



Otter Lake Residual Disposal Facility

Year 17 Operational Monitoring Program
Second Quarter (June 2015)

September 9, 2015

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*Year 17 Operational Monitoring Program – Second Quarter Report
Surface and Groundwater Monitoring Results*

Dillon Consulting Limited is pleased to provide the results of the second quarter surface water and groundwater sampling conducted in association with Year 17 operational monitoring program at the Residual Disposal Facility in Otter Lake, Nova Scotia.

Copies have been forwarded to Halifax Regional Municipality and Nova Scotia Environment on your behalf.

Yours sincerely,

DILLON CONSULTING LIMITED

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- A Field Methodology
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(CD in Pouch)

Introduction

The Otter Lake Solid Waste Management Facility includes the Residual Disposal Facility (RDF), the Front End Processor (FEP) and the Waste Stabilization Facility (WSF). The site, managed by MIRROR Nova Scotia, receives, sorts and disposes of waste generated from within Halifax Regional Municipality (HRM). The ongoing monitoring program is a stipulation of the Approval to Operate the Otter Lake Residual Disposal Facility (RDF), as issued and amended by Nova Scotia Environment (NSE). It includes collection of samples from surface and groundwater stations, leak detection sumps, the underdrains at the base of the disposal cells and leachate that is temporarily contained within a holding tank. On October 18, 2012, the Approval to Operate was amended to incorporate the operation of Cell 6 (Approval No. 2008-065580-A01).

Since initiation of site operations in January 1999, the monitoring program has involved quarterly sampling events. This document presents the second quarter results of the Year 17 operational monitoring program undertaken in June 2015.

Additional information pertaining to the monitoring network, along with a more detailed description of the hydrogeological and hydrologic environments, is provided in the Otter Lake RDF 2014 Annual Operational Monitoring Report, Dillon Consulting Limited, April 2015. The next comprehensive (or annual) report will be prepared upon completion of the final quarterly sampling event scheduled for December 2015.

2.0

Field Program

This section provides a description of the routine operational sampling event conducted in June 2015. Consistent with previous programs, analytical services were contracted to Maxxam Analytics in Bedford, Nova Scotia. A detailed protocol is included in Appendix A.

2.1

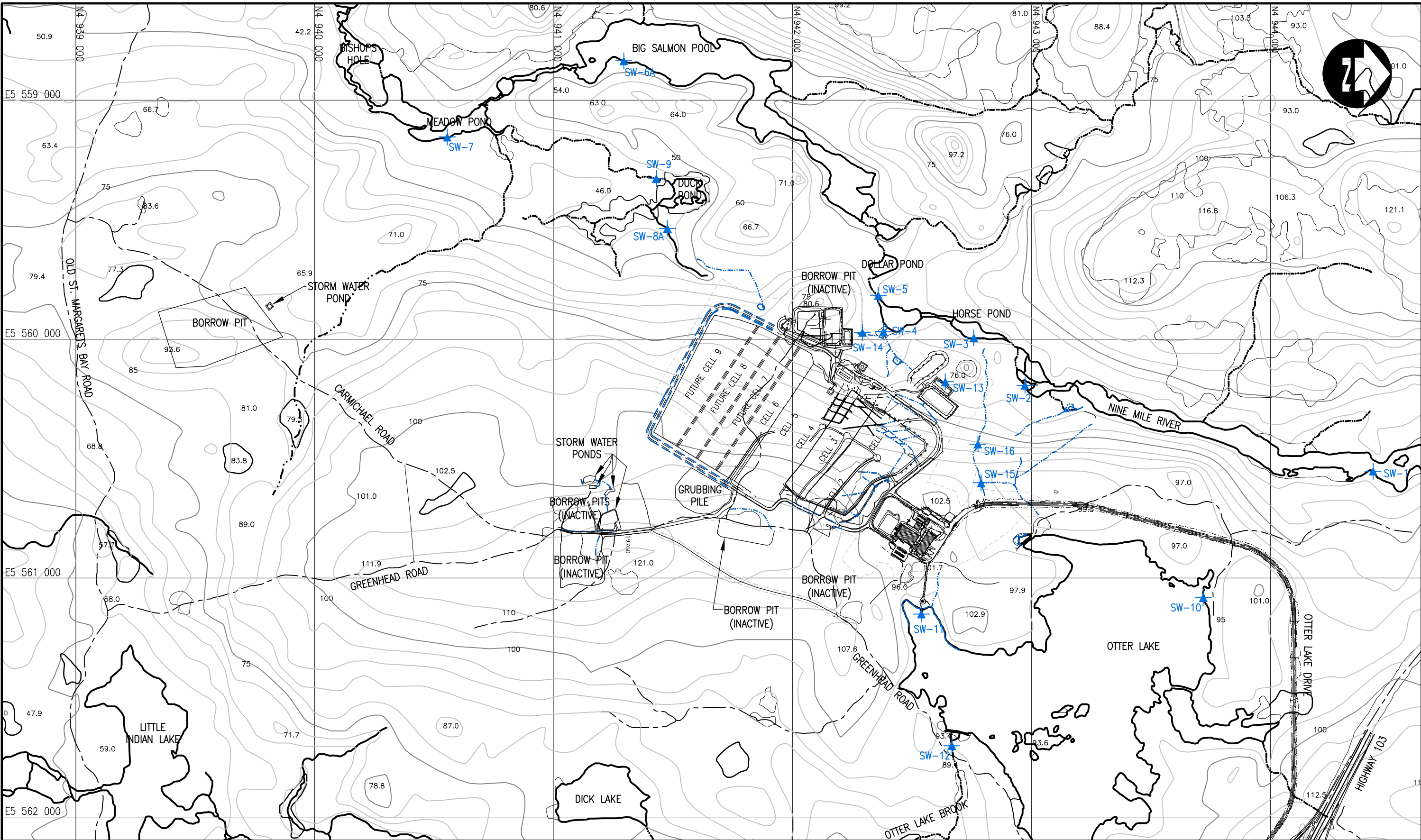
Surface Water

The surface water sampling network includes 15 stations along streams and drainage channels at points both upstream and downstream of site activities. Locations are shown on Figure 2-1 and described in Table 2-1. The June 2015 event involved collection of samples from the ten scheduled stations. Samples were analyzed for general inorganic chemistry, metals and total suspended solids (TSS). In addition, SW-2, SW-4, SW-13, SW-14 and SW-15 were analyzed for chemical oxygen demand (COD) and biological oxygen demand (BOD). Consistent with previous events, surface water samples were not filtered but the metal aliquots were acidified.

TABLE 2-1 SURFACE WATER SAMPLING SUMMARY

Station ID	Location	Description	Sampling Frequency
SW-1	Nine Mile River	Nine Mile River; furthest up gradient station, near Highway 103	Annual
SW-2	Nine Mile River	Nine Mile River; up gradient of site and downstream of SW-1	Quarterly
SW-3	Nine Mile River	Nine Mile River; down gradient of North Sedimentation Ponds	Quarterly
SW-4	Nine Mile River	Site receiving waters below South Sedimentation Ponds	Quarterly
SW-5	Nine Mile River	Nine Mile River; downstream of SW-4	Quarterly
SW-6A ^{Note 1}	Nine Mile River	Nine Mile River; downstream of SW-5	Annual
SW-7	Nine Mile River	Nine Mile River; furthest down gradient sampling station	Quarterly
SW-8A ^{Note 2}	Tributary into Duck Pond	Tributary into Duck Pond; down gradient	Quarterly
SW-9	Duck Pond Outlet	Duck Pond outlet; down gradient of site activities	Annual
SW-10	Otter Lake	Otter Lake; outside RDF watershed area but down gradient of other activities	Annual
SW-11	Otter Lake	Otter Lake; outside RDF watershed area but down gradient of other activities	Annual
SW-13	North Sedimentation Pond	On-site; North Sedimentation Ponds outlet	Quarterly
SW-14 ^{Note 3}	South Sedimentation Pond	On-site; South Sedimentation Ponds outlet	Quarterly
SW-15	Drainage Ditch	On-site; ditch near FEP down gradient of the site access road	Quarterly
SW-16 ^{Notes 4}	Tributary into Nine Mile River	Tributary to Nine Mile River, downstream of SW-15 near Nine Mile River	Quarterly
Notes: Note 1 Location of sample collection modified for better access; former location referred to SW-6. Note 2 Additional station added to monitor more direct flow from landfill, SW-8 was maintained for the 2001 program and discontinued for 2002. Note 3 Due to mechanical issues with the discharge pipe (i.e., the outlet to the pond could not be opened), samples have been collected from (or immediately prior to) the final pond overflow location since June 2012. Note 4 Additional station to monitor presence/absence of local impacts to Nine Mile River.			

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LEGEND: ★ SURFACE WATER SAMPLING LOCATION	 DILLON CONSULTING	TITLE SITE LOCATION AND SURFACE WATER SAMPLING		PROJECT No. 11-4873
		DATE SEPTEMBER 2015	PROJECT RESIDUALS DISPOSAL FACILITY OPERATIONAL SURFACE & GROUNDWATER MONITORING 2015 QUARTERLY REPORT	FIGURE No. 2-1

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2.2

Groundwater

The groundwater monitoring network consists of 51 monitor wells at 30 locations around the perimeter of the landfill and the underdrains at the base of the disposal cells. Some additional piezometers along the northeast side of Cells 1&2 and within the future portion of the landfill footprint have been maintained to measure water levels only. Monitor well and piezometer locations are described in Table 2-2 and shown on Figure 2-2.

The June 2015 operational monitoring included measurement of water levels from three piezometers and water level measurements (where possible) and collection of samples from the 28 of the 29 scheduled wells (MW96-5A contained insufficient water to sample). Water level measurements could not be obtained from MW97-2B1 and MW95-4B due to blockages in these wells, similar to recent events (i.e., since June 2014 and April 2015, respectively).

Underdrain samples were also collected from Cells 3, 5 and 6. Consistent with previous events, there was no flow through the underdrain at the base of Cells 1&2, and the Cell 4 underdrain (4A and 4B locations) was not flowing. Historically, there has never been flow observed at Cell 1 and 4A locations. Cell 4B has also been frequently dry with very little flow observed during previous sampling events.

TABLE 2-2 GROUNDWATER SAMPLING SUMMARY

Well ID	General Location	Sampling Frequency
MW96-1B	North corner and down gradient of Cells 1&2	Quarterly
MW97-2B1	Down gradient of Cells 1&2	Quarterly
MW96-3A, MW96-3B & MW96-3C	Down gradient of Cells 1&2 and Cell 3	Quarterly
MW96-4B	Down gradient of Cell 4 and adjacent to leachate holding tank	Quarterly
MW96-5A, MW96-5B & MW96-5C	Down gradient of Cells 5 and 6 and up gradient of the South Sedimentation Ponds	Quarterly
MW96-7A, MW96-7B & MW96-7C	Down gradient of future cells and south of borrow area	Annual
MW96-8A, MW96-8B & MW96-8C	Down gradient of future cells	Annual
MW96-9A & MW96-9B	Southwest of landfill and cross gradient of future cells	Annual
MW96-10B & MW96-10C	South/southwest of landfill and cross gradient of future cells	Annual
MW96-11B	South corner (up gradient) of future cells	Annual
MW96-12B	Southeast corner of landfill and up gradient of future cells	Annual
MW01-15B & MW01-15C ^{Note 1}	East of Cell 2 and up gradient of landfill	Annual
MW96-16A & MW96-16B ^{Note 2}	Northeast corner of landfill, south corner and topographically up gradient of the FEP compound	Quarterly
MW96-17A & MW96-17B	Between Cell 2 and the FEP compound; cross gradient	Quarterly

Well ID	General Location	Sampling Frequency
MW96-18B & MW96-18C	cross gradient between Cells 1&2 and the FEP compound	Quarterly/Annual (18C)
MW96-19A & MW96-19B	north corner of landfill (Cells 1&2) and down gradient of the FEP compound	Quarterly/Annual (19B)
MW96-20A & MW96-20B	down gradient of Cells 1&2 and Cell 3	Quarterly
MW96-21B	Down gradient between North Sedimentation Ponds and Nine Mile River	Quarterly
MW96-22A & MW97-22B	Down gradient between North Sedimentation Ponds and Nine Mile River	Quarterly
MW97-23A1	Down gradient just north of South Sedimentation Ponds; between South Sedimentation Ponds and borrow area	Quarterly
MW97-24A & MW97-24B	Down gradient of landfill; west of North Sedimentation Ponds	Quarterly
MW97-25B	Below North Sedimentation Ponds	Quarterly
MW95-2A & MW95-2B	up gradient of Cells 5 and 6	Annual
MW95-4A & MW95-4B	north of landfill and down gradient of FEP compound; cross gradient to Cell 1	Quarterly
MW01-26B ^{Note 3}	Along Greenhead Road and up gradient of landfill and borrow pit	Annual
MW01-27B ^{Note 3}	Along Greenhead Road and up gradient of landfill and borrow pit	Annual
MW05-28B ^{Note 4}	Down gradient of landfill and adjacent to leachate holding tank	Quarterly
MW05-29C ^{Note 4}	down gradient of future cells and south of borrow pit (inactive)	Quarterly
MW08-30B ^{Note 5}	down gradient of Cell 6 and up gradient of South Sedimentation Ponds	Quarterly
MW12-31B & MW12-31C ^{Note 6}	Up gradient of Cell 6 and future cells	Annual
Underdrains	Base of disposal cells	Quarterly
Notes: Note 1 MW01-15A/15B/15C were installed as replacements to MW96-15A,15B and 15C, which were destroyed during the winter 2000/2001. MW01-15A was found destroyed in November 2011. Note 2 Prior to 2014, wells MW96-16A and -16B were sampled on an annual basis. At NSE's request, the wells were sampled quarterly in 2014. These wells will be sampled quarterly in 2015. Note 3 Additional wells installed in 2001 to monitor conditions adjacent to borrow pit. Note 4 Additional wells installed in 2005 to monitor down gradient conditions. Note 5 Additional well installed in 2008 to monitor conditions associated with construction of Cell 5. Note 6 In April 2012, wells MW96-13B/13C were decommissioned in relation to Cell 6 construction activities and additional wells MW12-31B/31C were installed up gradient of Cell 6.		

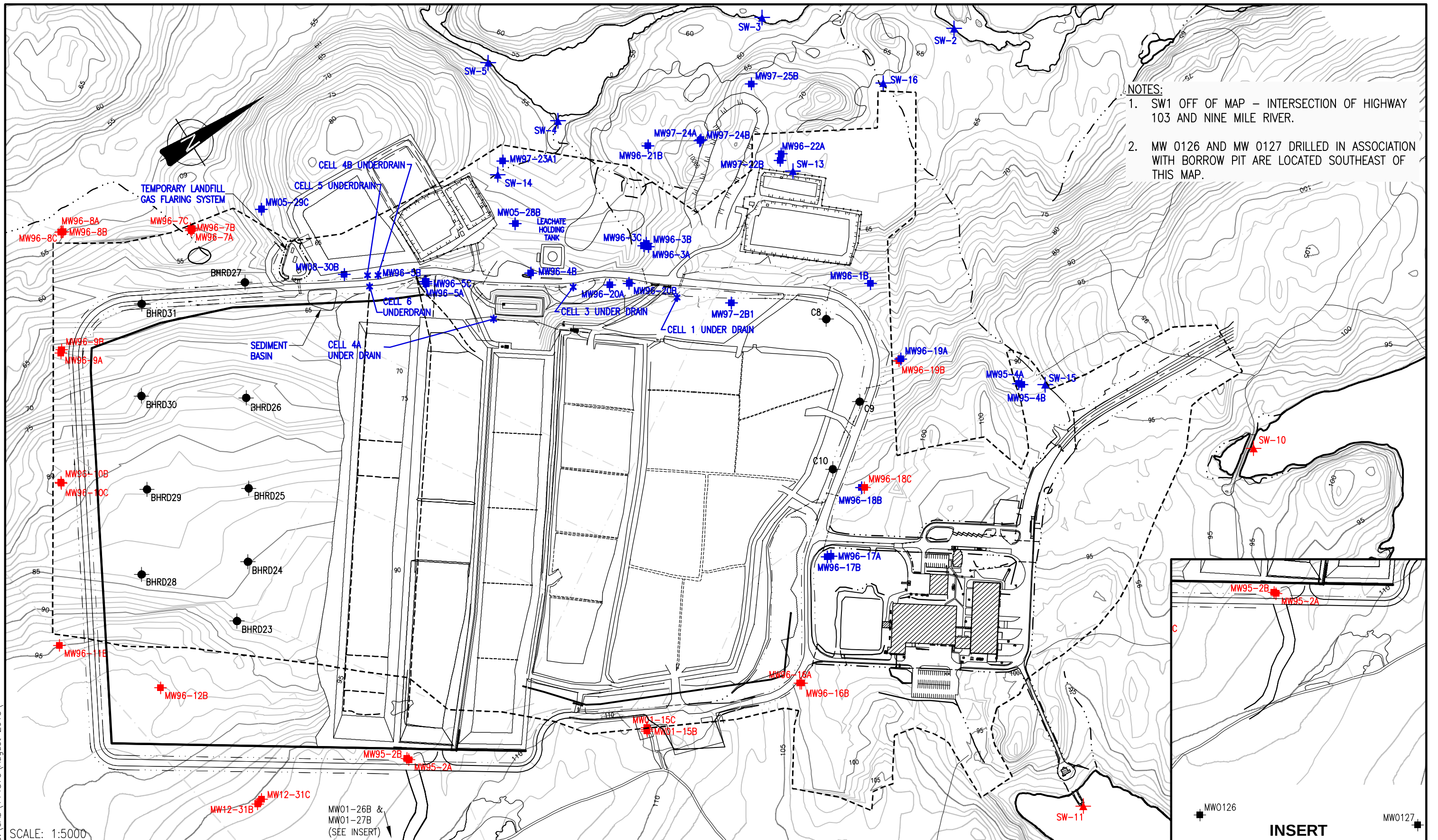
Groundwater samples were analyzed for general inorganic chemistry and metals. Consistent with previous sampling events, monitor well general chemistry and metals samples were field filtered and the metal aliquots preserved with nitric acid. The underdrain samples were not field filtered; however, the metals aliquots were acidified.

2.3

Other Monitoring

Other June 2015 monitoring included the collection of samples from the leak detection sumps (Cell 1&2 and Cells 3 through 6) and the leachate contained within the holding tank. These samples were analyzed for general inorganic chemistry and metals. The leachate was also analyzed for TSS. Consistent with previous events, the samples were not filtered; however, the metal aliquots were acidified.

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3.0 Results

3.1 Surface Water

The data collected during June 2015 represent generally moderate flow conditions, based on visual observations made in the field. Analytical results, including historical data, are presented in tables found in Appendix B-1. Exceedances to Freshwater Aquatic Life (FWAL) Guidelines and/or the Nova Scotia Pit and Quarry Guidelines (with respect to TSS) are shaded. Comments on the June 2015 data in comparison to these guidelines and to previous data are provided in the following paragraphs.

Inorganic chemistry parameters occurring outside the recommended guidelines in one or more surface water samples included low pH, aluminum, copper, iron, lead and zinc.

Two stations (noted below) exhibited pH below the recommended range (6.5 to 9.0 units) at levels comparable to previous results. Historically, pH has been below the recommended range in at least one sample collected from most surface water stations (including baseline); exceptions include the North Sedimentation Pond (SW-13) and FEP drainage ditch (SW-15), as well as downstream (SW-16), samples.

<u>Station</u>	<u>Location</u>	<u>Units</u>
SW-2	Nine Mile River, upstream	6.48
SW-7	Nine Mile River, furthest downstream station	6.26

Aluminum was above the guideline (0.005 to 0.1 mg/L, pH dependant) at the ten stations sampled (field pH is typically used to determine the guideline). Aluminum exceedances have been observed in the majority of samples from all stations, and the June 2015 concentrations were comparable to previous results. Aluminum levels tend to be variable in both sedimentation ponds. It is noted that flocculant, which is frequently used to treat sedimentation ponds at Otter Lake, can contribute to higher concentrations of aluminum. The presence of sediment can also contribute to metals concentrations, noting that the June 2015 concentration of aluminum in SW-13 corresponds with relatively higher concentrations of TSS and turbidity (i.e., 21 mg/L and 18 NTU, respectively).

<u>Station</u>	<u>Location</u>	<u>mg/L</u>
SW-2	Nine Mile River, upstream	0.25
SW-3	Nine Mile River, downstream of North Sedimentation Pond	0.25
SW-4	Nine Mile River, below South Sedimentation Pond	0.28
SW-5	Nine Mile River, downstream of SW-4	0.25
SW-7	Nine Mile River, furthest downstream station	0.28

SW-8A	Tributary into Duck Pond	0.71
SW-13	North Sedimentation Pond (discharge)	2.5
SW-14	South Sedimentation Pond	0.46
SW-15	On-site drainage ditch (FEP compound)	0.34
SW-16	Tributary into Nine Mile River	0.31

Copper was above the guideline (2 to 4 ug/L, hardness dependent) in three samples (shown below). The June 2015 data were comparable to previous results.

<u>Station</u>	<u>Location</u>	<u>ug/L</u>
SW-13	North Sedimentation Pond (discharge)	3.1
SW-15	On-site drainage ditch (FEP compound)	4.7
SW-16	Tributary into Nine Mile River	4.7

Iron exceeded the guideline (0.3 mg/L) in samples from four stations (shown below) at concentrations comparable to previous results.

<u>Station</u>	<u>Location</u>	<u>mg/L</u>
SW-8A	Tributary into Duck Pond	0.93
SW-13	North Sedimentation Pond (discharge)	0.78
SW-15	On-site drainage ditch	0.72
SW-16	Tributary into Nine Mile River	0.57

Lead exceeded the guideline (1 to 7 ug/L, hardness dependent) in three samples shown below. The concentration in SW-13 and SW-16 were marginally above the guideline. Lead has occasionally been above the guideline in samples from these locations at similar or higher concentrations.

<u>Station</u>	<u>Location</u>	<u>ug/L</u>
SW-13	North Sedimentation Pond (discharge)	1.1
SW-15	On-site drainage ditch	1.5
SW-16	Tributary into Nine Mile River (downstream of SW-15)	1.2

Zinc was above the guideline (30 ug/L) in the sample shown below. Although occasional exceedances of zinc have been recorded in SW-15 samples, the June 2015 concentration was notably higher than previously recorded (the prior high was 96 ug/L in December 2011). This concentration appears to be anomalous given the relatively low turbidity and TSS levels reported (i.e., 3.1 NTU and 5 mg/L, respectively) and the normal occurrence of other metals (both in terms of parameters detected and concentrations reported). The laboratory was contacted and subsequently confirmed this result. It is noted that, for SW-16, which is located

downstream of SW-15, the June 2015 concentration of zinc was much lower (14 ug/L) and below the FWAL guideline.

<u>Station</u>	<u>Location</u>	<u>ug/L</u>
SW-15	On-site drainage ditch	210

Table 3-1 presents a summary of the June 2015 concentrations for select inorganic chemistry parameters. As mentioned in earlier reports, the North and South Sedimentation Pond waters and, particularly, the on-site drainage ditch (SW-15) below the FEP compound have historically contained higher levels of general inorganic chemistry and metals parameters relative to other stations. One exception is chloride, which has generally been lower in sedimentation pond and associated downstream samples compared to Nine Mile River levels, which have been as high as 64 mg/L at the furthest upstream sample location (i.e., SW-1).

TABLE 3-1 SUMMARY OF JUNE 2015 INDICATOR PARAMETERS IN SURFACE WATER

Parameter	Nine Mile River			Duck Pond	North Sedimentation Pond		South Sedimentation Pond		FEP Ditch	Tributary Below FEP
	SW-2 (US)	SW-5 (DS)	SW-7 (DS)	SW-8A (DS)	SW-3 (DS)	SW-13 (discharge)	SW-4 (DS)	SW-14 (discharge)	SW-15 (DS)	SW-16 (DS)
Chloride	27	27	25	4.2	27	5.2	6.1	27	22	24
pH	6.48	6.67	6.26	6.52	6.53	7.80	7.42	7.92	7.07	7.28
Hardness	12	13	11	13	12	60	71	110	43	37
TDS	57	60	51	28	60	77	99	160	97	91
TSS	1	<1	<1	2	<1	21	2	1	5	8
Aluminum	0.25	0.25	0.28	0.71	0.25	2.5	0.28	0.46	0.34	0.31
Copper	<0.002	<0.002	<0.002	<0.002	<0.002	0.0031	<0.002	0.0023	0.0047	0.0047
Iron	0.21	0.21	0.24	0.93	0.21	0.78	0.29	<0.05	0.72	0.57
Manganese	0.038	0.042	0.041	0.020	0.039	0.026	0.065	0.49	0.21	0.097
Zinc	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.21	0.014

Notes:

All concentrations in mg/L except pH, which is expressed in "units"

US refers to Upstream Station

DS refers to Downstream Station

FEP Front End Processor

Bolding indicates highest concentration recorded to date

As noted above, higher zinc was recorded in SW-15, which appears to be anomalous. Remaining June 2015 indicator parameter concentrations were comparable to previous results. Some variation between sampling events is expected and, overall, water chemistry is comparable to previous results at these stations.

TDS, hardness and metals were generally highest in the sedimentation pond samples, with concentrations lower in the downstream receiving waters, with the exception of iron or

manganese. As previously reported, concentrations of metals, as well as turbidity, in the South Sedimentation Pond area of the site (i.e., SW-14 and the downstream SW-4) were generally higher during the construction of Cell 6 and occasionally once Cell 6 construction activities were complete (late 2012). However, since the implementation of sediment control measures following the April 2014 event, concentrations (including June 2015) have been comparable to those recorded prior to Cell 6 construction, indicating that the sedimentation control measures have been effective. FEP inorganic chemistry and metals concentrations in June 2015 (with the above-noted exception of chloride) were generally higher relative to Nine Mile River samples, consistent with historical observations. Concentrations of inorganic parameters in the sedimentation pond samples and FEP area samples have exhibited variation in chemistry from one sample event to another. Consistent with historical observations, chloride was highest (in general) in the Nine Mile River samples (both upstream and downstream). Concentrations of chloride and TDS were lowest in the Duck Pond sample. Of note, the downstream monitoring results from Nine Mile River continue to be generally similar to upstream.

3.2 Groundwater

3.2.1 Hydraulic Head Data

The June 2015 monitoring event included measurement of water levels in 27 of the 29 scheduled monitor wells. As noted above, water levels have not been obtained from MW97-2B1 since April 2014 and MW95-4B since April 2015 due to a blockage present in each well.

The June 2015 hydraulic head elevations, along with data collected since 1996, are presented in Appendix B-2. Groundwater levels were comparable to previous results indicating a westward flow toward the Nine Mile River. An equipotential contour map will be included in the 2015 annual report.

3.2.2 Analytical Data

Analytical results including historical data are presented in Appendix B-3. Exceedances to the Canadian Drinking Water Quality (CDWQ) Guidelines are shaded. Comments on the data in comparison to these guidelines, as well as commentary regarding the general overall character of the groundwater, are provided below.

Inorganic chemistry parameters occurring outside the recommended guidelines in one or more groundwater samples included pH, colour, turbidity, arsenic, iron, manganese and uranium. A value denoted in brackets by “-d” denotes the field duplicate value, which has been shown when the field duplicate sample concentration also exceeds.

At 16 sampling locations (shown below), pH was below the recommended range of 6.5 to 8.5 units at levels similar to previous data.

<u>Well ID</u>	<u>Location</u>	<u>Units</u>
MW96-1B	North corner of Cell 1	6.20, 6.32-d
MW96-3A	Down gradient of Cell 1	5.04
MW96-5B/5C	Down gradient of Cells 5 and 6	6.13/6.24
MW96-16A	Northeast corner of Landfill	6.36
MW96-17B	Cross gradient of Cell 2 and FEP	6.17
MW96-18B	Cross gradient of Cells 1&2 and FEP	6.28
MW96-21B	Down gradient of North Sedimentation Pond	5.72
MW96-22A	Down gradient of North Sedimentation Pond	6.03
MW97-23A1	Down gradient; near South Sedimentation Pond	6.39
MW97-24A/24B	West of North Sedimentation Pond	5.59/5.69
MW97-25B	Northwest of the North Sedimentation Pond	5.45
MW05-28B	Down gradient and west of leachate holding tank	6.09, 6.36-d
MW08-30B	Down gradient Cell 6 and future cells	5.95
MW95-4B	North of Cells 1&2, down gradient of FEP	6.21

Colour was above the guideline of 15 TCU at seven sampling locations (shown below). A general increase in colour had been observed in down gradient wells MW96-5A/5B/5C since the construction of Cell 5 in 2008, with the highest levels at this location recorded in shallow bedrock well MW96-5B. The June 2015 level in MW96-5B was significantly below the high recorded in the preceding (i.e., April 2015) sample (i.e., 710 TCU), with levels in both MW96-5B/5C comparable to levels recorded since 2008. As noted above, MW96-5A contained insufficient water to sample in June 2015. For MW05-28B, colour was above the previously recorded range (i.e., <5 to 63 TCU in April 2015). The level in MW08-30B was lower than the high of 87 TCU recorded in the preceding (April 2015) sample but above the range recorded prior to that time (i.e., <5 to 53 TCU in the December 2013 laboratory duplicate sample). For the remaining samples, levels were comparable to previous results. It is noted that colour has generally been higher in samples from surficial well MW96-22A relative to other locations (typically above 100 TCU and as high as >1,000 TCU in November 1997), and colour in MW96-3A is also frequently elevated (i.e., frequently above 100 TCU and as high as 410 TCU in June 1996). It is noted that elevated colour is common in monitor wells and usually reflective of disturbances around the well screen created during sporadic pumping and not considered to be representative of local groundwater conditions.

<u>Well ID</u>	<u>Location</u>	<u>TCU</u>
MW96-3A	Down gradient of Cell 1	230
MW96-5B	Down gradient of Cells 5 and 6	46
MW96-22A	Down gradient of North Sedimentation Pond	820
MW97-23A1	Down gradient; near South Sedimentation Pond	170
MW05-28B	Down gradient and west of leachate holding tank	92, 77-d

MW08-30B	Down gradient Cell 6 and future cells	58
MW95-4B	North of Cell 1 & down gradient of FEP	72

Turbidity was above the guideline of 1 NTU in samples from six sampling locations (shown below). The June 2015 levels were within the previously recorded ranges with the exception of MW05-28B, for which the primary sample concentration was slightly above the prior range (i.e., <0.1 to 4.3 NTU). The level in MW96-5B remains notably lower than the high recorded in June 2014 (i.e., 660 NTU). For MW96-5C, turbidity had been elevated in earlier samples, then, between 1999 and 2012, turbidity had been above the guideline only occasionally. Since April 2013, turbidity has been consistently above the guideline in MW96-5C samples, noting that levels remain relatively low (i.e., ranging from 1.9 to 16 NTU) in comparison to levels recorded prior to 1999 (i.e., as high as 490 NTU November 1997). Similar to colour, elevated turbidity is common in monitor wells and usually reflective of disturbances around the well screen created during sporadic pumping and not considered to be representative of local groundwater conditions.

<u>Well ID</u>	<u>Location</u>	<u>NTU</u>
MW96-5B/5C	Down gradient of Cells 5 and 6	11/16
MW96-22A	Down gradient of North Sedimentation Pond	3.0
MW97-23A1	Down gradient; near South Sedimentation Pond	3.5
MW05-28B	Down gradient and west of leachate holding tank	4.8, 2.3-d
MW95-4B	North of Cell 1 & down gradient of FEP	3.9

Arsenic was above the guideline of 0.010 mg/L in three bedrock well samples (shown below). For MW96-3C, arsenic concentrations have been consistently detected since the initiation of sampling; however, guideline exceedances have only been recorded since June 2006 (when the CDWQ Guideline for arsenic was lowered from 0.025 mg/L to 0.010 mg/L). For MW96-5C, prior to June 2010, arsenic had been detected on four occasions (November 1997, June and September 1998, and September 2001) at low concentrations (i.e., 0.002 to 0.003 mg/L). Since June 2010, arsenic has consistently been detected and has shown an overall general increase in concentration (i.e., from 0.002 to 0.017 mg/L in December 2014). Similarly, arsenic detections have been more frequent in the other wells at this location since 2010, with concentrations in MW96-5B also increasing over time and the June 2015 concentration marginally above the prior high (i.e., 0.012 mg/L in both September 2013 and December 2014). Until September 2013, concentrations in MW96-5B had not exceeded the guideline.

<u>Well ID</u>	<u>Location</u>	<u>mg/L</u>
MW96-3C	Down gradient of Cell 1	0.014
MW96-5B/5C	Down gradient of Cells 5 and 6	0.013/0.016

Iron was above the 0.3 mg/L guideline in samples from nine sampling locations (shown below). For wells MW96-5A/5B/5C, iron levels have exhibited a general increase since 2008 (coincident with the construction of Cell 5), and earthwork activities adjacent to the monitor well nest, undertaken in late 2011 (in relation to Cell 6 construction), further contributed to higher levels of iron (as well as arsenic, manganese and colour). Iron exceedances were rarely observed in earlier samples. In June 2015, the concentration in MW96-5B was equivalent to the high recorded in the preceding sampling (i.e., 19 mg/L in April 2015), and the concentration in MW95-5C was within the previously recorded range (i.e., up to 11 mg/L in December 2014). For comparison, prior to 2008, iron concentrations in these two wells ranged from <0.05 to 0.58 mg/L (November 1997) and <0.05 to 0.57 mg/L (November 1997), respectively, with iron above the guideline only once and twice, respectively. Iron concentrations have generally increased in MW05-28B, with the June 2015 concentration above the previously recorded range (i.e., 0.12 to 2.5 mg/L in May 2011). Concentrations in the remaining samples were comparable to previous results. Iron concentrations in the down gradient wells (most notably MW96-22A, for which concentrations have ranged up to 40 mg/L) tend to be high relative to those recorded in the up gradient samples (sampled annually).

<u>Well ID</u>	<u>Location</u>	<u>mg/L</u>
MW96-3A	Down gradient of Cell 1	2.0
MW96-5B/5C	Down gradient of Cells 5 and 6	19/9.6
MW96-22A	Down gradient of North Sedimentation Pond	27
MW97-23A1	Down gradient near South Sedimentation Pond	4.9
MW97-24A	West of North Sedimentation Pond	0.45
MW05-28B	Down gradient of leachate holding tank	3.1, 3.1-d
MW08-30B	Down gradient Cell 6 and future cells	1.8
MW95-4B	North of Cells 1&2, down gradient of FEP	2.0

Manganese was above the guideline of 0.05 mg/L in samples from 12 sampling locations (shown below), and the June 2015 concentrations were within the previously recorded ranges. Manganese increases (gradual and overall) have been observed at several locations including: MW96-20B (since September 2001); MW97-23A1 (since initiation of sampling); MW05-28B (since September 2006); MW05-29C (since September 2009); and MW08-30B (since August 2011). Similar to iron (as detailed above), manganese has exhibited a general increase in wells MW96-5A/5B/5C since 2008, with concentrations up to 4.0 mg/L in September 2012, 6.0 mg/L in December 2014 and 4.1 mg/L in December 2014, respectively (for comparison, pre-2008 concentrations ranged from 0.034 to 0.26 mg/L, 0.039 to 0.78 mg/L and 0.018 to 0.7 mg/L, respectively, including baseline). Monitor wells MW97-24A/24B initially exhibited an overall general increase; however, levels have decreased in recent years. Once again (and similar to iron), manganese concentrations in the down gradient wells (most notably MW97-24B, for

which concentrations have ranged up to 18 mg/L in September 2000) remain generally higher than the up gradient wells (sampled annually).

<u>Well ID</u>	<u>Location</u>	<u>mg/L</u>
MW96-5B/5C	Down gradient of Cells 5 and 6	4.9/3.1
MW96-19A	Down gradient of FEP	0.84
MW96-20B	Down gradient of Cells 1&2 and 3	2.9
MW96-22A	Down gradient of North Sedimentation Pond	1.6
MW97-23A1	Down gradient near South Sedimentation Pond	4.0
MW97-24A/24B	West of North Sedimentation Pond	0.20/3.8
MW05-28B	Down gradient of leachate holding tank	2.6, 2.6-d
MW05-29C	Down gradient of future cells	0.49
MW08-30B	Down gradient of Cell 6 and future cells	1.0
MW95-4B	North of Cells 1&2, down gradient of FEP	0.51

Uranium was above the guideline of 0.02 mg/L in samples from seven bedrock wells noted below. Uranium levels in MW96-5C have exceeded the guideline in more recent samples only (i.e., June 2010 and from December 2010 to present), and the June 2015 concentration remained below the high recorded in December 2012 (i.e., 0.16 mg/L). Concentrations up to 0.09 mg/L were recorded in the initial samples from MW96-5C prior to the lowering of the guideline from 0.1 mg/L to 0.02 mg/L in 1999. Overall, the June 2015 concentrations were consistent with previous results (both baseline and operational). The highest concentrations have generally been recorded in MW96-3C, for which the baseline concentration was 0.2 mg/L, and concentrations have been generally consistent since that time.

<u>Well ID</u>	<u>Location</u>	<u>mg/L</u>
MW97-2B1	Down gradient of Cell 1	0.037
MW96-3B/3C	Down gradient of Cell 1	0.045/0.15
MW96-5C	Down gradient Cells 5 and 6	0.092
MW96-20B	Down gradient of Cells 1&2 and 3	0.031
MW96-22B	Down gradient of North Sedimentation Pond	0.057
MW05-29C	Down gradient of future cells	0.029

Table 3-2 provides a summary of concentrations (baseline and current) of select indicator parameters (chloride, TDS, iron and manganese) for the wells sampled in June 2015 as part of the 2015 second quarterly operational monitoring event (noting that MW96-5A contained insufficient water to sample). For the most part, baseline data reflects the range in concentrations observed in samples collected between 1996 and 1998. In some instances (as noted in the table), baseline data reflects sample results collected when the well was installed subsequent to the initiation of site operations. The table is shown to provide a comparison of

current levels to pre-operational/baseline levels. Bolded values indicate a concentration higher than baseline. Bolded and underline values indicate the highest concentration recorded to date.

TABLE 3-2 SUMMARY OF INDICATOR PARAMETERS IN GROUNDWATER SAMPLES

Location	Chloride		TDS		Iron		Manganese	
	BL	June 2015	BL	June 2015	BL	June 2015	BL	June 2015
MW96-1B	5.5 - 10	7	38 - 71	37	<0.01 - 0.2	<0.05	0.019 - 0.26	0.0042
MW97-2B1	5 - 16	9	59 - 177	90	<0.01 - 0.2	<0.05	0.015 - 0.16	<0.002
MW96-3A	3.2 - 6.4	3	26 - 32	13	1.6 - 4.5	2.0	0.04 - 0.13	0.021
MW96-3B	4 - 7.8	8	42 - 89	82	ND - 0.8	<0.05	0.008 - 0.26	0.021
MW96-3C	4.4 - 6.5	7	95 - 126	120	ND - 1.1	<0.05	0.006 - 0.085	<0.002
MW96-4B	5.2 - 6.9	7	47 - 81	87	ND - 0.44	<0.05	ND - 0.048	0.010
MW96-5A	4.5 - 5.8	-	34 - 50	-	0.2 - 0.27	-	0.03 - 0.15	-
MW96-5B	3.5 - 13.5 ¹	10	17 - 72	160	ND - 0.58	19	0.05 - 0.78	4.9
MW96-5C	4.5 - 12.7 ¹	10	26 - 81	150	0.025 - 0.57	9.6	0.018 - 0.7	3.1
MW96-16A	5.6 - 17 ¹	32	60 - 88	160	0.11 - 0.15	<0.05	0.009 - 0.075	0.0059
MW96-16B	6.3 - 11 ¹	21	92 - 125	180	ND - 0.22	<0.05	0.002 - 0.043	0.011
MW96-17A	4.8 - 16.7 ¹	7	94 - 161	67	0.15 - 4.1	<0.05	0.049 - 0.32	<0.002
MW96-17B	5.2 - 8.7	22	47 - 103	81	0.039 - 0.35	<0.05	ND - 0.1	0.0032
MW96-18B	5 - 7.6	5	29 - 82	42	0.026 - 0.35	<0.05	0.058 - 0.49	<0.002
MW96-19A	4.9 - 5.5	8	252 - 285	180	ND - 1.6	0.069	1.7 - 2.7	0.84
MW96-20A	3 - 14.6	6	34 - 90	150	<0.01 - 2	<0.05	0.027 - 0.46	<0.002
MW96-20B	4 - 6.2	9	22 - 63	170	ND - 0.94	<0.05	0.02 - 0.17	2.9
MW96-21B	1.5 - 3.1	2	15 - 95	12	ND - 0.1	<0.05	0.033 - 0.15	0.0059
MW96-22A	4 - 16	6	41 - 72	52	0.42 - 14	27	0.46 - 4.4	1.6
MW97-22B	4 - 12.9 ¹	5	114 - 163 ¹	120	<0.01 - 3.4	<0.05	<0.005 - 0.48	<0.002
MW97-23A1	5.9 - 41.9 ¹	9	31 - 69	120	2.2 - 26 ¹	4.9	0.19 - 1.9	4.0
MW97-24A	7.2	5	28	25	<0.02	0.45	2.5	0.20
MW97-24B	8.4 - 18	13	44 - 149 ¹	71	0.65 - 4.7	<0.05	3.6 - 4.4	3.8
MW97-25B	8	3	49	16	0.12	<0.05	0.63	0.033
MW05-28B	9.8	10	77	91 d	0.71	<u>3.1</u>	1.1	2.6
MW05-29C	9.5	10	136	170	<0.05	0.13	0.19	0.49
MW08-30B	6	6	38	67	1.1	1.8	0.36	1.0
MW95-4A	4.7 - 7.7	6	52 - 64	74	ND - 0.16	<0.05	0.007 - 0.024	<0.002
MW95-4B	5 - 7	5	71 - 159	35	ND - 1.2	2.0	ND - 0.31	0.51

Notes:

All concentrations in mg/L.

¹ indicates anomalous concentration (not consistent with the majority of interim results), if anomalous concentration removed:

- BL chloride in MW96-5B: 3.5-7.1
- BL chloride in MW96-5C: 4.5-6.4
- BL chloride in MW96-16A: 5.6-7.2
- BL chloride in MW96-16B: 6.3-8
- BL chloride in MW96-17A: 4.8-6
- BL chloride in MW97-22B: 4-9
- BL TDS in MW97-22B: 114-137
- BL chloride in MW97-23A1: 5.9-8.3
- BL iron in MW97-23A1: 2.2-2.7
- BL TDS in MW97-24B: 44-55

ND indicates "not detected"

n/a; no baseline data; first sample collected

d – denotes field duplicate value shown (when higher than primary sample concentration)

BL (Baseline) generally represents data collected during 1996 through 1998 with the following exceptions:

- For replacement wells MW01-15A/15B/15C (sampled annually), BL refers to data collected from MW96-15A/15B/15C.
- BL for MW97-24A represents initial sample collected from this well in March 1999.
- BL for MW05-28B and 29C represents initial samples collected in July 2005.
- BL for MW08-30B represents initial sample collected in June 2008.

Bolding indicates concentration above baseline.

Bolding/underline indicates highest concentration recorded to date.

As noted, several samples contained concentrations of one or more indicator parameters higher than baseline. However, in some instances (MW96-3B/3C, MW96-4B, MW96-17B, MW96-19A, MW95-4A/4B), the difference is not considered to be significant and/or is not considered indicative of a change in chemical character. The comments below apply to potential exceptions.

- For MW96-5B/5C (down gradient of Cells 5 and 6), TDS, iron and manganese were above baseline. The June 2015 concentrations of these parameters were within the ranges recorded since 2008 (coincident with the construction of Cell 5), with iron in MW96-5B equivalent to and TDS in MW96-5B/5C slightly below the highs recorded in the preceding (April 2015) sample. As noted in previous reports, road work undertaken in the immediate vicinity of the wells during Cell 6 construction (late 2011/2012) further contributed to the general increases observed since 2008 (i.e., colour, iron, manganese and TDS). Although Cell 6 construction was completed in late 2012, the area continued to be influenced by site operations/runoff; however, sedimentation control measures were implemented during 2014, including hydro-seeding in the vicinity of the wells. Chloride in MW96-5B/5C (10 mg/L in both wells) remained below the highs recorded in June 2013 (15 mg/L and 13 mg/L, respectively); however, levels were above the modified baseline ranges noted within the table (i.e., 3.5 to 7.1 mg/L and 4.5 to 6.4 mg/L, respectively). Chloride concentrations, which had generally been less than 10 mg/L in these two wells prior to 2013, appear to be fluctuating.
- Prior to the 2014 monitoring program, MW96-16A/16B (northeast corner of the landfill, south corner and topographically up gradient of the FEP), were sampled on an annual basis (i.e., fall); however, at the request of NSE, these wells were sampled quarterly to further assess observed changes in chemistry and to see if there is any seasonal correlation. During 2014, seasonal influence was not apparent; however, sampling of these wells will continue to be on a quarterly basis in 2015. Chloride and/or TDS had been gradually increasing over time in both wells (most notably since 2010 and 2008, respectively). The June 2015 concentrations were above baseline but within the previously recorded ranges. It is noted that TDS in MW96-16A was equivalent to the prior high and that both TDS and chloride have been reported at consistent levels (i.e., 160 and 32 mg/L, respectively) since December 2014. The prior ranges for TDS (including baseline) were 59 to 160 mg/L (in both December 2014 and April 2015) and 92 to 200 mg/L (in June 2014), respectively, and the prior ranges for chloride (including baseline) were 4.3 to 36 mg/L (in September 2012) and 5.9 to 28 mg/L (in November 2011), respectively, for MW96-16A and MW96-16B. Of note, June 2015 hardness and sulphate concentrations were slightly higher in MW96-16A and within the previously recorded ranges for MW96-16B (but remain high relative to the majority of results); and conductivity in both wells was equivalent to the prior highs. As previously reported, conductivity, hardness and sulphate in both wells have been generally increasing, while indicator parameters, such as iron and/or manganese, were low and/or

non-detect (i.e., generally comparable to or lower than baseline). These wells are located within a ditch that receives drainage from the area up gradient of the landfill and are likely influenced by operations activities in the up gradient area of the site, roadway run-off and/or the cross gradient FEP/WSF compound.

- Chloride and/or TDS were above baseline in MW96-20A/20B but were within the previously recorded ranges. Since 2002, there has been a notable increase in TDS in both wells. Chloride has been variable in both MW96-20A/20B since the initiation of sampling; however, levels in MW96-20B have been much lower (for the most part 20 mg/L or less), including June 2015. As previously reported, chloride in MW96-20A has exhibited occasional concentrations above 100 mg/L since April 2009 (with the high of 140 mg/L recorded in April 2012) and appears to be seasonally influenced (by roadway runoff), with the highest annual concentrations during 2009 through 2015 occurring during the spring events (i.e., March or April). Manganese, which was above baseline in MW96-20B, has gradually increased over time. Since April 2002, concentrations have generally been above 1 mg/L and as high as 4.5 mg/L (in both June 2012 and September 2013).
- Iron in MW96-22A (down gradient of North Sedimentation Pond) has frequently been above baseline with no apparent trending. Iron in this well remains high relative to other locations (up to 40 mg/L in May 2011) with the June 2015 concentration consistent with previous results.
- TDS and manganese in MW97-23A1 (down gradient near the South Sedimentation Pond) were above baseline. Manganese was equivalent to the prior high (i.e., 4.0 mg/L in December 2014); and TDS was equivalent to the high recorded in the preceding (April 2015) sample (i.e., 120 mg/L). TDS has exhibited an overall increase from baseline, while manganese has been on a generally increasing trend since 2007. Iron has been variable, ranging from 2.2 to 9.6 mg/L, excluding the anomalous concentration (26 mg/L) recorded in June 1998. Chloride has been 11 mg/L or less, with the exception of the anomalous June 1998 concentration (41.9 mg/L).

For the following wells, it is noted that the baseline concentration represents one data set (from the first sample event):

- Indicator parameter concentrations were above baseline in MW05-28B (down gradient of leachate holding tank), with the June 2015 concentration of iron above the previously recorded range (i.e., 0.12 to 2.5 mg/L in May 2011). A general increase in iron and manganese has been observed in samples from this location; however, the June 2015 concentration of manganese was comparable to previous results (i.e., 1.0 to 2.8 mg/L in several samples since September 2013). TDS has exhibited some variation with no

apparent trending, and chloride was consistent with previous results (i.e., 6 to 18 mg/L in April 2007).

- The June 2015 concentrations of chloride, TDS, iron and manganese were above baseline but within the previously recorded ranges in MW05-29C (down gradient of future cells). The concentration of TDS was equivalent to the prior high and has consistently been reported at 170 mg/L since December 2014. Overall, manganese and TDS (as well as hardness and conductivity) have exhibited general (albeit slight) increases. Initially, iron levels tended to fluctuate between non-detect (i.e., below the LDL) and detectable concentrations; however, iron has consistently been detected since December 2010. Remaining inorganic chemistry for this well (including chloride) has been relatively consistent since initiation of sampling in 2005.
- For MW08-30B (down gradient of Cell 6 and future cells), TDS, iron and manganese were above baseline but within the prior ranges. Concentrations of these parameters manganese (as well as conductivity, hardness and other major cations and anions) have been gradually increasing over time (albeit slightly). The June 2015 concentrations were within the previously recorded ranges, with the exception of marginally higher calcium, magnesium, alkalinity and hardness.

It is noted that several samples contained indicator parameter concentrations that were lower than baseline, including manganese in approximately half of the June 2015 monitor well samples, as well as chloride, TDS and/or iron at some locations.

3.3 Underdrain Samples

Analytical results for Cell 3, Cell 4, Cell 5 and Cell 6 Underdrain samples are found in Appendix B-4. Consistent with previous events, there was no drainage under Cells 1&2. It is noted that there are two underdrain discharge locations in relation to Cell 4: 4A is located along the southwest edge of Cell 4 and daylights near the holding pond; and 4B, which was installed after encountering a spring during cell construction, daylights at the base of Cell 5 on the west side of the road. There has never been any flow at the 4A location and, therefore, Cell 4 Underdrain data collected to date represents samples collected from 4B. The Cell 4B Underdrain, which has historically exhibited very little or no flow, was not flowing and could not be sampled in June 2015.

Comments on the June 2015 data in comparison to the CDWQ Guidelines, as well as commentary regarding the general overall character of the underdrain groundwater, are provided below.

Exceedances to the CDWQ Guidelines in the June 2015 samples included:

- Uranium (0.022 mg/L) in the Cell 3 Underdrain; and
- Manganese (0.86 mg/L) in Cell 5 Underdrain.

The CDWQ Guidelines for uranium and manganese are 0.02 mg/L and 0.05 mg/L, respectively. The June 2015 concentrations were comparable to previous results, noting that the concentration of uranium in the Cell 3 Underdrain was marginally above the guideline. Manganese has consistently been above the CDWQ Guideline of 0.05 mg/L in the Cell 5 Underdrain samples, as well as the Cell 4B Underdrain historically.

Table 3-3 provides a summary of select indicator parameter concentrations (initial, interim and/or current) for Cell 3 and Cell 4B, Cell 5 and Cell 6 Underdrains. Indicator parameter concentrations in the Cell 3 Underdrain sample were similar to or lower than initial concentrations. It is noted that, since December 2010, iron (as well as the majority of manganese concentrations) has been non-detect. June 2015 concentrations in the Cell 5 Underdrain were comparable to previous results. Historically, chloride has exhibited little variation since initiation of sampling in April 2009. TDS, iron and manganese remain higher than the initial samples. For the Cell 6 Underdrain (where 11 samples have been collected to date), it is noted that anomalous concentrations recorded in the September 2013 field duplicate sample have been excluded from the following discussion. Indicator parameter concentrations were generally comparable to previous results, with TDS slightly below the high concentration recorded during the preceding (April 2015) event and equivalent to the June 2014 sample concentration. Although marginally higher in June 2015, chloride in Cell 6 has exhibited little variation since initiation of sampling. Of note, iron has not been detected in the Cell 6 Underdrain samples collected to date.

TABLE 3-3 SUMMARY OF INDICATOR PARAMETERS IN UNDERDRAIN SAMPLES

Location	Chloride			TDS			Iron			Manganese		
	Initial	Interim	June 2015	Initial	Interim	June 2015	Initial	Interim	June 2015	Initial	Interim	June 2015
Cell 3 Underdrain	8	3-14	9	228	160-436	190	<0.05	<0.05-1.1	<0.05	0.002	<0.002-0.13	<0.002
Cell 4B Underdrain	7	4-11	-	152	118-397	-	1.52	<0.05-14	-	0.065	0.081-0.66	-
Cell 5 Underdrain	6	6-10	10	135	138-170	160	<0.05	<0.05-0.35	0.099	0.16	0.18-1.0	0.86
Cell 6 Underdrain	8	8-9*	10	162	174-220*	210	<0.05	<0.05	<0.05	0.0028	0.0021-0.040	0.0045

Notes:

The Cell 3 Underdrain was not sampled in June 2015.

There has never been flow at Cell 4A Underdrain and the Cell 4B Underdrain was dry in November 2011; April, June & September 2012; April, September and December 2013; and April, June and September 2014.

All concentrations in mg/L.

Bolding indicates highest concentration recorded to date.

d – denotes field duplicate sample concentration (shown where higher than primary sample concentration).

Initial data refers to March 2003 for Cell 3; September 2008 for Cell 4; April 2009 for Cell 5; and December 2012 for Cell 6.

* In September 2013, the field duplicate results for chloride and TDS were 160 mg/L and 330 mg/L, respectively. The laboratory repeated the sample. The results appear to be anomalous and, therefore, were not included.

3.4

Leak Detection Sumps

Analytical data for the five leak detection sump sample locations are found in Appendix B-5. Consistent with previous results, water in the sumps exhibited a high dissolved ion load due to elevated concentrations of sodium and sulphate (likely a reflection of water contact with the bentonite layers within the liner system). Table 3-4 provides a summary of select indicator parameter concentrations (initial, interim and current).

The June 2015 concentrations of select indicator parameters were within the previously recorded ranges, with the exception of higher manganese in Cell 3. For the most part, concentrations of indicator parameters have been variable at all sump locations, although TDS has decreased from initial levels at all sumps. Chloride has been highest (overall) in Cell 1&2 relative to the other cells. As previously reported, for Cell 3, there was an increase in chloride concentrations from 2009 to 2012 (with the high of 28 mg/L recorded in March 2010). Concentrations since that time have been within the previously recorded range, including June 2015. Cell 4 data has been fairly consistent (overall) and, although recent TDS levels are high relative to the other cells, levels in Cell 4 have also decreased over time. For Cell 5, the initial 2008 data set represents a single sample collected following an observance by site personnel of abnormally coloured/turbid water during pumping. Iron concentrations since that time, as well as the majority of manganese concentrations, have been significantly lower than recorded in the initial sample. Chloride concentrations were initially recorded at 15 mg/L and 17 mg/L then were generally below 10 mg/L. However, since April 2012, concentrations have been similar to initial levels ranging from 11 to 16 mg/L. For Cell 6, levels of general inorganic chemistry and metals parameters remain lower than recorded in the initial (April 2013) sample, albeit based on ten sample sets to date. Since the initial sample, levels of chloride have been consistently 7 to 9 mg/L.

It is noted that chloride levels in Cell 1&2 were generally consistent up to June 2008 and, with the exception of some early samples and the September 2004 (44 mg/L) sample, concentrations were less than 20 mg/L. Since that time, chloride concentrations have shown significant variation, ranging from 16 to 83 mg/L (in December 2008). Calcium and hardness show gradually increasing trends, while nitrates were significantly higher in late 2008 and early 2009 (i.e., up to 13 mg/L in December 2008). No potential sources of nitrate have been identified and concentrations have lowered since that time, with the June 2015 concentration (i.e., 2.6 mg/L) within the previously recorded range and significantly below the high.

Upon comparison, calcium and hardness levels in Cell 3 (which tend to be more variable than Cell 1&2) appear to be on a generally increasing trend, although chloride (for the most part) has been generally consistent (see chloride discussion above). Nitrate has exhibited some variation, with concentrations up to 3.0 mg/L in June 2007; however, the majority of levels have been less than 0.50 mg/L. In June 2015, nitrate was 0.56 mg/L.

TABLE 3-4 SUMMARY OF INDICATOR PARAMETERS IN LEAK DETECTION SUMP SAMPLES

Location	Chloride			TDS			Iron			Manganese		
	Initial	Interim	June 2015	Initial	Interim	June 2015	Initial	Interim	June 2015	Initial	Interim	June 2015
Cell 1&2	28	7-83	24	1950	460-2660	520	0.6	nd-8.0	<0.05	8.1	nd - 4.2	<0.002
Cell 3	7	7-28	26	882	420-1730	500	5.0	nd-19	0.19	0.35	0.007 – 1.5	2.0
Cell 4	23	8-23	21	2450	508-1740	1100	1.1	nd-1.2	0.17	0.057	nd – 1.8	0.0064
Cell 5	15	5-17	16	2560	571-2340	790	21	nd-2.4	0.18	0.62	0.011-2.4	0.070
Cell 6	12	7-9	8	1040	710-860	720	0.54	nd-0.46	0.17	0.025	nd-0.018	0.010
Notes: All concentrations in mg/L. nd indicates a non-detectable concentration. Bolding indicates highest concentration recorded to date. Initial data refers to December 1998 for Cell 1&2; March 2003 for Cell 3; June 2006 for Cell 4; November 2008 for Cell 5; and April 2013 for Cell 6.												

3.5

Leachate

Leachate is collected and temporarily held in a tank prior to transport off site. Analytical data for samples collected since March 1999 are found in Appendix B-6.

As expected, there has been a gradual change in the inorganic character of the leachate since 1999 with a general increase in the concentration of major anions/cations (including chloride), TDS, ammonia and colour. The June 2015 concentrations were within the previously recorded ranges.

4.0

Summary and Conclusions

Surface Water

Samples were collected from the ten scheduled surface water stations in June 2015 under moderate flow conditions. Parameter occurrences above the FWAL Guidelines (or, in the case of pH, below the recommended range) are summarized below.

Sampling Area (No. of Stations)	Nine Mile River (3)	Duck Pond (1)	North Sed. Pond (2)	South Sed. Pond (2)	FEP (2)
Location	1 US, 2 DS	DS	DS	DS	DS
Parameter (No. of samples)	pH (1 low US, 1 low DS) Aluminum (3)	Aluminum (1) Iron (1)	Aluminum (2) Copper (1) Iron (1) Lead (1)	Aluminum (2)	Aluminum (2) Copper (2) Iron (2) Lead (2) Zinc (1)
Notes: US - refers to Upstream Station DS - refers to Downstream Station FEP - Front End Processor					

Overall, the exceedances summarized above are consistent with prior observations. Aluminum exceedances occurred in the ten samples collected at both upstream and downstream locations, and low pH was observed in the upstream Nine Mile River sample, as well as one downstream Nine Mile River sample. The North Sedimentation Pond and FEP samples exhibited the greatest number of exceedances. With the exception of higher zinc recorded in the FEP sample (SW-15) and considered anomalous, concentrations were comparable to previous results. It is noted that zinc was much lower and below the FWAL guideline in the furthest downstream FEP sample (i.e., SW-16).

Since Cell 6 construction activities have been completed (late 2012), concentrations of metals, as well as turbidity, have been lower at the south sedimentation pond (SW-14), as well as downstream SW-4. As previously reported, increased runoff as a result of precipitation events may have contributed to higher turbidity levels in this area, which tended to flood on occasion (as occurred in April 2015 when SW-4 was inaccessible). Since the implementation of sediment control measures in 2014, concentrations of metals at these locations have been comparable to levels recorded prior to Cell 6 construction.

The North and South Sedimentation Pond water, and particularly the FEP drainage ditch (and downstream) samples, have historically contained higher concentrations of inorganic chemistry and metals parameters relative to other stations. TDS remains higher in these areas of the site compared to the other stations, while chloride was highest in the Nine Mile River samples

(both upstream and downstream locations). The Duck Pond sample exhibited the lowest concentrations of these parameters. General inorganic chemistry and metals parameters were generally similar between Nile Mile River upstream and downstream samples.

Groundwater

Samples were collected from the 28 of the 29 scheduled wells in June 2015 (MW96-5A contained insufficient water to sample). Parameters above the CDWQ Guidelines (or, in the case of pH, below the recommended range) during the second quarterly event are summarized below.

Sampling Area (No. of Wells)	Down Gradient (20*)	Down Gradient of FEP/ Cross Gradient of Landfill (8)
Parameter (No. of samples)	pH (12 low) Colour (6) Turbidity (5) Arsenic (3) Iron (8) Manganese (10) Uranium (7)	pH (4 low) Colour (1) Turbidity (1) Iron (1) Manganese (2)
*excludes one well which contained insufficient water to sample in June 2015.		

The parameters exceeded were similar to previous events, with iron and manganese being the most commonly observed and pH below the recommended range in several samples. With the exception of arsenic and uranium, parameters were elevated in both the till (surficial) and bedrock wells. Uranium exceedances were observed at the down gradient, bedrock well locations, with the June 2015 concentrations generally consistent with previous results (i.e., baseline and operational). One possible exception was the deep bedrock well down gradient of Cells 5 and 6, where exceedances have been recorded since 2010 only. Arsenic appears to be generally increasing in the bedrock wells at this location. The presence of uranium and arsenic in groundwater at the site is presumed to be naturally occurring. Elevated concentrations of iron, manganese, colour, turbidity, as well as low pH, are typical in Nova Scotia groundwater and presence is, therefore, not normally considered to be an issue of concern.

Low pH or acidic waters are common in shallow aquifers throughout Nova Scotia and a limit is in effect for aesthetic reasons only. Elevated colour and turbidity are also common in monitor wells and likely reflect disturbances around the well screen created during sporadic pumping and are not reflective of local groundwater conditions. With respect to colour, the CDWQ Guideline is in effect for aesthetic reasons only. There are health limits for turbidity and arsenic; however, the limit for turbidity generally only applies to chlorinated drinking water supplies. Arsenic is a natural-occurring metal in groundwater through the dissolution of minerals. It is primarily associated with slate and granite formations throughout Nova Scotia.

Elevated concentrations of both iron and manganese are common in Nova Scotia groundwater and, once again, the recommended limit is based on aesthetics. The presence of elevated uranium in groundwater can also be naturally occurring.

A general increase in TDS, colour, iron and manganese had been noted in down gradient wells MW96-5A/5B/5C (below Cells 5 and 6). Chloride in the shallow and deep bedrock wells remained below the highs recorded in June 2013 but above the modified baseline range (i.e., excluding the anomalous November 1997 results). Overall, chloride concentrations, which had generally been less than 10 mg/L in all three wells prior to 2010, appear to be fluctuating, particularly in the shallow and deep bedrock wells. Concentrations of one or more indicator parameters have been gradually increasing at some down gradient locations, including till well MW97-23A1 (near the South Sedimentation Pond), interface well MW08-30B (which has been sampled since 2008) and deep bedrock well MW05-29C (which has been sampled since 2005); however, concentrations of these parameters in June 2015 were within the previously recorded ranges.

Levels of chloride, TDS, iron and manganese in the vicinity of the FEP have been variable, with TDS (as well as hardness, conductivity and sulphate) generally increasing at one location (MW96-16A/16B) topographically up gradient of the FEP and near the northeast corner of the landfill. MW96-16A/16B are located within a ditch along a site road that is heavily used by trucks to access the current disposal cell. Water quality in this area is likely influenced by operations activities in the up gradient area of the site, roadway runoff and/or the FEP/WSF compound.

Overall, the highest levels of colour and iron, as well as turbidity (historically), have been observed in the till (surficial) well MW96-22A (down gradient of the North Sedimentation Pond); while concentrations in the bedrock well at this location are significantly lower or non-detect. It is noted that these wells are located adjacent to the sedimentation pond discharge point. If, over time, the integrity of the surficial well has been compromised, then, based on future monitoring results and any observed increasing trend in chloride concentrations, consideration may need to be given to rehabilitating and/or replacing this well.

Consistent with comments made in previous reports, groundwater in the immediate vicinity of the FEP, as well as down gradient of landfill cells, exhibits elevated levels of indicator parameters. As noted above, concentrations of metals and turbidity have been lower at the south sedimentation pond and downstream receiving waters since completion of Cell 6 construction, and concentrations of metals in the area of the south sedimentation pond have been comparable to those recorded prior to Cell 6 construction since the implementation of sediment control measures following the April 2014 event.

Underdrains

In June 2015, samples were collected from the Cell 3, Cell 5 and Cell 6 Underdrains. Consistent with previous events, there was no flow in the Cell 1&2 or the Cell 4A and 4B Underdrain sample locations. CDWQ Guideline exceedances in June 2015 included uranium in the Cell 3 Underdrain and manganese in the Cell 5 Underdrain, similar to previous events. Levels of indicator parameters were generally comparable to previous results at this location.

Leak Detection Sumps

Five leak detection sump samples were collected as scheduled. Consistent with previous results, sump waters contained high TDS concentrations, likely due to water contact with the bentonite layers that are part of the liner systems. As previously reported, TDS has decreased from the initial levels recorded in all of the sumps. Cell 1&2 chloride levels were generally consistent to June 2008. Since that time, chloride levels have shown significant variation, ranging from 16 to 83 mg/L (in December 2008). Calcium and hardness show gradually increasing trends, while nitrate concentrations were significantly higher in late 2008 and early 2009 but have lowered since that time. With the exception of nitrate, similar trends have been observed in Cell 3 (although chloride concentrations have generally been lower than Cell 1). Chloride concentrations exhibited an increase from 2009 to 2012, with the high for Cell 3 (28 mg/L) recorded in March 2010. Concentrations since that time (including June 2015) have been within the prior range. Recent chloride concentrations in Cell 5, which had lowered from initial levels (up to 17 mg/L), have been similar to the initial sample concentrations (including June 2015). Levels of general inorganic chemistry and metals parameters in Cell 6 remained lower than recorded in the initial sample.

Leachate

Overall (and as expected), there has been some deterioration in the leachate quality (both organic and inorganic) since the initiation of testing. The June 2015 data did not, however, indicate a significant change in chemistry.

4.1 Closing Statements

Overall, the June 2015 data confirms that there are no significant issues of concern regarding surface and groundwater quality due to operation of the RDF. Elevated levels of some indicator parameters directly down gradient of the cells reflect general site operations. A general increase of some indicator parameters had been observed down gradient of Cells 5 and 6 during cell construction activities undertaken in 2008 and 2011/2012 and, particularly for the shallow bedrock well at this location, since that time; however, as noted above, sediment control measures were implemented during 2014 in the immediate vicinity, which should help stabilize concentrations of indicator parameters in this area. A general increase of some indicator parameters in one area south of the FEP is likely a result of the location of the wells (i.e., within a ditch that receives roadway runoff and may be influenced by up gradient site

operations), rather than impacts from the FEP. Prior to 2014, these wells were sampled annually. In 2014, samples were collected quarterly at the request of NSE and, during 2015, samples will continue to be collected quarterly to further assess this area and to see if there is any seasonal correlation. As previously reported, seasonal variation was not apparent during 2014. Similarly, a general increase in chemistry observed at some up gradient locations, as reported in our 2014 annual operational monitoring report, indicates influence from local site operations and/or roadway runoff. These locations will be assessed again during the annual 2015 monitoring event scheduled for September.

The receiving waters below the South Sedimentation Ponds exhibited generally higher levels during Cell 6 construction and/or during precipitation events, and more recent levels (i.e., recorded since 2014) were comparable to earlier results (i.e., prior to Cell 6 construction). A sediment basin constructed at the base of future Cell 7 in early to mid-2014 (prior to the second quarter sampling event in June 2014) now collects run-off from the Cell 6 area.

The waters discharging from the FEP area (as well as the sedimentation pond samples) continue to have higher levels of indicator parameters relative to other stations. Over the past few years, drainage control measures have been undertaken to mitigate this issue. As noted in previous documentation, soil along the edge of the FEP parking area was replaced with clean gravel; large stones were placed along the edge of the embankment to deter snow from being pushed into the ditch; and routine cleaning/sweeping was initiated in an effort to direct debris/water back into the FEP. Further drainage control and maintenance efforts may be necessary to decrease runoff into the drainage ditch.

The quarterly sampling schedule for the remainder of 2015 is provided in Tables 4-1 to 4-3 inclusive. The third quarter (or annual) event is scheduled for September. The fourth quarter event is scheduled for December.

TABLE 4-1 GROUNDWATER SAMPLING RECOMMENDATIONS

Well ID #	Aquifer	2015 Sampling Frequency	Analysis	Location
MW96-1B	Bedrock (Granite)	Quarterly	GC, M for each event	Perimeter well, down gradient of Cells 1&2
MW97-2B1	Bedrock (Granite)	Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX on one event (Sept.)	Perimeter well, down gradient of Cells 1&2
MW96-3A MW96-3B MW96-3C	Till Bedrock (Granite) Bedrock (Granite)	Quarterly Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 3A on one event (Sept.)	Nested perimeter wells, down gradient of Cells 1&2 and Cell 3
MW96-4B	Bedrock (Granite)	Quarterly	GC, M for each event	Perimeter well, down gradient of Cell 4 and adjacent to leachate holding tank
MW96-5A MW96-5B MW96-5C	Till Bedrock (Granite) Bedrock (Granite)	Quarterly Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 5B on one event (Sept.)	Nested perimeter wells, down gradient of Cell 5 and up gradient of South Sedimentation Ponds
MW96-7A MW96-7B MW96-7C	Till Bedrock (Granite) Bedrock (Granite)	Annually Annually Annually	GC, M for each event	Nested perimeter wells, down gradient of future cells and south of borrow area
MW96-8A MW96-8B MW96-8C	Till Bedrock (Granite) Bedrock (Granite)	Annually Annually Annually	GC, M for each event	Nested perimeter wells, down gradient of future cells
MW96-9A MW96-9B	Till Bedrock (Granite)	Annually Annually	GC, M for each event VOCs, PAHs, TPH/BTEX for 9A on one event (Sept.)	Nested perimeter wells, southwest of Cells 1&2, cross gradient of future cells

TABLE 4-1 GROUNDWATER SAMPLING RECOMMENDATIONS (CONT.)

Well ID #	Aquifer	2015 Sampling Frequency	Analysis	Location
MW96-10B MW96-10C	Bedrock (Granite) Bedrock (Granite)	Annually Annually	GC, M for each event	Nested perimeter wells, southwest of Cells 1&2, cross gradient of future cells
MW96-11B	Bedrock (Granite)	Annually	GC, M for each event	Perimeter well, south corner of landfill and up gradient of future cells
MW96-12B	Bedrock (Granite)	Annually	GC, M for each event	Perimeter well, southeast corner of landfill and up gradient of future cells
MW01-15B MW01-15C	Bedrock (Granite) Bedrock (Granite)	Annually Annually	GC, M for each event VOCs, PAHs, TPH/BTEX for 15B on one event (Sept.)	Nested perimeter wells, east of Cell 2 and up gradient of landfill
MW96-16A MW96-16B	Till Bedrock (Granite)	Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 16B on one event (Sept.)	Nested perimeter wells, northeast corner of the landfill, topographically up gradient of the FEP compound
MW96-17A MW96-17B	Bedrock (Granite) Bedrock (Granite)	Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 17B on one event (Sept.)	Nested perimeter wells, cross gradient between Cells 1&2 and the FEP compound
MW96-18B MW96-18C	Bedrock (Granite) Bedrock (Granite)	Quarterly Annually	GC, M for each event	Nested perimeter wells, cross gradient between Cells 1&2 and the FEP compound
MW96-19A MW96-19B	Bedrock (Till) Bedrock (Granite)	Quarterly Annually	GC, M for each event	Nested perimeter wells, north corner of the landfill (Cells 1&2) and down gradient of the FEP compound
MW96-20A MW96-20B	Bedrock (Till) Bedrock (Granite)	Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 20A on one event (Sept.)	Nested perimeter wells, down gradient of Cells 1&2 and Cell 3

TABLE 4-1 GROUNDWATER SAMPLING RECOMMENDATIONS (CONT.)

Well ID #	Aquifer	2015 Sampling Frequency	Analysis	Location
MW96-21B	Bedrock (Granite)	Quarterly	GC, M for each event	Down gradient between North Sedimentation Ponds and Nine Mile River
MW96-22A MW97-22B	Till Bedrock (Granite)	Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 22A on one event (Sept.)	Nested wells, down gradient between North Sedimentation Ponds and Nine Mile River
MW97-23A1	Till	Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX on one event (Sept.)	Down gradient between South Sedimentation Ponds and borrow pit area
MW97-24A MW97-24B	Till Bedrock (Granite)	Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 24B on one event (Sept.)	Nested wells west of the North Sedimentation Ponds and grubbing area
MW97-25B	Bedrock (Granite)	Quarterly	GC, M for each event	Well northwest of the North Sedimentation Ponds and grubbing area
MW01-26B	Bedrock (Granite)	Annually	GC, M for each event	Along Greenhead Road and up gradient of borrow pit area
MW01-27B	Bedrock (Granite)	Annually	GC, M for each event	Along Greenhead Road and up gradient of borrow pit area
MW05-28B	Bedrock (Granite)	Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX on one event (Sept.)	Perimeter well, down gradient of landfill and adjacent to leachate holding tank
MW05-29C	Bedrock (Granite)	Quarterly	GC, M for each event	Perimeter well, down gradient of future cells and south of borrow area

TABLE 4-1 GROUNDWATER SAMPLING RECOMMENDATIONS (CONT.)

Well ID #	Aquifer	2015 Sampling Frequency	Analysis	Location
MW08-30B	Till/Shallow Bedrock (Granite)	Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX on one event (Sept.)	Down gradient of Cell 6 and up gradient of South Sedimentation Ponds
MW12-31B MW12-31C	Bedrock (Granite) Bedrock (Granite)	Annually Annually	GC, M for each event	Nested perimeter wells, up gradient of Cell 6 and future cells
MW95-2A MW95-2B	Bedrock (Granite) Till	Annually Annually	GC, M for each event	Nested wells up gradient of Cell 5
MW95-4A MW95-4B	Bedrock (Granite) Till	Quarterly Quarterly	GC, M for each event VOCs, PAHs, TPH/BTEX for 4B on one event (Sept.)	Nested perimeter wells north/cross gradient of Cells 1&2 and down gradient of the FEP compound

Notes:

GC General Inorganic Chemistry Scan

M Metals

VOCs Volatile Organic Compounds (modified EPA 624 Scan)

PAHs Polycyclic Aromatic Hydrocarbons (priority pollutants, part of an EPA 625 Scan)

TPH/BTEX Petroleum Hydrocarbon Components (Atlantic RBCA Analysis)

* Wells MW96-16A and -16B will be sampled quarterly in 2015 (similar to 2014, which was at NSE's request)

TABLE 4-2 SURFACE WATER SAMPLING RECOMMENDATIONS

Station ID #	Status	2015 Sampling Frequency	Analysis	Location
SW-1	Up-gradient	Annually	GC, M, TSS for each event	Nine Mile River
SW-2	Up-gradient	Quarterly	GC, M, TSS, COD/BOD for each event	Nine Mile River
SW-3	Down-gradient	Quarterly	GC, M, TSS for each event VOCs, PAHs, TPH/BTEX on one event only Collection of a sediment sample for metals on one event only (Sept.)	Nine Mile River downstream of drainage from North Sedimentation Pond
SW-4	Facility Discharge Water	Quarterly	GC, M, TSS, COD/BOD for each event VOCs, PAHs, TPH/BTEX on one event only Collection of a sediment sample for metals on one event only (Sept.)	Drainage from South Sedimentation Pond
SW-5	Down-gradient	Quarterly	GC, M, TSS for each event	Nine Mile River
SW-6A	Down-gradient	Annually	GC, M, TSS for each event	Nine Mile River
SW-7	Down-gradient	Quarterly	GC, M, TSS for each event	Nine Mile River
SW-8A	Down-gradient	Quarterly	GC, M, TSS for each event	Duck Pond
SW-9	Down-gradient	Annually	GC, M, TSS for each event	Duck Pond
SW-10	Down-gradient, outside RDF watershed	Annually	GC, M, TSS for each event	Otter Lake

TABLE 4-2 SURFACE WATER SAMPLING RECOMMENDATIONS (CONT.)

Station ID #	Status	2015 Sampling Frequency	Analysis	Location
SW-11	Down-gradient, outside RDF watershed	Annually	GC, M, TSS for each event	Otter Lake
SW-13	On-Site	Quarterly (note: more frequent as part of operations)	pH and TSS either weekly or during rain events (part of operations) GC, M, TSS, COD/BOD for each event	North Sedimentation Pond
SW-14	On-Site	Quarterly (note: more frequent as part of operations)	pH and TSS either weekly or during rain events (part of operations) GC, M, TSS, COD/BOD for each event	South Sedimentation Pond
SW-15	On-Site	Quarterly (note: more frequent as part of operations)	pH and TSS either weekly or during rain events (part of operations) GC, M, TSS, COD/BOD for each quarterly event Collection of a sediment sample on one occasion	Ditch (FEP)
SW-16	Down-gradient	Quarterly	GC, M, TSS, for each event VOCs, PAHs, TPH/BTEX on one event (Sept)	Down-gradient of FEP ditch

Notes:

GC General Inorganic Chemistry Scan
 M Metals
 TSS Total Suspended Solids
 BOD Biochemical Oxygen Demand
 COD Chemical Oxygen Demand
 VOCs Volatile Organic Compounds (modified EPA 624 Scan)
 PAHs Polycyclic Aromatic Hydrocarbons (priority pollutants, part of an EPA 625 Scan)
 TPH/BTEX Petroleum Hydrocarbon Components (Atlantic RBCA Analysis)

TABLE 4-3 OTHER ENVIRONMENTAL QUALITY MONITORING RECOMMENDATIONS

Well ID #	2015 Sampling Frequency	Analysis
Underdrain Samples – Cell 1/2, Cell 3, Cell 4, Cell 5 and Cell 6	Quarterly	GC, M for each quarterly event VOCs, PAHs, TPH/BTEX on one event only (Sept)
Leachate	Quarterly	GC, M and TSS for each quarterly event VOCs, PAHs, TPH/BTEX on one event only (Sept)
Leak Detection Sump Cell 1/2, Cell 3, Cell 4, Cell 5 and Cell 6	Quarterly	GC parameters chloride, sodium and COD on a monthly basis as part of operations GC, M for each event VOCs, PAHs, TPH/BTEX on one event only (Sept)

Notes:

GC	General Inorganic Chemistry Scan
M	Metals
TSS	Total Suspended Solids
BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
VOCs	Volatile Organic Compounds (modified EPA 624 Scan)
PAHs	Polyaromatic Hydrocarbons (priority pollutants, part of an EPA 625 Scan)
TPH/BTEX	Petroleum Hydrocarbon Components (Atlantic RBCA Analysis)

Appendix A

Field Methodology

APPENDIX A FIELD METHODOLOGY

LABORATORY

Analytical services were contracted to Maxxam Analytics (Maxxam) in Bedford, Nova Scotia. Maxxam is accredited to ISO 17025 by the Standards Council of Canada. Communication between the Dillon project manager conducting the sampling and the project manager designated by the laboratory was maintained throughout the sampling program. The laboratory was advised of the details pertaining to the monitoring event. This included the number and type of samples to be collected, the analysis required, and the schedule. Prior to each monitoring event, the laboratory provided bottles, chemical preservatives, icepacks, labels, chain of custody forms and coolers for shipping.

FIELD EQUIPMENT PREPARATION

All of the monitor wells are *dedicated* with self-contained pumping units. These units consist of 13 mm diameter polyethylene tubing and an attached 25 mm diameter Delrin™ (acetal resin thermoplastic) foot valve. Although they are considered to be a part of the well, the tubing and/or foot valve can easily be removed for cleaning or replaced.

The following items are considered to be standard equipment used for measuring hydraulic head level, well development, purging and sampling:

- Water Level Indicator – measures the depth to water. The probe was wiped with distilled water and a clean cloth after each measurement;
- Conductivity/Temperature Meter – measures specific conductance and temperature. This meter was used to monitor these parameters throughout the development process. Generally, the readings were taken in a bucket; hence the probe did not contact the water in the well. The probe was, however, wiped with distilled water and a clean cloth after the completion of each well development;
- Waterra Pump/Generator – is a hydrolift pump operated by a generator. There was no contact between either the pump or the generator and the well water. The pump was supported on the side of the well casing. The tubing was clamped onto the arm of the pump and the open end secured so that the discharge waters were directed away from the wellhead. The arm of the pump, and hence the tubing moves up and down, activating the foot valve. A control dial regulated speed;

It is noted, that purging and sampling was also effectively completed by manually working the tubing up and down. This was often practical in instances where the wells are either shallow or low producing.

- In-line Filters – used for on-site filtration of samples. These are disposable aids, discarded after each sample use.
- Gloves – disposable latex and/or nitrile gloves used during well development and sampling. They were discarded subsequent to the completion of each sample.

FIELD QA/QC MEASURES

In addition to the careful use of field equipment, as described in the previous section, and standard laboratory procedures, the following measures were included in each sampling event to determine that the samples collected were representative of water quality:

Chain of custody forms, providing the sample identification, time of collection, analytical requirements and specific instructions were completed. One (1) copy was retained by Dillon Consulting Limited. Confirmation of sample shipment receipts and laboratory requirements were issued from the laboratory, and also retained in files.

All information, pertaining to site conditions including water level data was documented in a waterproof field book. This information was copied and maintained in Dillon's file.

SURFACE WATER SAMPLING

Surface water samples were collected as unfiltered grabs in order to assess the total (dissolved and un-dissolved) components in a manner representative of natural conditions. Care was taken to avoid disturbing sediment or collecting items floating on the water.

Physical changes to the surface water station and surrounding area, or unusual flow quantity or quality which may affect sample quality were noted at the time of sampling.

GROUNDWATER SAMPLING

Measurement of Hydraulic Head Levels

Each well was inspected to ensure its integrity as a sampling station. Inspection included an assessment of drainage to ensure that surface water is diverted away from the wellhead, checking the lock for security and checking the protective casing and PVC pipe for stability. Wells were rehabilitated as required.

Static water levels were measured to obtain a reading before aquifer disturbance. The depth to water in the monitor wells was determined by recording the depth to water from a reference point marked on the lip of the PVC casing (this reference point elevation and coordinates have been surveyed to geodetic datum).

Levels were taken at all monitor well locations within a limited time period (ideally less than four (4) hours) in order to avoid recording daily variation in elevations.

Well Purging

The monitor wells were developed upon completion of installation. This procedure involved the removal of, at a minimum three (3) borehole volumes to ensure 1) the removal of stagnant waters, and 2) to enhance the operation of the screen and sandpack as an effective particulate filter system. Pumping was accomplished using the Waterra pump system, which was either operated by the hydrolift pump or manually. Field specific conductance/temperature readings were recorded throughout the process. The stabilization of these parameters in addition to improvement of water clarity was used as indication that the process was complete.

Subsequent well purging was completed prior to the collection of each sample suite. This process, similar to the initial development, is done to remove stagnant water from within the well casing and sandpack prior to sample collection, thus allowing the collection of samples that are representative of true aquifer quality. Generally, this involved the removal of no less than three (3) volumes of water. Exceptions to this were, specifically, the shallow (surficial) wells, where the well was purged dry. Purging was accomplished using the Waterra system with field specific conductance/temperature readings recorded throughout. The stabilization of these parameters, in addition to water clarity was used as indication that the process was complete.

Sample Collection

In instances where the well exhibited sufficient recharge, samples were collected immediately upon completion of well purging. The time interval between completion of well purging and sample collection did not exceed 24 hours.

The pump was regulated, such that the flow rate was steady, generally less than one (1) liter per minute. Samples for volatile and semi-volatile compounds as well as other parameters such as alkalinity, which require filling with no air, were collected first. Once filled, the bottles were inverted to check for the presence of air bubbles. If observed, the sample was retaken.

Samples for general chemistry and metals were field-filtered using a 0.45 micron in-line disposable filter.

Whenever possible, samples requiring preservation was prepared by the laboratory.

Once collected, samples were immediately stored in coolers and kept at a constant temperature, four (4) degrees Celsius, during transport. Coolers were sealed.

LABORATORY PROCEDURES/PERFORMANCE STANDARDS

Refer to Statement of Qualifications, provided as follows. Results were received from the laboratory in both digitized and hard copy format.

Appendix B

Hydraulic Head Data and Site Analytical Results (CD in Pouch)