indicator of surface water intrusion in this analysis.
Increasing nitrate is not considered to be an indicator of surface water intrusion at locations near Lockport and the Outlet. Decreasing nitrate is not considered to be an indicator of surface water intrusion at other locations.
4. Conductivity may not be representative since total dissolved solid and other parameters decreased.

- Positive Water quality change in conductivity >5% detected, or decrease in nitrate (Outlet and Lockport) or increase in nitrate (other locations).

TABLE D6-4
2018 WATER QUALITY ASSESSMENT - INSTRUMENTED WELLS

TABLE D6-5
2018 WATER QUALITY ASSESSMENT - NON-INSTRUMENTED WELLS

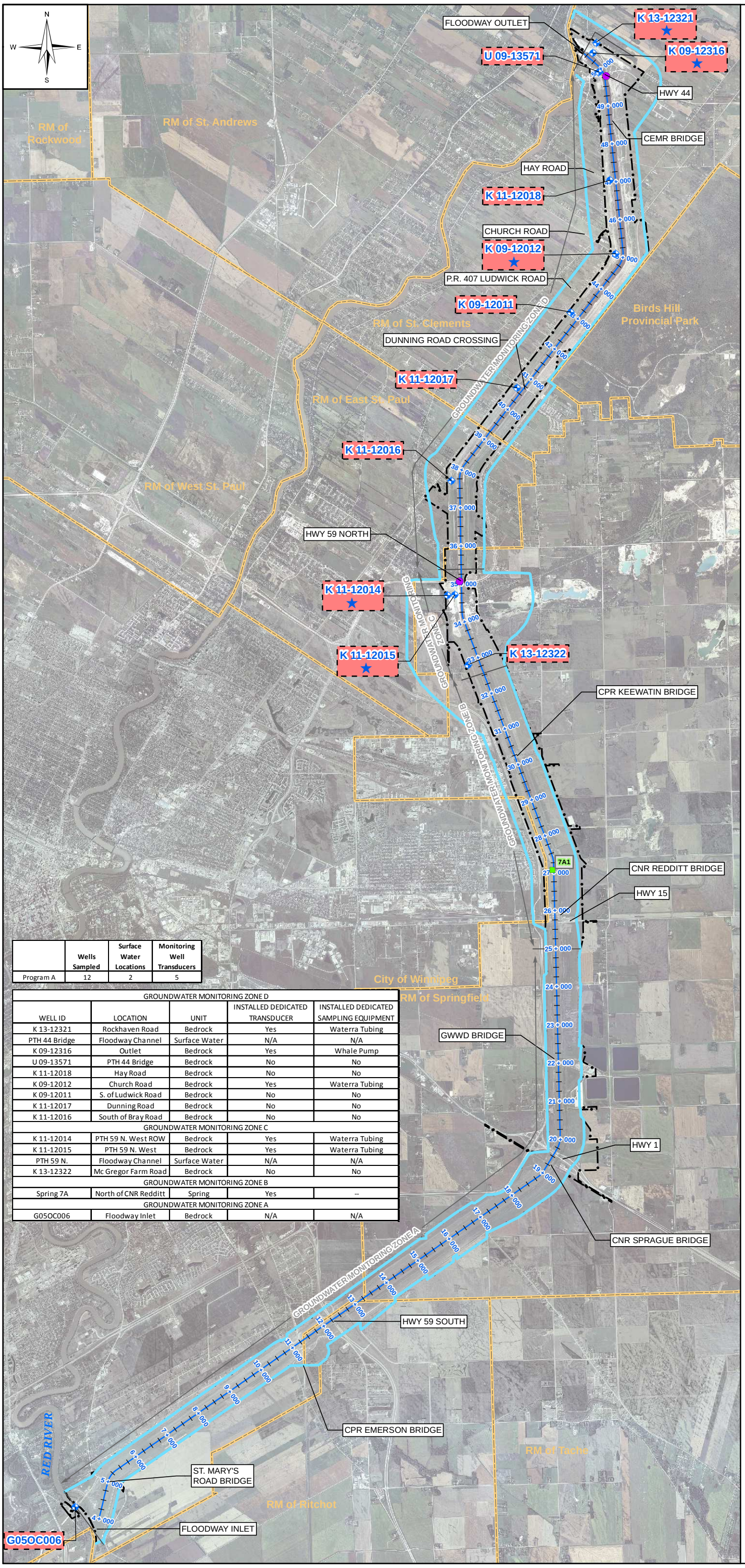
WELL ID	PROGRAM	CONDUCTIVITY							NITRATE		
		PRE-MELT CONDUCTIVITY PREVIOUS YEAR (2011, 2013 or 2014)	SPRING MELT CONDUCTIVITY (April 30-May 1, 2018)	% CHANGE [3]	CHANGE IS GREATER THAN 5%[2]	MAGNITUDE OF WATER QUALITY CHANGE [1]	WELL HAS PRE-MELT GROUNDWATER CONDUCTIVITY VALUES SIMILAR TO THE FLOODWAY CHANNEL SURFACE WATER DURING THE FLOOD	CONDUCTIVITY VALUES FOR GROUNDWATER DO NOT CHANGE ASSOCIATED WITH THE SPRING MELT EVENT	PRE-MELT NITRATE PREVIOUS YEAR (2013 or 2014)	SPRING MELT NITRATE PLUS NITRITE (as N) (April 30 - May 1, 2018)	% CHANGE [3]
U09-13571	Program A	1170	1010	16	Yes	C	No	No	1.42	1.03	38
K11-12018	Program A	1090	1090	0	No	-	No	Yes	<0.0050	<0.01	0
K09-12011	Program A	465	449	4	No	-	Yes	Yes	<0.0051	<0.0051	0
K11-12017	Program A	1080	995	9	Yes	C	No	No	<0.0051	<0.0051	0
K11-12016	Program A	1050	967	9	Yes	C	No	No	<0.0050	<0.0051	0
K13-12322	Program A	880	816	8	Yes	C	No	No	0.0116	<0.0051	127
G050C006	Program A	2890	2230	30	Yes	B	No	No	<0.35	<0.051	0

Notes:
1. Magnitude of water quality change: Type A (50% change), Type B (25 to 50% change). Type C (10% to 25% change), Type D (5 to 10%) change
2. Changes of ≤ 5% are considered to be within the accuracy of the analysis and are considered "no change" for purposes of this analysis.
3. Negative % change values indicate higher concentrations for flood peak vs pre-melt sampling. Increasing conductivity is not an indication of surface water intrusion in this analysis. Increasing nitrate is not considered to be an indicator of surface water intrusion at locations near Lockport and the Outlet. Decreasing nitrate is not considered to be an indicator of surface water intrusion at other locations.
4. Pre-melt value for previous years may not be representative of 2018; therefore, percent change may not be valid.
5. Change may not be valid due to low detection limits.

- Positive water quality change in conductivity > 5% detected, or decrease in nitrate (Outlet and Lockport) or increase in nitrate (other locations).

FIGURES

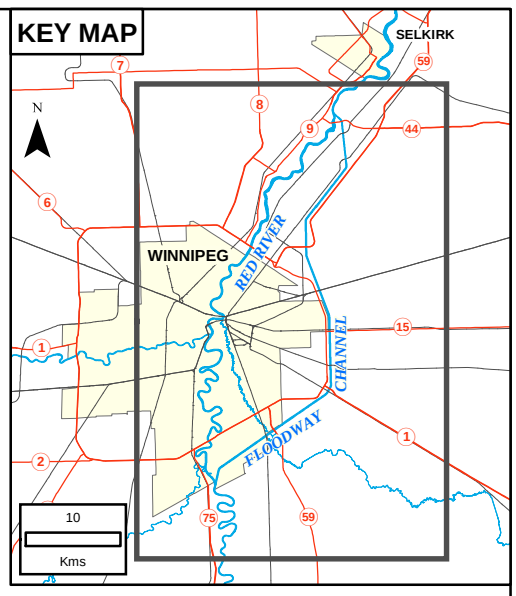
P:\Projects\2016\16-0300-002\Dwg\GIS\MXDs\Deliverable_D6\Rev0\16-0300-002_FigD6-1_Rev0.mxd



	Wells Sampled	Surface Water Locations	Monitoring Well Transducers
Program A	12	2	5

GROUNDWATER MONITORING ZONE D				
WELL ID	LOCATION	UNIT	INSTALLED DEDICATED TRANSDUCER	INSTALLED DEDICATED SAMPLING EQUIPMENT
K 13-12321	Rockhaven Road	Bedrock	Yes	Waterra Tubing
PTH 44 Bridge	Floodway Channel	Surface Water	N/A	N/A
K 09-12316	Outlet	Bedrock	Yes	Whale Pump
U 09-13571	PTH 44 Bridge	Bedrock	No	No
K 11-12018	Hay Road	Bedrock	No	No
K 09-12012	Church Road	Bedrock	Yes	Waterra Tubing
K 09-12011	S. of Ludwick Road	Bedrock	No	No
K 11-12017	Dunning Road	Bedrock	No	No
K 11-12016	South of Bray Road	Bedrock	No	No
GROUNDWATER MONITORING ZONE C				
K 11-12014	PTH 59 N. West ROW	Bedrock	Yes	Waterra Tubing
K 11-12015	PTH 59 N. West	Bedrock	Yes	Waterra Tubing
PTH 59 N.	Floodway Channel	Surface Water	N/A	N/A
K 13-12322	Mc Gregor Farm Road	Bedrock	No	No
GROUNDWATER MONITORING ZONE B				
Spring 7A	North of CNR Redditt	Spring	Yes	--
GROUNDWATER MONITORING ZONE A				
G05OC006	Floodway Inlet	Bedrock	N/A	N/A

KEY MAP



Legend

- Spring Treatment Site
- Monitoring Wells
- K11-12015 — Core Monitoring Well Location
- Instrumented Monitoring Well Location (5 Wells)
- Surface Water Sampling Location
- Proposed Groundwater Monitoring Boundary
- 4 + 000 — Floodway Channel Station
- Floodway Right of Way Limits
- RM Boundary

NOTES:
1. Instrumented monitoring well locations includes well disinfection, dedicated pumps and transducers, and analysis of dissolved oxygen and bacteria.
2. Imagery from the Manitoba Land Initiative website, and dated 2008-2010.

1 0 1 2 3
Kilometers

SCALE: 1:100,000 METRIC 11"x17"

All units are metric and in metres unless otherwise specified.
Transverse Mercator Projection, NAD 1983, Zone 14.
Elevations are in metres above sea level (MSL).

NO.	YY/MM/DD	DESCRIPTION	ISSUED BY	CHECK BY
0	18/12/19	ISSUED WITH FINAL REPORT	MPS	BAT

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY LONG TERM MONITORING PROGRAM – 2018 PROGRAM A MONITORING REPORT

PROGRAM A MONITORING WELL LOCATIONS

DECEMBER 2018 | FIG D6-1 | REV: 0

APPENDIX D6-A

FLOODWAY OPERATION AND RED RIVER WATER QUALITY

APPENDIX D6-A-1

TABLE D6-A-1 SUMMARY OF OBSERVED FLOW IN THE FLOODWAY DURING SPRING AND SUMMER OPERATION

TABLE D6-A-1
SUMMARY OF OBSERVED FLOW IN FLOODWAY DURING SPRING AND SUMMER OPERATION

Year	Spring Operation					Summer Operation					Comments
	Peak Flow (cms)	Date of Peak Flow	Start of Operation	End of Operation	No. of Days of Operation	Peak Flow (cms)	Date of Peak Flow	Start of Operation	End of Operation	No. of Days of Operation	
1969	626	May 3	April 14	May 18	35	-	-	-	-	-	
1970	646	May 1	April 17	May 21	35	-	-	-	-	-	
1971	257	April 14	April 11	April 21	11	-	-	-	-	-	
1972	33.4	April 18	April 14	April 21	8	-	-	-	-	-	
1973	-	-	-	-	-	-	-	-	-	-	
1974	1040	April 24 & 25	April 17	May 17	31	-	-	-	-	-	
			May 21	May 30	10						
1975	267	May 7 & 8	April 30	May 19	20	-	-	-	-	-	
1976	292	April 11	April 7	April 18	12	-	-	-	-	-	
1977	-	-	-	-	-	-	-	-	-	-	
1978	513	April 16	April 9	May 3	25	-	-	-	-	-	
1979	1190	May 9	April 19	May 29	41	-	-	-	-	-	
1980	-	-	-	-	-	-	-	-	-	-	
1981	-	-	-	-	-	-	-	-	-	-	
1982	17.8	April 18	April 15	April 21	7	-	-	-	-	-	
1983	26.4	April 11	April 9	April 13	5	-	-	-	-	-	
1984	-	-	-	-	-	-	-	-	-	-	
1985	-	-	-	-	-	-	-	-	-	-	
1986	278	April 3	April 1	April 14	14	-	-	-	-	-	
			May 6	May 11	6						
1987	507	April 10	April 5	April 18	14	-	-	-	-	-	
1988	-	-	-	-	-	-	-	-	-	-	
1989	136	April 24	April 21	May 1	11	-	-	-	-	-	
1990	-	-	-	-	-	-	-	-	-	-	
1991	-	-	-	-	-	-	-	-	-	-	
1992	101	April 8	April 7	April 12	6	-	-	-	-	-	
1993	-	-	-	-	-	-	-	-	-	-	
1994	-	-	-	-	-	-	-	-	-	-	
1995	387	March 29	March 22	April 25	35	-	-	-	-	-	
1996	1100	April 30 & May 1 & 2	April 18	June 9	53	-	-	-	-	-	
1997	1880	May 3 & 4	April 19	June 2	45	-	-	-	-	-	
1998	191	April 1	March 30	April 6	8	-	-	-	-	-	
1999	445	April 16	April 3	May 1	29	-	-	-	-	-	
2000	-	-	-	-	-	-	-	-	-	-	
2001	598	April 28	April 5	May 20	46	-	-	-	-	-	
2002	-	-	-	-	-	159	July 6	June 13	June 25	13	
								July 4	July 10	7	
								July 17	July 26	10	
2003	-	-	-	-	-	-	-	-	-	-	
2004	446	April 5	March 31	April 21	22	294	June 12	June 10	June 30	21	
2005	433	April 8	April 2	April 22	21	657	July 4	June 9	July 24	46	
								July 31	August 3	5	
2006	941	April 15	April 5	May 7	33	-	-	-	-	-	
2007	119	April 12	April 3	April 16	14	23	June 29	June 28	July 2	5	Summer Flood was with no operation
2008	-	-	-	-	-	-	-	-	-	-	
2009	1208	April 21	April 8	May 24	47	-	-	-	-	-	
2010	450	April 6	March 28	April 22	25	345	June 4	May 30	June 16	18	
2011	1019	May 4	April 9	June 2	55	64	July 10	July 7	July 15	8	
2012	-	-	-	-	-	-	-	-	-	-	-
2013	444	May 4	April 29	June 7	41	-	-	-	-	-	
2014	142	April 21	41748	41756	9.0	68.0	July 5	June 30	July 13	14.0	Spring Flood was with no operation
2015	-	-	-	-	-	-	-	-	-	-	
2016	-	-	-	-	-	-	-	-	-	-	
2017	635	April 6	March 31	April 21	22	-	-	-	-	-	
2018	-	-	-	-	-	-	-	-	-	-	

Data is based on recorded flows from the Water Survey of Canada Gauge 05OC017 except for the 2006 data which is based on the Province of Manitoba's Daily Flood Forecast Reports

APPENDIX D6-A-2

REAL-TIME HYDROGRAPH DATA GRAPH FOR RED RIVER ABOVE FLOODWAY CONTROL STRUCTURE (05OC021), ENVIRONMENT CANADA

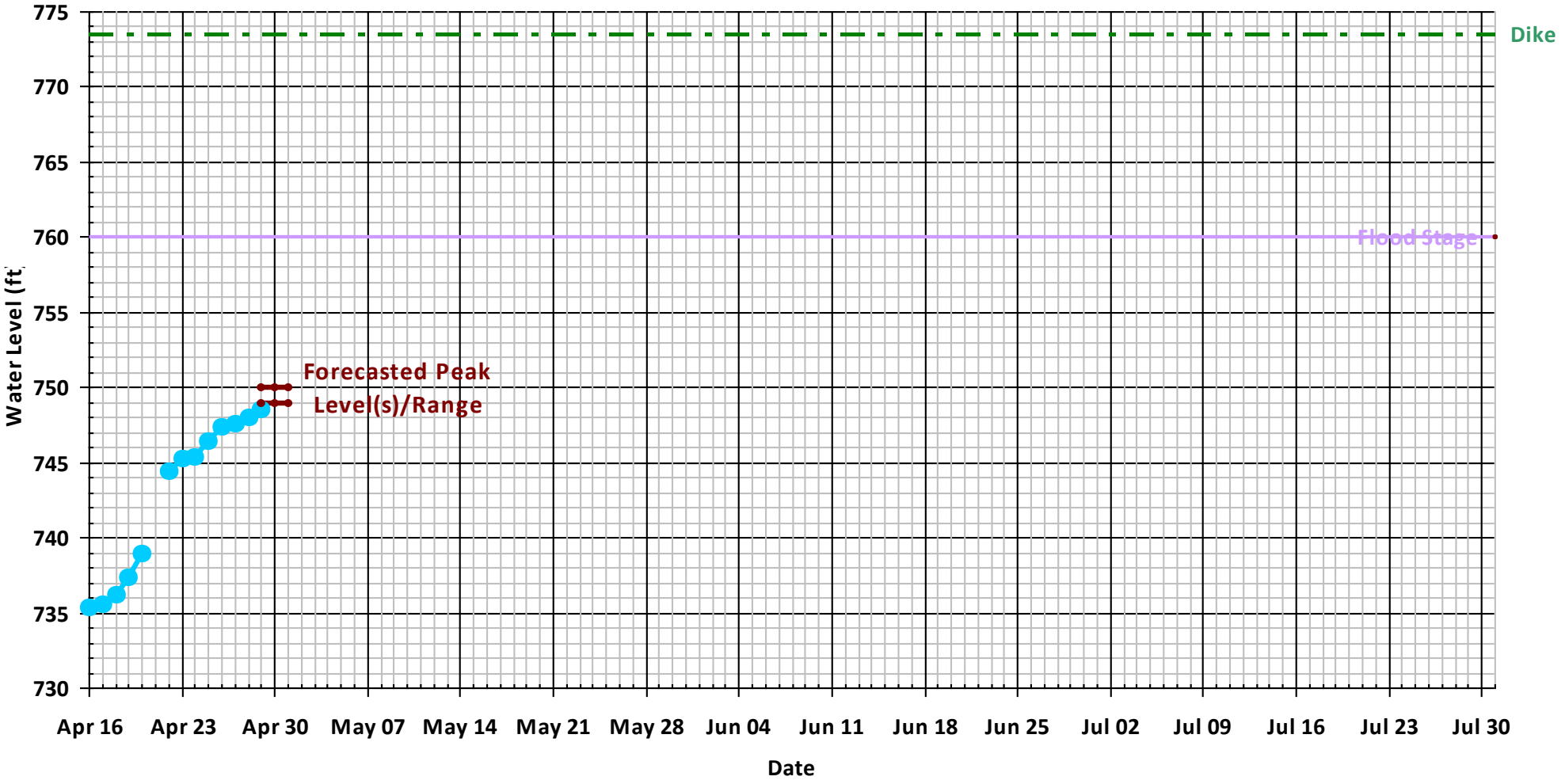
Hydrologic Forecasting and Water Management

Apr 29, 2018

http://www.gov.mb.ca/mit/floodinfo

Flood Hydrograph - Imperial

Red River: Above Floodway Inlet - Actual



Today's Level: 748.52 ft

Current Forecast: 749 - 750 ft, April 29 - May 1

Reference Year 1: 2010

Reference Year 2: 2013

Last Year: 2017

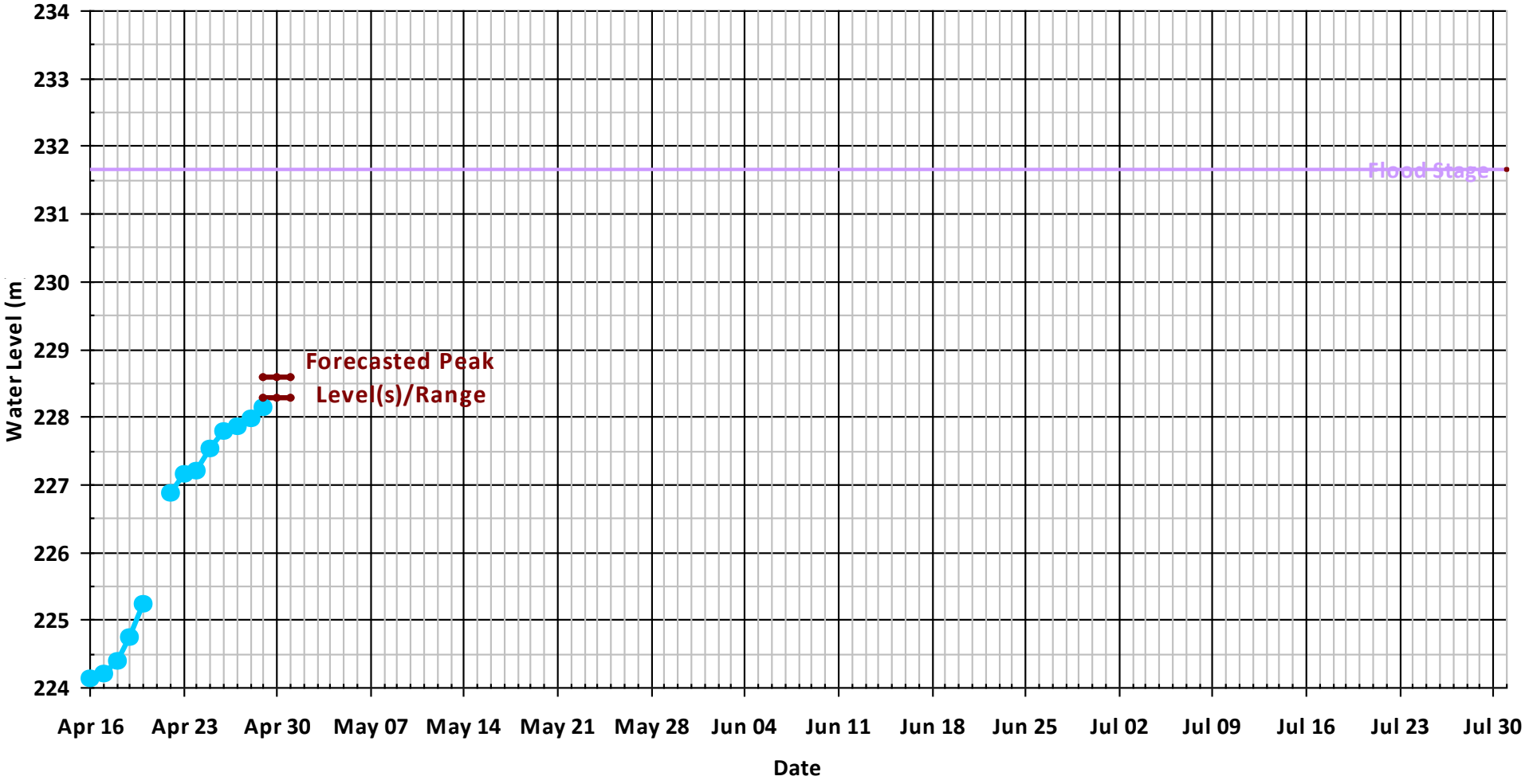
Hydrologic Forecasting and Water Management

Apr 29, 2018

http://www.gov.mb.ca/mit/floodinfo

Flood Hydrograph - Metric

Red River: Above Floodway Inlet - Actual



Today's Level: 228.15 m

Current Forecast: 228.295 - 228.6 m, April 29 - May 1

Reference Year 1: 2010

Reference Year 2: 2013

Last Year: 2017

APPENDIX D6-A-3

FLOOD REPORT AND DAILY FLOOD SHEET APRIL 30, 2018, MANITOBA SUSTAINABLE DEVELOPMENT

Manitoba
Infrastructure

FLOOD REPORT FOR MANITOBA

April 30, 2018 – 9:00 am

Summary

- Flows are still increasing on the Saskatchewan River upstream in Saskatchewan. Forecasting staff from Manitoba and Saskatchewan are coordinating and a forecast for the Saskatchewan River in Manitoba will be available soon.

- The Portage Diversion remains closed and it is not expected to be used this season. As of this morning, flow on the Assiniboine River downstream of the diversion is approximately 8,510 cfs (240 cms).

- The Red River upstream of the Floodway Inlet is near crest, water levels will remain below the top of bank. The Red River Floodway will not be operated this spring.

- As most flows are nearing or past their peak, Manitoba Infrastructure will discontinue production of the daily flood report and associated flood products. Staff will remain in regular communication with RM Kelsey to provide condition and forecasting reports on the Saskatchewan and Carrot Rivers. Any other questions or concerns about flood mitigation should be directed to the municipal authority.

Red River Basin

- With the exception of Emerson, flows on the Canadian portion of the Red River are continuing to rise but water levels remain within bank and the water levels are very near to cresting. Water levels on tributaries to the Red River are continuing to decline.

- The Red River upstream of the Floodway Inlet is near crest, water levels will remain below the top of bank. The Red River Floodway will not be operated this spring.

- The water level at James Ave is 15.6 feet. The water level at James Avenue in Winnipeg is expected to crest in the early part of this week, at approximately 16 feet.

Assiniboine River Basin

- The Shellmouth Reservoir was drawn down over the winter in preparation for spring runoff; water levels are now increasing to reach the summer target level. The current water level is at 1395.97 feet. Inflows into the reservoir are approximately 5,420 cfs (155 cms) and outflows are 1,390 cfs (39 cms).

- Water levels on the upper Assiniboine River have crested. Minor increases on the lower Assiniboine River will continue to occur until the river peaks in early May.

- Inflows to the Portage Reservoir this morning were recorded at 8,510 cfs (240 cms). The Portage Diversion remains closed as ice along the lower Assiniboine River has moved out and there is no longer a risk of ice jamming. Flows upstream of the diversion are near crest.

Parkland Region

- Flows on streams and tributaries in the Dauphin and Swan Rivers watersheds remain low and are generally declining.

- Dauphin Lake is reported to be 40% ice covered.

The Pas and Northern Manitoba

- The Carrot River is mostly ice-free, some ice remains in place at the Turk Road Bridge. The winter ice on the Saskatchewan River continues to break up and is mostly open water.

- Flows are increasing on the Saskatchewan River upstream in Saskatchewan. Flow on the Saskatchewan River at The Pas is 43,730 cfs (1,240 cms). The Tobin Reservoir on the Saskatchewan River is expected to rise to spillway level due to high inflow volumes. Officials in Saskatchewan are preparing an operational forecast for the dam and reservoir. Forecasting staff from Manitoba and Saskatchewan are coordinating and a forecast for the Saskatchewan and Carrot Rivers in Manitoba will be available soon.

- Flows on the Red Deer River at Erwood, Saskatchewan are 6,670 cfs (190 cms) and are continuing to decrease. Forecasted peak Red Deer Lake water levels are expected to cause no flooding problems.

Manitoba Lakes

- Generally, minimal ice cover is reported on all major Manitoba lakes (30-40% ice cover). The water levels on Manitoba's major lakes are relatively stable. Once the major lakes are ice free, wind alert maps for the lakes will be produced when significant wind events are forecasted.

- The Fairford River Water Control Structure is being operated for maximum possible discharge; outflow from Lake Manitoba is approximately 4,775 cfs (135 cms).

- With the exception of Lake St. Martin and Lake Winnipegosis which are higher than average, most of Manitoba's major lakes are near their average level for this time of year. Lake Manitoba, Lake Winnipeg and Lake St. Martin are within their desired operating range.

- Lake Manitoba is expected to peak around mid-May. Risk of ice pile-up is considered low, but wind forecasts will continue to be monitored. An updated lake level forecast will be provided in the next few days.

- Inflows into Pelican Lake remain low and lake levels are expected to remain near their current level until the occurrence of spring or summer rainfalls.

- Detailed information on lake levels is available online (http://www.gov.mb.ca/mit/floodinfo/index.html).

***Definitions**

Flood Warning: A flood warning is issued when river or lake levels are exceeding or are expected to be exceeding flood stage within the next 24 hours.

Flood Watch: A flood watch is issued when river or lake levels are approaching and likely to reach flood stage, but likely not within the next 24 hours.

High Water Advisory: A high water advisory is issued when a heavy storm or high flows are expected and may cause water levels to rise, but not necessarily reach flood stage. A high water advisory can be an early indicator for conditions that may develop into a flood watch or flood warning.

Hydrologic Forecasting and Water Management, Manitoba Infrastructure

DAILY FLOOD SHEET - Imperial
Red River

April 29, 2018

http://www.gov.mb.ca/mit/floodinfo

LOCATION	Today's Conditions		Change from Apr 28 (ft)	Total Rise (ft)	Forecasted Peak		DIKE ELEV (ft)	Existing Channel Capacity		2015 Spring Peak		Reference Years			
												2010		2013	
	FLOW (cfs)	LEVEL (ft)			LEVEL (ft)	DATE		FLOW (cfs)	LEVEL (ft)	FLOW (cfs)	LEVEL (ft)	FLOW (cfs)	LEVEL (ft)	FLOW (cfs)	LEVEL (ft)
Wahpeton, MN	1,572	7.39	-0.04		P:8.2	April 20			10.00		10.36				14.40
Fargo, ND	1,850	16.14	-0.07		P:18.5	April 19			18.00		22.26				33.30
Halstad, MN	6,431	14.13	-1.75		P:24.9	April 23				13,700					32.38
Grand Forks, ND	19,999	27.33	-3.37		P:35.0	April 24			28.00	19,600	29.58				40.85
Drayton, ND		33.74	-0.30		P:34.5	April 28			32.00	25,300	35.68				82.32
Emerson	32,874	774.71	+0.14			near peak	795.60		783.20						
Letellier		772.65	+0.23		773.0 - 774.0		790.60		780.10						
St. Jean		766.14	+0.25				788.00		771.60						
Morris - PTH 23		761.98	+0.32		762.5 - 763.5	April 29 - May 1	787.40		769.40						
Ste. Agathe	33,699	754.57	+0.42		755.0 - 756.0	April 29 - May 1	778.50		771.00						
St. Adolphe		751.36	+0.40		752.0 - 753.0	April 29 - May 1	775.50		757.50						
Above Floodway Inlet - Natural															
Above Floodway Inlet - Actual	31,321	748.52	+0.55		749.0 - 750.0	April 29 - May 1	773.50		760.00		759.81	68,500	759.00		758.10
Below Floodway		747.70	+0.55						752.00		753.82		755.20		752.72
Floodway Channel	0														
Winnipeg - James Avenue	39,658	15.42	+0.72		16.0 - 17.0	April 30 - May 2	26.50		18.00		747.10	56,400	18.60		18.70
Lockport - u/s Dam		726.60	+0.40						735.00						
Lockport - d/s Dam									735.00				727.50		
Selkirk - Dock		716.75	+0.12						727.50	112,301	723.81		727.20		719.82
Selkirk - PTH 4									724.50				723.50		719.85
Breezy Point		713.83	-0.13						718.00		720.70				715.85

P: Denotes a crested elevation that has occurred in the past.

Levels referenced to historical datum, except Emerson which is in CGVD2013 (add 1.539 ft to convert back to CGVD28). Please note that Water Survey of Canada will be reporting Ste. Agathe and Emerson levels on CGVD2013 datum.

Hydrologic Forecasting and Water Management, Manitoba Infrastructure

DAILY FLOOD SHEET - Metric

April 29, 2018

Red River

http://www.gov.mb.ca/mit/floodinfo

LOCATION	Today's Conditions		Change from Apr 28	Total Rise (m)	Forecasted Peak		DIKE ELEV (m)	Existing Channel Capacity		2015 Spring Peak		Reference Years			
												2010		2013	
	FLOW (cms)	LEVEL (m)	(m)		LEVEL (m)	DATE		FLOW (cms)	LEVEL (m)	FLOW (cms)	LEVEL (m)	FLOW (cms)	LEVEL (m)	FLOW (cms)	LEVEL (m)
Wahpeton, MN	44.5	2.25	-0.01		P:2.50	April 20			3.05		3.16				4.39
Fargo, ND	52.4	4.92	-0.02		P:5.64	April 19			5.49		6.78				10.15
Halstad, MN	182.1	4.31	-0.53		P:7.60	April 23				387.9					9.87
Grand Forks, ND	566.3	8.33	-1.03		P:10.67	April 24			8.53	555.0	9.02				12.45
Drayton, ND		10.28	-0.09		P:10.51	April 28			9.75	716.4	10.88				25.09
Emerson	930.9	236.13	+0.04			near peak	242.50		238.72						
Letellier		235.50	+0.07		235.61 - 235.92		240.97		237.77						
St. Jean		233.52	+0.08				240.18		235.18						
Morris - PTH 23		232.25	+0.10		232.41 - 232.72	April 29 - May 1	240.00		234.51						
Ste. Agathe	954.3	229.99	+0.13		230.12 - 230.43	April 29 - May 1	237.29		235.00						
St. Adolphe		229.01	+0.12		229.21 - 229.51	April 29 - May 1	236.37		230.89						
Above Floodway Inlet - Natural															
Above Floodway Inlet - Actual	886.9	228.15	+0.17		228.30 - 228.60	April 29 - May 1	235.76		231.65		231.59	1,939.7	231.34		231.07
Below Floodway		227.90	+0.17						229.21		229.76		230.18		229.43
Floodway Channel	0.0														
Winnipeg - James Avenue	1,123.0	4.70	+0.22		4.88 - 5.18	April 30 - May 2	8.08		5.49		227.72	1,597.1	5.67		5.70
Lockport - u/s Dam		221.47	+0.12						224.03						
Lockport - d/s Dam									224.03				221.74		
Selkirk - Dock		218.46	+0.04						221.74	3,180.0	220.62		221.65		219.40
Selkirk - PTH 4									220.83				220.52		219.41
Breezy Point		217.58	-0.04						218.85		219.67				218.19

P: Denotes a crested elevation that has occurred in the past.

Levels referenced to historical datum, except Emerson which is in CGVD2013 (add 1.539 ft to convert back to CGVD28). Please note that Water Survey of Canada will be reporting Ste. Agathe and Emerson levels on CGVD2013 datum.

APPENDIX D6-A-4

RED RIVER AT GRAND FORKS, REAL-TIME WATER QUALITY DATA-USGS

National Water Information System: Web Interface

Click to hideNews Bulletins

- Please see news on new formats
- **UPDATE, 11/9: As of November 8, the USGS has successfully restored all of the operational gages that stopped transmitting due to an issue with the satellite telemetry system that records and transmits data. The USGS will now focus on restoring other equipment that experienced the telemetry issues, including about 85 rapid deployment gages that are used periodically for emergency response. Read more**
- Full News

Click to hide state-specific text

USGS 05082500 RED RIVER OF THE NORTH AT GRAND FORKS, ND

PROVISIONAL DATA SUBJECT TO REVISION

Available data for this site: Time-series: Current/Historical Observations GO

Click to hidestation-specific text

USGS North Dakota Water Science Center Celebrating Over 100 Years of Streamgage Records

Water Quality data provided in cooperation with the North Dakota Department of Health, the cities of Grand Forks and East Grand Forks, and the Minnesota Pollution Control Agency.

Gage height and discharge data provided in cooperation with the following:

USGS Federal Priority Streamgage (fomerly NSIP)

Station 05082500 Gage Height History Write-up

- **Flood-tracking chart**
- **Streamflow duration hydrograph**
- **Current stage-discharge rating**
- **Water-quality Estimates**

This station managed by the Grand Forks Field Office.

Available Parameters	Available Period
☐ All 7 Available Parameters for this site	
☑ 00010 Temperature, water	2007-10-01 2018-11-12
☑ 00060 Discharge	1994-10-01 2018-11-12
☑ 00065 Gage height [Bubbler]	2007-10-01 2018-11-12
☑ 00095 Specific cond at 25C	2007-10-01 2018-11-12
☑ 00300 Dissolved oxygen	2007-10-01 2018-11-12
☑ 00400 pH	2007-10-01 2018-11-12
☑ 63680 Turbidity, Form Neph	2007-10-01 2018-11-12

Output format

◉ Graph
○ Graph w/ stats
○ Graph w/o stats
○ Graph w/ (up to 3) parms
○ Table
○ Tab-separated

Days (240) **Summary of all available data for this site** GO

Instantaneous-data availability statement

-- or --

Begin date

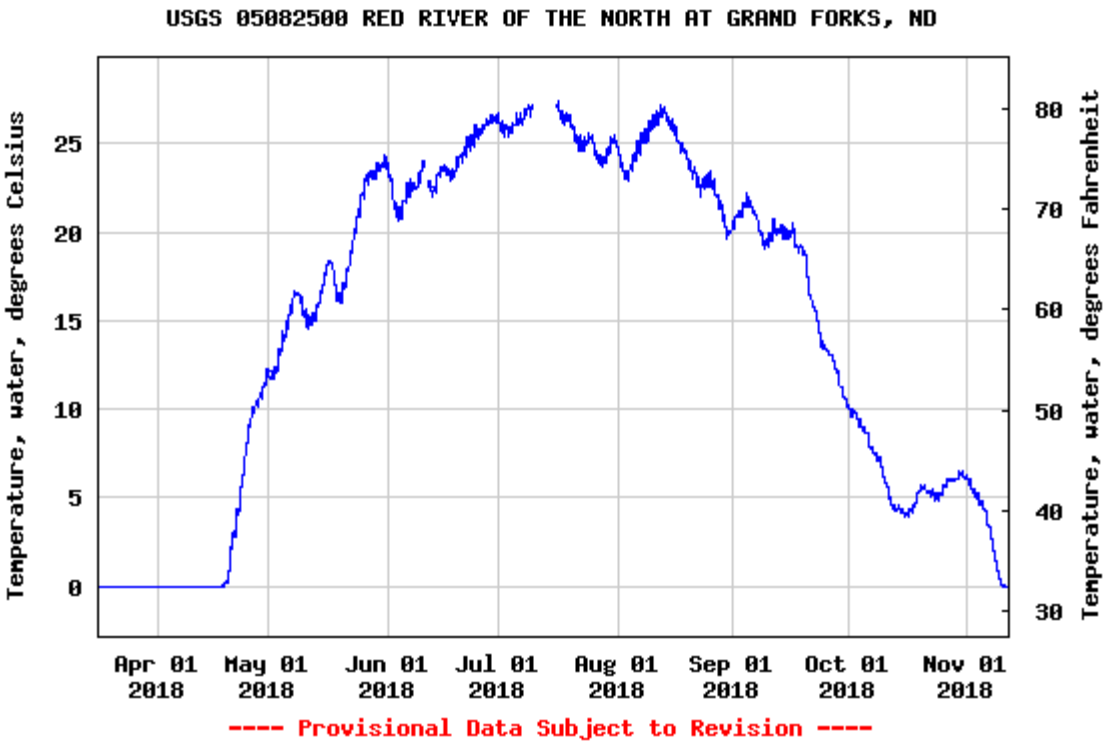
2018-03-17

End date

2018-11-12

Temperature, water, degrees Celsius

Most recent instantaneous value: 0.0 11-12-2018 10:45 CST



Add up to 2 more sites and replot for "Temperature, water, degrees Celsius"

?
Add site numbers
Note

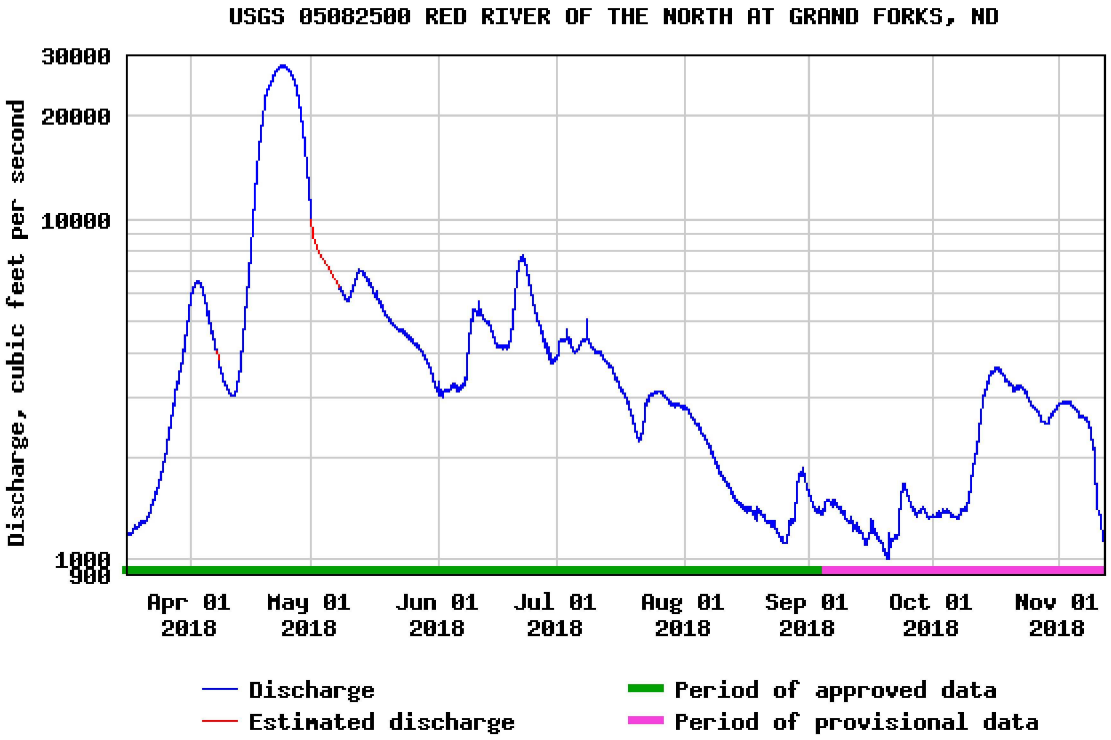
Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

GO

Create presentation-quality / stand-alone graph. Subscribe to
?
WaterAlert

Share this graph |

Discharge, cubic feet per second
Most recent instantaneous value: 1130 11-12-2018 10:45 CST



Add up to 2 more sites and replot for "Discharge, cubic feet per second"

?
Add site numbers
Note

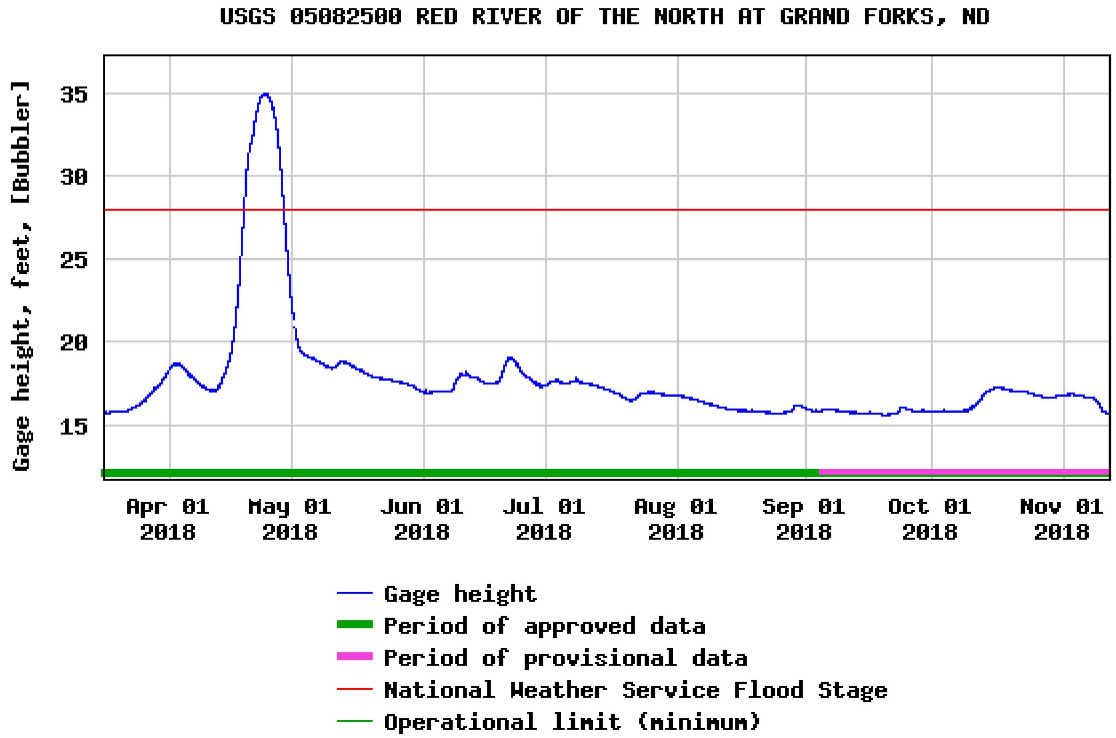
Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

GO

Create presentation-quality / stand-alone graph. Subscribe to
?
WaterAlert

Share this graph |

Gage height, feet, [Bubbler]
Most recent instantaneous value: 15.67 11-12-2018 10:45 CST



Add up to 2 more sites and replot for "Gage height, feet, [Bubbler]"

?
Add site numbers
Note

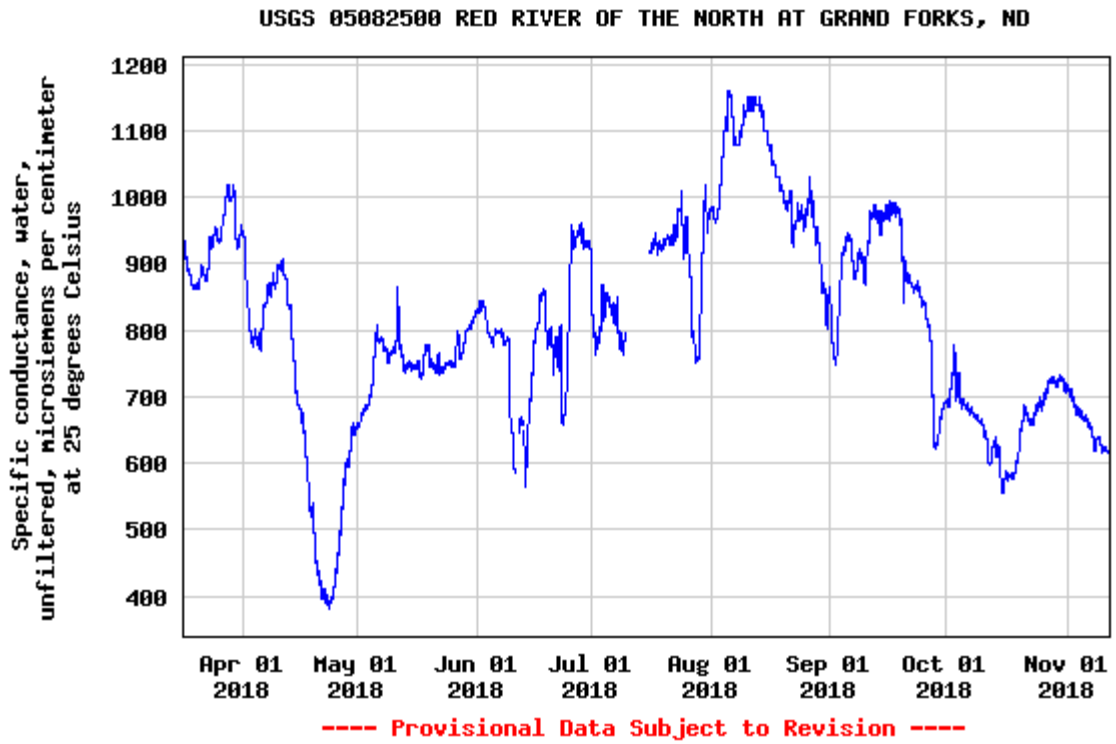
Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

GO

Create presentation-quality / stand-alone graph. Subscribe to
?
WaterAlert

Share this graph |

Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius
Most recent instantaneous value: 616 11-12-2018 10:45 CST



Add up to 2 more sites and replot for "Specific conductance, water, unfiltered, microsiemens per centimeter at 25 degrees Celsius"

?
Add site numbers
Note

Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

GO

Create presentation-quality / stand-alone graph. Subscribe to
?
WaterAlert

Share this graph |

Dissolved oxygen, water, unfiltered, milligrams per liter
Most recent instantaneous value: 14.6 11-12-2018 10:45 CST

Add up to 2 more sites and replot for "Dissolved oxygen, water, unfiltered, milligrams per liter"

?
Add site numbers
Note

Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

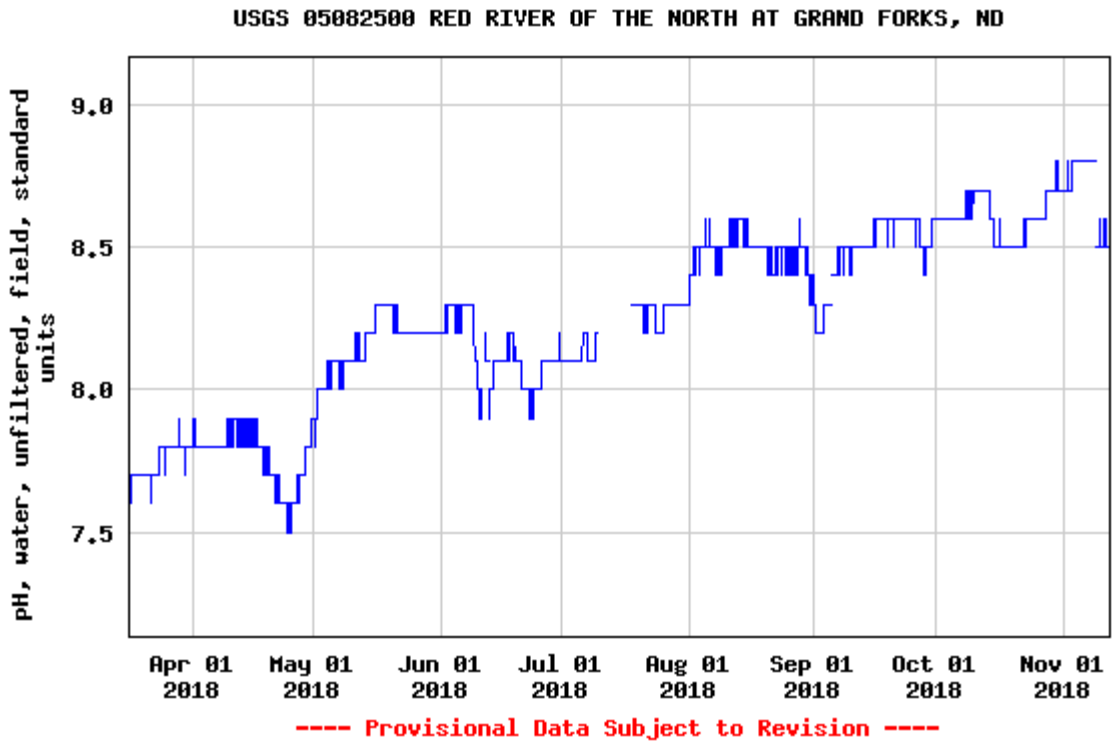
GO

Create presentation-quality / stand-alone graph. Subscribe to
?
WaterAlert

Share this graph |

---

pH, water, unfiltered, field, standard units
Most recent instantaneous value: 8.5 11-12-2018 10:45 CST



Add up to 2 more sites and replot for "pH, water, unfiltered, field, standard units"

?
Add site numbers
Note

Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

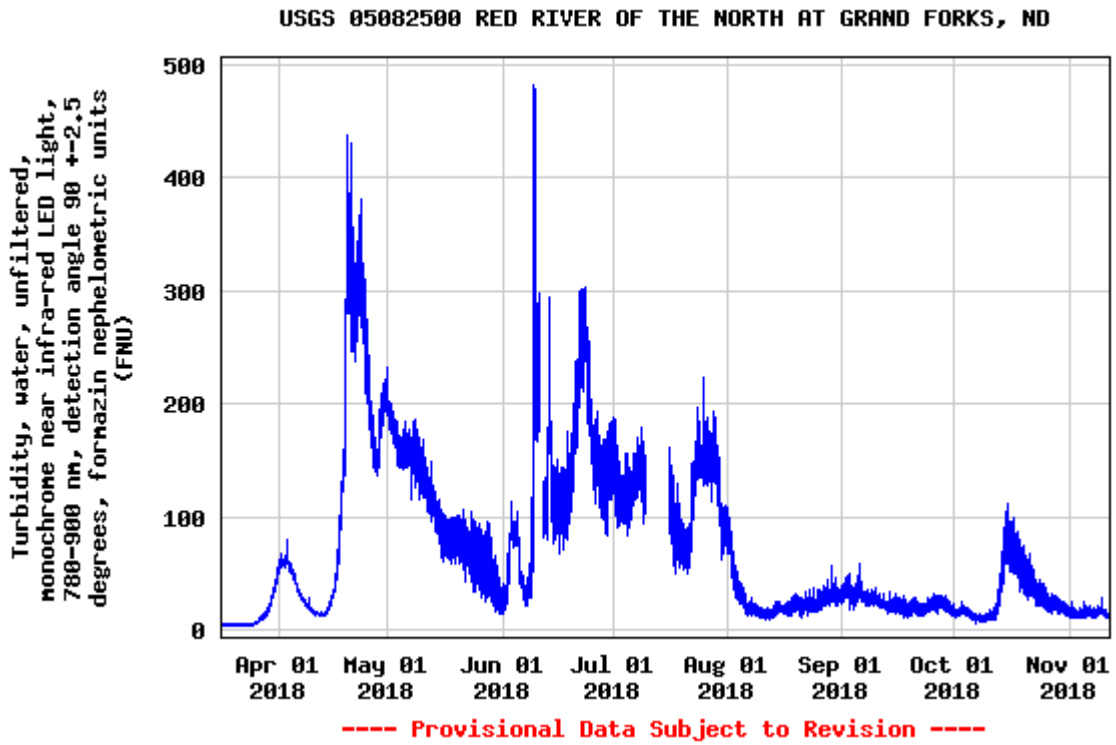
GO

Create presentation-quality / stand-alone graph. Subscribe to
?
WaterAlert

Share this graph |

Turbidity, water, unfiltered, monochrome near infra-red LED light, 780-900 nm, detection angle 90 +-2.5 degrees, formazin nephelometric units (FNU)

Most recent instantaneous value: 12.3 11-12-2018 10:45 CST



Add up to 2 more sites and replot for "Turbidity, water, unfiltered, monochrome near infra-red LED light, 780-900 nm, detection angle 90 +-2.5 degrees, formazin nephelometric units (FNU)"

?
Add site numbers
Note

Enter up to 2 site numbers separated by a comma. A site number consists of 8 to 15 digits

GO

Create presentation-quality / stand-alone graph. Subscribe to
?
WaterAlert

Share this graph |

Questions about sites/data?
Feedback on this web site

Automated retrievals
Help
Data Tips
Explanation of terms
Subscribe for system changes
News

Accessibility Plug-Ins FOIA Privacy Policies and Notices

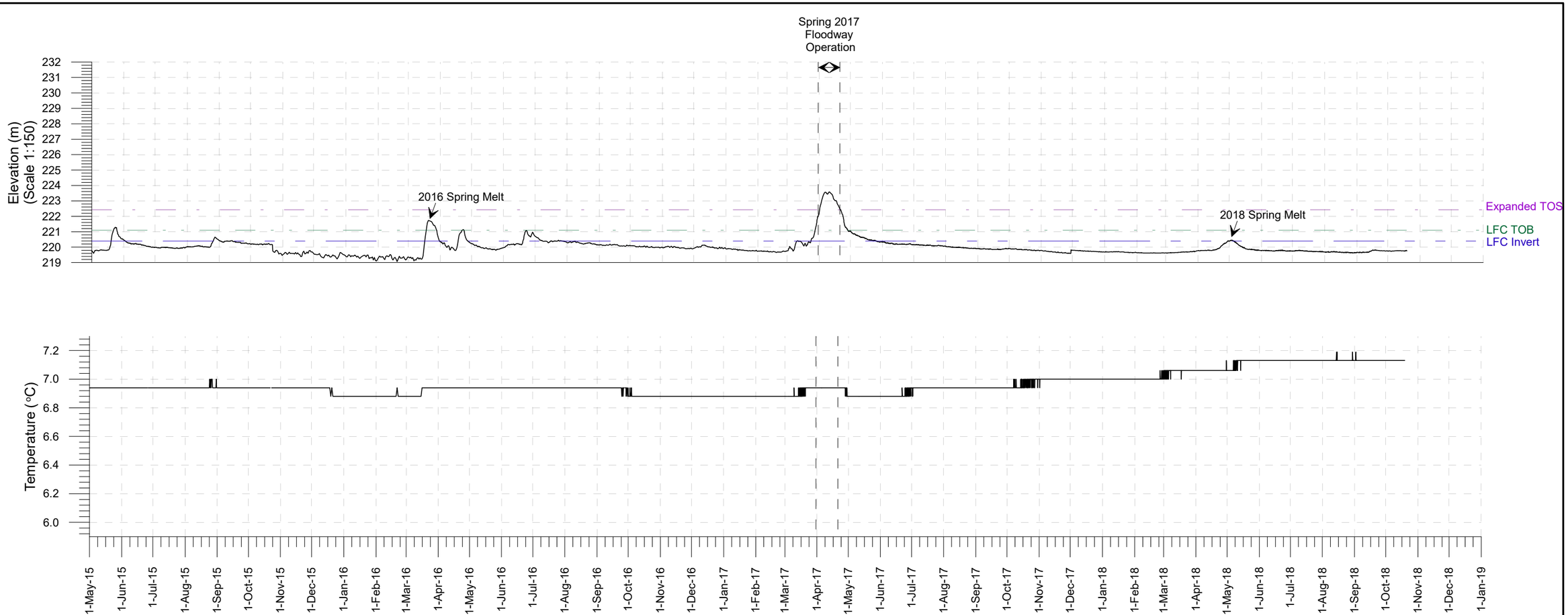
U.S. Department of the Interior | U.S. Geological Survey

Title: USGS Current Conditions for North Dakota
URL: https://nwis.waterdata.usgs.gov/nd/nwis/uv?

Page Contact Information: North Dakota Water Data Support Team
Page Last Modified: 2018-11-12 12:12:41 EST
41.81 29.05 nadww01

APPENDIX D6-B

2016 TO 2018 TRANSDUCER PROGRAM



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D4-C Figure HM66-13 Rev. 5 for historical data.

Groundwater
——— Transducer Data - K09-12316

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/12/19	ISSUED WITH FINAL REPORT	PJL	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

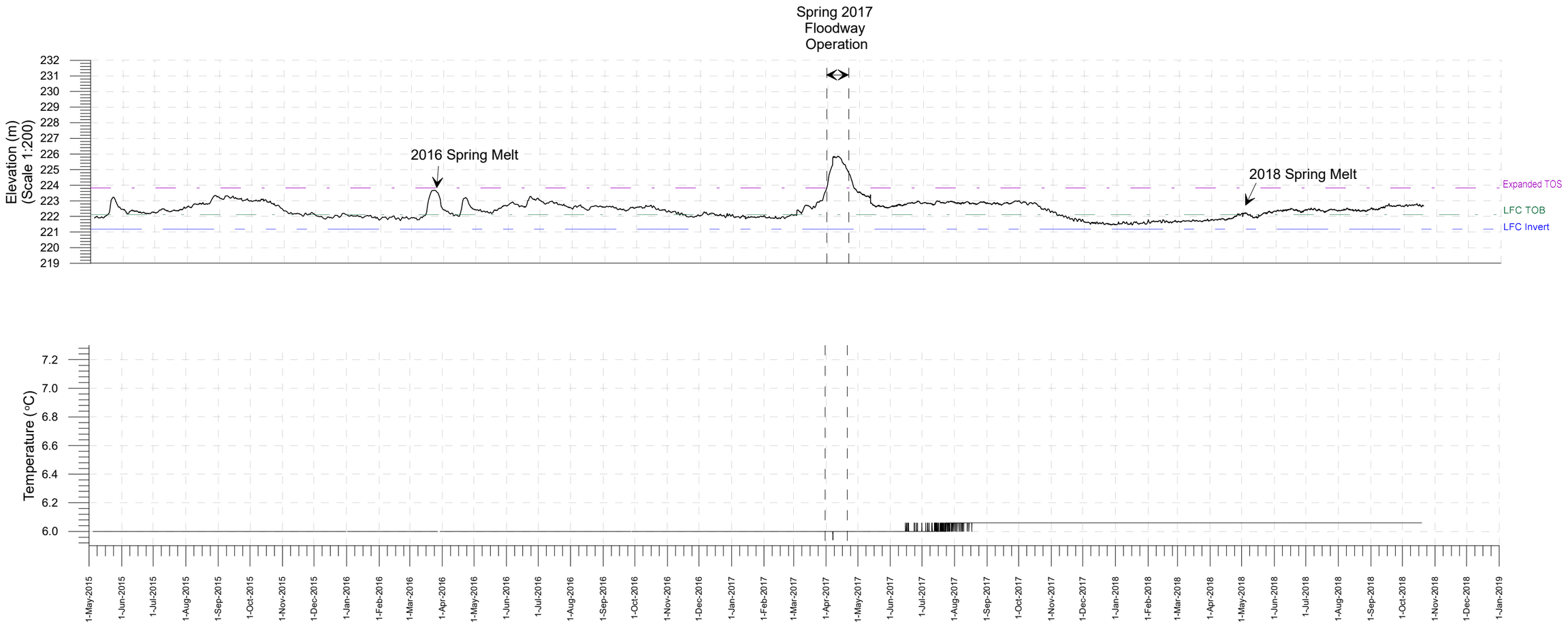
Manitoba Infrastructure

RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
2018 PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K09-12316 (Floodway Outlet)

DEC 2018 | APPENDIX D6-B-1 | REV: 0

P:\Projects\2016\16-0300-002\Design\Env\Grapher & Transducer Data\16-0300-002_Grapher Files\K09-12316 (9616)\K09-12316_(9616)_Hydrograph_16-0300-002.grf



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D4-C Figure HM66-13 Rev.5 for historical data.

Groundwater
Transducer Data - K09-12012

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/12/19	ISSUED WITH FINAL REPORT	PJL	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
2018 PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K09-12012 (Church Rd.)

DEC 2018 | APPENDIX D6-B-2 | REV: 0

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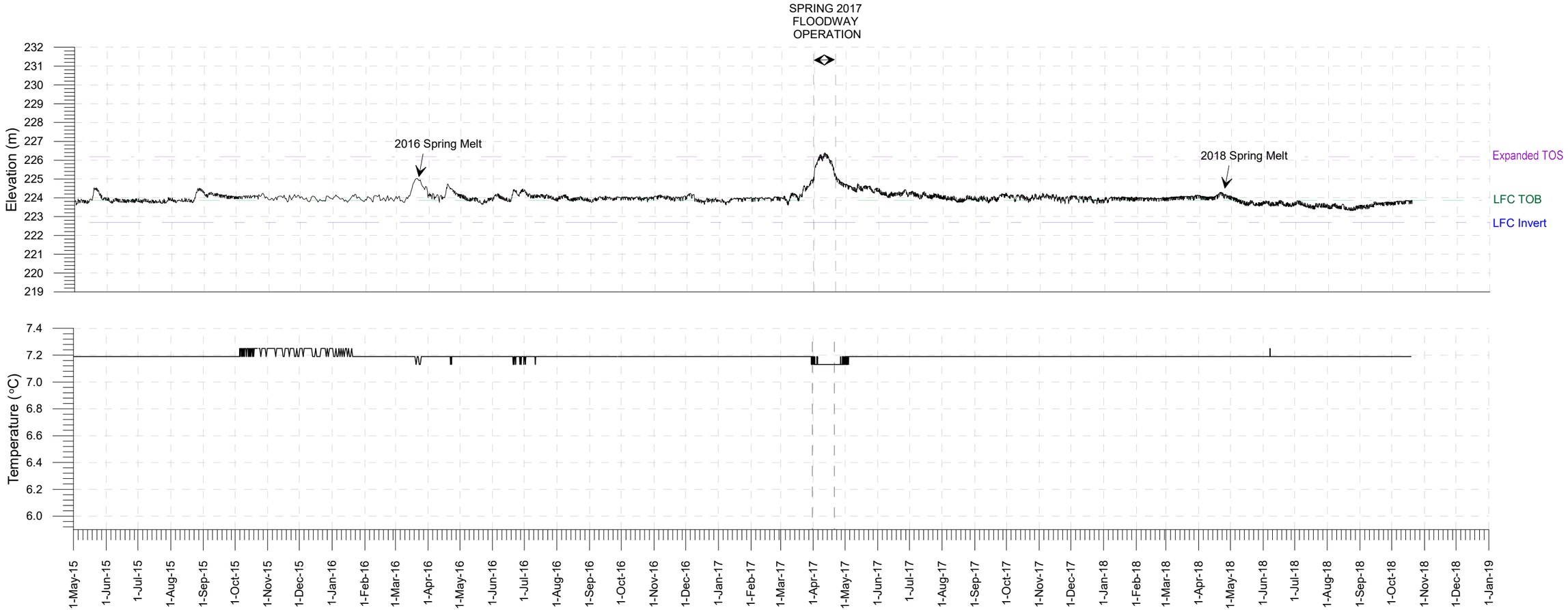

Note

TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D4-C Figure HM66-37 Rev.6 for historical data.

Groundwater
Transducer Data - K11-12014

NO	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/12/19	ISSUED WITH FINAL REPORT	PJL	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
2018 PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K11-12014 (PTH 59N West Side)

DEC 2018	APPENDIX D6-B-3	REV: 0

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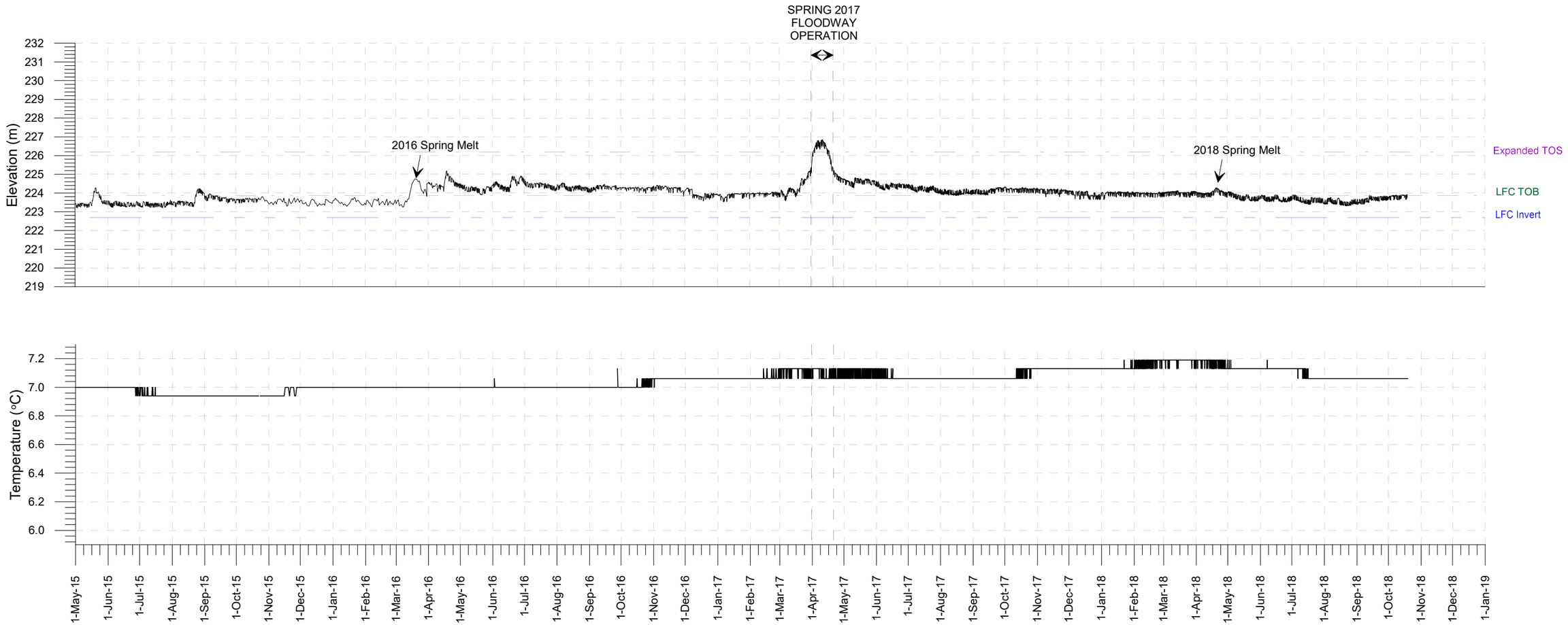

Note

TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank

1. See Appendix D4-C Figure HM66-38 - Rev. 6 for historical data.

Groundwater
Transducer data - K11-12015

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/12/19	ISSUED WITH FINAL REPORT	PJL	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
2018 PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K11-12015 (PTH 59N WEST)

DEC 2018	APPENDIX D6-B-4	REV: 0

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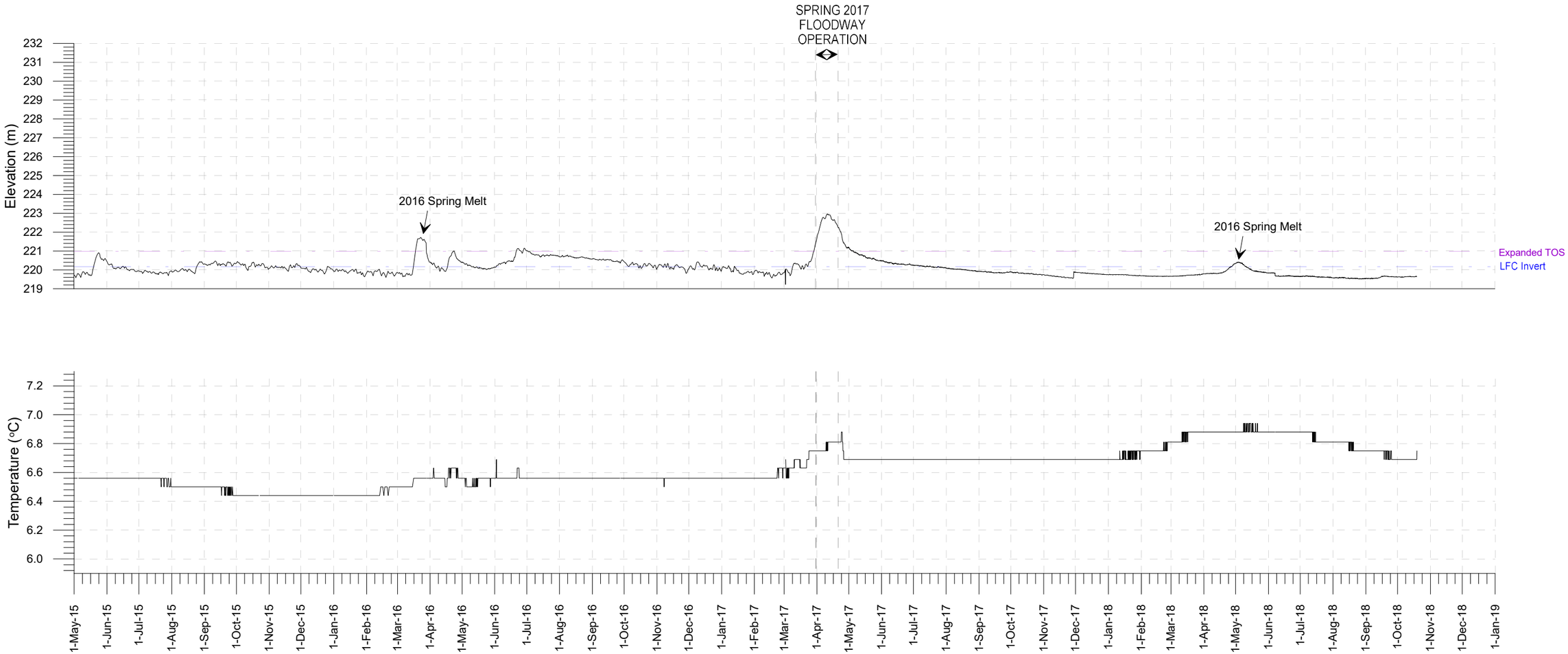

Note

TOS - Toe of Slope
TOB - Top of Bank

1. See Appendix D4-C Figure HM66-45 - Rev. 2 for historical data.

Groundwater
Transducer Data - K13-12321

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/12/19	ISSUED WITH FINAL REPORT	PJL	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
2018 PROGRAM A ANNUAL REPORT

WATER ELEVATION AND
TEMPERATURE READINGS AT
K13-12321 (Rockhaven Rd.)

DEC 2018 | APPENDIX D6-B-5 | REV: 0

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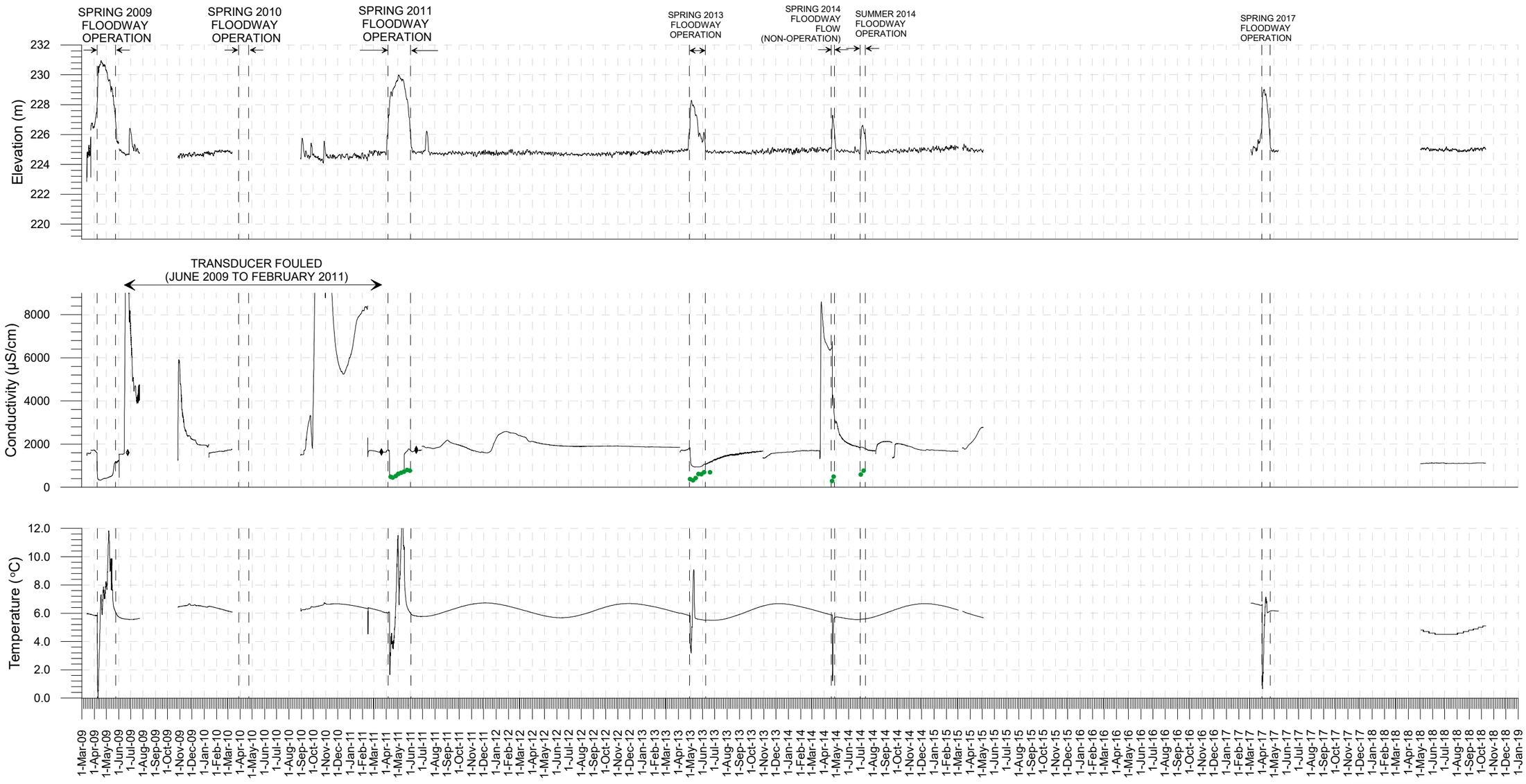


Surface Water
- Laboratory Measured Conductivity

Groundwater
- Transducer Data - 7A1 Spring
- Laboratory Measured Conductivity
- Field Measured Conductivity

NO.	YY/MM/DD	DESCRIPTION	DESIGN BY	DESIGN CHECK
0	18/12/19	ISSUED WITH FINAL REPORT	PJL	MFH

REVISIONS / ISSUE

KGS GROUP CONSULTING ENGINEERS

Manitoba Infrastructure

RED RIVER FLOODWAY
LONG TERM MONITORING PROGRAM
2018 PROGRAM A ANNUAL REPORT

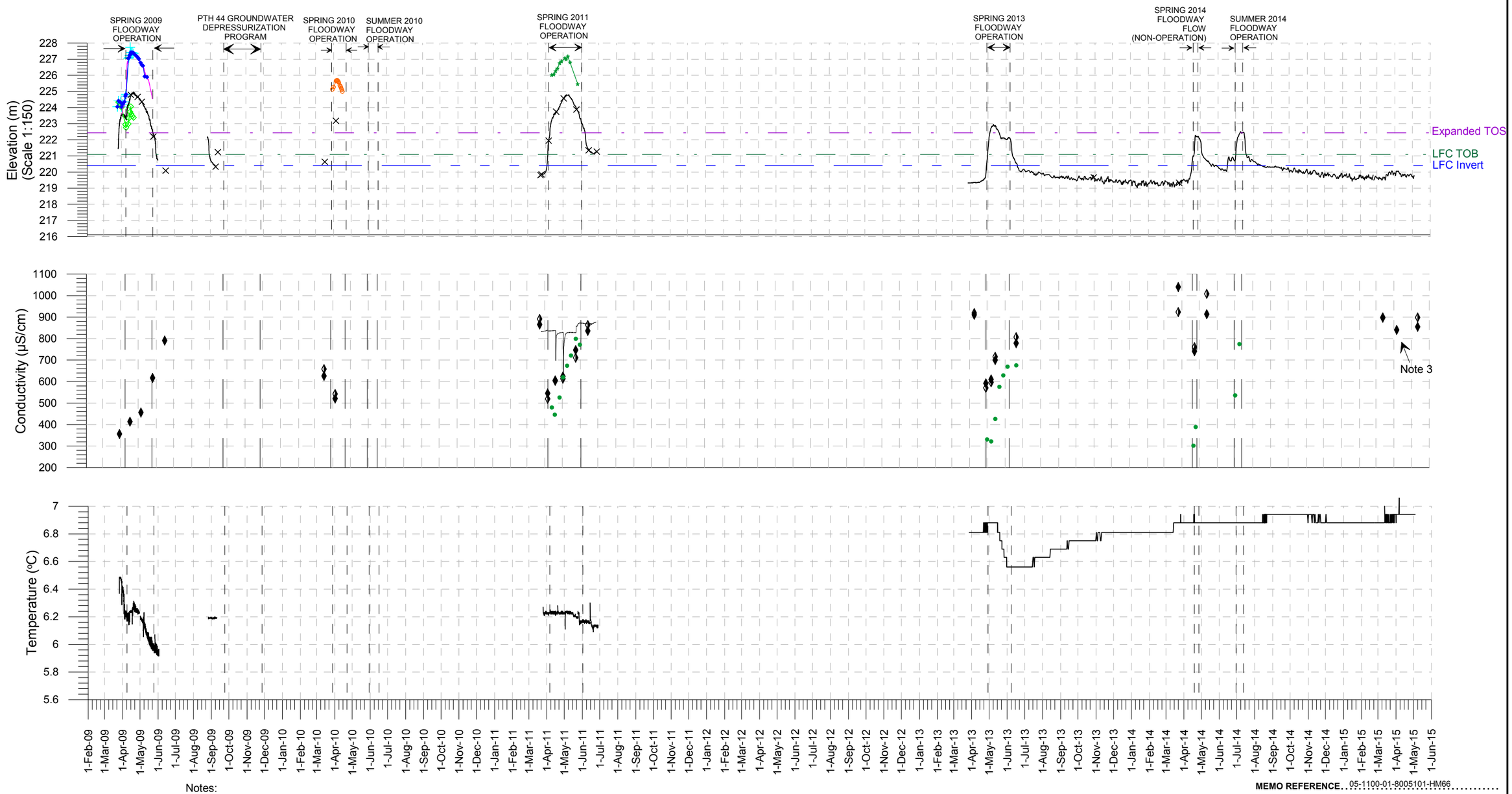
CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID 7A1 SPRING (CNR REDDITT/KILDARE AREA)

DEC 2018	APPENDIX D6-B-6	REV: 0

P:\Projects\2016\16-0300-002\Design\Env\Grapher & Transducer Data\16-0300-002_Grapher Files\Spring 7A1

APPENDIX D6-C

HISTORICAL TRANSDUCER PROGRAM



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank
1. Modelled 2009 surface water levels are derived from measured water levels and discharge hydrographs at the floodway inlet. The water surface elevation is computed using the hydrodynamic version of the HEC RAS computer program.
2. Measured 2009 and 2010 surface water levels are from KGS Group data taken at locations along the channel. The measured location closest to each monitoring well was used.
3. Field measured conductivity suspect on April 6, 2015, therefore not included in plot.

Surface Water
- 2009 Floodway Water Level Modelled (Stn 50+500)
- 2009 Floodway Water Level Measured (Stn 50+437)
- 2010 Floodway Water Level Measured (Stns 50+424 to 50+437)
- 2011 Floodway Water Level Measured (Stns 50+426 to 50+427)
- Laboratory Measured Conductivity

Groundwater
- Transducer Data - K09-12316
- Outlet Water Level Measured
- Red River Water Level Measured
- Manual GW DTW
- Laboratory Measured Conductivity
- Field Measured Conductivity

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

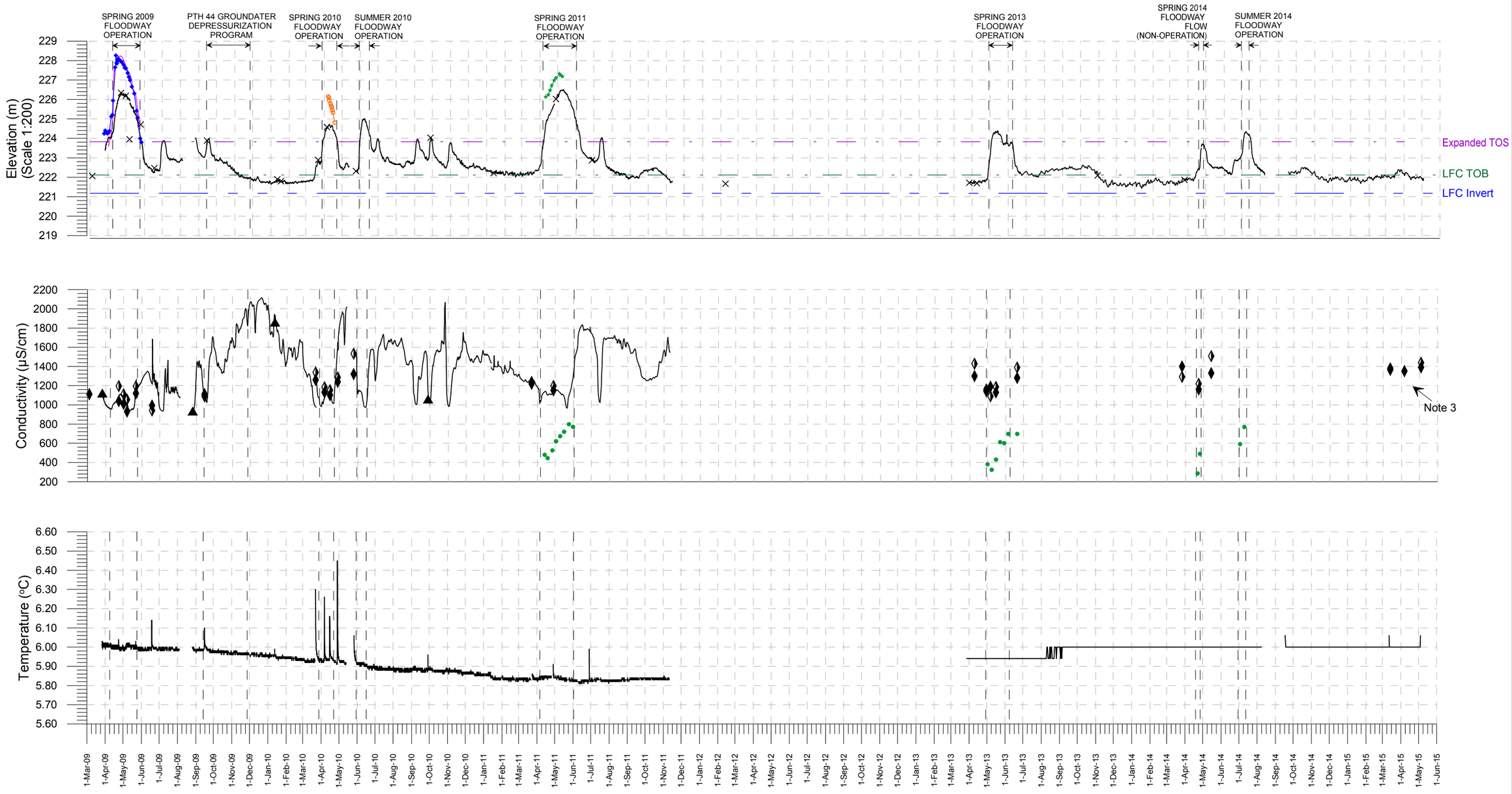
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K09-12316 (FLOODWAY OUTLET)

JUNE 2015	FIGURE HM66-3	REV 5

X:\projects\2003\03-1100-01\Structures & Systems\(.40) OutletStructure\Temp\Dewatering\Transducer_Data\12316 (9616)



Notes:
TOS - Toe of Slope
LFC - Low Flow Channel
TOB - Top of Bank
1. Modelled 2009 surface water levels are derived from measured water levels and discharge hydrographs at the floodway inlet. The water surface elevation is computed using the hydrodynamic version of the HEC RAS computer program.
2. Measured 2009 and 2010 surface water levels are from KGS Group data taken at locations along the channel. The measured location closest to each monitoring well was used.
3. Field measured conductivity suspect on April 6, 2015, therefore not included in plot.

Surface Water
- 2009 Floodway Water Level Modelled (Stn 45+000)
- 2009 Floodway Water Level Measured (Stn 47+064 (Hay Road))
- 2010 Floodway Water Level Measured (Stns 45+001 to 45+003)
- 2011 Floodway Water Level Measured (Stns 48+523 to 48+525)
- Laboratory Measured Conductivity

Groundwater
- Transducer Data - K09-12012
- × Manual Depth to Water Measurement
- ♦ Laboratory Measured Conductivity
- ◊ Field Measured Conductivity
- ▲ Field Calibrated Conductivity Date

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

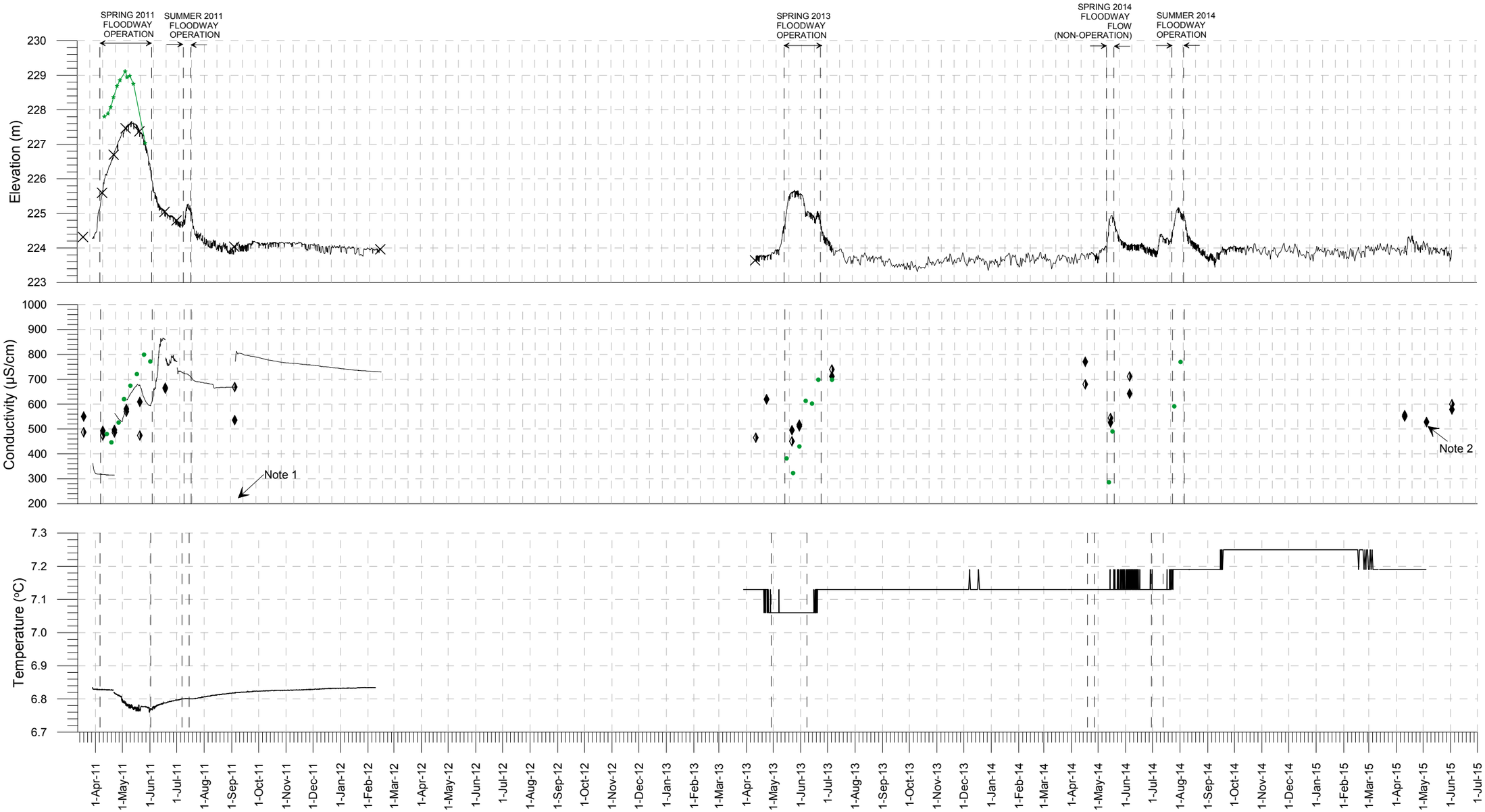
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K09-12012 (Church Road)

JUNE 2015	FIGURE HM66-13	REV 5

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K09-12012\K09-12012_



Note

1. Transducer fouled at bottom of well, relocated higher.
2. Field measured conductivity suspect on April 6, 2015 therefore not included.

Surface Water

- 2011 Floodway Water Level Measured (Stns 35+018 to 35+020)
- Laboratory Measured Conductivity

Groundwater

- Transducer Data - K11-12014
- Manual Depth to Water Measurement
- Field Measured Conductivity
- Laboratory Measured Conductivity

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

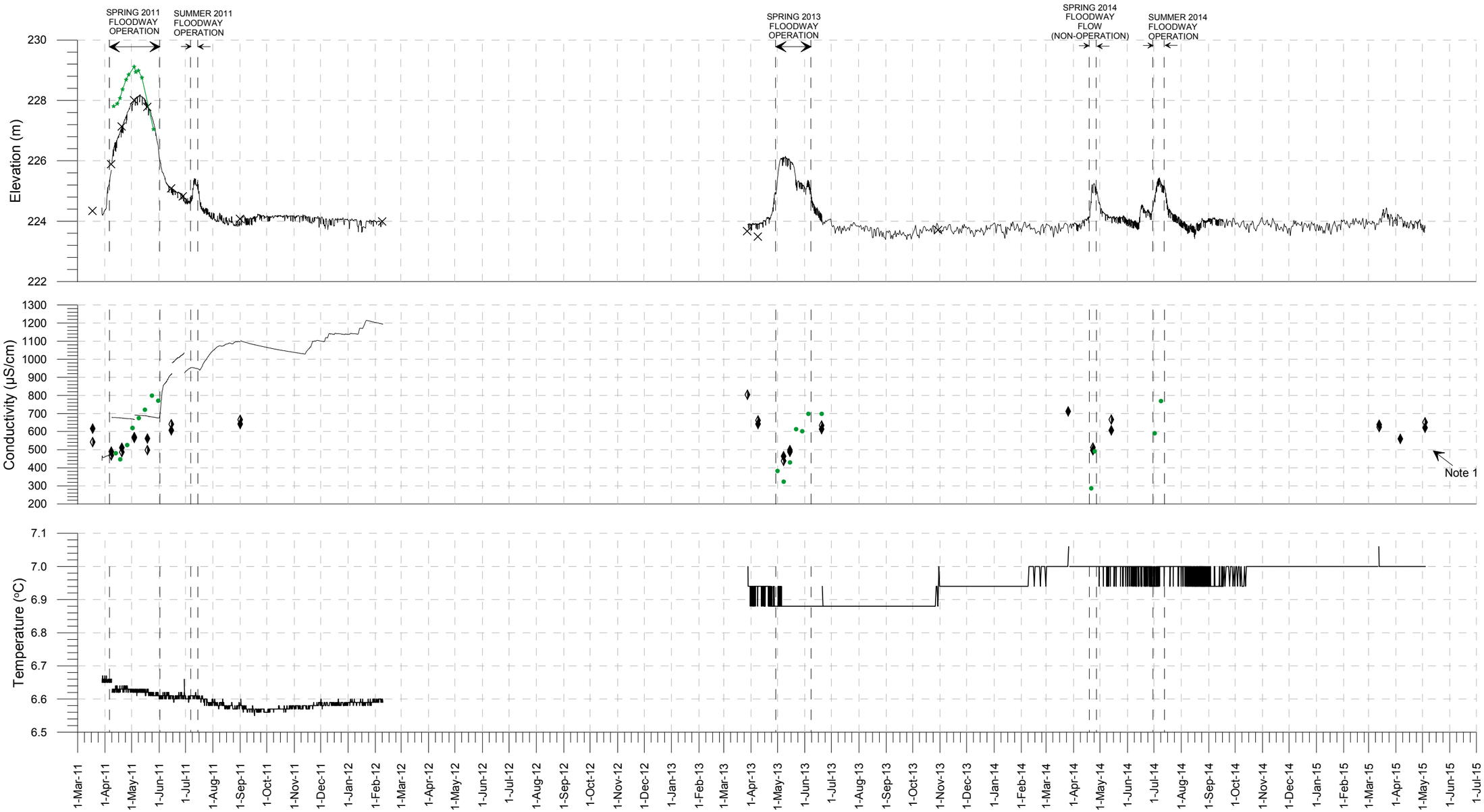
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K11-12014 (PTH59N - WEST SIDE)

JUNE 2015	FIGURE HM66-37	REV 6

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K11-12014



Note

1. Field measured conductivity suspect on April 6, 2015, therefore not included in plot.

Surface Water

- 2011 Floodway Water Level Measured (Stns 35+018 to 35+020)
- Laboratory Measured Conductivity

Groundwater

- Transducer data - K11-12015
- X Manual elevation
- Laboratory measured conductivity
- Field measured conductivity

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

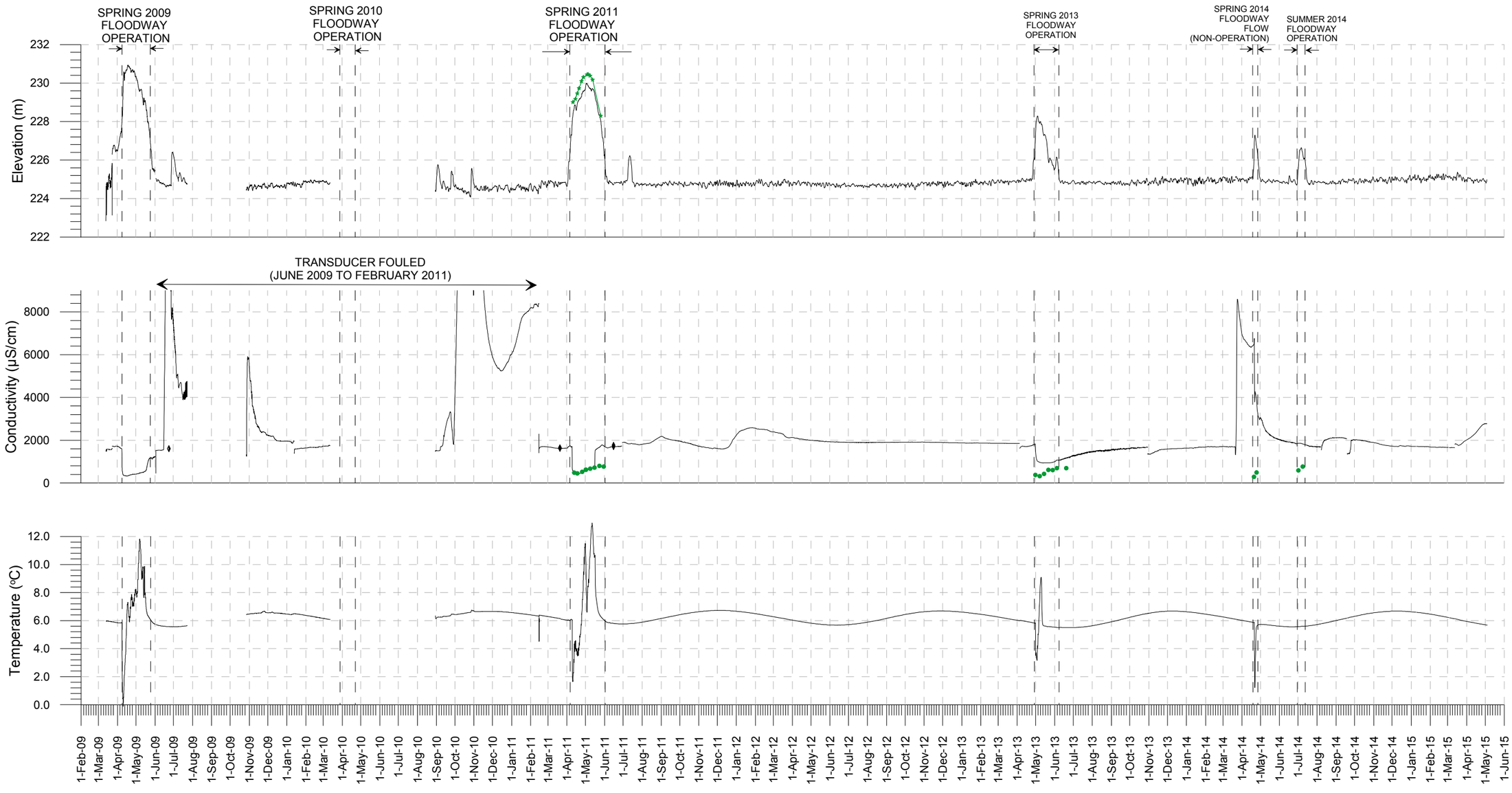
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K11-12015 (PTH 59N - WEST SIDE)

JUNE 2015	FIGURE HM66-38	REV 6

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K11-12015



Surface Water
- 2011 Floodway Water Level Measured (Stns 25+626 to 25+799)
- Laboratory Measured Conductivity

Groundwater
- Transducer Data - 7A1 Spring
- Laboratory Measured Conductivity
- Field Measured Conductivity

MEMO REFERENCE: 05-1100-01-8005101-HM66

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

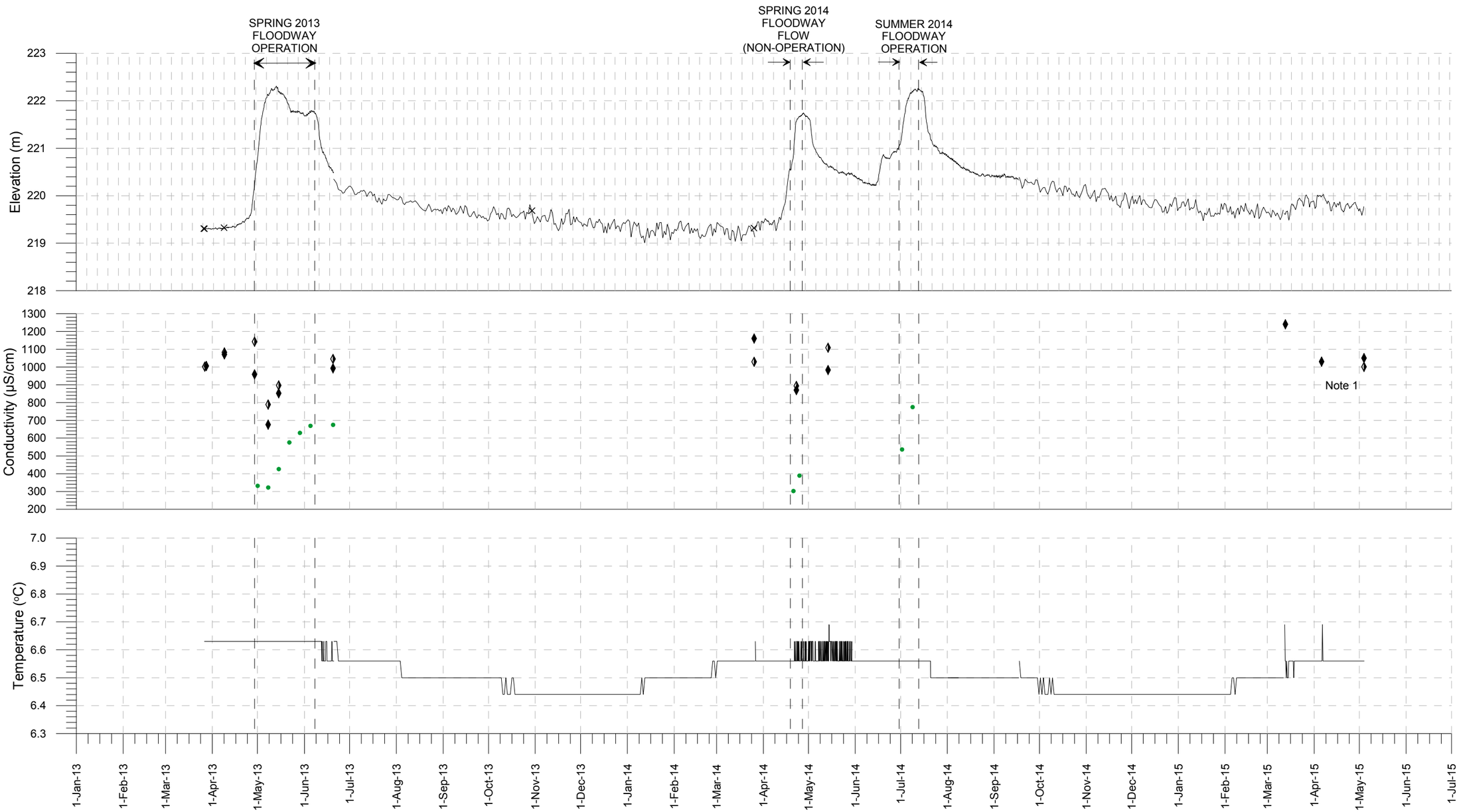
RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID 7A1 SPRING (CNR REDDITT/KILDARE AREA)

JUNE 2015	FIGURE HM66-43	REV 5

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.07) ChannBaseflow_GWDischarge\Spring 7A1 Transducer Data



MEMO REFERENCE 05-1100-01-8005101-HM66

Note

1. Field measured conductivity suspect on March 13 and April 6, 2015, therefore not included in plot.

Surface Water

- 2011 Floodway Water Level Measured (Stns 50+426 to 50+427)
- Laboratory Measured Conductivity

Groundwater

- Transducer Data - K13-12321
- × Manual Depth to Water Measurement
- ♦ Laboratory Measured Conductivity
- ◊ Field Measured Conductivity

KGS GROUP

MANITOBA FLOODWAY AUTHORITY

RED RIVER FLOODWAY EXPANSION

GROUNDWATER RESPONSE TO FLOODWAY WATER LEVELS

WATER ELEVATION, CONDUCTIVITY AND TEMPERATURE READINGS AT MFA ID K13-12321 (ROCKHAVEN RD)

JUNE 2015	FIGURE HM66-45	REV 2

X:\projects\2003\03-1100-01\General\(.19) SiteSurv&Invest\(.12) GW Invest\Temp\(.05) GW Piezo Levels\05-1100-01\Transducer_Data\K13-12321

APPENDIX D6-D

2018 INSPECTION OF SPRING TREATMENT AREAS

APPENDIX D6-D-1

SUMMARY 2018 INSPECTION OF SPRING TREATMENT AREAS

APPENDIX D6-D-1
2018 INSPECTION OF SPRING TREATMENT AREAS

1.0 INTRODUCTION AND SCOPE OF WORK

Annual summer inspections of the previously treated groundwater spring discharge areas are required in the Long-term monitoring program and were conducted in August 2018 by KGS Group. At total of 23 spring areas were treated as part of the program between March 2009 and February 2011. Treatment of these sites involved the construction of pervious graded sand filters to minimize potential for direct groundwater and surface water flow interconnections to develop. The filters were designed to: restrict the exfiltration rate of groundwater discharge by using the clean lower permeability sand layer while allowing for continued piezometric pressure relief; protect against ongoing piping and development of additional flow pathways under exfiltrating conditions; and satisfy requirements to restrict infiltration of silt and pathogens (e.g. bacteria) if possible.

The purpose of the 2018 inspection program was to:

- Document the condition of treated spring areas;
- Verify that additional discharge areas have not developed at the periphery of the treated area or immediately adjacent;
- Verify that the sampling standpipe is undamaged and accessible; and
- Identify any maintenance/repairs necessary.

A summary of the inspected sites is included in Appendix Table D6-D-1. Inspection forms including sketches and select photos for each of the treated spring areas are included in Appendix D6-D-2.

Detailed maps of spring locations can be found in the 2018 Annual Inspection and Monitoring Report Deliverable D-7 (Appendix B). These maps have not been updated for 2018 since the inspection areas were the same and no new springs were located in 2018. Springs noted in 2018 are the same as those identified in 2017. Spring locations are also included in the Floodway Drilling and Instrumentation Published Map File HM80 Rev 1 (November 2013) and the Compilation of Subsurface Investigations CCO-418Y-002g Rev0 included as a PDF copy in Appendix K of HM99.

Electronic files containing additional photographs and video of each site have been included on a CD only in Appendix D6-D-3 of this report. This report serves as a complete documentation of baseline conditions in the Long-term monitoring period and can be compared to future conditions.

2.0 INSPECTION PROGRAM METHODOLOGY

KGS Group representatives completed the spring inspections on August 28 to 29, 2018. An aluminum boat and motor was used to access the treated spring sites with a handheld GPS used to identify the location of each of the sites. The inspection for each spring included:

- Photographs of the filter, discharge trench, low level and high level sampling pipes, flow paths, and any additional discharge areas;

- Videos of flowing springs;
- Assessment of any damage to the filter, discharge trench, or sampling pipes and the repairs required;
- Identification of any additional discharge areas in the vicinity (~500 m north and south) of the treated spring areas;
- Measurement of water levels within low level sampling pipes where possible;
- Overall assessment of how the filter is working relative to design.

Observations from the inspections were recorded on inspection forms (Appendix D6-D-2) and the photograph and video numbers and times were recorded to identify the treated spring area.

3.0 SUMMARY OF INSPECTION FINDINGS

3.1 CONDITION OF FILTERS

The constructed filters were found to be in good condition and were working as designed. Flow appeared to be coming up through the filter and discharging through the granular layer overlying the sand filter bed. No settlement or heaving of the filters was observed.

3.2 ADDITIONAL DISCHARGE AREAS

Some additional discharge locations outside of the filtered springs were observed as follows:

AD17-1 – An additional discharge location into the low flow channel from the west side mid way between Church Rd. and Hay Rd. (UTM 648661, 5546623) is just 10 m downstream of a beaver dam across the low flow (UTM 648659, 5546613) and is potentially sourced from upstream water finding a new pathway around the dam as opposed to being from a spring source.

AD17-2 – A second similar location of discharge on the west side (UTM 648646, 5546742) is 129 m downstream of the beaver dam and it is possible that this also is a redirection of upstream water from the dam although this appears to be localized and no ponding is apparent at this location.

AD17-3 – During the 2016 springs inspection an additional discharge location (UTM 648624, 5547187) was observed on the east side of the low flow channel across from Hay Rd. This location was once again observed at UTM 648624, 5547181 several fanned pathways of individually low volume (<1 USgpm) discharge locations were found for approximately 64 m along the east side of the low flow channel.

AD17-4 – In 2017 on the west side, across the low flow channel from the AD17-3 additional discharge location there was also a section of discharge locations that extended from a ponding location starting at approximately UTM 648593, 5547218 downstream to UTM 648587, 5547306, approximately 88 m. In 2018 this area appeared dry in comparison, with only a small amount of soft soil along the bank.

AD17-5 – Low volume (<1 USgpm) discharge was observed in 2017 mid way between Hay Rd. and CEMR bridge on the east shore with no apparent ponding or source at UTM 648528, 5548099. In 2018 this area appeared dry.

3.3 CONDITION OF DISCHARGE TRENCHES

The discharge trenches were constructed as shallow excavated trenches that were filled with riprap to grade or slightly above grade. It was observed that at 11 of the 23 treated spring sites, the rip rap within the discharge trenches was infilling with sediment and spring discharge was finding alternate flow paths to the Low Flow Channel. This resulted in overland flow toward the Low Flow Channel or flow into low areas near the filter, creating wet and soft areas. No significant erosion channels were observed at any of these locations.

The discharge trenches at the 5A1 and 7A1 locations were constructed as ditches (see photos in inspection reports) which appeared to be more effective in directing discharge flows along the design discharge flow path.

3.4 CONDITION OF SAMPLING PIPES

The two high level sampling pipes, at 11A2 and 18A1, were both found to be in good condition with no damage observed.

The 10 low level sampling pipes were generally found to be in good condition. At location, 5A1 and location 7A1, a new large diameter cover and marker was installed by MI in 2018.

4.0 REPAIRS REQUIRED

4.1 FILTERS

No repairs of the filters are required. The filters appear to be operating as designed.

4.2 ADDITIONAL DISCHARGE AREAS

Additional eroded discharge areas were observed in a small area along the discharge trench at 9B2. Construction of a graded sand filter would minimize potential for direct groundwater and surface water flow interconnections to develop at this location.

4.3 DISCHARGE TRENCHES

The discharge trenches that were constructed with riprap to grade or above grade generally appeared to infill with sediment, resulting in spring flows finding alternate flow paths to the Low Flow Channel. Excavating out the existing discharge channel to create a ditch, similar to 5A1 and 7A1, would likely direct flow along the design discharge trench. Alternatively, constructing a new ditch, with riprap armouring, along the existing overland discharge path would also be effective in limiting any erosion concerns with overland flow. The discharge trenches that require some repair include:

- 5A1 – widening of the existing discharge ditch;
- 7C1 – excavating out discharge trench to create ditch, constructing new discharge ditch;
- 8B1 – excavating out discharge trench to create ditch;
- 8B2 – excavating out discharge trench to create ditch;
- 8C1 – excavating out discharge trench to create ditch;
- 9B1 – constructing new discharge ditch;
- 9B2 – excavating out discharge trench to create ditch;

- 10A1 – excavating out discharge trench to create ditch;
- 11A1 – constructing new discharge ditch;
- 18A1 – excavating out discharge trench to create ditch, constructing new discharge ditch;
- 21A1 – excavating out discharge trench to create ditch.

4.4 SAMPLING PIPES

The low level sampling pipe at spring 5A1 was missing its cap in 2017. Low level sampling pipes with vertical culvert protective casings at Spring 5A1 and Spring 7A1 both received replacement covers and markers provided and installed by MI in 2018.

Low Level Sampling Pipe Covers added to culvert casings at Springs 5A1 and 7A1 by MI.

APPENDIX TABLE D6-D1

TABLE D6-D1
2018 SUMMER INSPECTION OF SPRING TREATMENT AREAS

Site No.	Channel Side	Approximate Channel Station	Low Level Sampling Pipe Installed	High Level Sampling Pipe Installed	Northing	Easting	Flow Observed August 2018	Condition of Filter	Additional Discharge Areas in Vicinity of Filter	Constructed Discharge Trench Operating as Designed	Low Level Sampling Pipe Repairs Required
Spring Area Treatment Sites											
2A1	West	21+000	Yes	No	5523219	647097	Yes	Good	No	Yes	No
5A1	West	26+280	Yes	No	5528520	646961	Yes	Good	No	No	No (Cap and marker installed in 2018)
7A1	West	27+060	Yes	No	5529304	646939	Yes	Good	Yes. Very low flow discharge 10 m upstream	Yes	No (Cap and marker installed in 2018)
7B2	West	27+157	No	No	5529475	646951	Yes	Good	Yes. Very low flow: -7 m upstream; -14 m upstream; and -70 m downstream along LFC.	Yes	-
7C1	East	27+400	Yes	No	5529640	646969	Yes	Good	No	No	No
8B1	West	29+880	No	No	5531953	646023	Yes	Good	No	No	-
8B2	West	29+970	No	No	5532027	645993	Yes	Good	No	No	-
8C1	West	30+080	Yes	No	5532127	645959	Very Little	Good	No	No	No
9A6	East	30+400	No	No	5532480	645890	Yes	Good	No	Yes	-
9B1	West	30+840	No	No	5532846	645734	Very Little	Good	No	No	-
9B2	East	30+978	No	No	5532997	645715	No	Good	Yes	No	-
10A1	West	31+000	No	No	5533022	645665	Yes	Good	No	No	-
11A1	West	31+290	Yes	No	5533274	645559	Yes	Good	No	No	No
11A2	East	33+900	Yes	Yes	5535772	644767	No	Good	No	N/A (no flow)	No
16A2	West	42+180	No	No	5543145	647070	No	Good	No	No (Ponding)	-
17A2	East	42+769	Yes	No	5543545	647519	Yes	Good	No	Yes	No
18A1	West	42+800	Yes	Yes	5543620	647443	Yes	Good	No	No	No
18A2	West	42+900	No	No	5543718	647478	No	Good	No	N/A (no flow)	-
20A2	East	47+030	No	No	5547417	648610	Very Little	Good	No	N/A (no flow)	-
21A1	West	47+796	No	No	5548152	648465	Very Little	Good	No	No	-
21A2	East	47+796	No	No	5548170	648545	Yes	Good	No	N/A (no flow)	-
23A1	West	49+395	No	No	5549740	648290	No	Good	No	N/A (no flow)	-
23A2	East	49+450	Yes	No	5549842	648355	Yes	Good	No	N/A (no flow)	No

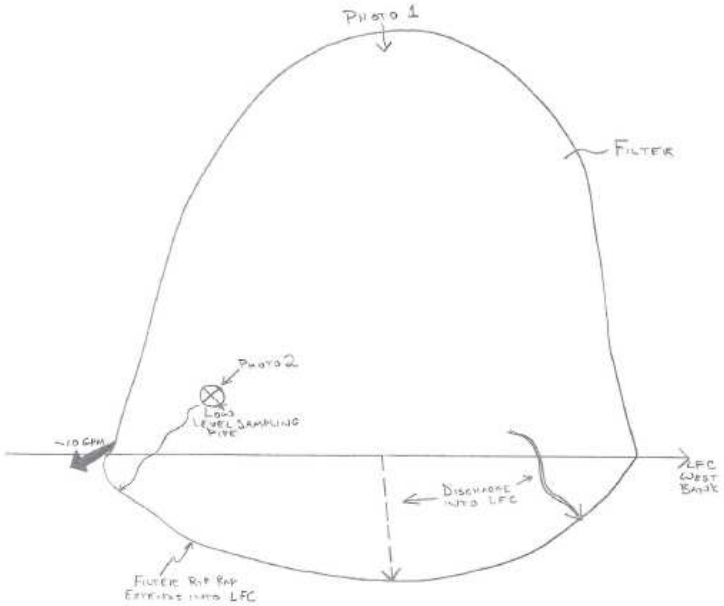
APPENDIX D6-D-2

FIELD DOCUMENTATION

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 2A1 **Date:** August 28, 2018
Site Description: West side, north of HWY1 bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 2A1.

Photo 2: Discharge into LFC at 2A1.

Filter Condition: Good
Repairs Required: None

Approximate Flow: 8 USgpm

Additional Discharge Areas: No

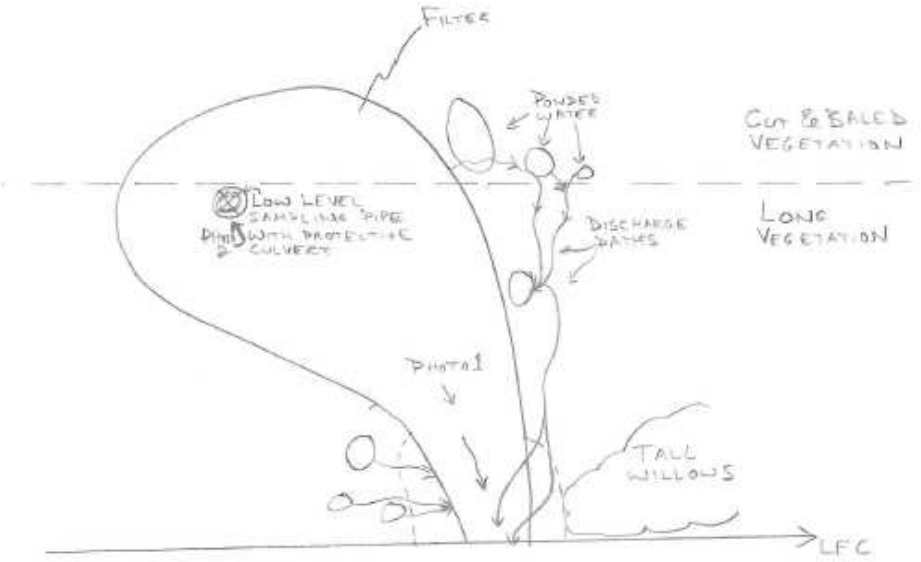
Sampling Standpipe: Yes, low level
Depth to bottom: Could not measure
Depth to water: At surface
Condition: Water above PVC, so left sealed to avoid cross contamination.
Repairs Required: None.

Other Comments: Filter appears to be working effectively.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 5A1 **Date:** August 28, 2018
Site Description: West side, north of Redditt bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 5A1 and constructed discharge trench.

Photo 2: Low level sampling pipe and protective steel casing at 5A1. Cover was missing in during 2018 springs inspections. MI added cap and marker in 2018.

Filter Condition: Good – water flowing along discharge channel as well as finding alternate flow paths to LFC. No significant erosion observed within overland discharge areas. Vegetation is quite grown over.
Repairs Required: Widening the discharge channel may focus flow along design discharge path and accommodate flows.

Approximate Flow: 15 USgpm

Additional Discharge Areas: No

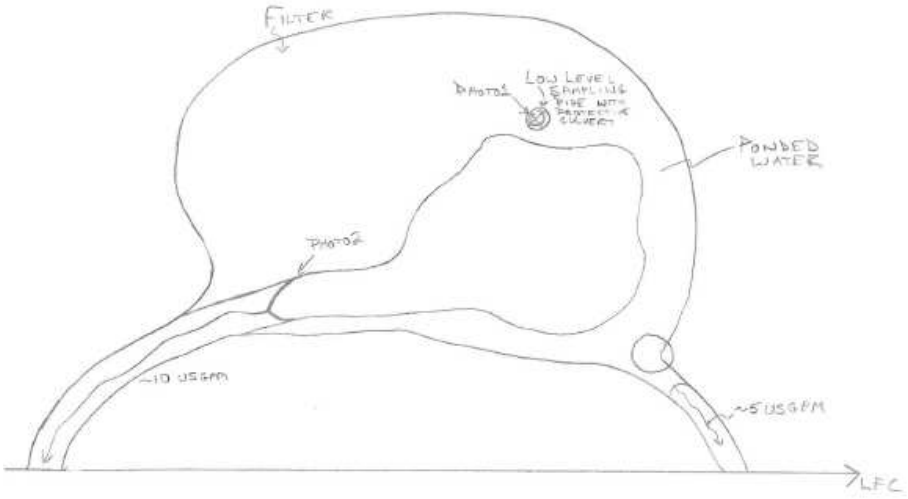
Sampling Standpipe: Yes, low level. MI added cap to culvert in 2018
Depth to bottom: Could not measure, 50 mm poly pipe, coiled in CMP protective casing
Depth to water: Water has filled protective steel casing
Condition: Missing a 30 inch cover
Repairs Required: Replace the 30 inch cover

Other Comments: Filter appears to be working effectively other than alternate flow paths.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 7A1 **Date:** August 28, 2018
Site Description: West side, south of 7B2.

Site Sketch and Photo Locations:



Photos:

Photo 1: Low level sampling pipe and water within protective casing. MI added a new protective cap and marker to the casing after the annual inspection was conducted.

Photo 2: Discharge ditches at 7A1 effectively direct water to LFC.

Filter Condition: Good
Repairs Required: None

Approximate Flow: 15 USgpm

Additional Discharge Areas: No

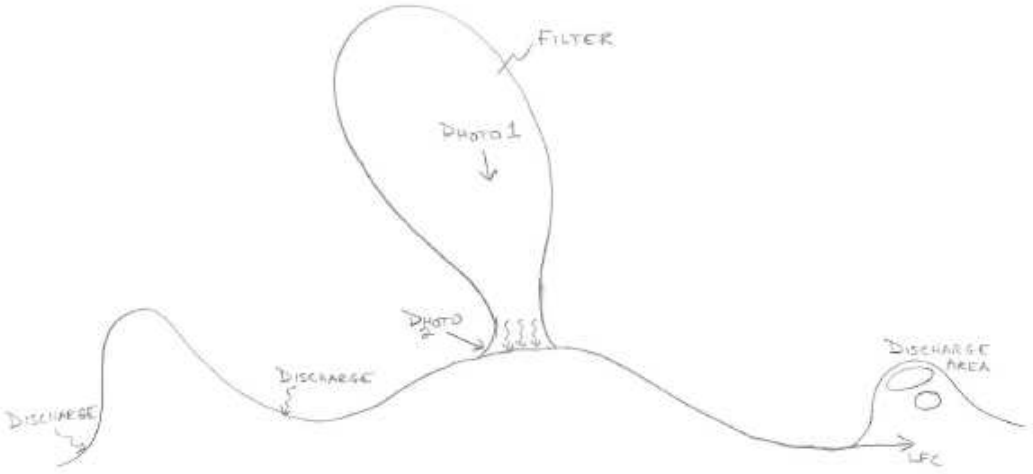
Sampling Standpipe: Yes, low level
Depth to bottom: Could not measure, 50 mm poly pipe, coiled in CMP protective casing.
Depth to water: Water has filled protective steel casing.
Condition: Good
Repairs Required: None

Other Comments: Large flow through filter, appears to be working effectively. Constructed discharge channels are formed as ditches and effectively direct discharge water to the LFC.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 7B2 **Date:** August 28, 2018
Site Description: West side, north of 7A1.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 7B2.

Photo 2: Filter discharge at 7B2 into LFC.

Filter Condition: Good
Repairs Required: None

Approximate Flow: 4 USgpm

Additional Discharge Areas: Two very low flow discharge areas approximately 7 m and 14 m upstream along LFC. One area of discharge approximately 70 m downstream along LFC.

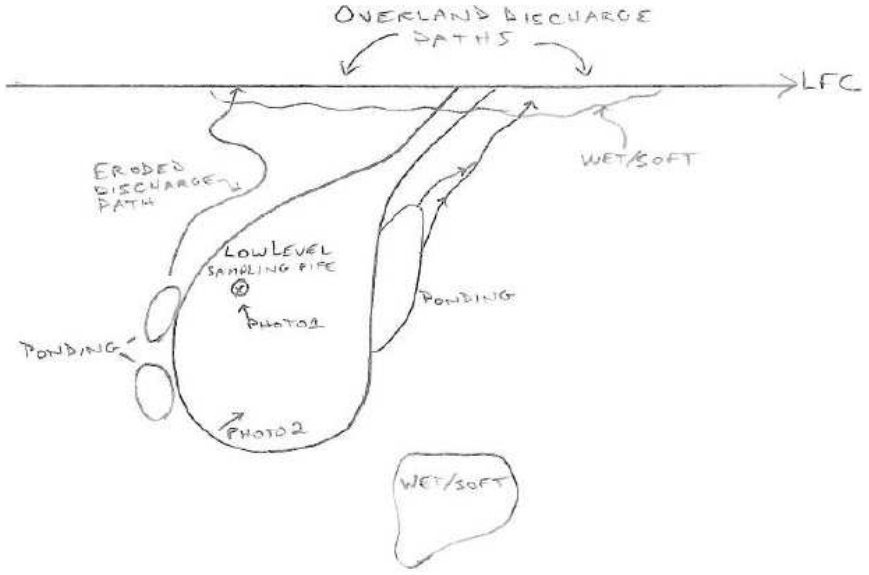
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 7C1 **Date:** August 28, 2018
Site Description: East side, between Redditt and Keewatin bridges.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 7C1.

Photo 2: Water flowing through 7C1 filter and finding alternate flow paths to LFC or ponding in low areas.

Filter Condition: Good – water finding alternate flow paths to LFC or ponding in low areas. Constructed discharge channel appears to be clogged with sediment. Eroded path on south side of filter.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: 4 USgpm

Additional Discharge Areas: No

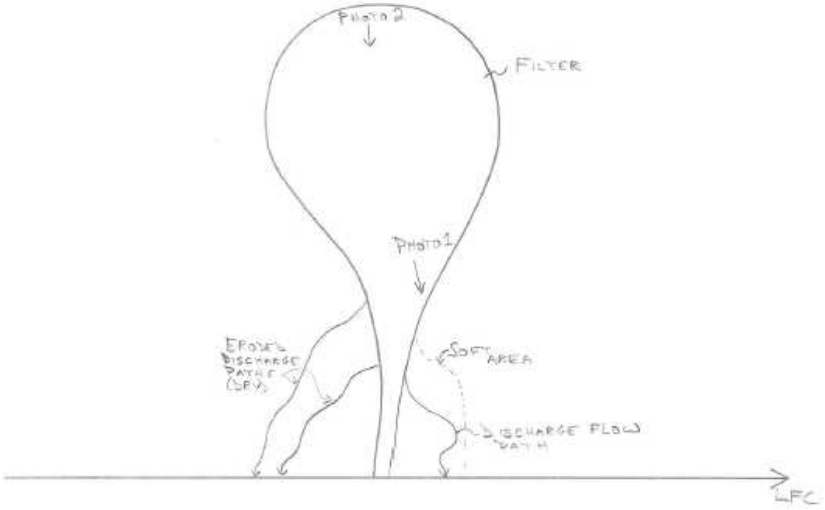
Sampling Standpipe: Yes, low level
Depth to bottom: Did not measure in order to avoid cross contamination. 2.41 m previously.
Depth to water: 0 m (at top of pipe). Artesian when opened.
Condition: Good
Repairs Required: Low level standpipe casing has shifted sideways and is holding PVC cap in place. Use pry bar to straighten and give space to the PVC cap.

Other Comments: Filter appears to be working effectively other than the discharge channel. Very soft along LFC.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 8B1 **Date:** August 28, 2018
Site Description: West side, south of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Water finding alternate flow path to LFC.

Photo 2: Spring treatment filter 8B1.

Filter Condition: Good – water finding alternate flow path to LFC. Constructed discharge channel appears to be clogged with sediment. Some erosion observed on south side in 2 paths but not currently flowing
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: 5 USgpm

Additional Discharge Areas: No

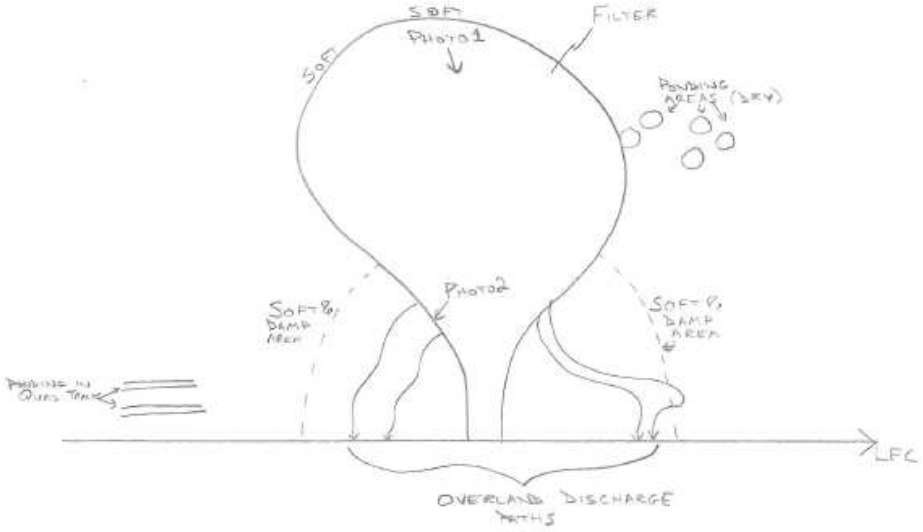
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 8B2 **Date:** August 28, 2018
Site Description: West side, south of Keewatin bridge, north of 8B1.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 8B2.

Photo 2: Water finding alternate flow path to LFC at 8B2.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge area.
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: 8 USgpm

Additional Discharge Areas: No

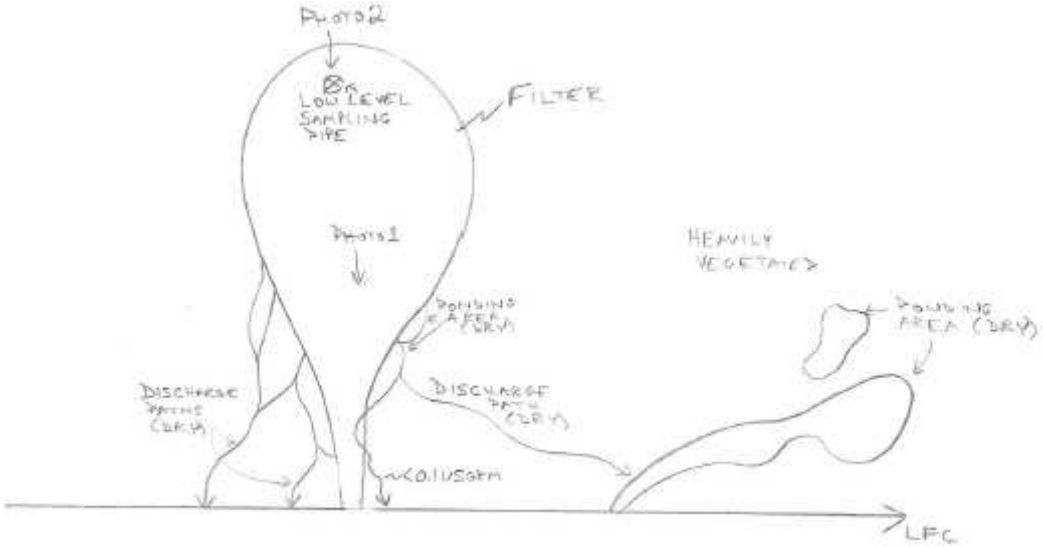
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 8C1 **Date:** August 28, 2018
Site Description: West side, south of Keewatin bridge, north of 8B2.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 8C1 and constructed discharge trench.

Photo 2: Low level sampling pipe and protective steel casing at 8C1.

Filter Condition: Good – water finding alternate flow paths to LFC. Flow paths wet and soft, but not currently flowing. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge areas.
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: >0.1USgpm

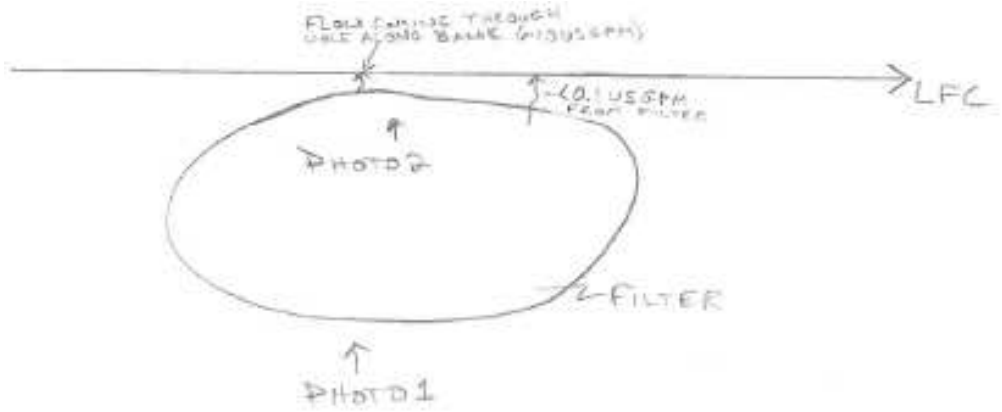
Additional Discharge Areas: No.
Sampling Standpipe: Yes, low level
Depth to bottom: 3.790 m
Depth to water: 0.173 m below steel casing.
Condition: Good
Repairs Required: None

Other Comments: Filter appears to be working effectively other than alternate flow path. Ponded area to the North of filter is discharging to LFC and appears to be sourced from the filter. PVC cap & threaded coupling was off of casing and was replaced upon inspection. Top of PVC casing measured at 0.19 m below ground surface.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 9A6 **Date:** August 28, 2018
Site Description: East side, north of CPR Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 9A6.

Photo 2: Spring 9A6 discharge into Low Flow Channel.

Filter Condition: Good

Repairs Required: None

Approximate Flow: 10 USgpm

Additional Discharge Areas: No

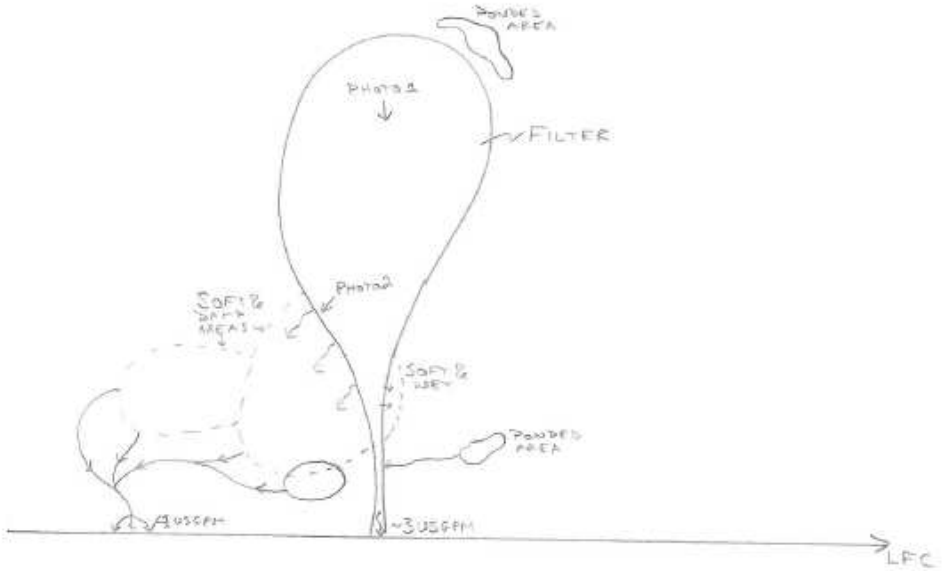
Sampling Standpipe: No

Other Comments: Flow coming through filter, appears to be working effectively.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 9B1 **Date:** August 28, 2018
Site Description: West side, north of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 9B1.

Photo 2: Water ponding to the south of 9B1 filter and finding alternate flow paths to LFC. Difficult to determine if additional springs in this area.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channel appear to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path. Alternatively, construct a new swale along existing overland discharge path.

Approximate Flow: 2 USgpm

Additional Discharge Areas: No, however, very difficult to tell if wet area to the south of the filter is a spring or is ponded water from discharge from the filter. Wet areas continue south, almost to Keewatin bridge.

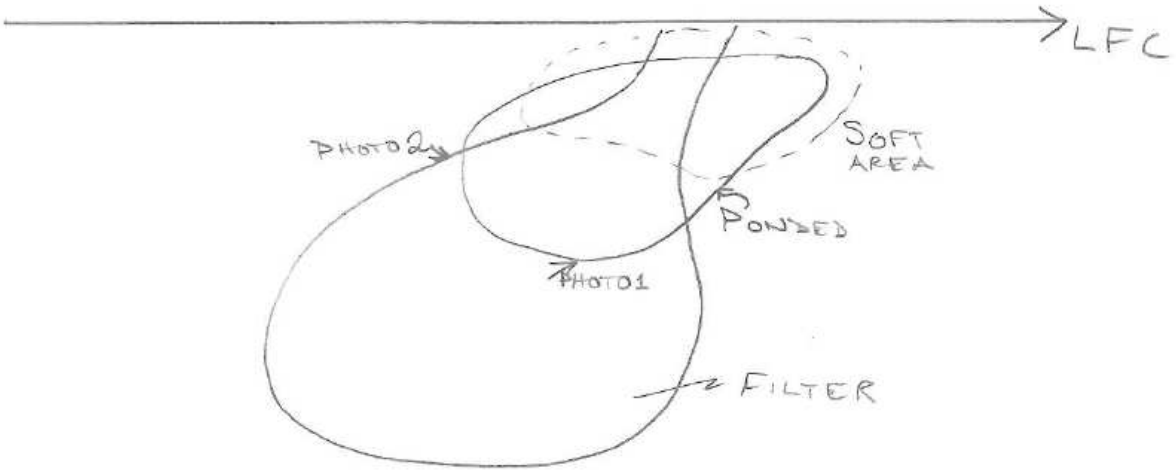
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 9B2 **Date:** August 28, 2018
Site Description: East side, north of CPR Keewatin Bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Additional discharge points along constructed discharge trench, very soft area.

Photo 2: Spring treatment filter 9B2.

Filter Condition: Good – water finding alternate flow paths to LFC. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: <1 USgpm

Additional Discharge Areas: Yes, piping observed along constructed discharge trench, very low flows. Further investigation treatment of additional discharge areas may be required.

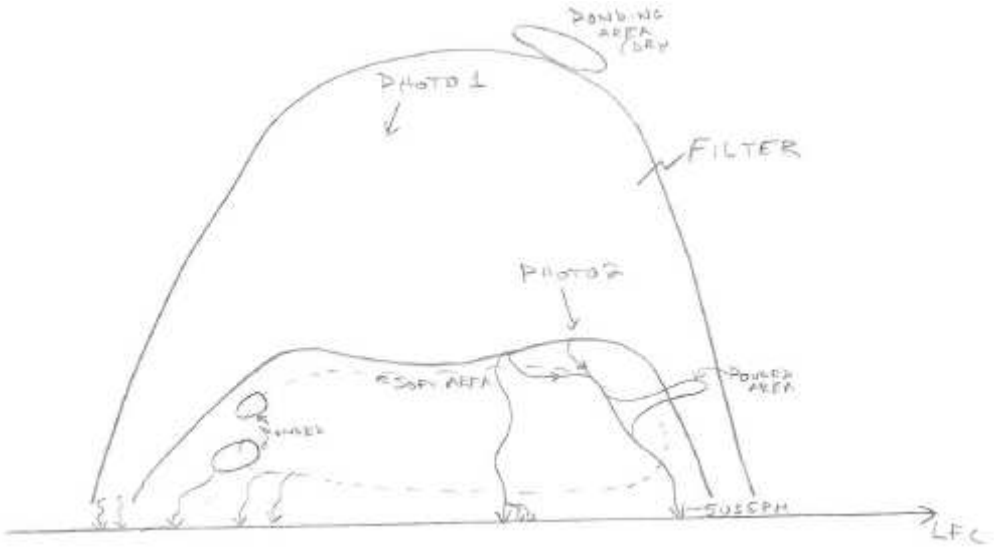
Sampling Standpipe: No

Other Comments: Wet and soft along discharge trench and near LFC.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 10A1 **Date:** August 28, 2018
Site Description: West side, north of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 10A1.

Photo 2: Water flowing through 10A1 filter and finding alternate flow paths to LFC.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channels appear to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channels and creating swales may focus flow along design discharge paths.

Approximate Flow: 5 USgpm at North discharge

Additional Discharge Areas: No

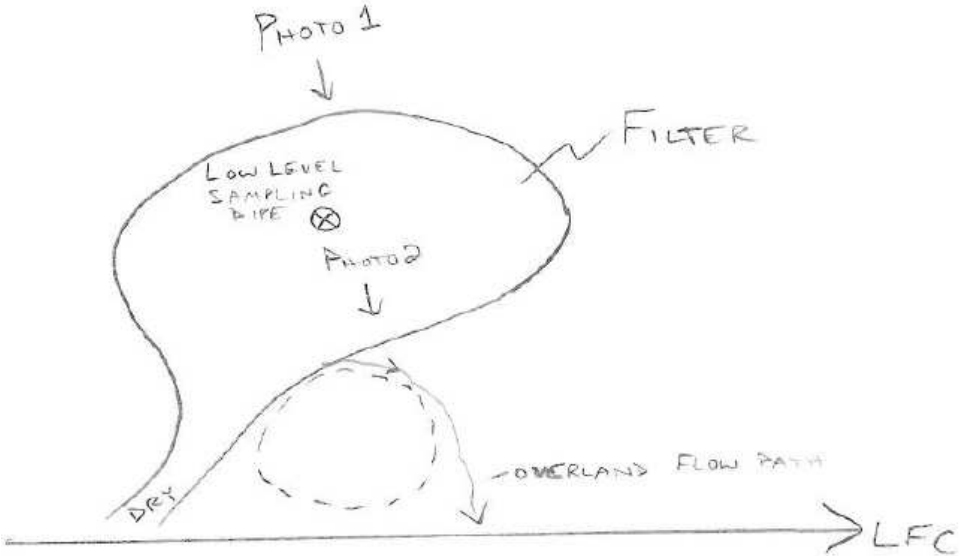
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channels.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 11A1 **Date:** August 28, 2018
Site Description: West side, north of Keewatin bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 11A1 and low level sampling pipe, covered by vegetation.

Photo 2: Water flowing through 11A1 filter and finding alternate flow path to LFC.

Filter Condition: Good – water finding alternate flow path to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path. Alternatively, construct a new swale along existing flow path.

Approximate Flow: 6 USgpm
Additional Discharge Areas: No

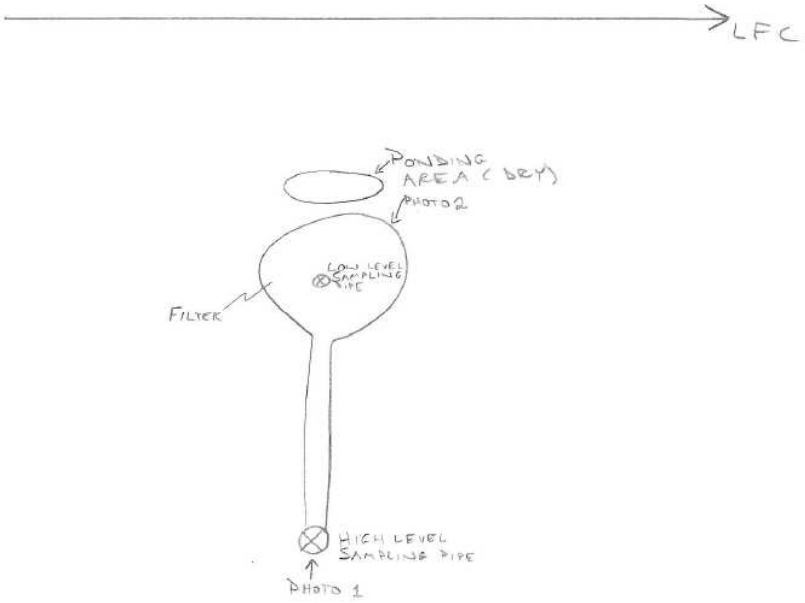
Sampling Standpipe: Yes, low level
Depth to bottom: 4.845 m (2016)
Depth to water: 0.204 m below PVC TOC
Condition: Good.
Repairs: Low level protective steel casing has settled and PVC casing is holding lid open. Prop up steel casing to allow lid to close

Other Comments: Filter appears to be working effectively other than alternate flow path. Water flowing over very soft soil between filter and LFC.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 11A2 **Date:** August 28, 2018
Site Description: East side of Floodway, south of PTH59N bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: High level sampling pipe and protective CMP casing.

Photo 2: Water flowing through 11A2 filter and finding alternate flow paths to LFC.

Filter Condition: Good

Repairs Required: None

Approximate Flow: 0 USgpm

Additional Discharge Areas: No

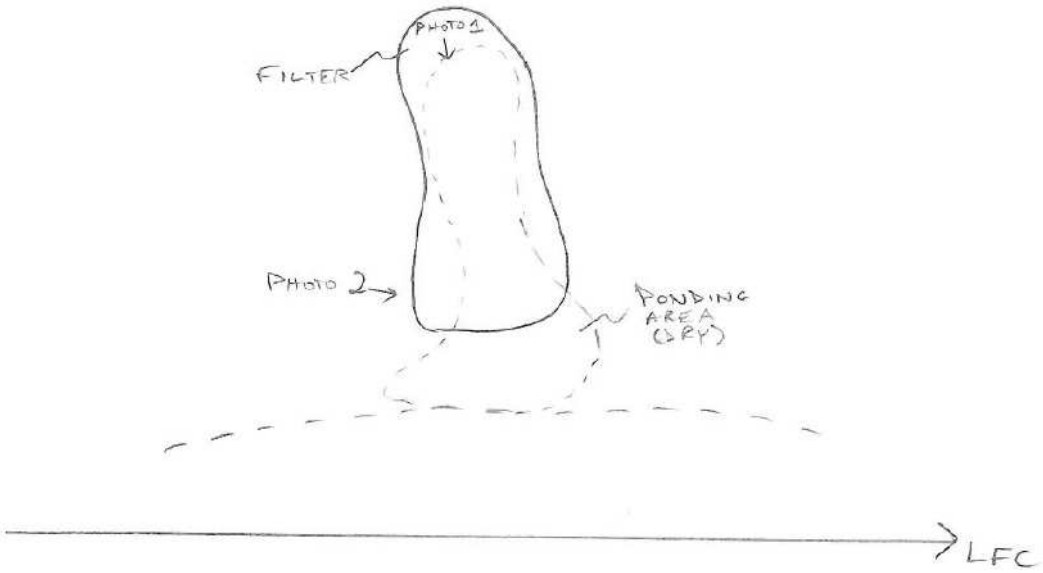
Sampling Standpipe: Yes, low level and high level
Depth to bottom: 3.60 m (low level).
Depth to water: 1.10m (low level)
Condition: Good
Repairs Required: None

Other Comments: There is no discharge trench constructed to Low Flow Channel. Dry around filter. Could add mono foam around PVC at opening in steel protector at high level standpipe but is a low priority.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 16A2 **Date:** August 29, 2018
Site Description: West side, north of Dunning Road.

Site Sketch and Photo Locations:



Photos:

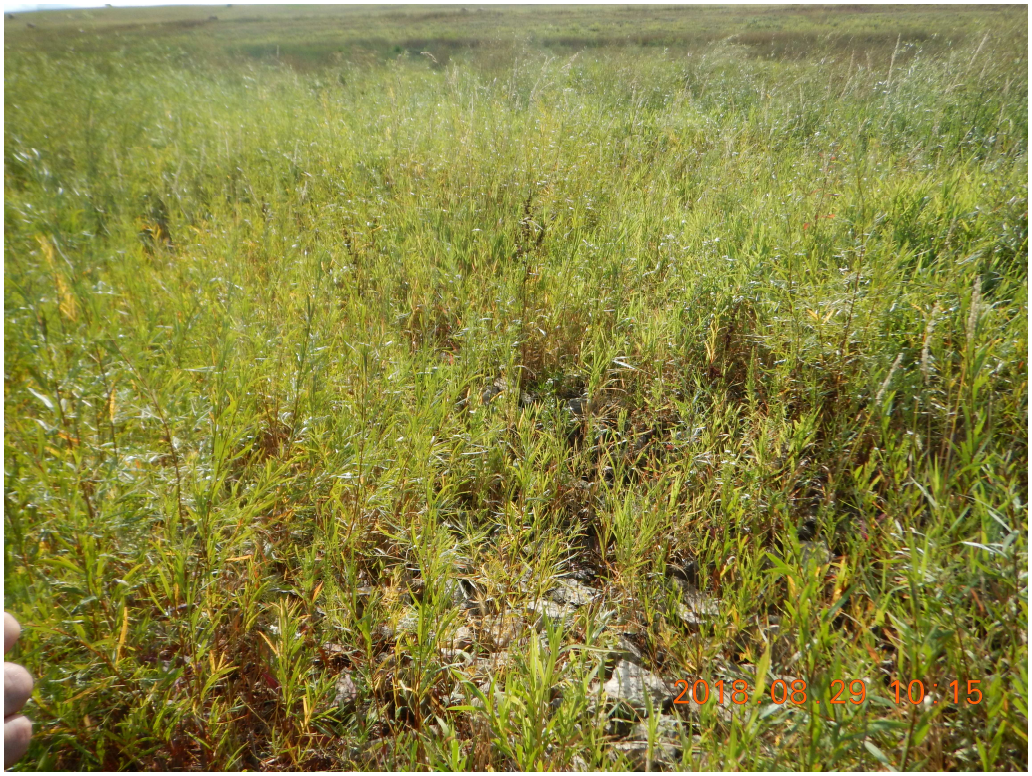


Photo 1: Spring treatment filter 16A2.

Photo 2: Spring treatment filter 16A2.

Filter Condition: Good. No apparent discharge path to drain into LFC.

Repairs Required: None.

Approximate Flow: No Flow

Additional Discharge Areas: No

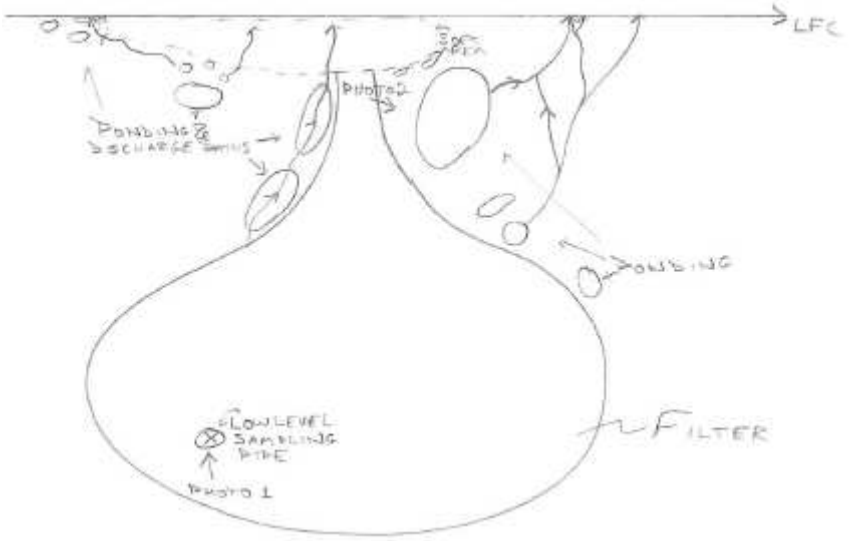
Sampling Standpipe: No

Other Comments: No flow observed. Dried ponding area exists on and around filter. Heavily vegetated.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 17A2 **Date:** August 29, 2018
Site Description: East side, north of Dunning Road

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 17A2 and low level sampling pipe.

Photo 2: Water ponding beside the French drain at 17A2.

Filter Condition: Good

Repairs Required: None

Approximate Flow: 1 USgpm

Additional Discharge Areas: Small discharge area along French Drain, may just be ponding water.

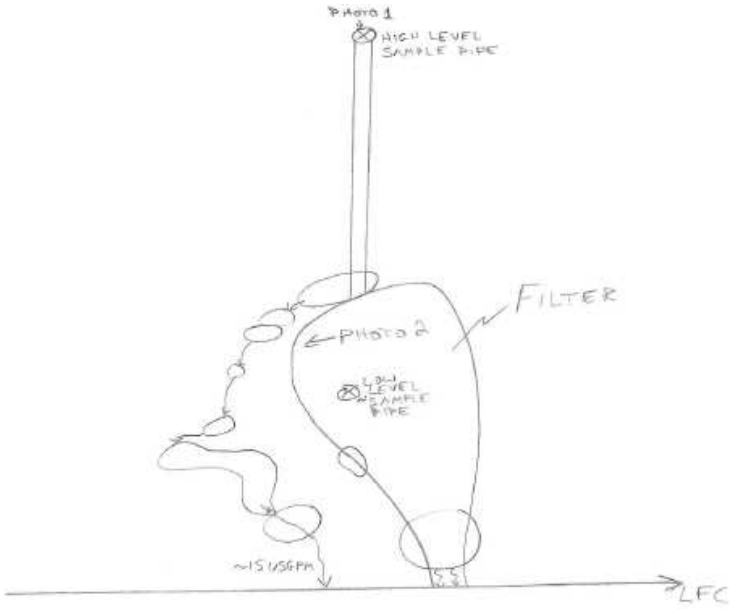
Sampling Standpipe: Yes, low level
Depth to bottom: 1.566 m
Depth to water: 0.274 m
Condition: Good
Repairs Required: None

Other Comments: Area around filter is dry; filter appears to be working well other than alternate flow path. Heavy vegetation in area.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 18A1 **Date:** August 29, 2018
Site Description: West side, north of LFC bike/pedestrian bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: High level sampling pipe and protective CMP casing.

Photo 2: Water flowing through filter and finding alternate flow paths to LFC at 18A1.

Filter Condition: Good – water finding alternate flow paths to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge areas.
Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: Path to South of discharge path ~ 15 USgpm. Path adjacent to discharge path ~ 3 USgpm.

Additional Discharge Areas: No

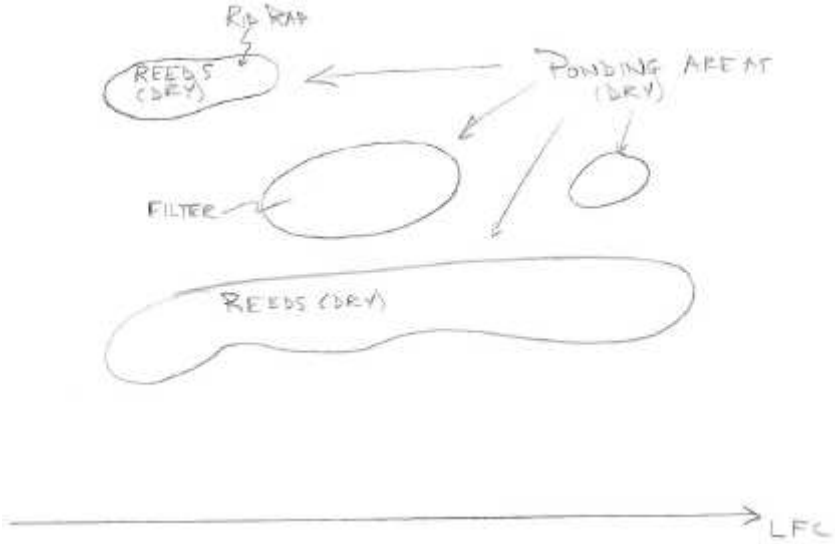
Sampling Standpipe: Yes, low level and high level.
Depth to bottom: 3.40 m (low level).
Depth to water: 0.117 m (low level).
Condition: PVC has lifted up and is in contact with steel protective casing.
Repairs: Protective steel casing on low level sampling pipe is leaning against PVC. Pry to reposition.

Other Comments: Filter appears to be working effectively other than the discharge channel.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 18A2 **Date:** September 6, 2018
Site Description: West side, approximately 100 m north of 18A1.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter site 18A2.

Photo 2: Dried ponding area near spring treatment filter site 18A2.

Filter Condition: Good
Repairs Required: None

Approximate Flow: No flow

Additional Discharge Areas: No

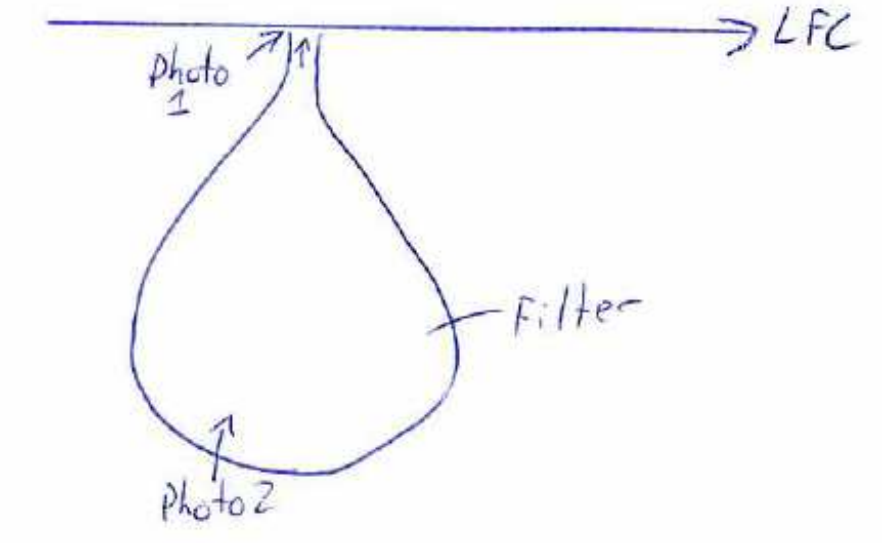
Sampling Standpipe: No

Other Comments: Dried areas with reeds from previous surface water ponding around filter.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 20A2 **Date:** August 29, 2018
Site Description: East side, south of 21A2

Site Sketch and Photo Locations:



Photos:

Photo 1: Tie-in of filter drain to Low Flow Channel.

Photo 2: Spring treatment filter 20A2.

Filter Condition: Good

Repairs Required: None

Approximate Flow: <0.1 USgpm

Additional Discharge Areas: No

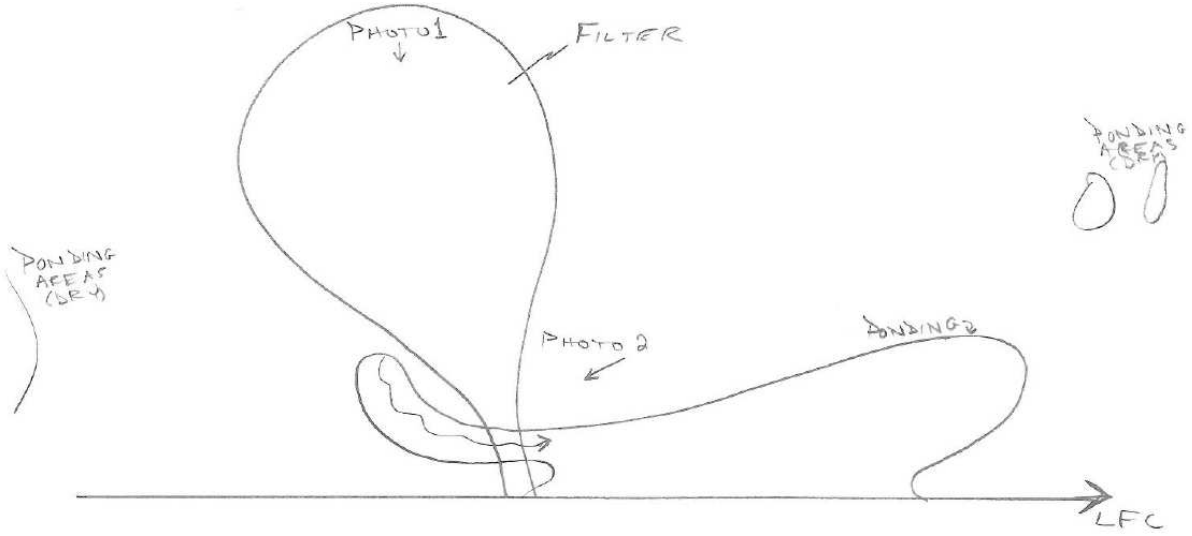
Sampling Standpipe: No

Other Comments: No flow observed, no wet or soft areas.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 21A1 **Date:** August 29, 2018
Site Description: West side, south of CEMR bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 21A1.

Photo 2: Water flowing through 21A1 filter and finding alternate flow path to LFC.

Filter Condition: Good – water finding alternate flow path to LFC. Constructed discharge channel appears to be clogged with sediment. No significant erosion observed within overland discharge area.

Repairs Required: Excavating rip rap from discharge channel and creating a swale may focus flow along design discharge path.

Approximate Flow: <1 USgpm

Additional Discharge Areas: No

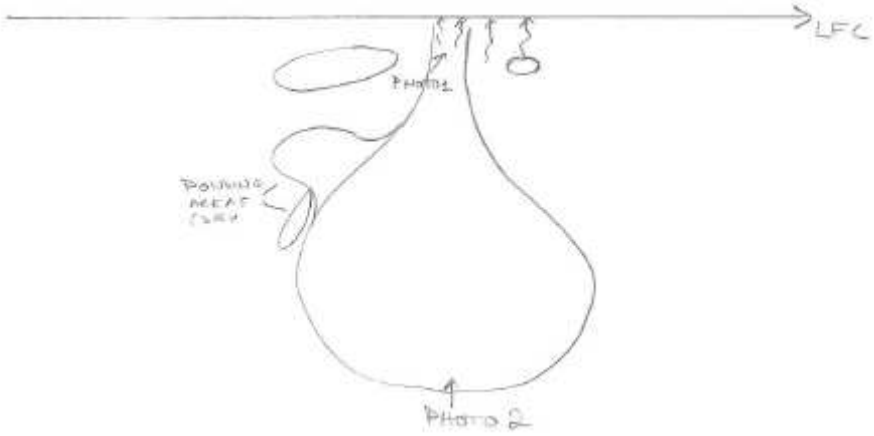
Sampling Standpipe: No

Other Comments: Filter appears to be working effectively other than the discharge channel. LFC at filter elevation / above discharge channel.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 21A2 **Date:** August 29, 2018
Site Description: East side, north of 20A2

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 21A2.

Photo 2: Tie-in of 21A2 filter drain to Low Flow Channel.

Filter Condition: Good

Repairs Required: None

Approximate Flow: <0.1 USgpm

Additional Discharge Areas: No

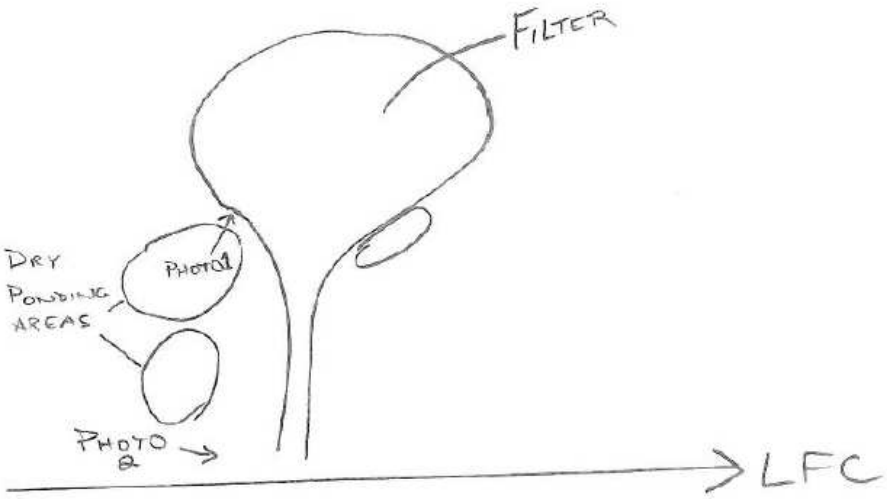
Sampling Standpipe: No

Other Comments: No flow observed, no wet or soft areas around filter.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 23A1 **Date:** August 29, 2018
Site Description: West side, south of PTH 44 bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Spring treatment filter 23A1.

Photo 2: Tie in of discharge channel to LFC at 23A1.

Filter Condition: Good

Repairs Required: None

Approximate Flow: No Flow

Additional Discharge Areas: No

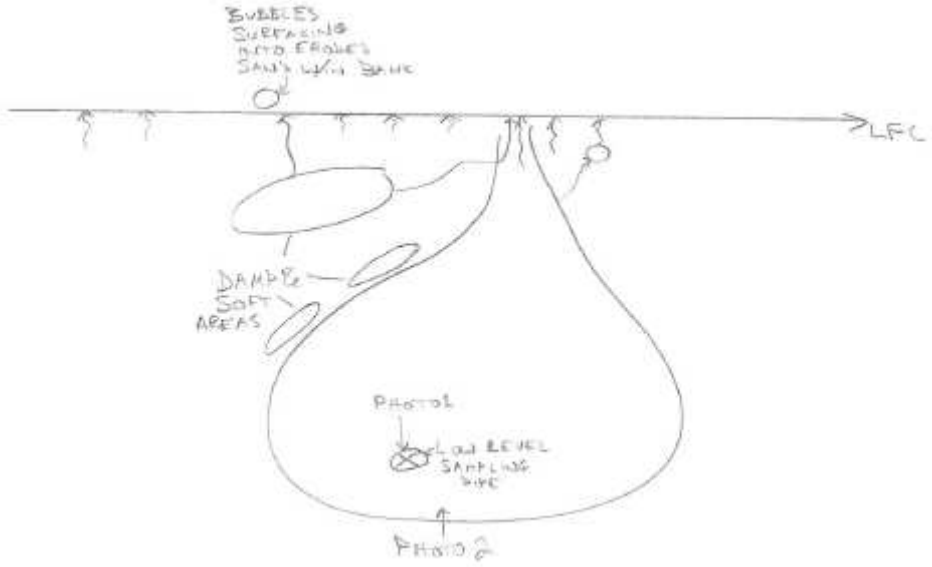
Sampling Standpipe: No

Other Comments: Rip rap is filling with sediment, hard to see filter and discharge channel. Heavy vegetation.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: 23A2 **Date:** August 29, 2018
Site Description: East side, just south of PTH 44 bridge.

Site Sketch and Photo Locations:



Photos:

Photo 1: Low level sampling pipe steel protective casing.

Photo 2: Spring treatment filter site 23A2.

Filter Condition: Good

Repairs Required: None

Approximate Flow: <0.1 USgpm

Additional Discharge Areas: No

Sampling Standpipe: Yes, low level
Depth to bottom: 3.18 m
Depth to water: 0.376 m below PVC top of casing.
Condition: Good.
Repairs: None.

Other Comments: PVC cap is friction fit, not threaded. Area where bubbles are emerging from along the bank just below the LFC water (see sketch).

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: AD17-1 **Date:** August 29, 2018
Site Description: West side, approximately 10 m downstream of a beaver dam crossing the low flow channel. Located mid way between Church Rd. and Hay Rd.
UTM: 14U 648661 5546623.

Photos:

Photo 1: Additional discharge location facing upstream toward beaver dam.

Photo 2: Slow seepage at additional discharge location.

Approximate Flow: <0.1 USgpm

Other Comments: Additional discharge location 10 m downstream of beaver dam and is potentially diverted flow from the dam.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: AD17-2 **Date:** August 29, 2018
Site Description: West side, approximately 129 m downstream of a beaver dam that crosses the low flow channel. Located mid way between Church Rd. and Hay Rd.
UTM: 14U 648646 5546742.

Photos:

Photo 1: Additional discharge location facing west from mid channel.

Photo 2: Slow seepage at additional discharge location.

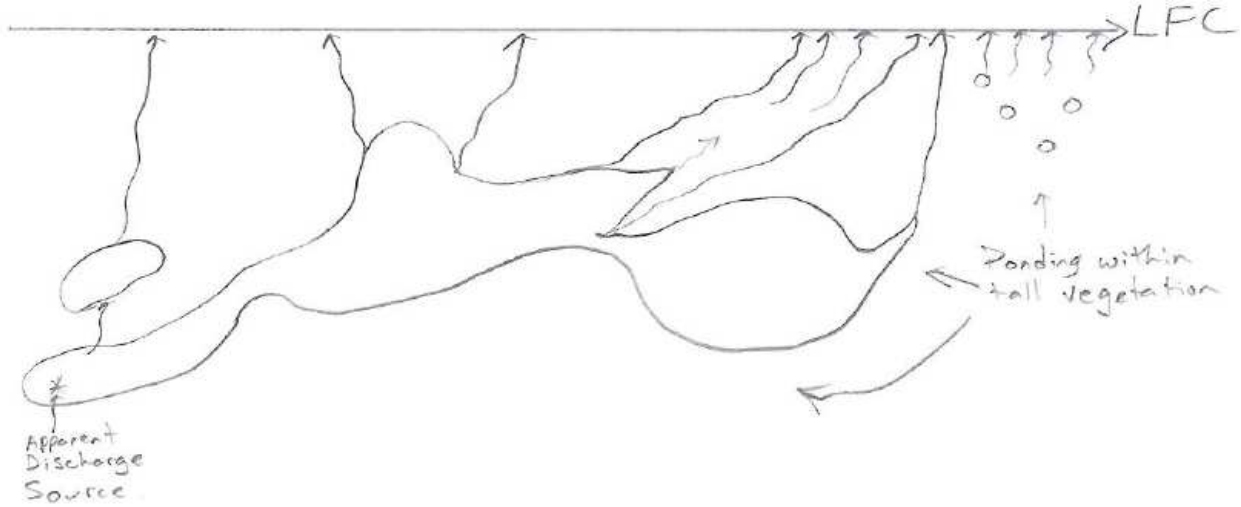
Approximate Flow: <0.1 USgpm

Other Comments: Additional discharge location 129 m downstream of beaver dam and is potentially diverted flow from the dam as opposed to groundwater discharge.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: AD17-3 **Date:** August 29, 2018
Site Description: East side of channel across from Hay Rd. Across channel from AD17-4.
UTM: 14U 0648624 5547181.

Site Sketch and Photo Locations:



Photos:

Photo 1: Additional discharge location apparent source pooling.

Photo 2: Low flow seepage into channel.

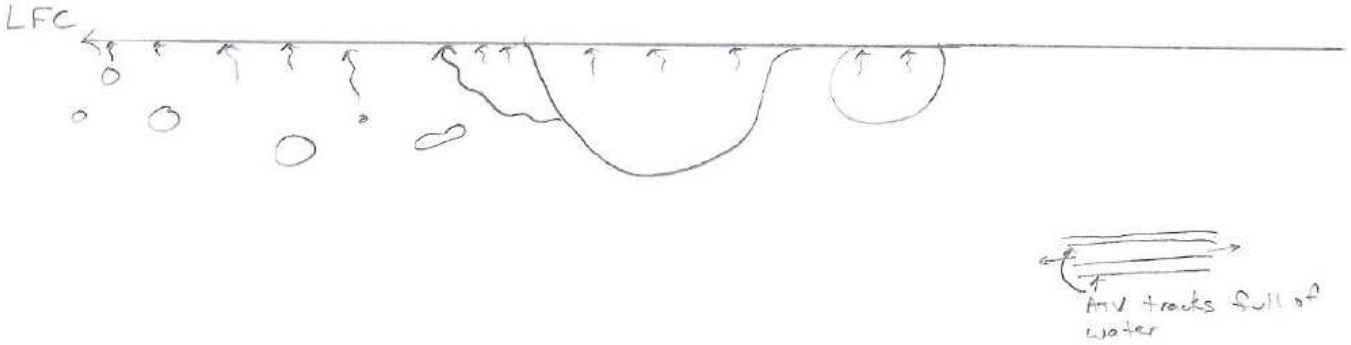
Approximate Flow: <0.1 USgpm individual streams. Approximately <5 USgpm total discharge.

Other Comments: Additional discharge location with low flow discharges into the channel spanning approximately 65 m from 14U 0648624 5547181 downstream to 14U 0648614 5547245.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: AD17-4 **Date:** August 29, 2018
Site Description: West side of channel across from Hay Rd. Across the channel from AD17-3.
UTM: 14U 0648593 5547218.

Site Sketch and Photo Locations:



Photos:

Photo 1: Additional discharge pooling and seepage area from 2017 appears dry in 2018.

Photo 2: Area of low flow seepage into channel.

Approximate Flow: <0.1 USgpm

Other Comments: Additional discharge location from 2017 with very little discharge in 2018.

2018 Summer Inspection of Spring Treatment Areas

Treatment Site ID: AD17-5 **Date:** August 28, 2018
Site Description: West side of channel between Hay Rd. and CEMR Bridge and approximately 70 m south of Spring 21A2.
UTM: 14U 0648492 5548099.

Photos:

Photo 1: Additional discharge location from 2017 adjacent to low flow channel not flowing in 2018.

Photo 2: Area appeared dry along bank.

Approximate Flow: 0 USgpm

Other Comments: Additional discharge identified in 2017 was not apparent during the 2018 investigation.

APPENDIX D6-D-3

ADDITIONAL PHOTOGRAPHS AND VIDEO (INCLUDED ON DVD)

APPENDIX D6-E

LABORATORY REPORTS

APPENDIX D6-E-1

PRE-MELT

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

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K13-12321
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-1
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	666		mg/L			20-MAR-18
Carbonate (CO3)	<0.60		mg/L			20-MAR-18
Hydroxide (OH)	<0.34		mg/L			20-MAR-18
*Nitrate and Nitrite as N	6.83		mg/L	10		22-MAR-18
pH						
pH	7.55		pH units			19-MAR-18
Turbidity						
*Turbidity	42.6		NTU			16-MAR-18
TDS calculated						
TDS (Calculated)	714		mg/L		500	20-MAR-18
Sulfate in Water by IC						
Sulfate (SO4)	82.1		mg/L		500	16-MAR-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0074		mg/L	1		16-MAR-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	6.83		mg/L	10		16-MAR-18
Ion Balance Calculation						
Ion Balance	103		%			22-MAR-18
Cation - Anion Balance	1.4		%			22-MAR-18
Anion Sum	14.9		me/L			22-MAR-18
Cation Sum	15.3		me/L			22-MAR-18
Hardness Calculated						
Hardness (as CaCO3)	693		mg/L		500	20-MAR-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					19-MAR-18
Calcium (Ca)-Dissolved	92.8		mg/L			19-MAR-18
Magnesium (Mg)-Dissolved	112		mg/L			19-MAR-18
Potassium (K)-Dissolved	5.18		mg/L			19-MAR-18
Sodium (Na)-Dissolved	30.6		mg/L		200	19-MAR-18
Conductivity						
Conductivity	1030		umhos/cm			19-MAR-18
Chloride in Water by IC						
Chloride (Cl)	63.3		mg/L		250	16-MAR-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	546		mg/L			19-MAR-18

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Paul Lindell

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K13-12321
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-1
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		16-MAR-18
Escherichia Coli	<1		MPN/100mL	0		16-MAR-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K09-12316
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-2
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	522		mg/L			20-MAR-18
Carbonate (CO3)	<0.60		mg/L			20-MAR-18
Hydroxide (OH)	<0.34		mg/L			20-MAR-18
*Nitrate and Nitrite as N	2.29		mg/L	10		22-MAR-18
pH						
pH	7.62		pH units			19-MAR-18
Turbidity						
*Turbidity	0.19		NTU			16-MAR-18
TDS calculated						
TDS (Calculated)	529		mg/L		500	20-MAR-18
Sulfate in Water by IC						
Sulfate (SO4)	60.9		mg/L		500	16-MAR-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0022		mg/L	1		16-MAR-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	2.29		mg/L	10		16-MAR-18
Ion Balance Calculation						
Ion Balance	104		%			22-MAR-18
Cation - Anion Balance	2.0		%			22-MAR-18
Anion Sum	10.8		me/L			22-MAR-18
Cation Sum	11.3		me/L			22-MAR-18
Hardness Calculated						
Hardness (as CaCO3)	509		mg/L		500	20-MAR-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					19-MAR-18
Calcium (Ca)-Dissolved	77.2		mg/L			19-MAR-18
Magnesium (Mg)-Dissolved	76.7		mg/L			19-MAR-18
Potassium (K)-Dissolved	4.22		mg/L			19-MAR-18
Sodium (Na)-Dissolved	23.2		mg/L		200	19-MAR-18
Conductivity						
Conductivity	790		umhos/cm			19-MAR-18
Chloride in Water by IC						
Chloride (Cl)	30.4		mg/L		250	16-MAR-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	428		mg/L			19-MAR-18

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Date: 22-MAR-18
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WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K09-12316
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-2
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		16-MAR-18
Escherichia Coli	<1		MPN/100mL	0		16-MAR-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

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Winnipeg MB R3T 5P4
ATTN: Paul Lindell

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K09-12012
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-3
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	435		mg/L			20-MAR-18
Carbonate (CO3)	<0.60		mg/L			20-MAR-18
Hydroxide (OH)	<0.34		mg/L			20-MAR-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		22-MAR-18
pH						
pH	7.77		pH units			20-MAR-18
Turbidity						
*Turbidity	0.27		NTU			16-MAR-18
TDS calculated						
TDS (Calculated)	672		mg/L		500	20-MAR-18
Sulfate in Water by IC						
Sulfate (SO4)	214		mg/L		500	16-MAR-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-18
Ion Balance Calculation						
Ion Balance	106		%			22-MAR-18
Cation - Anion Balance	3.0		%			22-MAR-18
Anion Sum	12.3		me/L			22-MAR-18
Cation Sum	13.0		me/L			22-MAR-18
Hardness Calculated						
Hardness (as CaCO3)	539		mg/L		500	20-MAR-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					19-MAR-18
Calcium (Ca)-Dissolved	88.4		mg/L			19-MAR-18
Magnesium (Mg)-Dissolved	77.4		mg/L			19-MAR-18
Potassium (K)-Dissolved	4.48		mg/L			19-MAR-18
Sodium (Na)-Dissolved	49.0		mg/L		200	19-MAR-18
Conductivity						
Conductivity	976		umhos/cm			19-MAR-18
Chloride in Water by IC						
Chloride (Cl)	24.5		mg/L		250	16-MAR-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	356		mg/L			19-MAR-18

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ATTN: Paul Lindell

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K09-12012
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-3
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		16-MAR-18
Escherichia Coli	<1		MPN/100mL	0		16-MAR-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

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Winnipeg MB R3T 5P4
ATTN: Paul Lindell

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K11-12015
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-4
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	336		mg/L			20-MAR-18
Carbonate (CO3)	<0.60		mg/L			20-MAR-18
Hydroxide (OH)	<0.34		mg/L			20-MAR-18
*Nitrate and Nitrite as N	0.0641		mg/L	10		22-MAR-18
pH						
pH	7.77		pH units			19-MAR-18
Turbidity						
*Turbidity	0.23		NTU			16-MAR-18
TDS calculated						
TDS (Calculated)	381		mg/L		500	20-MAR-18
Sulfate in Water by IC						
Sulfate (SO4)	68.4		mg/L		500	16-MAR-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0014		mg/L	1		16-MAR-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0627		mg/L	10		16-MAR-18
Ion Balance Calculation						
Ion Balance	104		%			22-MAR-18
Cation - Anion Balance	2.0		%			22-MAR-18
Anion Sum	7.44		me/L			22-MAR-18
Cation Sum	7.74		me/L			22-MAR-18
Hardness Calculated						
Hardness (as CaCO3)	364		mg/L		500	20-MAR-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					19-MAR-18
Calcium (Ca)-Dissolved	73.1		mg/L			19-MAR-18
Magnesium (Mg)-Dissolved	44.1		mg/L			19-MAR-18
Potassium (K)-Dissolved	4.28		mg/L			19-MAR-18
Sodium (Na)-Dissolved	8.09		mg/L		200	19-MAR-18
Conductivity						
Conductivity	594		umhos/cm			19-MAR-18
Chloride in Water by IC						
Chloride (Cl)	17.9		mg/L		250	16-MAR-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	276		mg/L			19-MAR-18

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Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K11-12015
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-4
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		16-MAR-18
Escherichia Coli	<1		MPN/100mL	0		16-MAR-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
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ATTN: Paul Lindell

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K11-12014
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-5
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	345		mg/L			20-MAR-18
Carbonate (CO3)	<0.60		mg/L			20-MAR-18
Hydroxide (OH)	<0.34		mg/L			20-MAR-18
*Nitrate and Nitrite as N	0.112		mg/L	10		22-MAR-18
pH						
pH	7.77		pH units			19-MAR-18
Turbidity						
*Turbidity	2.66		NTU			16-MAR-18
TDS calculated						
TDS (Calculated)	370		mg/L		500	20-MAR-18
Sulfate in Water by IC						
Sulfate (SO4)	55.1		mg/L		500	16-MAR-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		16-MAR-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.112		mg/L	10		16-MAR-18
Ion Balance Calculation						
Ion Balance	104		%			22-MAR-18
Cation - Anion Balance	1.9		%			22-MAR-18
Anion Sum	7.33		me/L			22-MAR-18
Cation Sum	7.61		me/L			22-MAR-18
Hardness Calculated						
Hardness (as CaCO3)	356		mg/L		500	20-MAR-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					19-MAR-18
Calcium (Ca)-Dissolved	69.6		mg/L			19-MAR-18
Magnesium (Mg)-Dissolved	44.3		mg/L			19-MAR-18
Potassium (K)-Dissolved	4.12		mg/L			19-MAR-18
Sodium (Na)-Dissolved	8.84		mg/L		200	19-MAR-18
Conductivity						
Conductivity	582		umhos/cm			19-MAR-18
Chloride in Water by IC						
Chloride (Cl)	18.3		mg/L		250	16-MAR-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	283		mg/L			19-MAR-18

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ATTN: Paul Lindell

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: K11-12014
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-5
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		16-MAR-18
Escherichia Coli	<1		MPN/100mL	0		16-MAR-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

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

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: S100
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-6
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	440		mg/L			20-MAR-18
Carbonate (CO3)	<0.60		mg/L			20-MAR-18
Hydroxide (OH)	<0.34		mg/L			20-MAR-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		22-MAR-18
pH						
pH	7.66		pH units			19-MAR-18
Turbidity						
*Turbidity	0.28		NTU			16-MAR-18
TDS calculated						
TDS (Calculated)	672		mg/L		500	20-MAR-18
Sulfate in Water by IC						
Sulfate (SO4)	216		mg/L		500	16-MAR-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		16-MAR-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		16-MAR-18
Ion Balance Calculation						
Ion Balance	103		%			22-MAR-18
Cation - Anion Balance	1.6		%			22-MAR-18
Anion Sum	12.4		me/L			22-MAR-18
Cation Sum	12.8		me/L			22-MAR-18
Hardness Calculated						
Hardness (as CaCO3)	528		mg/L		500	20-MAR-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					19-MAR-18
Calcium (Ca)-Dissolved	85.7		mg/L			19-MAR-18
Magnesium (Mg)-Dissolved	76.2		mg/L			19-MAR-18
Potassium (K)-Dissolved	4.49		mg/L			19-MAR-18
Sodium (Na)-Dissolved	48.9		mg/L		200	19-MAR-18
Conductivity						
Conductivity	902		umhos/cm			19-MAR-18
Chloride in Water by IC						
Chloride (Cl)	24.5		mg/L		250	16-MAR-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	361		mg/L			19-MAR-18

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ATTN: Paul Lindell

Date: 22-MAR-18
PO No.: MI Floodway Premelt
WO No.: L2068496
Project Ref: 16-0300-002
Sample ID: S100
Sampled By: ATM/AS
Date Collected: 15-MAR-18
Lab Sample ID: L2068496-6
Matrix: Ground Water

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		16-MAR-18
Escherichia Coli	<1		MPN/100mL	0		16-MAR-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R3989068								
WG2735653-10 DUP		**L2068496-3**						
Alkalinity, Total (as CaCO3)		356	353		mg/L	1.0	20	19-MAR-18
WG2735653-4 LCS								
Alkalinity, Total (as CaCO3)			101.4		%		85-115	19-MAR-18
WG2735653-9 LCS								
Alkalinity, Total (as CaCO3)			104.0		%		85-115	19-MAR-18
WG2735653-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	19-MAR-18
WG2735653-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	19-MAR-18
CL-IC-N-WP	**Water**							
Batch R3992910								
WG2734198-6 LCS								
Chloride (Cl)			100.1		%		90-110	16-MAR-18
WG2734198-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	16-MAR-18
EC-WP	**Water**							
Batch R3989068								
WG2735653-10 DUP		**L2068496-3**						
Conductivity		976	937		umhos/cm	4.1	10	19-MAR-18
WG2735653-3 LCS								
Conductivity			100.1		%		90-110	19-MAR-18
WG2735653-8 LCS								
Conductivity			99.8		%		90-110	19-MAR-18
WG2735653-1 MB								
Conductivity			<1.0		umhos/cm		1	19-MAR-18
WG2735653-6 MB								
Conductivity			<1.0		umhos/cm		1	19-MAR-18
MET-D-MS-WP	**Water**							
Batch R3989069								
WG2735288-2 LCS								
Calcium (Ca)-Dissolved			103.9		%		80-120	19-MAR-18
Magnesium (Mg)-Dissolved			107.3		%		80-120	19-MAR-18
Potassium (K)-Dissolved			99.2		%		80-120	19-MAR-18
Sodium (Na)-Dissolved			104.7		%		80-120	19-MAR-18
WG2735288-1 MB								
Calcium (Ca)-Dissolved			<0.50		mg/L		0.5	19-MAR-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-MS-WP	**Water**							
Batch R3989069								
WG2735288-1 MB								
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	19-MAR-18
Potassium (K)-Dissolved			<0.50		mg/L		0.5	19-MAR-18
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	19-MAR-18
NO2-L-IC-N-WP	**Water**							
Batch R3992910								
WG2734198-6 LCS								
Nitrite (as N)			99.0		%		90-110	16-MAR-18
WG2734198-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	16-MAR-18
NO3-L-IC-N-WP	**Water**							
Batch R3992910								
WG2734198-6 LCS								
Nitrate (as N)			99.9		%		90-110	16-MAR-18
WG2734198-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	16-MAR-18
PH-WP	**Water**							
Batch R3989068								
WG2735653-2 LCS								
pH			7.42		pH units		7.3-7.5	19-MAR-18
WG2735653-7 LCS								
pH			7.42		pH units		7.3-7.5	19-MAR-18
Batch R3991489								
WG2736519-2 LCS								
pH			7.43		pH units		7.3-7.5	20-MAR-18
SO4-IC-N-WP	**Water**							
Batch R3992910								
WG2734198-6 LCS								
Sulfate (SO4)			100.9		%		90-110	16-MAR-18
WG2734198-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	16-MAR-18
TC,EC-QT97-WP	**Water**							
Batch R3987160								
WG2733897-1 DUP		**L2068496-1**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	16-MAR-18
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	16-MAR-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT97-WP	**Water**							
Batch R3987160								
WG2733897-2 MB								
Total Coliforms			<1		MPN/100mL		1	16-MAR-18
Escherichia Coli			<1		MPN/100mL		1	16-MAR-18
TURBIDITY-WP	**Water**							
Batch R3989369								
WG2735177-2 LCS								
Turbidity			100.5		%		85-115	16-MAR-18
WG2735177-1 MB								
Turbidity			<0.10		NTU		0.1	16-MAR-18

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
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	15-MAR-18 10:30	19-MAR-18 12:00	0.25	97	hours	EHTR-FM
	2	15-MAR-18 11:40	19-MAR-18 12:00	0.25	96	hours	EHTR-FM
	3	15-MAR-18 13:07	20-MAR-18 12:00	0.25	119	hours	EHTR-FM
	4	15-MAR-18 14:40	19-MAR-18 12:00	0.25	93	hours	EHTR-FM
	5	15-MAR-18 15:40	19-MAR-18 12:00	0.25	92	hours	EHTR-FM
	6	15-MAR-18 13:10	19-MAR-18 12:00	0.25	95	hours	EHTR-FM

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 L2068496 were received on 15-MAR-18 16:30.

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.

10-223181

L2068496-COFC

ALS Environmental

Page 1 of 1

Report To		Report Format / Distribution		Service Request: (Rush subject to availability - Contact ALS to confirm TAT)
Company:	KGS Group	Standard: X Other (specify):		X Regular (Standard Turnaround Times - Business Days)
Contact:	Paul Lindell	Select: PDF X Excel X Digital Fax		Priority(2-4 Business Days)-50% surcharge - Contact ALS to confirm TAT
Address:	865 Waverley Street Wpg MB R3T 5P4	Email 1:	plindell@kgsgroup.com	Emergency (1-2 Business Days)-100% Surcharge - Contact ALS to confirm TAT
		Email 2:	Amelvin@kgsgroup.com	Same Day or Weekend Emergency - Contact ALS to confirm TAT
Phone: 204-896-1209	Fax: 204-896-0754		MSmith@kgsgroup.com	Analysis Request

Invoice To		Client / Project Information	
Same as Report ? (circle) (Yes) or No (if No, provide details)			
Copy of Invoice with Report? (circle) (Yes) or No		Job #:	16-0300-002
Company:		PO / AFE:	MI Floodway Premelt
Contact:	Accounts Payable	LSD:	MB Floodway
Address:			
Phone:	Fax:	Quote #:	Q56271
Lab Work Order # (lab use only)	L2068496	ALS Contact: Jody D	Sampler: ATM / AS

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

Sample #	Sample Identification (This description will appear on the report)	Date (dd-mmm-yy)	Time (hh:mm)	Sample Type	KGS-Pavlov-D-Flood-WP	TC, EC-QT97-WP	Number of Containers
1	K13-12321	15 Mar-18	10:30	GW	X	X	3
2	K09-12316	15 Mar-18	11:40	GW	X	X	3
3	K09-12012	15 Mar-18	13:07	GW	X	X	3
4	K11-12015	15 Mar-18	14:40	GW	X	X	3
5	K11-12014	15 Mar-18	15:40	GW	X	X	3
6	S-100	15 Mar-18	13:10	GW	X	X	3

Special Instructions / Regulation with water or land use (CCME- Freshwater Aquatic Life/BC CSR-Commercial/AB Tier 1-Natural/ETC) / Hazardous Details

Not filtered / Not preserved

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.

SHIPMENT RELEASE (client use)			SHIPMENT RECEPTION (lab use only)				SHIPMENT VERIFICATION (lab use only)			
Released by: [signature]	Date: March 15	Time: 4:30	Received by: [signature]	Date: 15-Mar-18	Time: 4:30	Temperature: 5.2 °C	Verified by:	Date:	Time:	Observations: Yes / No ? If Yes add SIF

APPENDIX D6-E-2

SPRING MELT

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: K13-12321
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	610		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	3.78		mg/L	10		03-MAY-18
pH						
pH	7.37		pH units			02-MAY-18
Turbidity						
*Turbidity	2.88		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	648		mg/L		500	03-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	80.6		mg/L		500	01-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0011		mg/L	1		01-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	3.78		mg/L	10		01-MAY-18
Ion Balance Calculation						
Ion Balance	102		%			03-MAY-18
Cation - Anion Balance	1.2		%			03-MAY-18
Anion Sum	13.4		me/L			03-MAY-18
Cation Sum	13.7		me/L			03-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	613		mg/L		500	03-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					02-MAY-18
Calcium (Ca)-Dissolved	83.6		mg/L			02-MAY-18
Magnesium (Mg)-Dissolved	98.1		mg/L			02-MAY-18
Potassium (K)-Dissolved	5.11		mg/L			02-MAY-18
Sodium (Na)-Dissolved	30.2		mg/L		200	02-MAY-18
Conductivity						
Conductivity	1100		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	50.1		mg/L		250	01-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	500		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: K13-12321
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		01-MAY-18
Escherichia Coli	<1		MPN/100mL	0		01-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: K09-12316
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	513		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	2.24		mg/L	10		03-MAY-18
pH						
pH	7.43		pH units			02-MAY-18
Turbidity						
*Turbidity	0.96		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	528		mg/L		500	03-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	61.5		mg/L		500	01-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0013		mg/L	1		01-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	2.24		mg/L	10		01-MAY-18
Ion Balance Calculation						
Ion Balance	102		%			03-MAY-18
Cation - Anion Balance	1.0		%			03-MAY-18
Anion Sum	10.9		me/L			03-MAY-18
Cation Sum	11.1		me/L			03-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	494		mg/L		500	03-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					02-MAY-18
Calcium (Ca)-Dissolved	75.8		mg/L			02-MAY-18
Magnesium (Mg)-Dissolved	74.1		mg/L			02-MAY-18
Potassium (K)-Dissolved	4.29		mg/L			02-MAY-18
Sodium (Na)-Dissolved	24.8		mg/L		200	02-MAY-18
Conductivity						
Conductivity	885		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	35.7		mg/L		250	01-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	421		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: K09-12316
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		01-MAY-18
Escherichia Coli	<1		MPN/100mL	0		01-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: U09-13571
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	488		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	1.85		mg/L	10		03-MAY-18
pH						
pH	7.42		pH units			02-MAY-18
Turbidity						
*Turbidity	0.54		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	607		mg/L		500	03-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	102		mg/L		500	01-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		01-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	1.85		mg/L	10		01-MAY-18
Ion Balance Calculation						
Ion Balance	102		%			03-MAY-18
Cation - Anion Balance	1.0		%			03-MAY-18
Anion Sum	12.0		me/L			03-MAY-18
Cation Sum	12.2		me/L			03-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	509		mg/L		500	03-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					02-MAY-18
Calcium (Ca)-Dissolved	76.8		mg/L			02-MAY-18
Magnesium (Mg)-Dissolved	77.2		mg/L			02-MAY-18
Potassium (K)-Dissolved	4.83		mg/L			02-MAY-18
Sodium (Na)-Dissolved	44.6		mg/L		200	02-MAY-18
Conductivity						
Conductivity	1010		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	62.1		mg/L		250	01-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	400		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: U09-13571
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: K11-12018
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	736		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		03-MAY-18
pH						
pH	7.20		pH units			02-MAY-18
Turbidity						
*Turbidity	8.06		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	695		mg/L		500	03-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	102		mg/L		500	01-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		01-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		01-MAY-18
Ion Balance Calculation						
Ion Balance	102		%			03-MAY-18
Cation - Anion Balance	0.8		%			03-MAY-18
Anion Sum	14.3		me/L			03-MAY-18
Cation Sum	14.5		me/L			03-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	654		mg/L		500	03-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					02-MAY-18
Calcium (Ca)-Dissolved	89.6		mg/L			02-MAY-18
Magnesium (Mg)-Dissolved	105		mg/L			02-MAY-18
Potassium (K)-Dissolved	5.03		mg/L			02-MAY-18
Sodium (Na)-Dissolved	28.9		mg/L		200	02-MAY-18
Conductivity						
Conductivity	1090		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	2.51		mg/L		250	01-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	603		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: K11-12018
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: SWPTH44
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	210		mg/L			03-MAY-18
Carbonate (CO3)	5.76		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		03-MAY-18
pH						
pH	8.44		pH units			02-MAY-18
Turbidity						
*Turbidity	27.6		NTU			02-MAY-18
Total Metals by ICP-MS						
Calcium (Ca)-Total	44.5		mg/L			02-MAY-18
Magnesium (Mg)-Total	29.2		mg/L			02-MAY-18
Potassium (K)-Total	6.42		mg/L			02-MAY-18
Sodium (Na)-Total	24.7		mg/L		200	02-MAY-18
TDS calculated						
TDS (Calculated)	301		mg/L		500	03-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	56.5		mg/L		500	01-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		01-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		01-MAY-18
Ion Balance Calculation						
Ion Balance	103		%			03-MAY-18
Cation - Anion Balance	1.7		%			03-MAY-18
Anion Sum	5.67		me/L			03-MAY-18
Cation Sum	5.86		me/L			03-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	231	HTC	mg/L		500	03-MAY-18
Conductivity						
Conductivity	496		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	30.4		mg/L		250	01-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	182		mg/L			02-MAY-18
Phosphorus (P)-Total	0.175		mg/L			03-MAY-18
Ammonia, Total (as N)	<0.010		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: SWPTH44
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-5
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Escherichia Coli	5		MPN/100mL	0		01-MAY-18
Total Coliforms	649		MPN/100mL	0		01-MAY-18
Total Kjeldahl Nitrogen	0.84		mg/L			04-MAY-18
Total Suspended Solids	29.2		mg/L			04-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: SW100
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	208		mg/L			03-MAY-18
Carbonate (CO3)	6.48		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		03-MAY-18
pH						
pH	8.46		pH units			02-MAY-18
Turbidity						
*Turbidity	28.3		NTU			02-MAY-18
Total Metals by ICP-MS						
Calcium (Ca)-Total	45.9		mg/L			03-MAY-18
Magnesium (Mg)-Total	25.0		mg/L			03-MAY-18
Potassium (K)-Total	6.04		mg/L			03-MAY-18
Sodium (Na)-Total	22.4		mg/L		200	03-MAY-18
TDS calculated						
TDS (Calculated)	295		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	56.5		mg/L		500	01-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0020		mg/L	1		01-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		01-MAY-18
Ion Balance Calculation						
Ion Balance	96.7		%			04-MAY-18
Cation - Anion Balance	-1.7		%			04-MAY-18
Anion Sum	5.66		me/L			04-MAY-18
Cation Sum	5.48		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	217	HTC	mg/L		500	04-MAY-18
Conductivity						
Conductivity	496		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	30.5		mg/L		250	01-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	182		mg/L			02-MAY-18
Phosphorus (P)-Total	0.180		mg/L			03-MAY-18
Ammonia, Total (as N)	<0.010		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087084
Project Ref: 16-0300-002
Sample ID: SW100
Sampled By: ATM & ACM
Date Collected: 30-APR-18
Lab Sample ID: L2087084-6
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Escherichia Coli	5		MPN/100mL	0		01-MAY-18
Total Coliforms	866		MPN/100mL	0		01-MAY-18
Total Kjeldahl Nitrogen	0.74		mg/L			04-MAY-18
Total Suspended Solids	34.8		mg/L			04-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

Workorder: L2087084 Report Date: 08-MAY-18

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4031307								
WG2763726-10 DUP		**L2087084-3**						
Alkalinity, Total (as CaCO3)		400	398		mg/L	0.4	20	02-MAY-18
WG2763726-4 LCS								
Alkalinity, Total (as CaCO3)			102.4		%		85-115	02-MAY-18
WG2763726-9 LCS								
Alkalinity, Total (as CaCO3)			99.9		%		85-115	02-MAY-18
WG2763726-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-MAY-18
WG2763726-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-MAY-18
CL-IC-N-WP	**Water**							
Batch R4031661								
WG2762141-6 LCS								
Chloride (Cl)			100.3		%		90-110	01-MAY-18
WG2762141-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	01-MAY-18
EC-QT97-ENDPT-WP	**Water**							
Batch R4030596								
WG2762340-4 DUP		**L2087084-5**						
Escherichia Coli		5	2	DUP-H	MPN/100mL	89	65	01-MAY-18
WG2762340-3 MB								
Escherichia Coli			<1		MPN/100mL		1	01-MAY-18
EC-WP	**Water**							
Batch R4031307								
WG2763726-10 DUP		**L2087084-3**						
Conductivity		1010	1010		umhos/cm	0.1	10	02-MAY-18
WG2763726-3 LCS								
Conductivity			96.7		%		90-110	02-MAY-18
WG2763726-8 LCS								
Conductivity			97.2		%		90-110	02-MAY-18
WG2763726-1 MB								
Conductivity			<1.0		umhos/cm		1	02-MAY-18
WG2763726-6 MB								
Conductivity			<1.0		umhos/cm		1	02-MAY-18
MET-D-MS-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-MS-WP	**Water**							
Batch R4031209								
WG2763283-2 LCS								
Calcium (Ca)-Dissolved			101.3		%		80-120	02-MAY-18
Magnesium (Mg)-Dissolved			107.7		%		80-120	02-MAY-18
Potassium (K)-Dissolved			100.1		%		80-120	02-MAY-18
Sodium (Na)-Dissolved			104.1		%		80-120	02-MAY-18
WG2763283-1 MB								
Calcium (Ca)-Dissolved			<0.50		mg/L		0.5	02-MAY-18
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	02-MAY-18
Potassium (K)-Dissolved			<0.50		mg/L		0.5	02-MAY-18
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	02-MAY-18
MET-T-MS-WP	**Water**							
Batch R4031209								
WG2763221-2 LCS								
Calcium (Ca)-Total			97.4		%		80-120	02-MAY-18
Magnesium (Mg)-Total			109.7		%		80-120	02-MAY-18
Potassium (K)-Total			98.1		%		80-120	02-MAY-18
Sodium (Na)-Total			102.8		%		80-120	02-MAY-18
WG2763221-1 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	02-MAY-18
Magnesium (Mg)-Total			<0.050		mg/L		0.05	02-MAY-18
Potassium (K)-Total			<0.50		mg/L		0.5	02-MAY-18
Sodium (Na)-Total			<0.50		mg/L		0.5	02-MAY-18
Batch R4032905								
WG2764068-2 LCS								
Calcium (Ca)-Total			93.5		%		80-120	03-MAY-18
Magnesium (Mg)-Total			102.6		%		80-120	03-MAY-18
Potassium (K)-Total			99.9		%		80-120	03-MAY-18
Sodium (Na)-Total			99.8		%		80-120	03-MAY-18
WG2764068-1 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	03-MAY-18
Magnesium (Mg)-Total			<0.050		mg/L		0.05	03-MAY-18
Potassium (K)-Total			<0.50		mg/L		0.5	03-MAY-18
Sodium (Na)-Total			<0.50		mg/L		0.5	03-MAY-18
N-TOTKJ-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
N-TOTKJ-WP	**Water**							
Batch R4033470								
WG2761420-10 LCS								
Total Kjeldahl Nitrogen			108.6		%		75-125	04-MAY-18
WG2761420-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	04-MAY-18
NH3-COL-WP	**Water**							
Batch R4031908								
WG2763944-2 LCS								
Ammonia, Total (as N)			99.7		%		85-115	02-MAY-18
WG2763944-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	02-MAY-18
NO2-L-IC-N-WP	**Water**							
Batch R4031661								
WG2762141-6 LCS								
Nitrite (as N)			99.0		%		90-110	01-MAY-18
WG2762141-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	01-MAY-18
NO3-L-IC-N-WP	**Water**							
Batch R4031661								
WG2762141-6 LCS								
Nitrate (as N)			101.2		%		90-110	01-MAY-18
WG2762141-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	01-MAY-18
P-T-L-COL-WP	**Water**							
Batch R4033256								
WG2764646-14 LCS								
Phosphorus (P)-Total			101.1		%		80-120	03-MAY-18
WG2764646-13 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	03-MAY-18
PH-WP	**Water**							
Batch R4031307								
WG2763726-10 DUP		**L2087084-3**						
pH		7.42	7.39	J	pH units	0.03	0.2	02-MAY-18
WG2763726-2 LCS								
pH			7.39		pH units		7.3-7.5	02-MAY-18
WG2763726-7 LCS								
pH			7.39		pH units		7.3-7.5	02-MAY-18
SO4-IC-N-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R4031661								
WG2762141-6 LCS								
Sulfate (SO4)			100.8		%		90-110	01-MAY-18
WG2762141-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	01-MAY-18
SOLIDS-TOTSUS-WP	**Water**							
Batch R4035288								
WG2764707-10 LCS								
Total Suspended Solids			92.0		%		85-115	04-MAY-18
WG2764707-9 MB								
Total Suspended Solids			<2.0		mg/L		2	04-MAY-18
TC,EC-QT97-WP	**Water**							
Batch R4030646								
WG2762186-2 DUP		**L2087084-1**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	01-MAY-18
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	01-MAY-18
WG2762186-1 MB								
Total Coliforms			<1		MPN/100mL		1	01-MAY-18
Escherichia Coli			<1		MPN/100mL		1	01-MAY-18
TC-QT97-ENDPT-WP	**Water**							
Batch R4030600								
WG2762342-2 DUP		**L2087084-5**						
Total Coliforms		649	435		MPN/100mL	39	65	01-MAY-18
WG2762342-1 MB								
Total Coliforms			<1		MPN/100mL		1	01-MAY-18
TURBIDITY-WP	**Water**							
Batch R4031688								
WG2763322-3 DUP		**L2087084-1**						
Turbidity		2.88	2.94		NTU	2.1	15	02-MAY-18
WG2763322-2 LCS								
Turbidity			98.5		%		85-115	02-MAY-18
WG2763322-1 MB								
Turbidity			<0.10		NTU		0.1	02-MAY-18

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
DUP-H	Duplicate results outside ALS DQO, due to sample heterogeneity.
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	30-APR-18 10:45	02-MAY-18 12:00	0.25	49	hours	EHTR-FM
	2	30-APR-18 11:25	02-MAY-18 12:00	0.25	48	hours	EHTR-FM
	3	30-APR-18 12:35	02-MAY-18 12:00	0.25	48	hours	EHTR-FM
	4	30-APR-18 15:45	02-MAY-18 12:00	0.25	44	hours	EHTR-FM
	5	30-APR-18 12:50	02-MAY-18 12:00	0.25	47	hours	EHTR-FM
	6	30-APR-18 16:00	02-MAY-18 12:00	0.25	44	hours	EHTR-FM

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 L2087084 were received on 01-MAY-18 08:45.

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

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

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

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2087084-COFC

COC Number: 14 - 450379

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS Group	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3pm)
Contact:	Marci Friedman-Hamm	Quality Control (QC) Report with Report	☑ Yes ☐ No	P ☐ Priority (2-4 business days if received by 3pm)
Address:	3rd Floor - 865 Waverley St. Winnipeg, MB R3T 5P4	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 business days if received by 3pm)
		Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
Phone:	204-896-1209	Email 1 or Fax	mfhamm@kgsgroup.com	Specify Date Required for E2,E or P:
		Email 2	plindell@kgsgroup.com	

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:	KGS Group	Email 1 or Fax	wmacquarrie@kgsgroup.com	
Contact:	Bill MacQuarrie	Email 2		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q56271	Approver ID:	Cost Center:
Job #:	16-0300-002	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact: Judy	Sampler: ATM + ACM

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	KGS-ROU1W-D-FLDWY-WP	TC, EC-QT97-WP	KGS-ROU1W-T-FLDWY-WP	P-T-COL-WP	N, TOT-KJ-WP	NH3-COL-WP	SOLIDS-TOTSUS-WP	TC-QT97-ENDPT-WP	EC-QT97-ENDPT-WP	Number of Containers
	K13-12321	30-APR-18	10:45	GW	X	X								3
	K09-12316	↓	11:25	↓	X	X								3
	U09-13571		12:35		X									2
	K11-12018		15:45		X									2
	SWPTH44		12:50	SW			X	X	X	X	X	X	X	5
	SW100		16:00	↓			X	X	X	X	X	X	X	5

Drinking Water (DW) Samples[1] (client use)	Special Instructions / Specify Criteria to add on report (client Use)	SAMPLE CONDITION AS RECEIVED (lab use only)
Are samples taken from a Regulated DW System? ☐ Yes ☐ No	Samples not filtered Groundwater samples not preserved Surface water samples preserved. Please filter &/or preserve in lab.	Frozen ☐ SIF Observations Yes ☐ No ☐ Ice packs Yes ☐ No ☐ Custody seal intact Yes ☐ No ☐ Cooling Initiated ☐
Are samples for human drinking water use? ☐ Yes ☐ No		INITIAL COOLER TEMPERATURES °C: -.9 / FINAL COOLER TEMPERATURES °C:

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Ariel Mallory	Date: May 1/18	Time: 8:30	Received by: AAL	Date: 11/05/18	Time: 8:26	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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

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

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K09-12012
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	411		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		03-MAY-18
pH						
pH	7.52		pH units			02-MAY-18
Turbidity						
*Turbidity	10.8		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	611		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	192		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	99.4		%			04-MAY-18
Cation - Anion Balance	-0.3		%			04-MAY-18
Anion Sum	11.4		me/L			04-MAY-18
Cation Sum	11.4		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	462		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	74.4		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	67.2		mg/L			03-MAY-18
Potassium (K)-Dissolved	4.33		mg/L			03-MAY-18
Sodium (Na)-Dissolved	45.9		mg/L		200	03-MAY-18
Conductivity						
Conductivity	953		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	24.4		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	337		mg/L			02-MAY-18

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Date: 08-MAY-18
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Project Ref: 16-0300-002
Sample ID: K09-12012
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-1
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		02-MAY-18
Escherichia Coli	<1		MPN/100mL	0		02-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K09-12011
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	288		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	0.0135		mg/L	10		03-MAY-18
pH						
pH	7.67		pH units			02-MAY-18
Turbidity						
*Turbidity	1.18		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	251		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	14.8		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0135		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	98.3		%			04-MAY-18
Cation - Anion Balance	-0.8		%			04-MAY-18
Anion Sum	5.24		me/L			04-MAY-18
Cation Sum	5.15		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	235		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	47.1		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	28.5		mg/L			03-MAY-18
Potassium (K)-Dissolved	2.60		mg/L			03-MAY-18
Sodium (Na)-Dissolved	9.01		mg/L		200	03-MAY-18
Conductivity						
Conductivity	449		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	7.56		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	236		mg/L			02-MAY-18

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Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K09-12011
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-2
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
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- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12017
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	322		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		03-MAY-18
pH						
pH	7.52		pH units			02-MAY-18
Turbidity						
*Turbidity	2.38		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	659		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	282		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	100		%			04-MAY-18
Cation - Anion Balance	0.1		%			04-MAY-18
Anion Sum	11.7		me/L			04-MAY-18
Cation Sum	11.7		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	479		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	79.9		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	67.9		mg/L			03-MAY-18
Potassium (K)-Dissolved	3.81		mg/L			03-MAY-18
Sodium (Na)-Dissolved	47.2		mg/L		200	03-MAY-18
Conductivity						
Conductivity	995		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	20.0		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	264		mg/L			02-MAY-18

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Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12017
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-3
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

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Account Manager

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ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12016
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	375		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		03-MAY-18
pH						
pH	7.52		pH units			02-MAY-18
Turbidity						
*Turbidity	1.04		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	641		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	230		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	106		%			04-MAY-18
Cation - Anion Balance	2.8		%			04-MAY-18
Anion Sum	11.5		me/L			04-MAY-18
Cation Sum	12.2		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	519		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	88.7		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	72.2		mg/L			03-MAY-18
Potassium (K)-Dissolved	4.73		mg/L			03-MAY-18
Sodium (Na)-Dissolved	39.2		mg/L		200	03-MAY-18
Conductivity						
Conductivity	967		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	21.5		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	307		mg/L			02-MAY-18

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Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12016
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-4
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
CDWQG = Health Canada Guideline Limits updated	**DECEMBER 2015**					

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12014
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	332		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	0.100		mg/L	10		03-MAY-18
pH						
pH	7.63		pH units			02-MAY-18
Turbidity						
*Turbidity	0.76		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	350		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	52.1		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0012		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0990		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	104		%			04-MAY-18
Cation - Anion Balance	1.8		%			04-MAY-18
Anion Sum	6.97		me/L			04-MAY-18
Cation Sum	7.23		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	338		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	60.0		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	45.8		mg/L			03-MAY-18
Potassium (K)-Dissolved	4.46		mg/L			03-MAY-18
Sodium (Na)-Dissolved	8.09		mg/L		200	03-MAY-18
Conductivity						
Conductivity	600		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	15.6		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	272		mg/L			02-MAY-18

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Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12014
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-5
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		02-MAY-18
Escherichia Coli	<1		MPN/100mL	0		02-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
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Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12015
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	307		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	0.0527		mg/L	10		03-MAY-18
pH						
pH	7.62		pH units			02-MAY-18
Turbidity						
*Turbidity	0.56		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	334		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	54.0		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0527		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	99.2		%			04-MAY-18
Cation - Anion Balance	-0.4		%			04-MAY-18
Anion Sum	6.69		me/L			04-MAY-18
Cation Sum	6.63		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	310		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	59.7		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	39.1		mg/L			03-MAY-18
Potassium (K)-Dissolved	4.13		mg/L			03-MAY-18
Sodium (Na)-Dissolved	7.56		mg/L		200	03-MAY-18
Conductivity						
Conductivity	590		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	18.7		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	252		mg/L			02-MAY-18

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ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: K11-12015
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-6
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		02-MAY-18
Escherichia Coli	<1		MPN/100mL	0		02-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
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Approved by

Hua Wo
Account Manager

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865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: MW-100
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	329		mg/L			03-MAY-18
Carbonate (CO3)	<0.60		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	0.0954		mg/L	10		03-MAY-18
pH						
pH	7.64		pH units			02-MAY-18
Turbidity						
*Turbidity	1.13		NTU			02-MAY-18
TDS calculated						
TDS (Calculated)	346		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	51.4		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0954		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	102		%			04-MAY-18
Cation - Anion Balance	1.0		%			04-MAY-18
Anion Sum	6.92		me/L			04-MAY-18
Cation Sum	7.06		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	332		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	60.8		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	43.7		mg/L			03-MAY-18
Potassium (K)-Dissolved	4.16		mg/L			03-MAY-18
Sodium (Na)-Dissolved	7.52		mg/L		200	03-MAY-18
Conductivity						
Conductivity	599		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	16.0		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	269		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: MW-100
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-7
Matrix: GW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		02-MAY-18
Escherichia Coli	<1		MPN/100mL	0		02-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: SW-PTH59N
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	239		mg/L			03-MAY-18
Carbonate (CO3)	7.44		mg/L			03-MAY-18
Hydroxide (OH)	<0.34		mg/L			03-MAY-18
*Nitrate and Nitrite as N	0.0156		mg/L	10		03-MAY-18
pH						
pH	8.42		pH units			02-MAY-18
Turbidity						
*Turbidity	42.7		NTU			02-MAY-18
Total Metals by ICP-MS						
Calcium (Ca)-Total	51.8		mg/L			03-MAY-18
Magnesium (Mg)-Total	29.5		mg/L			03-MAY-18
Potassium (K)-Total	6.21		mg/L			03-MAY-18
Sodium (Na)-Total	23.7		mg/L		200	03-MAY-18
TDS calculated						
TDS (Calculated)	343		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	73.4		mg/L		500	02-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0038		mg/L	1		02-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0118		mg/L	10		02-MAY-18
Ion Balance Calculation						
Ion Balance	93.6		%			04-MAY-18
Cation - Anion Balance	-3.3		%			04-MAY-18
Anion Sum	6.63		me/L			04-MAY-18
Cation Sum	6.21		me/L			04-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	251	HTC	mg/L		500	04-MAY-18
Conductivity						
Conductivity	578		umhos/cm			02-MAY-18
Chloride in Water by IC						
Chloride (Cl)	33.1		mg/L		250	02-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	209		mg/L			02-MAY-18
Phosphorus (P)-Total	0.174		mg/L			03-MAY-18
Ammonia, Total (as N)	0.054		mg/L			02-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2087686
Project Ref: 16-0300-002
Sample ID: SW-PTH59N
Sampled By: ATM + ACM
Date Collected: 01-MAY-18
Lab Sample ID: L2087686-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Kjeldahl Nitrogen	0.66		mg/L			04-MAY-18
Total Suspended Solids	24.9		mg/L			04-MAY-18
Total and E. coli to endpoint by QT97						
Total Coliforms	866		MPN/100mL	0		02-MAY-18
Escherichia Coli	94		MPN/100mL	0		02-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4031307								
WG2763726-15 DUP		**L2087686-8**						
Alkalinity, Total (as CaCO3)		209	206		mg/L	1.3	20	02-MAY-18
WG2763726-14 LCS								
Alkalinity, Total (as CaCO3)			102.2		%		85-115	02-MAY-18
WG2763726-9 LCS								
Alkalinity, Total (as CaCO3)			99.9		%		85-115	02-MAY-18
WG2763726-11 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-MAY-18
WG2763726-6 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	02-MAY-18
CL-IC-N-WP	**Water**							
Batch R4031664								
WG2763269-10 LCS								
Chloride (Cl)			100.0		%		90-110	02-MAY-18
WG2763269-6 LCS								
Chloride (Cl)			100.8		%		90-110	02-MAY-18
WG2763269-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	02-MAY-18
WG2763269-9 MB								
Chloride (Cl)			<0.50		mg/L		0.5	02-MAY-18
EC-WP	**Water**							
Batch R4031307								
WG2763726-15 DUP		**L2087686-8**						
Conductivity		578	576		umhos/cm	0.3	10	02-MAY-18
WG2763726-13 LCS								
Conductivity			97.0		%		90-110	02-MAY-18
WG2763726-8 LCS								
Conductivity			97.2		%		90-110	02-MAY-18
WG2763726-11 MB								
Conductivity			<1.0		umhos/cm		1	02-MAY-18
WG2763726-6 MB								
Conductivity			<1.0		umhos/cm		1	02-MAY-18
MET-D-MS-WP	**Water**							
Batch R4032905								
WG2764087-2 LCS								
Calcium (Ca)-Dissolved			96.3		%		80-120	03-MAY-18
Magnesium (Mg)-Dissolved			102.0		%		80-120	03-MAY-18
Potassium (K)-Dissolved			101.7		%		80-120	03-MAY-18

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-D-MS-WP	**Water**							
Batch R4032905								
WG2764087-2 LCS								
Sodium (Na)-Dissolved			101.9		%		80-120	03-MAY-18
WG2764087-1 MB								
Calcium (Ca)-Dissolved			<0.50		mg/L		0.5	03-MAY-18
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	03-MAY-18
Potassium (K)-Dissolved			<0.50		mg/L		0.5	03-MAY-18
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	03-MAY-18
MET-T-MS-WP	**Water**							
Batch R4032905								
WG2764082-2 LCS								
Calcium (Ca)-Total			100.5		%		80-120	03-MAY-18
Magnesium (Mg)-Total			103.9		%		80-120	03-MAY-18
Potassium (K)-Total			103.6		%		80-120	03-MAY-18
Sodium (Na)-Total			104.8		%		80-120	03-MAY-18
WG2764082-1 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	03-MAY-18
Magnesium (Mg)-Total			<0.050		mg/L		0.05	03-MAY-18
Potassium (K)-Total			<0.50		mg/L		0.5	03-MAY-18
Sodium (Na)-Total			<0.50		mg/L		0.5	03-MAY-18
N-TOTKJ-WP	**Water**							
Batch R4033470								
WG2761420-14 LCS								
Total Kjeldahl Nitrogen			98.7		%		75-125	04-MAY-18
WG2761420-13 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	04-MAY-18
NH3-COL-WP	**Water**							
Batch R4031908								
WG2763944-2 LCS								
Ammonia, Total (as N)			99.7		%		85-115	02-MAY-18
WG2763944-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	02-MAY-18
NO2-L-IC-N-WP	**Water**							
Batch R4031664								
WG2763269-10 LCS								
Nitrite (as N)			98.1		%		90-110	02-MAY-18
WG2763269-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO2-L-IC-N-WP	**Water**							
Batch R4031664								
WG2763269-6 LCS								
Nitrite (as N)			97.6		%		90-110	02-MAY-18
WG2763269-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	02-MAY-18
WG2763269-9 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	02-MAY-18
NO3-L-IC-N-WP	**Water**							
Batch R4031664								
WG2763269-10 LCS								
Nitrate (as N)			100.4		%		90-110	02-MAY-18
WG2763269-6 LCS								
Nitrate (as N)			99.5		%		90-110	02-MAY-18
WG2763269-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	02-MAY-18
WG2763269-9 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	02-MAY-18
P-T-L-COL-WP	**Water**							
Batch R4033256								
WG2764646-14 LCS								
Phosphorus (P)-Total			101.1		%		80-120	03-MAY-18
WG2764646-13 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	03-MAY-18
PH-WP	**Water**							
Batch R4031307								
WG2763726-15 DUP		**L2087686-8**						
pH		8.42	8.41	J	pH units	0.01	0.2	02-MAY-18
WG2763726-12 LCS								
pH			7.38		pH units		7.3-7.5	02-MAY-18
WG2763726-7 LCS								
pH			7.39		pH units		7.3-7.5	02-MAY-18
SO4-IC-N-WP	**Water**							
Batch R4031664								
WG2763269-10 LCS								
Sulfate (SO4)			101.3		%		90-110	02-MAY-18
WG2763269-6 LCS								
Sulfate (SO4)			101.1		%		90-110	02-MAY-18
WG2763269-5 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R4031664								
WG2763269-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	02-MAY-18
WG2763269-9 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	02-MAY-18
SOLIDS-TOTSUS-WP	**Water**							
Batch R4035288								
WG2764707-10 LCS								
Total Suspended Solids			92.0		%		85-115	04-MAY-18
WG2764707-9 MB								
Total Suspended Solids			<2.0		mg/L		2	04-MAY-18
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R4031710								
WG2763335-2 DUP		**L2087686-8**						
Total Coliforms		866	579		MPN/100mL	40	65	02-MAY-18
Escherichia Coli		94	72		MPN/100mL	26	65	02-MAY-18
WG2763335-1 MB								
Total Coliforms			<1		MPN/100mL		1	02-MAY-18
Escherichia Coli			<1		MPN/100mL		1	02-MAY-18
TC,EC-QT97-WP	**Water**							
Batch R4031567								
WG2763333-2 DUP		**L2087686-1**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-MAY-18
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	02-MAY-18
WG2763333-1 MB								
Total Coliforms			<1		MPN/100mL		1	02-MAY-18
Escherichia Coli			<1		MPN/100mL		1	02-MAY-18
TURBIDITY-WP	**Water**							
Batch R4031688								
WG2763322-2 LCS								
Turbidity			98.5		%		85-115	02-MAY-18
WG2763322-1 MB								
Turbidity			<0.10		NTU		0.1	02-MAY-18

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	01-MAY-18 09:40	02-MAY-18 12:00	0.25	26	hours	EHTR-FM
	2	01-MAY-18 10:40	02-MAY-18 12:00	0.25	25	hours	EHTR-FM
	3	01-MAY-18 11:45	02-MAY-18 12:00	0.25	24	hours	EHTR-FM
	4	01-MAY-18 12:55	02-MAY-18 12:00	0.25	23	hours	EHTR-FM
	5	01-MAY-18 14:35	02-MAY-18 12:00	0.25	21	hours	EHTR-FM
	6	01-MAY-18 15:45	02-MAY-18 12:00	0.25	20	hours	EHTR-FM
	7	01-MAY-18 16:30	02-MAY-18 12:00	0.25	19	hours	EHTR-FM
	8	01-MAY-18 16:10	02-MAY-18 12:00	0.25	20	hours	EHTR-FM

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 L2087686 were received on 02-MAY-18 09:10.

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.

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2087686-COFC

COC Number: 14 - 450380

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS Group	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3pm)
Contact:	Marci Friedman-Hamm	Quality Control (QC) Report with Report	☑ Yes ☐ No	P ☐ Priority (2-4 business days if received by 3pm)
Address:	3rd Floor - 865 Waverley St. Winnipeg, MB R3T 5P4	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 business days if received by 3pm)
Phone:	(204) 896-1209	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	mfhamm@kgsgroup.com	Specify Date Required for E2,E or P:
		Email 2	plindell@kgsgroup.com	

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

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q56271	Approver ID:	Cost Center:
Job #:	16-0300-002	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	

ALS Lab Work Order # (lab use only):

ALS Contact: Judy

Sampler: ATM + ACM

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	KGS-ROUTW-D-FLDWP	TC, EC-QT97-WP	KGS-ROUTW-T-FLDWP	P-T-COL-WP	2, TOT KJ-WP	NH3-COL-WP	SOLIDS-TOTSUS-WP	TC-QT-97-ENDPT-WP	EC-QT-97-ENDPT-WP				Number of Containers
	K09-12012	01-MAY-18	9:40	GW	X	X											3
	K09-12011		10:40		X												2
	K11-12017		11:45		X												2
	K11-12016		12:55		X												2
	K11-12014		14:35		X	X											3
	K11-12015		15:45		X	X											3
	MW-100		16:30		X	X											3
	SW-PTH59N		16:10	SW			X	X	X	X	X	X	X				5

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	Samples not filtered. Groundwater samples not preserved. Surface water sample preserved. Please filter &/or preserve in lab.
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		
5.2					

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:
Ariel Mallory	May 2/18	4:00	NAL	2/05/18	9:10			

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

NA-FM-0326a v08 Front/03 October 2013

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**.

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2088204
Project Ref: 16-0300-002.1200.16A
Sample ID: GO5OCOO6
Sampled By: ATM AND ACM
Date Collected: 02-MAY-18
Lab Sample ID: L2088204-1
Matrix: DOMESTIC WELL

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Total Floodway						
Bicarbonate (HCO3)	272		mg/L			04-MAY-18
Carbonate (CO3)	<0.60		mg/L			04-MAY-18
Hydroxide (OH)	<0.34		mg/L			04-MAY-18
*Nitrate and Nitrite as N	<0.025		mg/L	10		08-MAY-18
pH						
pH	7.84		pH units			03-MAY-18
Turbidity						
*Turbidity	38.8		NTU			03-MAY-18
Total Metals by ICP-MS						
Calcium (Ca)-Total	91.5		mg/L			04-MAY-18
Iron (Fe)-Total	2.37		mg/L		0.3	04-MAY-18
Magnesium (Mg)-Total	56.0		mg/L			04-MAY-18
Manganese (Mn)-Total	0.0355		mg/L		0.05	04-MAY-18
Potassium (K)-Total	12.0		mg/L			04-MAY-18
Sodium (Na)-Total	326		mg/L		200	04-MAY-18
TDS calculated						
Sulfate in Water by IC						
Sulfate (SO4)	278		mg/L		500	04-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0050	DLM	mg/L	1		04-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.025	DLM	mg/L	10		04-MAY-18
Ion Balance Calculation						
Ion Balance	103		%			08-MAY-18
Cation - Anion Balance	1.4		%			08-MAY-18
TDS (Calculated)	1350		mg/L		500	08-MAY-18
Anion Sum	23.0		me/L			08-MAY-18
Cation Sum	23.7		me/L			08-MAY-18
Hardness (as CaCO3)	459		mg/L		500	08-MAY-18
Hardness Calculated						
Fluoride in Water by IC						
Fluoride (F)	0.49		mg/L	1.5		04-MAY-18
Conductivity						
Conductivity	2230		umhos/cm			03-MAY-18
Chloride in Water by IC						
Chloride (Cl)	451		mg/L		250	04-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as	223		mg/L			03-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2088204
Project Ref: 16-0300-002.1200.16A
Sample ID: GO5OCOO6
Sampled By: ATM AND ACM
Date Collected: 02-MAY-18
Lab Sample ID: L2088204-1
Matrix: DOMESTIC WELL

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU4W Total Floodway						
Alkalinity, Total (as CaCO3)						
CaCO3)						
Total Coliform and E.coli						
Total Coliforms	3		MPN/100mL	0		02-MAY-18
Escherichia Coli	0		MPN/100mL	0		02-MAY-18

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2088204
Project Ref: 16-0300-002.1200.16A
Sample ID: K13-12322
Sampled By: ATM AND ACM
Date Collected: 02-MAY-18
Lab Sample ID: L2088204-2
Matrix: GROUND WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	318		mg/L			04-MAY-18
Carbonate (CO3)	<0.60		mg/L			04-MAY-18
Hydroxide (OH)	<0.34		mg/L			04-MAY-18
*Nitrate and Nitrite as N	<0.0051		mg/L	10		08-MAY-18
pH						
pH	7.67		pH units			03-MAY-18
Turbidity						
*Turbidity	1.50		NTU			03-MAY-18
TDS calculated						
TDS (Calculated)	519		mg/L		500	04-MAY-18
Sulfate in Water by IC						
Sulfate (SO4)	184		mg/L		500	04-MAY-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		04-MAY-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.0050		mg/L	10		04-MAY-18
Ion Balance Calculation						
Ion Balance	102		%			08-MAY-18
Cation - Anion Balance	0.7		%			08-MAY-18
Anion Sum	9.52		me/L			08-MAY-18
Cation Sum	9.66		me/L			08-MAY-18
Hardness Calculated						
Hardness (as CaCO3)	416		mg/L		500	04-MAY-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					03-MAY-18
Calcium (Ca)-Dissolved	71.5		mg/L			03-MAY-18
Magnesium (Mg)-Dissolved	57.6		mg/L			03-MAY-18
Potassium (K)-Dissolved	3.80		mg/L			03-MAY-18
Sodium (Na)-Dissolved	28.9		mg/L		200	03-MAY-18
Conductivity						
Conductivity	816		umhos/cm			03-MAY-18
Chloride in Water by IC						
Chloride (Cl)	16.9		mg/L		250	04-MAY-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	261		mg/L			03-MAY-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 08-MAY-18
PO No.:
WO No.: L2088204
Project Ref: 16-0300-002.1200.16A
Sample ID: K13-12322
Sampled By: ATM AND ACM
Date Collected: 02-MAY-18
Lab Sample ID: L2088204-2
Matrix: GROUND WATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed

CDWQG = Health Canada Guideline Limits updated DECEMBER 2015

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4032930								
WG2764672-4 LCS								
Alkalinity, Total (as CaCO3)			103.9		%		85-115	03-MAY-18
WG2764672-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	03-MAY-18
CL-IC-N-WP	**Water**							
Batch R4034953								
WG2764092-2 LCS								
Chloride (Cl)			99.9		%		90-110	04-MAY-18
WG2764092-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	04-MAY-18
EC-WP	**Water**							
Batch R4032930								
WG2764672-3 LCS								
Conductivity			96.6		%		90-110	03-MAY-18
WG2764672-1 MB								
Conductivity			<1.0		umhos/cm		1	03-MAY-18
F-IC-N-WP	**Water**							
Batch R4034953								
WG2764092-2 LCS								
Fluoride (F)			101.3		%		90-110	04-MAY-18
WG2764092-1 MB								
Fluoride (F)			<0.020		mg/L		0.02	04-MAY-18
MET-D-MS-WP	**Water**							
Batch R4032905								
WG2764087-2 LCS								
Calcium (Ca)-Dissolved			96.3		%		80-120	03-MAY-18
Magnesium (Mg)-Dissolved			102.0		%		80-120	03-MAY-18
Potassium (K)-Dissolved			101.7		%		80-120	03-MAY-18
Sodium (Na)-Dissolved			101.9		%		80-120	03-MAY-18
WG2764087-1 MB								
Calcium (Ca)-Dissolved			<0.50		mg/L		0.5	03-MAY-18
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	03-MAY-18
Potassium (K)-Dissolved			<0.50		mg/L		0.5	03-MAY-18
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	03-MAY-18
MET-T-MS-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-MS-WP	**Water**							
Batch R4034012								
WG2764769-2 LCS								
Calcium (Ca)-Total			100.6		%		80-120	04-MAY-18
Iron (Fe)-Total			99.4		%		80-120	04-MAY-18
Magnesium (Mg)-Total			102.2		%		80-120	04-MAY-18
Manganese (Mn)-Total			98.6		%		80-120	04-MAY-18
Potassium (K)-Total			100.9		%		80-120	04-MAY-18
Sodium (Na)-Total			104.3		%		80-120	04-MAY-18
WG2764769-1 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	04-MAY-18
Iron (Fe)-Total			<0.10		mg/L		0.1	04-MAY-18
Magnesium (Mg)-Total			<0.050		mg/L		0.05	04-MAY-18
Manganese (Mn)-Total			<0.0010		mg/L		0.001	04-MAY-18
Potassium (K)-Total			<0.50		mg/L		0.5	04-MAY-18
Sodium (Na)-Total			<0.50		mg/L		0.5	04-MAY-18
NO2-L-IC-N-WP	**Water**							
Batch R4034953								
WG2764092-2 LCS								
Nitrite (as N)			99.9		%		90-110	04-MAY-18
WG2764092-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	04-MAY-18
NO3-L-IC-N-WP	**Water**							
Batch R4034953								
WG2764092-2 LCS								
Nitrate (as N)			99.3		%		90-110	04-MAY-18
WG2764092-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	04-MAY-18
PH-WP	**Water**							
Batch R4032930								
WG2764672-2 LCS								
pH			7.42		pH units		7.3-7.5	03-MAY-18
SO4-IC-N-WP	**Water**							
Batch R4034953								
WG2764092-2 LCS								
Sulfate (SO4)			100.8		%		90-110	04-MAY-18
WG2764092-1 MB								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
SO4-IC-N-WP	**Water**							
Batch R4034953								
WG2764092-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	04-MAY-18
TC,EC-QT51-WP	**Water**							
Batch R4032268								
WG2763493-4 DUP		**L2088204-1**						
Total Coliforms		3	1	DUPM	MPN/100mL	2	2	02-MAY-18
Escherichia Coli		0	0		MPN/100mL	0.0	65	02-MAY-18
WG2763493-1 MB								
Total Coliforms			0		MPN/100mL		1	02-MAY-18
Escherichia Coli			0		MPN/100mL		1	02-MAY-18
WG2763493-2 MB								
Total Coliforms			0		MPN/100mL		1	02-MAY-18
Escherichia Coli			0		MPN/100mL		1	02-MAY-18
TURBIDITY-WP	**Water**							
Batch R4034473								
WG2766106-2 LCS								
Turbidity			101.0		%		85-115	03-MAY-18
WG2766106-1 MB								
Turbidity			<0.10		NTU		0.1	03-MAY-18

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
DUPM	MPN duplicate results were outside default ALS Data Quality Objective, but within 95% confidence interval for MPN reference method. Sample results are reliable.

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	02-MAY-18 10:40	03-MAY-18 12:00	0.25	25	hours	EHTR-FM
	2	02-MAY-18 13:00	03-MAY-18 12:00	0.25	23	hours	EHTR-FM

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 L2088204 were received on 02-MAY-18 15:15.

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 / Reque

Canada Toll Fre

L2088204-COFC

code label here
se only)

COC Number: 15 - 550880

Page 1 of 1

L2088254

Report To	Contact and company name below will appear on the final report
Company:	KGS Group
Contact:	Marci Friedman-Hamm
Phone:	204-896-1209
	Company address below will appear on the final report
Street:	3rd Floor - 865 Waverley St.
City/Province:	Winnipeg, MB
Postal Code:	R3T 5P4
Invoice To	Same as Report To ☐ YES ☑ NO
	Copy of Invoice with Report ☐ YES ☐ NO
Company:	KGS Group
Contact:	Bill MacQuarrie

Report Format / Distribution	
Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)
Quality Control (QC) Report with Report	☑ YES ☐ NO
☐ Compare Results to Criteria on Report - provide details below if box checked	
Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	mfhamm@kgsgroup.com
Email 2	pliodell@kgsgroup.com
Email 3	dmallory@kgsgroup.com
Invoice Distribution	
Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
Email 1 or Fax	wmacquarrie@kgsgroup.com
Email 2	

Project Information	
ALS Account # / Quote #:	Q56271
Job #:	16-0300-002.1200.16A
PO / AFE:	
LSD:	

Oil and Gas Required Fields (client use)	
AFE/Cost Center:	PO#
Major/Minor Code:	Routing Code:
Requisitioner:	
Location:	

ALS Lab Work Order # (lab use only):

ALS Contact: Judy

Sampler: ATM + ACM

Select Service Level Below - Please confirm all E&P TATs with your AM - surcharges will apply

Regular [R] ☑ Standard TAT if received by 3 pm - business days - no surcharges apply

PRIORITY (Business Days): 4 day [P4] ☐ | 3 day [P3] ☐ | 2 day [P2] ☐

EMERGENCY: 1 Business day [E1] ☐ | Same Day, Weekend or Statutory holiday [E0] ☐

Date and Time Required for all E&P TATs: dd-mmm-yy hh:mm

For tests that can not be performed according to the service level selected, you will be contacted.

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	KGS-ROUW-D-FLDW-WP	KGS-ROUW-T-FLDW-WP	TC, EC-QT51-WP	Number of Containers
	G050C006	02-MAY-18	10:40	SW		X	X	3
	K13-12322	02-MAY-18	13:00	GW	X			2

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 by clicking on the drop-down list below (electronic COC only)

Samples not filtered.
Groundwater sample not preserved.
Surface water sample preserved.
Please filter +/or preserve in lab.

SAMPLE CONDITION AS RECEIVED (lab use only)

Frozen ☐ | SIF Observations Yes ☐ No ☐

Ice Packs ☐ Ice Cubes ☐ | Custody seal intact Yes ☐ No ☐

Cooling Initiated ☐

INITIAL COOLER TEMPERATURES °C	FINAL COOLER TEMPERATURES °C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Dreel Mallory	Date: 02-MAY-18	Time: 3:10	Received by:	Date:	Time:	Received by: JD	Date: 05/02/18	Time: 3:15 pm

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

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OCTOBER 2015 FRONT

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

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

FC 4.1 °C

APPENDIX D6-E-3

POST MELT

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K11-12015
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-1
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	338		mg/L			12-JUN-18
Carbonate (CO3)	<0.60		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	0.042		mg/L	10		11-JUN-18
pH						
pH	7.64		pH units			12-JUN-18
Turbidity						
*Turbidity	0.23		NTU			08-JUN-18
TDS calculated						
TDS (Calculated)	396		mg/L		500	12-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	77.5		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.042		mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	107		%			12-JUN-18
Cation - Anion Balance	3.2		%			12-JUN-18
Anion Sum	7.61		me/L			12-JUN-18
Cation Sum	8.11		me/L			12-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	382		mg/L		500	12-JUN-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					11-JUN-18
Calcium (Ca)-Dissolved	77.2		mg/L			11-JUN-18
Magnesium (Mg)-Dissolved	46.0		mg/L			11-JUN-18
Potassium (K)-Dissolved	4.15		mg/L			11-JUN-18
Sodium (Na)-Dissolved	8.43		mg/L		200	11-JUN-18
Conductivity						
Conductivity	677		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	16.0		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	277		mg/L			12-JUN-18

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ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K11-12015
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-1
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		08-JUN-18
Escherichia Coli	<1		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K09-12012
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-2
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	415		mg/L			12-JUN-18
Carbonate (CO3)	<0.60		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		11-JUN-18
pH						
pH	7.66		pH units			12-JUN-18
Turbidity						
*Turbidity	0.14		NTU			08-JUN-18
TDS calculated						
TDS (Calculated)	610		mg/L		500	12-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	175		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	112		%			12-JUN-18
Cation - Anion Balance	5.6		%			12-JUN-18
Anion Sum	11.1		me/L			12-JUN-18
Cation Sum	12.4		me/L			12-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	510		mg/L		500	12-JUN-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					11-JUN-18
Calcium (Ca)-Dissolved	82.8		mg/L			11-JUN-18
Magnesium (Mg)-Dissolved	73.6		mg/L			11-JUN-18
Potassium (K)-Dissolved	4.45		mg/L			11-JUN-18
Sodium (Na)-Dissolved	48.0		mg/L		200	11-JUN-18
Conductivity						
Conductivity	987		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	22.8		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	340		mg/L			12-JUN-18

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Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K09-12012
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-2
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		08-JUN-18
Escherichia Coli	<1		MPN/100mL	0		08-JUN-18

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Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K11-100
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-3
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	345		mg/L			12-JUN-18
Carbonate (CO3)	<0.60		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	0.0348		mg/L	10		11-JUN-18
pH						
pH	7.71		pH units			12-JUN-18
Turbidity						
*Turbidity	0.22		NTU			08-JUN-18
TDS calculated						
TDS (Calculated)	401		mg/L		500	12-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	78.0		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0010		mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.0348		mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	106		%			12-JUN-18
Cation - Anion Balance	3.0		%			12-JUN-18
Anion Sum	7.73		me/L			12-JUN-18
Cation Sum	8.22		me/L			12-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	387		mg/L		500	12-JUN-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					11-JUN-18
Calcium (Ca)-Dissolved	78.7		mg/L			11-JUN-18
Magnesium (Mg)-Dissolved	46.3		mg/L			11-JUN-18
Potassium (K)-Dissolved	4.25		mg/L			11-JUN-18
Sodium (Na)-Dissolved	8.48		mg/L		200	11-JUN-18
Conductivity						
Conductivity	673		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	16.0		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	283		mg/L			12-JUN-18

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Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K11-100
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-3
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		08-JUN-18
Escherichia Coli	<1		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

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Account Manager

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Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K13-12321
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-4
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	622		mg/L			12-JUN-18
Carbonate (CO3)	<0.60		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	5.55		mg/L	10		11-JUN-18
pH						
pH	7.55		pH units			12-JUN-18
Turbidity						
*Turbidity	4.51		NTU			08-JUN-18
TDS calculated						
TDS (Calculated)	717		mg/L		500	12-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	98.9		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	5.55		mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	104		%			12-JUN-18
Cation - Anion Balance	1.9		%			12-JUN-18
Anion Sum	14.2		me/L			12-JUN-18
Cation Sum	14.8		me/L			12-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	670		mg/L		500	12-JUN-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					11-JUN-18
Calcium (Ca)-Dissolved	89.6		mg/L			11-JUN-18
Magnesium (Mg)-Dissolved	108		mg/L			11-JUN-18
Potassium (K)-Dissolved	5.16		mg/L			11-JUN-18
Sodium (Na)-Dissolved	29.4		mg/L		200	11-JUN-18
Conductivity						
Conductivity	1150		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	55.4		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	510		mg/L			12-JUN-18

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Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K13-12321
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-4
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		08-JUN-18
Escherichia Coli	<1		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
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- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

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Account Manager

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ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K09-12316
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-5
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	505		mg/L			12-JUN-18
Carbonate (CO3)	<0.60		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	2.29		mg/L	10		11-JUN-18
pH						
pH	7.53		pH units			12-JUN-18
Turbidity						
*Turbidity	0.12		NTU			08-JUN-18
TDS calculated						
TDS (Calculated)	535		mg/L		500	12-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	60.8		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	2.29		mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	107		%			12-JUN-18
Cation - Anion Balance	3.3		%			12-JUN-18
Anion Sum	10.6		me/L			12-JUN-18
Cation Sum	11.4		me/L			12-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	512		mg/L		500	12-JUN-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					11-JUN-18
Calcium (Ca)-Dissolved	78.0		mg/L			11-JUN-18
Magnesium (Mg)-Dissolved	77.0		mg/L			11-JUN-18
Potassium (K)-Dissolved	4.26		mg/L			11-JUN-18
Sodium (Na)-Dissolved	23.5		mg/L		200	11-JUN-18
Conductivity						
Conductivity	908		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	33.0		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	414		mg/L			12-JUN-18

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Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K09-12316
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-5
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	<1		MPN/100mL	0		08-JUN-18
Escherichia Coli	<1		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

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- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

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Account Manager

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ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K11-12014
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-6
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Dissolved Floodway						
Bicarbonate (HCO3)	379		mg/L			12-JUN-18
Carbonate (CO3)	<0.60		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	0.146		mg/L	10		11-JUN-18
pH						
pH	7.61		pH units			12-JUN-18
Turbidity						
*Turbidity	0.55		NTU			08-JUN-18
TDS calculated						
TDS (Calculated)	403		mg/L		500	12-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	61.5		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0010		mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.145		mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	109		%			12-JUN-18
Cation - Anion Balance	4.4		%			12-JUN-18
Anion Sum	7.88		me/L			12-JUN-18
Cation Sum	8.61		me/L			12-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	408		mg/L		500	12-JUN-18
Dissolved Metals by ICP-MS						
Dissolved Metals Filtration Location	LAB					11-JUN-18
Calcium (Ca)-Dissolved	76.6		mg/L			11-JUN-18
Magnesium (Mg)-Dissolved	52.7		mg/L			11-JUN-18
Potassium (K)-Dissolved	4.39		mg/L			11-JUN-18
Sodium (Na)-Dissolved	7.73		mg/L		200	11-JUN-18
Conductivity						
Conductivity	689		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	13.3		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	311		mg/L			12-JUN-18

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ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: K11-12014
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-6
Matrix: GROUNDWATER

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Coliform and E.coli by MPN QT97						
Total Coliforms	1		MPN/100mL	0		08-JUN-18
Escherichia Coli	<1		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

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Account Manager

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ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: SW-PTH59N
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	109		mg/L			12-JUN-18
Carbonate (CO3)	36.6		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	<0.010		mg/L	10		11-JUN-18
pH						
pH	9.46		pH units			12-JUN-18
Turbidity						
*Turbidity	1.31		NTU			08-JUN-18
Total Metals by ICP-MS						
Calcium (Ca)-Total	41.3		mg/L			12-JUN-18
Magnesium (Mg)-Total	51.3		mg/L			12-JUN-18
Potassium (K)-Total	6.98		mg/L			12-JUN-18
Sodium (Na)-Total	105		mg/L		200	12-JUN-18
TDS calculated						
TDS (Calculated)	590		mg/L		500	13-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	140		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	<0.010	DLM	mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	107		%			13-JUN-18
Cation - Anion Balance	3.3		%			13-JUN-18
Anion Sum	10.3		me/L			13-JUN-18
Cation Sum	11.0		me/L			13-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	314	HTC	mg/L		500	13-JUN-18
Conductivity						
Conductivity	983		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	156		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	150		mg/L			12-JUN-18
Phosphorus (P)-Total	0.0531		mg/L			11-JUN-18
Ammonia, Total (as N)	0.017		mg/L			12-JUN-18

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: SW-PTH59N
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-7
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Kjeldahl Nitrogen	0.58		mg/L			12-JUN-18
Total Suspended Solids	<2.0		mg/L			11-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	6200		MPN/100mL	0		08-JUN-18
Escherichia Coli	6		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: SW44
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	260		mg/L			12-JUN-18
Carbonate (CO3)	13.6		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	0.046		mg/L	10		11-JUN-18
pH						
pH	8.61		pH units			12-JUN-18
Turbidity						
*Turbidity	1.65		NTU			08-JUN-18
Total Metals by ICP-MS						
Calcium (Ca)-Total	58.3		mg/L			12-JUN-18
Magnesium (Mg)-Total	78.4		mg/L			12-JUN-18
Potassium (K)-Total	7.33		mg/L			12-JUN-18
Sodium (Na)-Total	78.2		mg/L		200	12-JUN-18
TDS calculated						
TDS (Calculated)	694		mg/L		500	13-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	246		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	0.0023		mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.044		mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	106		%			13-JUN-18
Cation - Anion Balance	2.9		%			13-JUN-18
Anion Sum	12.2		me/L			13-JUN-18
Cation Sum	13.0		me/L			13-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	468	HTC	mg/L		500	13-JUN-18
Conductivity						
Conductivity	1070		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	84.2		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	236		mg/L			12-JUN-18
Phosphorus (P)-Total	0.111		mg/L			11-JUN-18
Ammonia, Total (as N)	0.020		mg/L			12-JUN-18

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ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: SW44
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-8
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Kjeldahl Nitrogen	0.60		mg/L			12-JUN-18
Total Suspended Solids	2.9		mg/L			11-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	5900		MPN/100mL	0		08-JUN-18
Escherichia Coli	73		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

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* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

KGS Group Consultants (Winnipeg)
865 Waverly Street - 3rd Floor
Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: SW100
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
ROU1W Total Floodway						
Bicarbonate (HCO3)	263		mg/L			12-JUN-18
Carbonate (CO3)	13.9		mg/L			12-JUN-18
Hydroxide (OH)	<0.34		mg/L			12-JUN-18
*Nitrate and Nitrite as N	0.045		mg/L	10		11-JUN-18
pH						
pH	8.61		pH units			12-JUN-18
Turbidity						
*Turbidity	1.81		NTU			08-JUN-18
Total Metals by ICP-MS						
Calcium (Ca)-Total	59.1		mg/L			12-JUN-18
Magnesium (Mg)-Total	78.5		mg/L			12-JUN-18
Potassium (K)-Total	7.52		mg/L			12-JUN-18
Sodium (Na)-Total	79.9		mg/L		200	12-JUN-18
TDS calculated						
TDS (Calculated)	665		mg/L		500	13-JUN-18
Sulfate in Water by IC						
Sulfate (SO4)	219		mg/L		500	08-JUN-18
Nitrite in Water by IC (Low Level)						
*Nitrite (as N)	<0.0020	DLM	mg/L	1		08-JUN-18
Nitrate in Water by IC (Low Level)						
*Nitrate (as N)	0.045		mg/L	10		08-JUN-18
Ion Balance Calculation						
Ion Balance	113		%			13-JUN-18
Cation - Anion Balance	6.3		%			13-JUN-18
Anion Sum	11.5		me/L			13-JUN-18
Cation Sum	13.1		me/L			13-JUN-18
Hardness Calculated						
Hardness (as CaCO3)	471	HTC	mg/L		500	13-JUN-18
Conductivity						
Conductivity	1070		umhos/cm			12-JUN-18
Chloride in Water by IC						
Chloride (Cl)	77.7		mg/L		250	08-JUN-18
Alkalinity, Total (as CaCO3)						
Alkalinity, Total (as CaCO3)	238		mg/L			12-JUN-18
Phosphorus (P)-Total	0.109		mg/L			11-JUN-18
Ammonia, Total (as N)	0.020		mg/L			12-JUN-18

KGS Group Consultants (Winnipeg)
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Winnipeg MB R3T 5P4
ATTN: Marci Friedman Hamm

Date: 14-JUN-18
PO No.:
WO No.: L2108732
Project Ref: 16-0300-002
Sample ID: SW100
Sampled By:
Date Collected: 07-JUN-18
Lab Sample ID: L2108732-9
Matrix: SW

Test Description	Result	Qualifier	Units of Measure	CDWQG MAC	Aesthetic Objective	Date Analyzed
Total Kjeldahl Nitrogen	0.62		mg/L			12-JUN-18
Total Suspended Solids	<2.0		mg/L			11-JUN-18
Total and E. coli to endpoint by QT97						
Total Coliforms	2420		MPN/100mL	0		08-JUN-18
Escherichia Coli	66		MPN/100mL	0		08-JUN-18

CDWQG = Health Canada Guideline Limits updated MAY 2018

* CDWQG for Nitrate+Nitrite-N is the limit for nitrate only. If present as Nitrate then the limit is 10mg/L < or N.D. = less than detection limit.
* Turbidity guideline based on membrane filtration. For guidelines on conventional treatment and slow sand or diatomaceous earth filtration please see Summary Table of Guidelines for Canadian Drinking Water Quality
- A blank entry designates no known limit.
- A shaded value in the Results column exceeds CDWQG MAC and/ or Aesthetic Objective.

Approved by

Hua Wo
Account Manager

Guidelines & Objectives

Sample Parameter Qualifier key listed:

Qualifier	Description
HTC	Hardness was calculated from Total Ca and/or Mg concentrations and may be biased high (dissolved Ca/Mg results unavailable).
DLM	Detection Limit Adjusted due to sample matrix effects (e.g. chemical interference, colour, turbidity).

Health Canada MAC Health Related Criteria Limits

Nitrate/Nitrite-N*	Criteria limit is 10 mg/L (1.0 mg/L if present as all Nitrite-N). High concentrations may contribute to blue baby syndrome in infants.
Lead*	A cumulative body poison, uncommon in naturally occurring hard waters.
Fluoride*	Present in fluoridated water supplies at 0.8 mg/L to reduce dental caries. Elevated levels causes fluorosis (mottling of teeth).
Total Coliforms*	Criteria is 0 CFU/100mL. Adverse health effects.
E. Coli*	Criteria is 0 CFU/100 mL. Certain E. Coli bacteria can be life threatening.

*Health Canada Canadian Drinking Water Quality Guidelines (MAC limit)

Aesthetic Objective Concentration Levels

Alkalinity	Acid neutralizing capacity. Usually a measure of carbonate and bicarbonates and calculated and reported as calcium carbonate.
Balance	Quality control parameter ratioing cations to anions
Bicarbonate	See Alkalinity. Report as the anion HCO3-1
Carbonate	See Alkalinity. Reported at the anion CO3-2
Calcium	See Hardness. Common major cation of water chemistry.
Chloride	Common major anion of water chemistry.
Conductance	Physical test measuring water salinity (dissolved ions or solids)
Hardness	Classical measure or capacity of water to precipitate soap (chiefly calcium and magnesium ions). Causes scaling tendency in water if carbonates/bicarbonates are present (if >200 mg/L). For drinking water purposes waters with results <200 mg/L are considered acceptable, results >200 mg/L are considered poor but can be tolerated. Results >500 mg/L are unacceptable.
Hydroxide	See alkalinity
Magnesium	See hardness. Common major cation of water chemistry. Elevated levels (>125 mg/L) may exert a cathartic or diuretic action.
pH	Measure of water acidity/alkalinity. Normal range is 7.0-8.5.
Potassium	Common major cation of water chemistry.
Sodium	Common major cation of water chemistry. Measure of salinity (saltiness).The aesthetic objective (not related to health) for sodium in drinking water is 200 mg/L. However, where sodium concentration of the drinking water exceeds 20 mg/L, it is recommended that any person on a sodium restricted diet consult with his/her physician or Medical Officer of Health concerning the use of that water.
Sulphate	Common major anion of water chemistry. Elevated levels may exert a cathartic or diuretic action.
Total Dissolved Solids	A measure of water salinity.
Iron	Causes staining to laundry and porcelain and astringent taste. Oxidizes to red-brown precipitate on exposure to air.
Manganese	Elevated levels may cause staining of laundry and porcelain.
Heterotrophic Plate Count	Criteria is 500 cfu/mL Measure of heterotrophic bacteria present.

GLOSSARY OF REPORT TERMS

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

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

Quality Control Report

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

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
ALK-TITR-WP	**Water**							
Batch R4081171								
WG2795073-5 DUP		**L2108732-1**						
Alkalinity, Total (as CaCO3)		277	281		mg/L	1.5	20	12-JUN-18
WG2795073-4 LCS								
Alkalinity, Total (as CaCO3)			101.5		%		85-115	12-JUN-18
WG2795073-1 MB								
Alkalinity, Total (as CaCO3)			<1.0		mg/L		1	12-JUN-18
CL-IC-N-WP	**Water**							
Batch R4078817								
WG2792418-2 LCS								
Chloride (Cl)			95.0		%		90-110	08-JUN-18
WG2792418-6 LCS								
Chloride (Cl)			104.0		%		90-110	08-JUN-18
WG2792418-1 MB								
Chloride (Cl)			<0.50		mg/L		0.5	08-JUN-18
WG2792418-5 MB								
Chloride (Cl)			<0.50		mg/L		0.5	08-JUN-18
EC-WP	**Water**							
Batch R4081171								
WG2795073-5 DUP		**L2108732-1**						
Conductivity		677	671		umhos/cm	0.9	10	12-JUN-18
WG2795073-3 LCS								
Conductivity			98.2		%		90-110	12-JUN-18
WG2795073-1 MB								
Conductivity			<1.0		umhos/cm		1	12-JUN-18
MET-D-MS-WP	**Water**							
Batch R4079897								
WG2793686-2 LCS								
Calcium (Ca)-Dissolved			103.2		%		80-120	11-JUN-18
Magnesium (Mg)-Dissolved			113.4		%		80-120	11-JUN-18
Potassium (K)-Dissolved			102.3		%		80-120	11-JUN-18
Sodium (Na)-Dissolved			107.1		%		80-120	11-JUN-18
WG2793686-1 MB								
Calcium (Ca)-Dissolved			<0.50		mg/L		0.5	11-JUN-18
Magnesium (Mg)-Dissolved			<0.050		mg/L		0.05	11-JUN-18
Potassium (K)-Dissolved			<0.50		mg/L		0.5	11-JUN-18
Sodium (Na)-Dissolved			<0.50		mg/L		0.5	11-JUN-18
MET-T-MS-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
MET-T-MS-WP	**Water**							
Batch R4081608								
WG2794716-2 LCS								
Calcium (Ca)-Total			105.8		%		80-120	12-JUN-18
Magnesium (Mg)-Total			109.5		%		80-120	12-JUN-18
Potassium (K)-Total			106.7		%		80-120	12-JUN-18
Sodium (Na)-Total			104.4		%		80-120	12-JUN-18
WG2794716-1 MB								
Calcium (Ca)-Total			<0.50		mg/L		0.5	12-JUN-18
Magnesium (Mg)-Total			<0.050		mg/L		0.05	12-JUN-18
Potassium (K)-Total			<0.50		mg/L		0.5	12-JUN-18
Sodium (Na)-Total			<0.50		mg/L		0.5	12-JUN-18
N-TOTKJ-WP	**Water**							
Batch R4080831								
WG2791438-10 LCS								
Total Kjeldahl Nitrogen			97.2		%		75-125	12-JUN-18
WG2791438-9 MB								
Total Kjeldahl Nitrogen			<0.20		mg/L		0.2	12-JUN-18
NH3-COL-WP	**Water**							
Batch R4082086								
WG2795243-2 LCS								
Ammonia, Total (as N)			96.2		%		85-115	12-JUN-18
WG2795243-1 MB								
Ammonia, Total (as N)			<0.010		mg/L		0.01	12-JUN-18
NO2-L-IC-N-WP	**Water**							
Batch R4078817								
WG2792418-2 LCS								
Nitrite (as N)			96.2		%		90-110	08-JUN-18
WG2792418-6 LCS								
Nitrite (as N)			102.3		%		90-110	08-JUN-18
WG2792418-1 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	08-JUN-18
WG2792418-5 MB								
Nitrite (as N)			<0.0010		mg/L		0.001	08-JUN-18
NO3-L-IC-N-WP	**Water**							
Batch R4078817								
WG2792418-2 LCS								
Nitrate (as N)			96.2		%		90-110	08-JUN-18
WG2792418-6 LCS								

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
NO3-L-IC-N-WP	**Water**							
Batch R4078817								
WG2792418-6 LCS								
Nitrate (as N)			105.1		%		90-110	08-JUN-18
WG2792418-1 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	08-JUN-18
WG2792418-5 MB								
Nitrate (as N)			<0.0050		mg/L		0.005	08-JUN-18
P-T-L-COL-WP	**Water**							
Batch R4081262								
WG2792588-2 LCS								
Phosphorus (P)-Total			95.3		%		80-120	11-JUN-18
WG2792588-1 MB								
Phosphorus (P)-Total			<0.0010		mg/L		0.001	11-JUN-18
PH-WP	**Water**							
Batch R4081171								
WG2795073-5 DUP		**L2108732-1**						
pH		7.64	7.64	J	pH units	0.00	0.2	12-JUN-18
WG2795073-2 LCS								
pH			7.43		pH units		7.3-7.5	12-JUN-18
SO4-IC-N-WP	**Water**							
Batch R4078817								
WG2792418-2 LCS								
Sulfate (SO4)			93.7		%		90-110	08-JUN-18
WG2792418-6 LCS								
Sulfate (SO4)			105.4		%		90-110	08-JUN-18
WG2792418-1 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	08-JUN-18
WG2792418-5 MB								
Sulfate (SO4)			<0.30		mg/L		0.3	08-JUN-18
SOLIDS-TOTSUS-WP	**Water**							
Batch R4081675								
WG2793839-10 LCS								
Total Suspended Solids			91.3		%		85-115	11-JUN-18
WG2793839-9 MB								
Total Suspended Solids			<2.0		mg/L		2	11-JUN-18
TC,EC-QT97-ENDPT-WP	**Water**							

Quality Control Report

Test	Matrix	Reference	Result	Qualifier	Units	RPD	Limit	Analyzed
TC,EC-QT97-ENDPT-WP	**Water**							
Batch R4077998								
WG2792332-2 DUP		**L2108732-7**						
Total Coliforms		6200	5600		MPN/100mL	9.6	65	08-JUN-18
Escherichia Coli		6	5		MPN/100mL	19	65	08-JUN-18
WG2792332-1 MB								
Total Coliforms			<1		MPN/100mL		1	08-JUN-18
Escherichia Coli			<1		MPN/100mL		1	08-JUN-18
TC,EC-QT97-WP	**Water**							
Batch R4077413								
WG2792328-2 DUP		**L2108732-1**						
Total Coliforms		<1	<1	RPD-NA	MPN/100mL	N/A	65	08-JUN-18
Escherichia Coli		<1	<1	RPD-NA	MPN/100mL	N/A	65	08-JUN-18
WG2792328-1 MB								
Total Coliforms			<1		MPN/100mL		1	08-JUN-18
Escherichia Coli			<1		MPN/100mL		1	08-JUN-18
TURBIDITY-WP	**Water**							
Batch R4077369								
WG2792556-6 LCS								
Turbidity			105.0		%		85-115	08-JUN-18
WG2792556-9 LCS								
Turbidity			105.0		%		85-115	08-JUN-18
WG2792556-4 MB								
Turbidity			<0.10		NTU		0.1	08-JUN-18
WG2792556-7 MB								
Turbidity			<0.10		NTU		0.1	08-JUN-18

Legend:

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

Sample Parameter Qualifier Definitions:

Qualifier	Description
J	Duplicate results and limits are expressed in terms of absolute difference.
RPD-NA	Relative Percent Difference Not Available due to result(s) being less than detection limit.

Quality Control Report

Hold Time Exceedances:

ALS Product Description	Sample ID	Sampling Date	Date Processed	Rec. HT	Actual HT	Units	Qualifier
Physical Tests							
pH							
	1	07-JUN-18 15:00	12-JUN-18 12:00	0.25	117	hours	EHTR-FM
	2	07-JUN-18 12:45	12-JUN-18 12:00	0.25	119	hours	EHTR-FM
	3	07-JUN-18 18:30	12-JUN-18 12:00	0.25	114	hours	EHTR-FM
	4	07-JUN-18 10:10	12-JUN-18 12:00	0.25	122	hours	EHTR-FM
	5	07-JUN-18 10:55	12-JUN-18 12:00	0.25	121	hours	EHTR-FM
	6	07-JUN-18 16:00	12-JUN-18 12:00	0.25	116	hours	EHTR-FM
	7	07-JUN-18 16:55	12-JUN-18 12:00	0.25	115	hours	EHTR-FM
	8	07-JUN-18 11:20	12-JUN-18 12:00	0.25	121	hours	EHTR-FM
	9	07-JUN-18 18:00	12-JUN-18 12:00	0.25	114	hours	EHTR-FM

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 L2108732 were received on 08-JUN-18 07:45.

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.

L2108732

ALS Environmental
www.alsglobal.com

Chain of Custody (COC) / Analytical Request Form

Canada Toll Free: 1 800 668 9878

L2108732-COFC

COC Number: 14 - 451148

Page 1 of 1

Report To		Report Format / Distribution		Select Service Level Below (Rush Turnaround Time (TAT) is not available for all tests)
Company:	KGS Group	Select Report Format:	☑ PDF ☑ EXCEL ☐ EDD (DIGITAL)	R ☑ Regular (Standard TAT if received by 3pm)
Contact:	Marci Friedman-Hamm	Quality Control (QC) Report with Report	☑ Yes ☐ No	P ☐ Priority (2-4 business days if received by 3pm)
Address:	3rd Floor - 865 Waverley St. Winnipeg MB R3T 5P4	☐ Criteria on Report - provide details below if box checked		E ☐ Emergency (1-2 business days if received by 3pm)
Phone:	204 896 1209	Select Distribution:	☑ EMAIL ☐ MAIL ☐ FAX	E2 ☐ Same day or weekend emergency if received by 10am – contact ALS for surcharge.
		Email 1 or Fax	mfhamm@kgsgroup.com	Specify Date Required for E2,E or P:
		Email 2	amallory@kgsgroup.com; plindell@kgsgroup.com	Analysis Request

Invoice To		Invoice Distribution	
	Same as Report To ☐ Yes ☑ No	Select Invoice Distribution:	☑ EMAIL ☐ MAIL ☐ FAX
	Copy of Invoice with Report ☐ Yes ☐ No	Email 1 or Fax	wmacquarrie@kgsgroup.com
Company:	KGS Group	Email 2	
Contact:	Bill MacQuarrie		

Project Information		Oil and Gas Required Fields (client use)	
ALS Quote #:	Q56271	Approver ID:	Cost Center:
Job #:	16-0300-002	GL Account:	Routing Code:
PO / AFE:		Activity Code:	
LSD:		Location:	
ALS Lab Work Order # (lab use only)		ALS Contact:	Sampler:

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	KGS-ROUND-FLDWP	TC, EC-QT97-WP	KGS-ROUND-FLDWP	P-T-COL-WP	N,TOTKJ-WP	NH3-COL-WP	SOLIDS-TOTSUS-WP	TC-QT-97-ENDPT-WP	EC-QT-97-ENDPT-WP	Number of Containers
	K11-12015	07-JUN-18	15:00	Ground water	X	X								3
	K09-12012	↓	12:45	↓	X	X								3
	K11-100		18:30		X	X								3
	K13-12321		10:10		X	X								3
	K09-12316		10:55		X	X								3
	K11-12014	↓	16:00	↓	X	X								3
	SW-PT159N	07-JUN-18	16:55	SW			X	X	X	X	X	X	X	4
	SW44	↓	11:20	↓			X	X	X	X	X	X	X	4
	SW100	↓	18:00	↓			X	X	X	X	X	X	X	4

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	-Metals not field filtered or preserved; lab to F/P -Nutrients in SW preserved

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		
					5°C

SHIPMENT RELEASE (client use)			INITIAL SHIPMENT RECEPTION (lab use only)			FINAL SHIPMENT RECEPTION (lab use only)		
Released by: Amil Mallory	Date: 07-JUN-18	Time: 18:15	Received by:	Date: JUN 08 2018	Time: 7:45	Received by:	Date:	Time:

REFER TO BACK PAGE FOR ALS LOCATIONS AND SAMPLING INFORMATION

WHITE - LABORATORY COPY YELLOW - CLIENT COPY

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

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

KGS GROUP

CONSULTING ENGINEERS