REPORT

2022 Site Development, Operations and Environmental Monitoring

Arnprior Waste Disposal Site
Township of McNab/Braeside, Ontario

Submitted to:

Town of Arnprior
105 Elgin Street West
P.O. Box 130
Arnprior, Ontario
K7S 3H4

Submitted by:

WSP Canada Inc.
1931 Robertson Road, Ottawa, Ontario, K2H 5B7, Canada

+1 613 592 9600

21500011 (3000)

March 2023

Appendix D-Monitoring and Screening Checklist
General Information and Instructions

General Information: The checklist is to be completed, and submitted with the Monitoring Report.
Instructions: A complete checklist consists of:
(a) a completed and signed checklist, including any additional pages of information which can be attached as needed to provide further details where indicated.
(b) completed contact information for the Competent Environmental Practitioner (CEP)
(c) self-declaration that CEP(s) meet(s) the qualifications as set out below and in Section 1.2 of the Technical Guidance Document.

Definition of Groundwater CEP:
For groundwater, the CEP must have expertise in hydrogeology and meet one of the following:
(a) the person holds a licence, limited licence or temporary licence under the *Professional Engineers Act*; or
(b) the person holds a certificate of registration under the *Professional Geoscientists Act, 2000* and is a practicing member, temporary, member or limited member of the Association of Professional Geoscientists of Ontario. O. Reg. 66/08, s. 2..
Definition of Surface water CEP:
A CEP for surface water assessments is a scientist, professional engineer or professional geoscientist as described in (a) and (b) above with demonstrated experience and post-secondary education, either a diploma or degree, in hydrology, aquatic ecology, limnology, aquatic biology, physical geography with specialization in surface water, and/or water resource management.

The type of scientific work that a CEP performs must be consistent with that person's education and experience. If an individual has appropriate training and credentials in both groundwater and surface water and is responsible for both areas of expertise, the CEP may then complete and validate both sections of the checklist.

Monitoring Report and Site Information	
Waste Disposal Site (WDS) Name	Arnprior Waste Disposal Site
Location (e.g. street address, lot, concession)	Part of Lots 9, 10 & 11, Concession XIII
GPS Location (taken within the property boundary at front gate/ front entry)	390860 m E 5034788 m N, 18T
Municipality	Township of McNab - Amalgamated Township of McNab/Braeside
Client and/or Site Owner	Town of Arnprior
Monitoring Period (Year)	2022
This Monitoring Report is being submitted under the following:	
Environmental Compliance Approval (ECA) Number (formerly "Certificate of Approval" (C of A)) :	A412603
Director's Order No.:	
Provincial Officer's Order No.:	

Other:			
Report Submission Frequency	(•) **Annual** ( ) **Other**		
The site is: **(Operation Status)**	(•) **Open** ( ) **Inactive** ( ) **Closed**		
Is there an active waste transfer station at the site?	( ) **Yes** (•) **No**		
Does this WDS have a Closure Plan?	(•) **Not yet submitted** ( ) **Submitted and under review** ( ) **Submitted and approved**		
Total Approved Capacity	Unknown	*Units*	Cubic Metres
Maximum Approved Fill Rate		*Units*	Tonnes per Day
Total Waste Received within Monitoring Period (Year)	4,148	*Units*	Tonnes
Total Waste Received within Monitoring Period (Year) *Describe the methodology used to determine this quantity*	Estimated		
Estimated Remaining Capacity	143,160	*Units*	Cubic Metres
Estimated Remaining Capacity *Describe the methodology used to determine this quantity*	Direct Survey (GPS/Total Station)		
Estimated Remaining Capacity *Date Last Determined*	December 2022		
Non-Hazardous Approved Waste Types	[X] Domestic [X] Industrial, Commercial & Institutional (IC&I) [ ] Source Separated Organics (Green Bin) [X] Tires	[X] Contaminated Soil [X] Wood Waste [X] Blue Box Material [ ] Processed Organics [X] Leaf and Yard Waste	[ ] Food Processing/Preparation Operations Waste [X] Hauled Sewage Other:
Subject Waste Approved Waste Classes: Hazardous & Liquid Industrial *(separate waste classes by comma)*	None		

Year Site Opened *(enter the Calendar Year only)*	1960	**Current ECA Issue Date**	March 10, 2020
Is your Site required to submit Financial Assurance?		○ **Yes** ◉ **No**	
Describe how your WDS is designed.		◉ Natural Attenuation only ○ Fully engineered Facility ○ Partially engineered Facility	
Does your Site have an approved Contaminant Attenuation Zone?		◉ **Yes** ○ **No**	
If closed, specify ECA, control or authorizing document closure date:		N/A	
Has the nature of the operations at the site changed during this monitoring period?	○ **Yes** ◉ **No**		
If yes, provide details:			

Have any measurements been taken since the last reporting period that indicate landfill gas volumes have exceeded the MOE limits for subsurface or adjacent buildings? (i.e. exceeded the LEL for methane)	○ Yes ◉ No

Groundwater WDS Verification:

Based on all available information about the site and site knowledge, it is my opinion that:

Sampling and Monitoring Program Status:

1) The monitoring program continues to effectively characterize site conditions and any groundwater discharges from the site. All monitoring wells are confirmed to be in good condition and are secure:	○ **Yes** ◉ **No**	New lock required on BR08-1D. Casing repair required for groundwater monitors BR-8D and BR-8S.
2) All groundwater, leachate and landfill gas sampling and monitoring for the monitoring period being reported on was successfully completed as required by ECA or other relevant authorizing/ control document(s):	◉ **Yes** ○ **No** ○ **Not Applicable**	If no, list exceptions below or attach information.

Groundwater Sampling Location	**Description/Explanation for change (change in name or location, additions, deletions)**	**Date**

3) a) Some or all groundwater, leachate and landfill gas sampling and monitoring requirements have been established or defined outside of a ministry ECA, authorizing, or control document *, or Ministry concurrence.*	○ **Yes** ◉ **No** ○ **Not Applicable**

b) If yes, the sampling and monitoring identified under 3(a) for the monitoring period being reported on was successfully completed in accordance with established protocols, frequencies, locations, and parameters developed as per the Technical Guidance Document:	○ **Yes** ○ **No** ◉ **Not Applicable**	If no, list exceptions below or attach additional information.

Groundwater Sampling Location	**Description/Explanation for change (change in name or location, additions, deletions)**	**Date**

4) All field work for groundwater investigations was done in accordance with Standard Operating Procedures (SOP) as established/outlined per the Technical Guidance Document (including internal/external QA/QC requirements) (Note: A SOP can be from a published source, developed internally by the site owner's consultant, or adopted by the consultant from another organization):	○ **Yes** ◉ **No**	WSP Canada Inc. standard practices were followed as described in the report.
Sampling and Monitoring Program Results/WDS Conditions and Assessment:		
5) The site has an adequate buffer, Contaminant Attenuation Zone (CAZ) and/ or contingency plan in place. Design and operational measures, including the size and configuration of any CAZ, are adequate to prevent potential human health impacts and impairment of the environment.	○ **Yes** ◉ **No**	An amended ECA No. A412603 was issued on March 10, 2020 which removed the deadline for submission of a revised trigger mechanism. The Town undertook and submitted an Options Assessment that considered contingency options available to alleviate groundwater compliance issues at the Site. Timing of next steps will be determined following comments on the Options Assessment. Refer to Section 11.1 of the Report.
6) The site meets compliance and assessment criteria.	○ **Yes** ◉ **No**	See attached sheet.
7) The site continues to perform as anticipated. There have been no unusual trends/ changes in measured leachate and groundwater levels or concentrations.	○ **Yes** ◉ **No**	Elevated concentrations of some leachate indicator parameters at OV-10 may be attributed to the landfill based on a change in the understanding of groundwater flow direction from previous years. A new well has been installed in January 2023 to evaluate further.

1) Is one or more of the following risk reduction practices in place at the site: ***(a)*** **There is minimal reliance on natural attenuation of leachate due to the presence of an effective waste liner and active leachate collection/ treatment; or** ***(b)*** **There is a predictive monitoring program in-place (modeled indicator concentrations projected over time for key locations); or** ***(c)*** **The site meets the following two conditions (typically achieved after 15 years or longer of site operation):** ***i.*** **The site has developed stable leachate mound(s) and stable leachate plume geometry/ concentrations; and** ***ii.*** **Seasonal and annual water levels and water quality fluctuations are well understood.**	○ **Yes** ● **No**	**Note which practice(s):**	☐ **(a)** ☐ **(b)** ☐ **(c)**
9) Have trigger values for contingency plans or site remedial actions been exceeded (where they exist):	● **Yes** ○ **No** ○ **Not Applicable**	See attached sheet.	

Groundwater CEP Declaration:

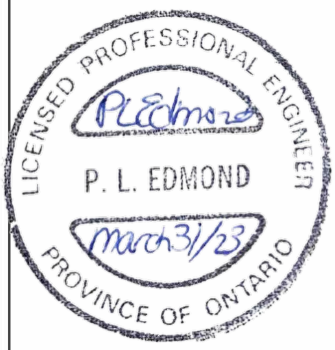
I am a licensed professional Engineer or a registered professional geoscientist in Ontario with expertise in hydrogeology, as defined in Appendix D under Instructions. Where additional expertise was needed to evaluate the site monitoring data, I have relied on individuals who I believe to be experts in the relevant discipline, who have co-signed the compliance monitoring report or monitoring program status report, and who have provided evidence to me of their credentials.

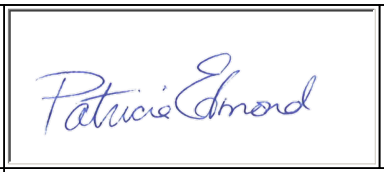
I have examined the applicable Environmental Compliance Approval and any other environmental authorizing or control documents that apply to the site. I have read and followed, *as deemed appropriate for this site in my professional judgement,* the Monitoring and Reporting for Waste Disposal Sites Groundwater and Surface Water Technical Guidance Document (MOE, 2010, or as amended), and associated monitoring and sampling guidance documents, as amended from time to time. I have reviewed all of the data collected for the above-referenced site for the monitoring period(s) identified in this checklist. Except as otherwise agreed with the ministry for certain parameters, all of the analytical work has been undertaken by a laboratory which is accredited for the parameters analysed to *ISO/IEC 17025-2005 (E)- General requirements for the competence of testing and calibration laboratories*, or as amended from time to time by the ministry.

If any exceptions or potential concerns have been noted in the questions in the checklist attached to this declaration, it is my opinion that these exceptions and concerns are minor in nature and will be rectified for the next monitoring/reporting period. Where this is not the case, the circumstances concerning the exception or potential concern and my client's proposed action have been documented in writing to the Ministry of the Environment District Manager in a letter from me dated:

Recommendations:

Based on my technical review of the monitoring results for the waste disposal site:

○ **No changes to the monitoring program are recommended**	
◉ **The following change(s) to the monitoring program is/ are recommended:**	An additional overburden and bedrock monitoring well was installed near the southern corner of CAZ Area B in January 2023 to discern groundwater flow direction and possible landfill leachate impacts at the southern property boundary. It is recommended that these monitoring wells be included in the monitoring program for 2023.
◉ **No Changes to site design and operation are recommended**	
○ **The following change(s) to the site design and operation is/are recommended:**	
Name:	Trish Edmond, P.Eng. with demonstrated relevant experience.
Seal:	

Signature:		**Date:**	31 March 2023
CEP Contact Information:			
Company:	WSP Canada Inc.		
Address:	1931 Robertson Road, Ottawa, ON, K2H 5B7		
Telephone No.:	613-592-9600	Fax No. :	613-592-9601
E-mail Address:			
Co-signers for additional expertise provided:			
Signature:		**Date:**	
Signature:		**Date:**	

Surface Water WDS Verification:

Provide the name of surface water body/bodies potentially receiving the WDS effluent and the approximate distance to the waterbody (including the nearest surface water body/bodies to the site):	
Name (s)	On-site wetland / perennial ponds

Distance(s)	

Based on all available information and site knowledge, it is my opinion that:

Sampling and Monitoring Program Status:

1) The current surface water monitoring program continues to effectively characterize the surface water conditions, and includes data that relates upstream/background and downstream receiving water conditions:	◉ **Yes** ○ **No**	If no, identify issues (Type Here):
2) All surface water sampling for the monitoring period being reported was successfully completed in accordance with the ECA or relevant authorizing/control document(s) (if applicable):	◉ **Yes** ○ **No** ○ **Not applicable**	If no, specify below or provide details in an attachment.

Surface Water Sampling Location	**Description/Explanation for change (change in name or location, additions, deletions)**	**Date**

3) a) Some or all surface water sampling and monitoring program requirements for the monitoring period have been established outside of a ministry ECA or authorizing/control document *, or Ministry concurrence.*	○ **Yes** ◉ **No** ○ **Not Applicable**	
b) If yes, all surface water sampling and monitoring identified under 3 (a) was successfully completed in accordance with the established program from the site, including sampling protocols, frequencies, locations and parameters) as developed per the Technical Guidance Document:	○ **Yes** ○ **No** ◉ **Not Applicable**	If no, specify below or provide details in an attachment.

Surface Water Sampling Location	Description/Explanation for change (change in name or location, additions, deletions)	Date

4) All field work for surface water investigations was done in accordance with SOP, including internal/external QA/QC requirements, as established/outlined as per the Technical Guidance Document, MOE 2010, or as amended. (Note: A SOP can be from a published source, developed internally by the site owner's consultant, or adopted by the consultant from another organization):	○ **Yes** ◉ **No**	WSP Canada Inc. standard practices were followed as described in the report.

Sampling and Monitoring Program Results/WDS Conditions and Assessment:

5) The receiving water body meets surface water-related compliance criteria and assessment criteria: i.e., there are no exceedances of criteria, based on MOE legislation, regulations, Water Management Policies, Guidelines and Provincial Water Quality Objectives and other assessment criteria (e.g., CWQGs, APVs), as noted in Table A or Table B in the Technical Guidance Document (Section 4.6):	○ **Yes** ◉ **No**

If no, list parameters that exceed criteria outlined above and the amount/percentage of the exceedance as per the table on the following page or provide details in an attachment:

Parameter	Compliance or Assessment Criteria or Background	Amount by which Compliance or Assessment Criteria or Background Exceeded
e.g. Nickel	e.g. ECA limit, PWQO, background	e.g. X% above PWQO
Dissolved Oxygen at SW-1 (Apr, Dec) Total Phosphorous (Aug) Boron at SW-1 (Aug) Iron at SW-1 (Aug)	PWQO	27% and 19% below PWQO for dissolved oxygen in April and December respectively. 147% above PWQO for total phosphorous in August. 50% above PWQO for boron in August. 633% above PWQO for iron in August.
Unionized Ammonia at SW-2 (Apr) Dissolved Oxygen at SW-2 (Dec) Total Phosphorus (Dec) Boron at SW-2 (Apr) Iron at SW-2 (Aug, Dec)	PWQO	108% above PWQO for unionized ammonia in April. 2% below PWQO for DO in December. 4% above PWQO for total phosphorus in December. 80% above PWQO for boron in Apr. 170% and 130% above PWQO for iron in August and December, respectively.
6) In my opinion, any exceedances listed in Question 5 are the result of non-WDS related influences (such as background, road salting, sampling site conditions)? ○ **Yes** ◉ **No**		SW-2 is interpreted to be impacted by the landfill and possibly by other industrial activities (like wood waste and railway fill of unknown quality). SW-1 is interpreted to be possibly impacted by the landfill or other industrial activities. SW-1 and SW-2 are located within the onsite wetland. Natural wetland systems and their sediments can adsorb contaminants as a natural sink. These contaminants can be released from time to time which could be contributing to the iron trigger exceedances sometimes observed at SW-1 and SW-2.

7) All monitoring program surface water parameter concentrations fall within a stable or decreasing trend. The site is not characterized by historical ranges of concentrations above assessment and compliance criteria.	○ **Yes** ◉ **No**	SW-2 has periodic exceedances of PWQO and water quality at this location is consistent over time, however concentrations of boron and potassium appear to be potentially be increasing. Water quality at all other surface water monitoring locations at the site is generally consistent over time.
8) For the monitoring program parameters, does the water quality in the groundwater zones adjacent to surface water receivers exceed assessment or compliance criteria (e.g. , PWQOs, CWQGs, or toxicity values for aquatic biota (APVs)):	○ Yes ○ No ◉ Not Known ○ Not Applicable	If yes, provide details and whether remedial measures are necessary
9) Have trigger values for contingency plans or site remedial actions been exceeded (where they exist):	◉ **Yes** ○ **No** ○ **Not Applicable**	No action taken, parameter concentrations have been consistent.

Surface Water CEP Declaration:

I, the undersigned hereby declare that I am a Competent Environmental Practitioner as defined in Appendix D under Instructions, holding the necessary level of experience and education to design surface water monitoring and sampling programs, conduct appropriate surface water investigations and interpret the related data as it pertains to the site for this monitoring period.

I have examined the applicable Environmental Compliance Approval and any other environmental authorizing or control documents that apply to the site. I have read and followed, *as deemed appropriate for this site in my professional judgement,* the Monitoring and Reporting for Waste Disposal Sites Groundwater and Surface Water Technical Guidance Document (MOE, 2010, or as amended), and associated monitoring and sampling guidance documents, as amended from time to time. I have reviewed all of the data collected for the above-referenced site for the monitoring period(s) identified in this checklist. Except as otherwise agreed with the ministry for certain parameters, all of the analytical work has been undertaken by a laboratory which is accredited for the parameters analysed to *ISO/IEC 17025-2005 (E)- General requirements for the competence of testing and calibration laboratories,* or as amended from time to time by the ministry.

If any exceptions or potential concerns have been noted in the questions in the checklist attached to this declaration, it is my opinion that these exceptions and concerns are minor in nature or will be rectified for future monitoring events. Where this is not the case, the circumstances concerning the exception or potential concern and my client's proposed action have been documented in writing to the Ministry of the Environment District Manager in a letter from me dated:

Select Date

Recommendations:

Based on my technical review of the monitoring results for the waste disposal site:

◉ **No Changes to the monitoring program are recommended** ○ **The following change(s) to the monitoring program is/are recommended:**	
◉ **No changes to the site design and operation are recommended** ○ **The following change(s) to the site design and operation is/ are recommended:**	

CEP Signature	
Relevant Discipline	P.Eng. with demonstrated relevant experience.
Date:	
CEP Contact Information:	Trish Edmond
Company:	WSP Canada Inc.
Address:	1931 Robertson Road Ottawa, Ontario K2H 5B7
Telephone No.:	613-592-9600
Fax No. :	613-592-9601
E-mail Address:	tedmond@golder.com

Save As **Print Form**

Arnprior Waste Disposal Site
2022 MECP Checklist

Sections 6 & 9 – The Site Meets Groundwater Compliance and Assessment Criteria & Trigger Values for Contingency Plans or Site Remedial Action Exceeded

Not including iron, manganese and TDS which are problematic leachate indicator parameters due to their presence in the background monitor, at least one leachate indicator parameter from Section 7.2.2 of the annual monitoring report exceeded the trigger concentration in either the spring or fall round, or both of the spring and fall rounds in monitors BR-5D, BR-6D, BR-10, BR-11 and BR-12. It is interpreted that exceedances of trigger concentrations in monitors BR-5D, BR-6D, and BR-12 result from the effect of the wood waste historically deposited on the CAZ lands north of the Canadian Pacific Rail line, road salting and/or the effect of the landfill. It is interpreted that exceedances of trigger concentrations in monitors BR-10 and BR-11 result from road salt, wood waste, or other industrial activities formerly undertaken on the CAZ lands, but not by landfill leachate, based on the piper plots. It is important to note that the leachate indicator parameters exceeding the trigger concentrations at these locations all have concentrations which are generally consistent, consistently variable or slightly decreasing over time with the exception of concentrations of DOC at monitoring well BR-6D.

Distribution List

1 copy	Ministry of Environment, Conservation and Parks
1 e-copy	Ministry of Environment, Conservation and Parks
1 copy	Township of McNab/Braeside
1 copy	Town of Arnprior
1 e-copy	WSP, Ottawa

Executive Summary

This 2022 Annual Site Development, Operations and Environmental Monitoring Report has been prepared to fulfill the annual reporting requirements as set out in the Provisional Certificate of Approval (C of A.) No. A412603.

The Executive Summary highlights key points from the report only; for complete information and findings, as well as the limitations, the reader should examine the complete report.

The volume of material added to the waste mound (including waste and daily/interim cover material) between December 2021 survey and December 2022 survey is estimated to be 11,826 cubic metres.

The annual airspace consumed has ranged between 5,987 and 12,845 cubic metres over the past ten years. Assuming the annual waste receipt rate remains around the average 8,740 cubic metres per year between 2013 and 2022, the remaining landfill life is approximately 16 to 17 years.

The 2022 field investigation activities included groundwater level measurements and sampling of groundwater in April/May and December and surface water in April, August and December. There were no deviations from the groundwater or surface water monitoring programs outlined in the 2021 Site Development, Operations and Environmental Monitoring Report (WSP Golder, 2022).

The direction of groundwater flow in the overburden and in the bedrock at the site is interpreted to be in a north, north-easterly and east direction towards the Ottawa River. As a result of the more recent groundwater elevations observed, it is possible that horizontal groundwater flow in the overburden in CAZ area D has an eastward component.

Conventional borehole logs detailing the geological conditions encountered in each borehole augered during the previous investigation programs were obtained and reviewed in 2006. There is a limited thickness of overburden downgradient of the site which explains why there are no overburden compliance monitoring wells. The bedrock encountered at the site generally consists of limestone, siltstone, shale and/or sandstone.

The groundwater data from background monitoring wells (OV-13, BR-13S and BR-13D), the background surface water location (SW-10), and the monitoring well most indicative of leachate quality (OV-7) were examined to determine site-specific *leachate indicator parameters*. Thirteen parameters typically monitored in the groundwater and often monitored in the surface water were identified as site-specific *leachate indicator parameters* and they include: alkalinity, ammonia (for groundwater) and unionized ammonia (for surface water), boron, barium, chloride, iron, hardness, potassium, manganese, sodium, TDS, DOC, and dissolved reactive phosphorus (for groundwater) and total phosphorus (for surface water). These parameters were primarily used to evaluate site compliance with trigger mechanisms.

Based on historical results, the historical tannin and lignin concentrations, the piper trilinear diagrams, the groundwater flow directions, and the 2022 monitoring activities, groundwater monitors OV-7, BR-1D, BR-1S have been interpreted to be impacted by landfill leachate. Groundwater monitors BR-5D, BR-5S, BR-6D, BR-6S, BR-8D, BR-8S, BR-9D, BR-9S, BR-12, BR 08-1D, BR 08-1S, BR 08-2S and BR 08-2D are interpreted to be impacted by wood waste deposited on the CAZ Areas, and/or by landfill leachate. It is possible that groundwater monitors BR-5D, BR-5S, BR-6D and BR-6S are also impacted by road salt. Groundwater monitors BR-7D, BR-7S, BR-10 and BR-11 are interpreted to be impacted by road salt, wood waste, or other industrial activities on the CAZ lands, but not by landfill leachate. Groundwater monitors BR08-3D and BR08-3S are interpreted to be

potentially impacted by landfill leachate, as well as wood waste or other industrial activities in the CAZ lands. Recent groundwater elevation data suggests that groundwater monitors BR-3, OV-9 and OV-10 could be downgradient of a part of the landfill. At OV-10, increasing trends have been reported for several leachate indicator parameters, including chloride, barium, and sodium since 2006, and iron, potassium, ammonia, and manganese. Similar increasing trends are being observed at BR-3, including concentrations of ammonia, DOC, hardness, potassium, TDS, chloride, and sodium. Although there are no increasing trends being observed at OV-9, with the exception of sodium concentrations, elevated concentrations of ammonia, boron, and sulphate were observed in 2022. It is interpreted that OV-9, OV-10, and BR-3 may be potentially impacted by landfill leachate. The samples collected from these groundwater monitors will be evaluated carefully in 2023 along with ongoing assessment of groundwater flow direction to assess on-going trends. Some additional parameters were observed to be increasing at BR-8S / BR-8D and at BR08-1S in 2022, these trends will continue to be monitored. The Town installed an additional overburden and bedrock monitoring well near the eastern corner of CAZ Area D to discern groundwater flow direction and possible landfill leachate impacts at the southern property boundary. Groundwater samples and groundwater elevations will be obtained from these wells in 2023 and results provided in the 2023 monitoring report.

The water quality data for locations SW-10, SW-11 and SW-12 suggest a consistent water quality that is not being impacted by the landfill. The concentrations of total phosphorous, aluminum, and total iron were outside their respective PWQO during the April sampling session at SW-10 (SW-10 was dry in August and December). The concentration of total iron was outside the PWQO during all three sampling sessions at SW-11 and in the summer at SW-12. The concentration of unionized ammonia was outside the PWQO during the summer sampling session at SW-11 and SW-12.. There were no other exceedances of the PWQO during the 2022 sampling sessions at these locations. There were no exceedances of the CCME guidelines for chloride (short-term and long-term exposure) or boron at these locations during 2022. Historical exceedances observed at these sampling locations may be natural or may be attributable to road salting activities and/or industrial activities.

All of the surface water sampling stations sampled within and on the periphery of the wetland (SW-1, SW-2, SW-21, SW-22 and SW-23) had one or more parameters that did not meet the PWQO (unionized ammonia, dissolved oxygen, total phosphorus, boron, and/or iron) in 2022. These exceedances may be attributable to the landfill, industrial activities associated with the railway or lumber industries (i.e., the wood waste). Evaporation from the stagnant water within the wetland may be resulting in elevated parameter concentrations in surface water. Surface water sampling locations SW-18 located within the Ottawa River is interpreted not to be impacted by the landfill leachate even though several parameters exceed PWQO. Several metals, as well as chloride, hardness and TDS, exceeded the historical maximum background concentration (at the river background location, SW-26) at SW-18 in the fall of 2022. The data will be evaluated in 2023 to determine if this could be a trend. SW-19, located in close proximity to the Ottawa River is interpreted to be potentially impacted by landfill leachate. The background surface water sampling location within the Ottawa River, SW-26, was found to have similar water quality to SW-18 with respect to PWQO exceedances in 2022. Water quality within the river (i.e., SW-18) is distinctly different than the ephemeral/intermittent stream and the ponds/wetland.

At surface water sampling station SW-2, leachate indicator parameter unionized ammonia, boron, and total iron exceeded the PWQO trigger concentrations during at least one monitoring session in 2022. No other PWQO trigger concentrations were exceeded in 2022 at surface water sampling station SW-2. Boron and total iron exceeded the respective PWQO trigger concentrations at surface water sampling station SW-1 during the summer monitoring session in 2022. The concentrations of boron and iron exceeding the trigger concentrations at SW-2 in 2022 were within the historical concentrations at this location, however, total iron was noted as being

elevated relative to recent concentrations in the summer of 2022 (returning to concentrations below the PWQO trigger in the fall). Note that the CCME criteria for chloride and boron were not exceeded at SW-1 or SW-2 in 2021. A review of the 2022 surface water concentrations indicate that contingency measures are not required at this time.

The concern with beaver dams at landfills is with the potential for failure, causing potentially leachate-impacted water and sediment to suddenly be released to downstream surface waters. For this reason, the extent of beaver activity within the wetland watershed was monitored during the 2022 monitoring, with emphasis on documenting the location and age of the beaver dams. As in previous years (since 2014), beaver activity was reported upstream of SW-2 in 2022. Beaver activity will continue to be monitored during the 2023 monitoring program to determine the extent of the beaver activity and if steps need to be taken to control the activity.

Groundwater and surface water monitoring programs will be continued in order to evaluate site compliance on an ongoing basis and a proposed groundwater and surface water monitoring program for 2023 is presented in Section 12.0 of this report.

Condition 28.1 of the revised ECA received on March 10, 2020 (see Section 11.2) required that by no later than June 30, 2020, the Town shall submit to the District Manager contingency measures to address groundwater compliance at the Site. This deadline was subsequently changed to December 31, 2020, following submission of a “Request for Pandemic Related Temporary Regulatory Relief (Alternate Arrangement) for Waste Disposal Sites and Waste Management System” by the Town dated June 15, 2020. In a letter dated December 3, 2020, Golder provided the District Manager with the Town’s preferred contingency option to address the groundwater compliance issue. It is considered that the submission of this letter fulfills the requirements of Condition 28.1. Comments dated April 16, 2021, from MECP groundwater reviewer Thomas Guo were received on the 2020 Annual Monitoring Report (Golder, 2021) and on the December 3, 2020, letter titled “Arnprior Waste Disposal – Groundwater Compliance Contingency Plan”. Comments dated April 23, 2021, from MECP surface water reviewer Lauren Forrester were received on the 2020 Annual Monitoring Report (Golder, 2021) and on the December 3, 2020 letter titled “Arnprior Waste Disposal – Groundwater Compliance Contingency Plan”. Golder addressed these comments within the 2021 Annual Monitoring Report.

As discussed in Section 2.5 of this report, the Town intends to enter into discussion with the MECP to determine how the fill beyond approved limits, which is now understood to consist of waste material, is to be managed.

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APPENDIX E
Photographs of Surface Water Sampling Locations

APPENDIX F
MECP Correspondence

1.0 INTRODUCTION

This report serves as the 2022 site development and operations report and presents the results of monitoring activities carried out during 2022 at the Arnprior Waste Disposal Site (Site).

The Arnprior Waste Disposal Site is located on Part of Lots 9, 10, and 11, Concession XIII in the Geographic Township of McNab which is now part of the amalgamated municipality of the Township of McNab/Braeside, Ontario. The Site is situated south of County Road Number 3 (Usborne Street) and north of County Road Number 1 (River Road) (see Key Plan, Figure 1). This site is operated under Amended Environmental Compliance Approval (ECA) No. A412603, issued on March 10, 2020. The site originally operated under Provisional Certificate of Approval (C of A) No. A412603, dated October 26, 1999, which was amended by Notices on June 20, 2003, April 28, 2008, August 18, 2017, and October 12, 2018. The 2008 notice was an administrative amendment to resolve discrepancies between the approval documents and Annual Reports regarding the size of the Site and Contaminant Attenuation Zone (CAZ), and the 2017 notice added a requirement for an assessment for a landfill gas venting system in the final cover as part of the Closure Plan for the Site, approved waste diversion activities at the Site, added a requirement to update the proposed trigger mechanism and contingency plan, and added associated documents to Schedule A. The 2018 amendment was a minor change regarding an updated date for submission of the trigger mechanism. The March 2020 revision of the ECA was initiated by changes to the requirements to submit an updated trigger mechanism, as discussed in Section 11.2 of this report; the amended ECA generally incorporates the previously issued amendments to the C of A No. A412603, dated October 26, 1999.

This report has been prepared to fulfil the reporting requirements outlined in Condition 20 of ECA No. A412603.

Historically, the CAZ land located north and northeast of the existing approved landfill (between a Canadian Pacific Rail Line and Usborne Street) was owned by various industrial owners some of whom processed wood. It has been reported that much of this property is covered with wood waste fill and the property was used for lumber industry related activities. In addition, berms on this site related to the rail line are of unknown fill quality.

2.0 OPERATIONS

2.1 Description of Operations

The site consists of a 9.6 hectare landfilling area (6.2 hectare waste footprint surrounded by a 30 metre buffer) within a total site area of 40.4 hectares, as shown in Figure 2. The landfill has been in operation since about 1970 and as of July 1, 2011, the site operations were subcontracted to Tomlinson Environmental Services Inc. (Tomlinson) of Ottawa, Ontario.

A summary of the operations at the Arnprior Waste Disposal Site with respect to compliance with the conditions of ECA A412603 (issued March 10, 2020) at the time of 2022 are shown in Table 1. The site is in compliance with the conditions as available in 2022 with respect to the inspection and reporting as required in the ECA.

2.2 Site Plan Preparation

On December 20, 2022, a site survey was conducted by WSP Canada Inc. (WSP, previously Golder) using total station survey equipment to prepare a site plan showing the existing site conditions in 2022. The survey allowed WSP to establish the fill volume placed since the previous survey which was conducted in December 2021 by Golder.

The site plan, showing the landfill conditions in December 2022 is provided in Figure 2. Selected cross-sections showing the recent survey in comparison to historical surveys and proposed fill limits are provided in Figure 3; cross-sections A and J are not shown, as no new fill was placed in these areas in 2022.

2.3 Cover Quantities

For 2022, the Town of Arnprior estimated that 4,404 cubic metres of sand (based on loads of sand) and an estimated 1,600 cubic metres of wood chips from ground leaf and yard waste was used as daily cover.

2.4 Air Space Utilization and Quantity of Waste Received

The volume of material added to the waste mound between December 30, 2021 and December 20, 2022 was calculated by WSP based on a comparison of the topographic data collected within the active waste disposal area (see Figure 2) during the site surveys carried out by WSP in December 2022 and previous surveys. The volume of material added to the waste mound (including waste and daily/interim cover material) between the December 2021 survey and the December 2022 survey is estimated to be 11,826 cubic metres. The volume of material added to the waste mound in 2022 was similar to 2020 and 2021, but higher than in previous years, with the average volume of material added to the waste mound per year between 2013 and 2019 being 7,427 cubic metres. The increase in volume of material added to the waste mound could be due in part to a larger amount of landfill material accepted compared to previous years.

The quarterly masses of waste received and landfilled (excluding dewatered sludge) by the Town of Arnprior in 2022 were as follows:

- January to March – 955 tonnes
- April to June – 1,118 tonnes
- July to September – 1,009 tonnes
- October to December – 1,066 tonnes

These quantities are based on estimates of the average weight of municipal garbage collected weekly from the curbside in addition to the known weight and estimated volumes of garbage delivered in vehicles and other containers for direct disposal at the landfill. Assuming a waste density of 0.41 tonnes per cubic metre (CSR, 2003), the volumes of waste received (prior to compaction) are estimated to be:

- January to March – 2,329 cubic metres
- April to June – 2,727 cubic metres
- July to September – 2,461 cubic metres
- October to December – 2,600 cubic metres

Approximately 390 tonnes of dewatered sludge was received from the Town of Arnprior Sewage Treatment Plant in 2022. It is noted that the sludge has been dewatered to approximately 25%, is anaerobic and has minimal odours due to the upgrades at the Water Pollution Control Centre.

The Town also stockpiled approximately 12,137 tonnes of clean fill in 2022 to be used as cover material during final closure.

2.5 Remaining Capacity

The overall volumetric capacity remaining at the Arnprior Waste Disposal Site was estimated by WSP based on a comparison of the December 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, and 2022 topographic survey information and the approved final contour elevations over the entire licensed fill limit. Based on this comparison, the total volumetric capacity remaining at the Arnprior Waste Disposal Site in December 2022 is estimated to be 186,560 cubic metres, which includes the final cover. The final cover is required to be 0.7 metres over the area of the landfill (6.2 hectares) for a volume of approximately 43,400 cubic metres. Therefore, the estimated airspace remaining for waste and daily cover is estimated to be 143,160 cubic metres.

The annual airspace consumed has ranged between approximately 5,990 and 12,845 cubic metres over the past ten years. From 2008 to 2012, the annual airspace consumed ranged from 11,087 cubic metres to 19,310 cubic metres per year (Golder, 2013). The annual airspace consumed between 2013 and 2019 has been consistently lower than the previous six years and the average airspace consumed over that time period was approximately 7,430 cubic metres per year. Between 2020 and 2022, the airspace consumed is more consistent with the consumed airspace between 2008 to 2012. This could be partially due to the increase in cover material used on site, a higher amount of waste landfilled, as well as the inclusion of a small fill stockpile within the survey in 2021. The average 10 year airspace consumption is estimated to be about 8,740 cubic metres based on survey information between 2013 and 2022.

As reported in previous years, there is a fill beyond approved limits within the landfill footprint that was previously understood to consist primarily of clay material placed within the landfill footprint approximately eight years ago prior to establishment of the clean fill stockpile area. As it was understood that this material was clean soil material available for use, this volume was not previously considered as contributing to the airspace consumed at the Site. Partial removal of this overfill area was undertaken in 2017. During removal, previously landfilled waste material and leachate were encountered at a depth shallower than anticipated; excavation activities were immediately stopped to avoid potential flow of leachate overland and to mitigate the development of odours. The exposed area was re-covered with a clay. As a result, the full depth of the overfill area was not excavated, and the remaining fill beyond approved limits is considered to be waste contributing to the airspace consumed. As such, when comparing the remaining airspace in 2016 and 2017, the apparent airspace consumed between those years was 18,930 cubic metres, which is not reflective of the waste and cover materials added to the waste mound as part of regular operations in 2017. Assuming the annual waste receipt rate remains around the 10 year average of 8,740 cubic metres per year between 2013 and 2022, the remaining landfill life is approximately 16 to17 years.

Selected cross-sections showing the recent December 2022 survey in comparison to the topographic elevation as of December 2021 based on the combined surveys between 2013 and 2021 and proposed fill limits are provided in Figure 3. Landfilling activities were not undertaken in the area of the fill beyond approved limits in 2022, so it is not shown in the sections on Figure 3. Now that it is understood that the fill beyond approved limits consist of waste material and not clean soil, the Town intends to enter into discussion with the MECP to determine how this material is to be managed.

2.6 Major Activities and Capital Works

No new capital works projects were undertaken in 2022.

2.7 Public Complaints and Response

One complaint was received in 2022 relating to the landfill operating hours. The landfill previously closed at 4PM and has since changed to close at 3:30PM to the public to allow the operator to finish covering the landfill within the hours specified in ECA No. A412603. The landfill sign still states the previous hours of closure as 4PM. The Town is currently working on updating the landfill information sign and expects to install a new sign in spring 2023 after the snow melts.

3.0 FIELD ENVIRONMENTAL MONITORING PROCEDURES

3.1 Objectives

The objectives of the 2022 environmental monitoring program were:

- To comply with the annual monitoring and reporting requirements stipulated in Conditions 20 and 27 of ECA No. A412603.
- To monitor background groundwater and surface water quality; groundwater quality immediately downgradient of the landfilled area; surface water quality at various locations in the vicinity of the site.
- To assess site compliance with site-specific trigger levels relating to potential groundwater and surface water impacts due to leachate generated within the waste disposal area.

3.2 Groundwater Monitoring

The 2022 groundwater monitoring program followed the program outlined in Table 5 of the 2021 Site Development, Operations and Environmental Monitoring Report by Golder (Golder, 2022). The locations of all the groundwater monitors that WSP sampled are illustrated on the Site Plan (Figure 2). The groundwater levels in the monitors included in the sampling sessions were measured on April 24, 2022 and December 11, 2022. The spring groundwater monitoring session was conducted on April 25 and April 26, 2022. The fall groundwater monitoring session was conducted on December 17, 18, and 19, 2022.

The 2022 groundwater monitoring program was the same as the 2021 groundwater monitoring program. Volatile organic compounds (VOCs) are only analyzed every five (5) years and were included as part of the 2019 spring monitoring session. The next scheduled session is in spring 2024.

In 2022, a groundwater monitor condition survey was carried out during each groundwater monitoring session. In the fall of 2022, it was noted that BR08-1D requires a new lock. In 2021, it was noted that BR-8D and BR-8S required the casings to be lowered. This process was started during the spring monitoring session and was planned to be completed during the fall monitoring session. Due to frozen ground conditions during the fall monitoring session, BR-8D and BR-8S could not be repaired. These repairs are planned for 2023. No other maintenance issues were identified during the surveys.

All monitors sampled during 2022 were developed through the removal of at least three standing volumes of water or until dry, using dedicated samplers which have been provided in each groundwater monitor. Sampling of groundwater was generally performed immediately after monitor development.

The temperature, pH and electrical conductivity of the groundwater samples were measured in the field at the time of sample collection. All field instruments were calibrated in the field prior to use. All samples collected were entered on a Chain of Custody Form and placed in coolers with ice packs until they were delivered in person to the private analytical laboratory.

The groundwater samples were collected, prepared and preserved in the field as follows:

- one plastic bottle, field filtered to 0.45 microns and preserved with nitric acid for analysis of aluminum, barium, beryllium, boron, cadmium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, vanadium and zinc
- one clear glass bottle, field filtered to 0.45 microns and preserved with hydrochloric acid for mercury analysis
- one plastic bottle, unfiltered and unpreserved for analysis of dissolved organic carbon (DOC)
- one plastic bottle, unfiltered and unpreserved for analysis of alkalinity, chloride, sulphate, pH, dissolved reactive phosphorus (orthophosphate) and conductivity
- one plastic bottle, unfiltered and unpreserved for analysis of total dissolved solids (TDS)
- one plastic bottle, unfiltered and preserved with sulphuric acid for analysis of total phosphorus
- one glass vial, unfiltered and preserved with sulphuric acid for analysis of ammonia
- hardness was calculated based on the laboratory calcium and magnesium concentrations

Bureau Veritas Laboratories in Ottawa, Ontario performed all laboratory chemical and physical analyses on the groundwater samples. The Report of Analyses sheets from Bureau Veritas Laboratories are provided in Appendix A. The reportable detection limits (RDLs) for the specific groundwater analyses were commensurate with the standards established in the MECP's (formerly Ministry of Environment [MOE]), Ontario Drinking Water Quality Standards, Objectives and Guidelines (MOE, 2003).

3.3 Surface Water Monitoring

As outlined in Table 6 of the 2021 Site Development, Operations and Environmental Monitoring Report (Golder, 2022), surface water samples were taken during the prescribed periods of the year at stations SW-1, SW-2, SW-10, SW-11, SW-12, SW-18, SW-19, SW-21, SW-22, SW-23 and SW-26 except when a station was dry or frozen. Figure 2 shows the locations of these surface water sampling stations.

Surface water sampling sessions were carried out on April 27, August 17 and December 11, 2022. There were no deviations from the surface water monitoring program outlined in the 2021 Site Development, Operations and Environmental Monitoring Report (Golder, 2022).

The temperature, pH, dissolved oxygen and electrical conductivity of the surface water samples were measured in the field at the time of sample collection. All field instruments were calibrated in the field prior to use. All samples collected were entered on a Chain of Custody Form and placed in coolers with ice packs until they were delivered in person to the private analytical laboratory.

The surface water samples were collected, prepared and preserved in the field as follows:

- one plastic bottle, unfiltered and preserved with nitric acid for analysis of barium, beryllium, boron, cadmium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, vanadium and zinc
- one plastic bottle, field filtered to 0.45 microns and preserved with nitric acid for analysis of dissolved barium, beryllium, boron, cadmium, calcium, chromium, cobalt, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, silver, sodium, vanadium and zinc

- one plastic bottle, field filtered to 0.45 microns and preserved with ammonium hydroxide for analysis of chromium
- one clear glass bottle, field filtered to 0.45 microns and preserved with hydrochloric acid for mercury analysis
- one plastic bottle, field filtered to 0.45 microns and lab filtered to 0.2 microns with no preservative for analysis of aluminum
- one plastic bottle, unfiltered and unpreserved for analysis of DOC
- one plastic bottle, unfiltered and unpreserved for analysis of alkalinity, chloride, hardness, nitrate, sulphate, temperature, and conductivity
- one plastic bottle, unfiltered and unpreserved for analysis of biological oxygen demand (BOD)
- one plastic bottle, unfiltered and preserved with sulphuric acid for analysis of total phosphorus
- one glass vial, unfiltered and preserved with sulphuric acid for analysis of ammonia
- one plastic bottle, unfiltered and unpreserved for analysis of TDS and total suspended solid (TSS)
- unionized ammonia was calculated based on the laboratory ammonia concentration and the field temperature and pH measurements
- hardness was calculated based on the laboratory dissolved calcium and magnesium concentrations

Bureau Veritas Laboratories in Ottawa, Ontario performed all laboratory chemical and physical analyses on the surface water samples. The Report of Analyses sheets from Bureau Veritas Laboratories are provided in Appendix A. The RDLs for the specific surface water analyses were commensurate with the standards established in the Provincial Water Quality Objectives (PWQO) (MOE, 1994b, reprinted 1999).

3.4 Landfill Gas Monitoring

In the 2013 Site Development, Operations and Environmental Monitoring Report (Jp2g, 2014), it was recommended that landfill gas monitoring be undertaken. All of the monitoring wells at the site have screens that are below the water table. Monitoring for landfill gas in these wells will not provide information about potential lateral migration of landfill gas since this migration will occur above the water table. The Town could consider installation of shallow landfill gas monitoring wells at the western property boundary to properly assess lateral subsurface migration of landfill gas. Landfill gas monitoring is not listed as a requirement in the ECA.

4.0 GEOLOGICAL CONDITIONS

Borehole logs detailing the geological conditions encountered during the previous investigation programs, conducted by Robinson Consultants Inc., and Golder are provided in Appendix B. The following discussion is based on a review of the information in Appendix B and the following maps:

- Natural Resources Canada – Topographical Map 31F8, Arnprior, 8th Edition, 1994
- Ministry of Natural Resources, Ontario Geological Survey – Map P2726, Paleozoic Geology, Arnprior – Quyon Area, 1984
- Geological Survey of Canada – Surficial Geology, Map 1599A Arnprior, 1976

4.1 Overburden Geology

The regional overburden geology consists of a complex pattern of glacial deposits, Champlain Sea deposits, and Post Champlain Sea deposits. The area has undergone a series of glacial events followed by an incursion of the Champlain Sea and more recent shoreline deposition and fluvial erosion.

In the direct area of the site, deposits from the boundary of abandoned channels of the Ottawa River occur. Within this area, bedrock outcrops have been covered by recent sediments and old channel sediments. The alluvial deposit consists of medium to fine grained fluvial sands with some silt.

To the south of the site and to the east towards Arnprior, lies a deposit of off-shore shallow marine materials. This unit consists of marine clay, silty clay and silt. Closer to the Ottawa River, the clay and silt of the off-shore marine deposit has been eroded by channel flow processes. Depending on the depth of erosion, uniform clay or sandy silty clay with sand bars and non-marine silts may be present.

Underneath the alluvial and marine deposits, fluvial-glacial materials can be encountered. The material is reported to be primarily sand and gravel with numerous cobbles and boulders and lenses of till.

According to Robinson (1997b), the major overburden deposits encountered in the study area are an alluvial sand unit and glacial sand and/or gravel. The alluvial sand is encountered as the surficial unit in approximately half of the augerholes/probeholes. A maximum thickness of 5.5 metres was encountered for this unit in monitor OV-5. The glacial material occurs as surficial material or below the alluvial material. The thickness of the glacial deposit ranges from less than a metre to up to 7 metres. The overburden thickness varied from less than 1 metre to approximately 24 metres. The thicker material is encountered in the southeastern portion of the study area.

Based on the borehole logs, overburden located within the CAZ northeast of the Canadian Pacific Railway line ranges from 0.5 to 1.8 metres in thickness and consists of topsoil, sawdust fill and/or sand and gravel fill. In particular, sawdust fill is noted to be present at monitors BR-8S, BR-8D, BR-9S and BR-9D.

4.2 Bedrock Geology

The regional bedrock geology consists of Precambrian rocks, and Lower to Middle Ordovician formations. The region is transected by several faults which generally trend in a northwesterly to southeasterly direction. One fault is reported to the southwest of the site with the landfill situated on the up-thrown side. In Robinson (1997b), it is reported that this fault is believed to coincide with the bedrock scarp observed on site.

In the direct area of the site, the Paleozoic geology consists of the Gull River Formation, the Rockcliffe Formation and the Oxford Formation. The Gull River Formation consists of interbedded silty dolostone, lithographic to fine crystalline limestone, oolitic limestone, shale, and fine-grained calcareous quartz sandstone. The Rockcliffe Formation consists of interbedded fine-grained light greenish grey quartz sandstone, shaly limestone, and shale. The Oxford and March Formations are often combined and consist of sublithographic to fine crystalline dolostone and interbedded quartz sandstone, sandy dolostone and dolostone, respectively.

According to Robinson (1997b), the Rockcliffe Formation occurs as outcrops or near surface bedrock in the study area and on adjacent properties. Red and green shale layers were observed in test holes and in outcrops. Robinson also reports that the test holes encountered primarily limestone bedrock. Shale layers were encountered in the limestone, primarily nearer the surface. In monitor BR-4, a conglomerate unit was encountered and Robinson interprets this as indicative of the base of the Rockcliffe Formation. Bedrock monitors

BR-5, BR-6 and BR-7 are located along Usborne Street north and east of the site and were drilled through the limestone of the March Formation and Oxford Formation. Shale was encountered in the upper regions of BR-6 which is believed to be the base of the Rockcliffe Formation.

Limestone and/or shale were encountered in the boreholes BR 08-1 and BR 08-3 from the ground surface to depths of 12.14 metres and 15.85 metres, respectively. BR 08-2 consisted of approximately 0.76 metres of sand and gravel fill underlain by sandstone, followed by layers of limestone, siltstone and shale. No field evidence indicative of soil or groundwater impacts were noted during the installation of these monitoring wells.

5.0 PHYSICAL HYDROGEOLOGY

5.1 Groundwater Level Data

Reference elevation data for the groundwater monitors installed at the Arnprior Waste Disposal Site are presented in Table 2.

Groundwater elevations in the overburden are fairly consistent over time with previously reported slightly overall decreasing groundwater elevation trends between 2009 and 2015 at groundwater monitors OV-5, OV-7, OV-9 and OV-13, and with slightly overall decreasing groundwater elevation trends since 2012 at OV-10, however this trend is stabilizing. In spring of 2016, groundwater elevations in all overburden monitors were higher than in recent years at their respective locations. Between 2016 and 2020, groundwater elevations at most overburden wells remained slightly elevated compared to pre-2016 conditions, with the exception of OV-7 which decreased to within historic conditions. In 2021, the groundwater elevation increased slightly in the spring and decreased back to or near to typical (i.e., pre-2016) historical levels at OV-2, OV-5, OV-7, OV-9 and OV-10 in the fall of 2021.. In 2022, water levels at OV-5, OV-9, and OV-10 were elevated compared to 2020 and 2021. Groundwater elevations at OV-13 decreased by approximately 2 m to pre-2016 elevations in both spring and fall of 2022. Water levels at OV-2 and OV-7 in 2022 remained consistent with historic concentrations.

Historically, groundwater elevations at OV-9 were typically lower than elevations reported at OV-10 which is located just south of OV-9, and groundwater flow in this area was generally interpreted to be cross-gradient from the landfill. Due to persistent issues with monitoring well OV-9 heaving out of the ground, the well was replaced in the summer of 2017 and was re-surveyed in 2019. Evidence of heaving at OV-9 has not been reported since the re-surveying in 2019, however will be monitored during the 2023 monitoring session. Groundwater elevations at this location reported in November 2017 and during the 2018 monitoring session were similar to elevations reported at OV-10, making the interpretation of the direction of groundwater flow different from previous years. In 2021, groundwater elevations at OV-9 were higher than at OV-10, but elevations were slightly higher at OV-10 than OV-9 in 2022. As a result of the more recent groundwater elevations observed, it is possible that OV-9 and OV-10 are slightly downgradient of a small portion of the landfill (see Section 5.3).

The depth to groundwater reported at OV-4 during the fall 2018 monitoring session is more consistent with historical data from monitoring well OV-5 and vice versa. While it was not possible to confirm, it was assumed that the data recorded at these wells were accidentally mis-transcribed and switched, with the intent that if groundwater elevation measurements showed results consistent with November 2018 results during the 2019 monitoring session, this assumed mislabelling would be corrected in the 2019 annual monitoring report. During the November 2019 monitoring session, there was some confusion in the field around the association of groundwater level measurements to groundwater monitors, resulting in it not being possible to rely on the measurements recorded at OV-4 and OV-5. As such, groundwater levels at OV-4 and OV-5 in the fall of 2019

were not included in the 2019 report, nor subsequent reports. Since the fall of 2020, monitoring well OV-4 has been observed to be blocked between 4.46 metres and 4.40 metres below top of casing.

Groundwater elevations in the bedrock are fairly consistent over time, with the exception of the groundwater elevations at groundwater monitor BR-13D, which consistently varies three to five metres over time, and BR-3, which varied three to five metres between 2013 to 2016 and between 2019 and 2020. In general, groundwater elevations in most bedrock groundwater monitors have been observed to be slightly elevated in the spring 2016, 2017 and 2019, however were slightly lower and more consistent with historical groundwater elevations from fall 2020 to fall 2021. In 2022, many of the bedrock groundwater monitoring wells had slightly elevated water levels in the spring, generally returning 2021 levels in the fall except those noted below.

Some specific trends at bedrock groundwater monitors are provided below:

- The groundwater elevation at BR-13D has been observed to be decreasing since spring of 2018 with an approximate 5 m decrease in elevations in spring and fall 2022, marking a historic low for groundwater elevations at this location. Conversely, groundwater elevations at BR-13S were slightly elevated in spring and fall 2022.
- Groundwater elevations observed at monitor BR-11 were elevated over 1 metre above historical elevations in fall of 2019, fall of 2020, and spring and fall of 2021 but returned to within historic elevation ranges in 2022.
- An historical low groundwater elevation was observed at BR-12 in the fall of 2020 (by about 1 metre) and continued to decrease in 2021. Groundwater elevations at BR-12 in 2022 returned to within pre-2020 historic ranges.
- Groundwater elevations at BR-1D had been lower between 2014 and 2016 compared to historical data at this location, however returned to pre-2013 elevations in 2017. Since 2017, groundwater elevations at BR-1D have been slightly variable, ranging between 78 and 76 masl.
- Groundwater elevations at BR-1S were significantly lower in 2019 (approximately 5 to 6 metres) compared to historical data. In spring of 2020, the groundwater elevation at BR-1S returned to historical levels, but in the fall of 2020 and both spring and fall of 2021, groundwater levels were similar to 2019. In 2022, groundwater elevations returned to levels consistent with historic ranges of around 82 to 83 masl.
- Groundwater elevations at BR 08-1D has been reported approximately 3 to 4 metres higher compared to historical data since 2016.

5.2 Hydraulic Gradients

5.2.1 Vertical Component

During the April 2022 monitoring event, the vertical gradient in multi-level bedrock monitoring wells, BR-1S/BR-1D, BR6S/BR-6D, BR-8S/BR-8D, BR-9S/BR-9D, and BR-13S/BR-13D was downward or recharging and was upward or discharging at BR-7S/BR-7D and BR-18S/BR-18D. A vertical gradient did not exist at BR-5S/BR-5D during the April 2022 monitoring event. The vertical gradient at all multi-level wells in December 2022, except for BR-6S/BR-6D were downward or recharging. BR-6S/BR-6D which has historically had vertical gradients that were upward or discharging during both monitoring sessions, is located north of the licensed landfill area and in proximity to the Ottawa River and is likely discharging to the river.

Monitoring wells installed in July 2008 (BR 08-1S/BR 08-1D, BR 08-2S/BR 08-2D and BR 08-3S/BR 08-3D) were surveyed in January 2019. The vertical gradients in multi-level bedrock monitoring wells BR 08-2S/BR 08-2D and BR 08-3S/BR 08-3D were estimated to be downward or recharging during both monitoring sessions. A very slight downward vertical gradient was observed at BR 08-1S/BR 08-1D during the April and December 2022 monitoring sessions.

Based on the April and December data available at boreholes OV-13/BR-13S, the vertical gradient between the overburden and bedrock at the site was downward or recharging.

5.2.2 Horizontal Component

The horizontal hydraulic gradients for the overburden and bedrock flow system at the site were estimated from the 2022 groundwater elevation data. The horizontal hydraulic gradient in the overburden groundwater flow system from borehole OV-13 to borehole OV-7 was estimated to be 0.010 in April 2022 and 0.009 in December 2022. In the shallow bedrock, the horizontal hydraulic gradient from monitoring well BR-13S to BR-9S was estimated to be 0.010 in April 2022 and 0.011 in December 2022. These bedrock and overburden horizontal gradients are generally similar to the values obtained in previous years.

5.3 Horizontal Groundwater Flow Conditions

The horizontal groundwater flow direction within the shallow bedrock zone near the site is shown on Figure 4 for the April 2022 groundwater elevation data and Figure 5 for the December2022 groundwater elevation data. In general, the groundwater flow direction is north, north-easterly and east toward the Ottawa River. With the addition of monitoring well BR-18S there is now also a more noticeable component of easterly flow.

The horizontal groundwater flow direction within the overburden near the site is shown on Figure 6 for the April 2022 groundwater elevation data and Figure 7 for the December 2022 groundwater elevation data. In general, the groundwater flow direction is towards the north and east. The easterly component hadn't been observed in previous years but, as discussed in Section 5.1, monitoring well OV-9 was replaced in 2017 and water elevation data from this location is providing more information about horizontal groundwater flow direction in the overburden. As a result of the more recent groundwater elevations observed, it is possible that horizontal groundwater flow in the overburden in this area has an eastward component, and that OV-9 and OV-10 are slightly downgradient of a small portion of the landfill.

With this more recently identified easterly flow in the bedrock and possibly the overburden, it was identified in recent annual monitoring reports that it would be helpful to install another monitoring well in the southern corner of CAZ Area B or the eastern corner of CAZ Area D if either of these locations is accessible. Monitoring well, OV-23, BR-23S, and BR-23D was installed in January 2023. Additional elevation data will obtained during the 2023 monitoring session and these elevations will be included in the 2023 monitoring report.

6.0 IDENTIFICATION OF SITE-SPECIFIC LEACHATE INDICATOR PARAMETERS

A *leachate indicator parameter* for a landfill site is defined as being a parameter which is useful in determining the presence/absence of landfill leachate impact on water resources; assessing the degree of leachate impact on water resources; and is useful in determining the extent of leachate impact near the landfill site.

For a parameter to be useful as a *leachate indicator parameter* at a landfill site, the following characteristics are desirable:

- The parameter is present in relatively low concentrations in background water quality near the site and characterized by significantly higher concentrations in leachate generated at the landfill site.
- The concentration of a *leachate indicator parameter* should not vary significantly over time at background monitoring locations (i.e., low variability is desirable) in order to be a reliable indicator of leachate impact.
- The trend in the parameter concentration must be relatively consistent over time (allowing for seasonal variations in quality) in terms of the persistence of elevated levels in leachate relative to background conditions (i.e., parameter concentration should not vary dramatically over short periods of time such that during one monitoring event the concentration is indicative of background conditions, whereas during another monitoring event the concentration at the same monitoring location is indicative of leachate impact).
- For natural attenuation landfill sites, conservative parameters which are relatively mobile in the groundwater flow system (i.e., chloride) and are not subject to attenuation mechanisms (i.e., adsorption, biological uptake, precipitation, etc.) are most appropriate for characterizing the extent of leachate impact from a landfill site on water resources; potential leachate constituents characterized by a lower mobility in the subsurface environment (i.e., heavy metals) are typically attenuated by the soil in close proximity to the fill area and thus the extent of impact on groundwater resources is minimal.
- Parameter concentrations in groundwater and surface water should exhibit spatial variations in concentration relative to the location of the fill area(s) and physical hydrogeological setting of the site (i.e., higher parameter concentrations immediately downgradient from the fill area with progressively lower concentrations with increasing distances downgradient from the fill area).

The groundwater data from background monitoring wells at the Arnprior Waste Disposal Site, specifically OV-13, BR-13S and BR-13D, and the monitoring well most indicative of leachate quality, OV-7, were examined to determine site-specific *leachate indicator parameters*. Thirteen parameters typically monitored in the groundwater and often monitored in the surface water were identified as site-specific *leachate indicator parameters* and they include: alkalinity, ammonia (for groundwater) and unionized ammonia (for surface water), boron, barium, chloride, iron, hardness, potassium, manganese, sodium, TDS, DOC and dissolved reactive phosphorus (for groundwater) and total phosphorus (for surface water). It is recommended that these parameters be primarily used to define the extent of landfill leachate related impacts and to evaluate site compliance with specific trigger mechanisms as discussed in the following sections.

It is acknowledged that several of these parameters would also be indicative of impact associated with wood waste and/or road salting activities. This is particularly relevant when evaluating potential impact from the landfill on the CAZ land located northeast of the Canadian Pacific Railway line. Specifically, wood waste can contain high concentrations of the *leachate indicator parameters* TDS, alkalinity, DOC, iron and manganese and elevated levels of hardness, sodium and potassium. Other *leachate indicator parameters* such as boron and barium may also be elevated. With respect to road salting activities, *leachate indicator parameters* chloride, sodium and TDS may be elevated.

7.0 GROUNDWATER QUALITY

The groundwater quality in the vicinity of the Arnprior Waste Disposal Site was assessed by collecting groundwater samples from the existing monitoring wells and submitting them for chemical and physical analyses. The results of the field and laboratory chemical and physical analyses conducted during the 2022 monitoring program are presented in Appendix C along with relevant Ontario Drinking Water Quality Standards, Objectives and Guidelines (ODWQS, MOE, 2003) and the data from previous monitoring sessions, including data from monitoring wells not included in the 2022 monitoring program. Data from the 2013 monitoring session is provided in a separate table within Appendix C, with the exception of the background data that is included with all historical data in the main tables in Appendix C. Appendix D contains graphs of all *leachate indicator parameter* concentrations versus time for monitoring wells included in the 2022 monitoring program. These graphs are useful for ascertaining trends in the data but are not specifically referenced in the remainder of the report.

Historical groundwater chemical data were collected by Robinson Consultants Inc. The exact sampling methodology used by Robinson is unclear. For example, sample filtration and preservation methods may vary from Golder's sampling program. Therefore, some differences in historical data prior to 2005 data may be attributable to this factor. Sampling methods implemented by Jp2g during the 2013 monitoring program are documented in the 2013 Site Development, Operations and Environmental Monitoring Report (Jp2g, 2014).

Discussions relating to compliance with the ODWQS relate specifically to both non-health related objectives (i.e., aesthetic parameters) and health-related parameters for which a Maximum Acceptable Concentration (MAC) or Interim Maximum Acceptable Concentration (IMAC) have been established.

7.1 Quality Assurance/Quality Control

Two blind groundwater duplicates were analyzed during each of the spring and fall groundwater monitoring sessions in 2022, as part of the quality assurance/quality control (QA/QC) protocol. In addition, the laboratory performs equipment blanks as an internal method of QA/QC. All laboratory QA/QC results were reported to be within acceptable criteria limits by the laboratory in 2022.

Analytical results on blind sample duplicates are deemed to be outside of acceptable tolerance limits if the relative percent difference (RPD) between the original sample and its duplicate is greater than 50% and both analytical results are greater than 10 times the detection limit, or if the RPD is greater than 30% and both analytical results are greater than 20 times the detection limit. All parameter concentrations were within acceptable tolerance limits during the spring and fall monitoring sessions.

7.2 Background Water Quality and Trigger Concentrations

MECP Guideline B-7 (MOEE, 1994a) addresses the level of off-site leachate impact on groundwater considered acceptable by the MECP and defines the level of impact on groundwater beyond which some form of remedial measure(s) would be warranted.

Under MECP Guideline B-7 (the "Reasonable Use Guideline"), a change in the quality of groundwater on adjacent properties will only be acceptable if the quality is not degraded in excess of fifty percent of the difference between background concentrations and established water quality criteria for aesthetic related parameters, and twenty-five percent of the difference between background conditions and established water quality criteria for health-related parameters. In this assessment, the Reasonable Use Performance Objectives (RUPO) are calculated on the basis of the established background concentrations and the ODWQS, with details provided below. Also, trigger

levels are established based on the greater of 75 percent of the RUPO or the median background concentration. ECA No. A412603, issued March 10, 2020, stipulates that trigger values shall be 75% of the RUPO.

Condition 28.2 of ECA No. A412603 requires that within six (6) months of the receipt of comments on the submission mentioned in Condition 28.1 from the District Manager (see Section 11.1 of this Report), the Owner shall submit to the Director for approval an amendment application for an update to this ECA that will include details of the contingency plan to be implemented as approved by the District Manager and a proposed deadline for an update to the trigger mechanism.

7.2.1 Overburden Background Water Quality

Prior to 2001, background groundwater conditions were represented by monitor OV-5 for the overburden and several nearby bedrock residential wells. In 2001, monitoring wells OV-13, BR-13S and BR-13D were installed to provide a more suitable background source of water quality data at the site. These monitoring wells are located over 100 metres upgradient of the active landfill. It should be noted that these new background monitoring wells are located closer to River Road and as such could be impacted by road salting activities.

Historic groundwater quality at monitoring well OV-13 is somewhat variable with concentrations of *leachate indicator parameters* historically being higher in the spring monitoring event than the fall monitoring event. Water quality from OV-13 is characterized by elevated concentrations of manganese (exceeding the ODWQS three times) and TDS (occasionally exceeding the ODWQS); slightly elevated concentrations of chloride (typically in the spring); and low or non-detect concentrations of boron. Concentrations of iron have historically exceeded the ODWQS twice. Elevated chloride and TDS concentrations are likely the result of road salting on River Road.

The background groundwater quality for each of the *leachate indicator parameters*, the RUPO and current trigger concentrations for the overburden are presented in the following table.

Leachate Indicator Parameters	ODWQS[2] (mg/L)	n	Background Range[1] (mg/L)	Reasonable Use Performance Objective Based on Median Background Concentration (mg/L)	Trigger Concentration (75% of the RUPO or Median Background Value) (mg/L)
Alkalinity	- -	44	210 – 367	- -	- -
Ammonia	- -	43	<0.02 – 0.09	- -	- -
Barium	1 (MAC)	43	0.08 – 0.24	0.35	>0.26
Boron	5 (IMAC)	45	<0.01 – 0.06	1.27	>0.95
Chloride	250 (AO)	45	<1 – 85	142	>106
Iron	0.3 (AO)	45	0.01 – 1.83*	0.18	>0.13
Hardness	- -	39	190 – 424	- -	- -
Manganese	0.05 (AO)	43	<0.002 – 0.17*	0.03	>0.02
Potassium	- -	44	2.9 – 5.3	- -	- -
Sodium	200 (AO)	44	8 – 32	110	>82
DOC	5 (AO)	34	0.6 – 2.1	3.0	>2.24
TDS	500 (AO)	45	200 – 645*	455	>410**
Dissolved Reactive Phosphorus	- -	34	<0.01 – 0.09	- -	- -

Notes:
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mg/L – milligrams per Litre
n – Number of groundwater samples collected
AO – Aesthetic Objective
MAC – Maximum Acceptable Concentration
IMAC – Interim Maximum Acceptable Concentration
NC – Median concentration exceeds ODWQS hence it is not possible to calculate the RUPO
ODWQS – Ontario Drinking Water Quality Standards (2003)
* Maximum background concentration exceeds ODWQS
** Median background concentration is greater than 75% of the RUPO.
1 Background data obtained from monitor OV-13
2 ODWQS values presented relate specifically to non-health related parameters (i.e., aesthetic parameters) and health related parameters for which a MAC or IMAC has been established

The calculated RUPO concentrations (MECP Guideline B-7) and trigger concentrations for the *leachate indicator parameters* will be modified, as required, based on additional background groundwater quality data which will be obtained during future monitoring programs.

7.2.2 Bedrock Background Water Quality

Robinson (2005) suggests that monitoring well BR-13S is representative of the Rockcliffe Formation and that monitoring well BR-13D is representative of the March-Oxford Formation. This cannot be verified based on the borehole log available for monitoring wells BR-13S and BR-13D.

Historic groundwater quality at monitoring wells BR-13S and BR-13D is characterized by elevated concentrations of TDS and chloride. Iron and manganese parameters measured from BR-13S and BR-13D have exceeded the ODWQS on occasion while TDS measured from these bedrock background wells frequently exceeds the ODWQS. In general, water quality within the bedrock is more mineralized than the overburden.

The concentration of ammonia reported at BR-13D in the fall of 2020 (2.7 mg/L) and at BR-13S in the spring of 2020 (8.5 mg/L) are considered outliers and have not been included in the background range. Should future concentrations of ammonia at BR-13S and BR-13D be in line with the higher concentrations observed in 2020, the RUPO and trigger concentrations will be updated accordingly.

The background groundwater quality for each of the *leachate indicator parameters*, the RUPO and current trigger concentrations for the bedrock are presented in the table below:

Leachate Indicator Parameters	ODWQS[2] (mg/L)	n	Background Range[1] (mg/L)	Reasonable Use Performance Objective Based on Median Background Concentration (mg/L)	Trigger Concentration (75% of the RUPO or Median Background Value) (mg/L)
Alkalinity	- -	88	220 – 355	- -	- -
Ammonia	- -	87	<0.02 – 0.47	- -	- -
Barium	1 (MAC)	83	<0.002 – 0.23	0.32	>0.24
Boron	5 (IMAC)	88	0.01 – 0.49	1.31	>0.98
Chloride	250 (AO)	88	6 – 88	154	>115
Iron	0.3 (AO)	85	<0.01 – 1*	0.18	>0.13
Hardness	- -	75	205 – 431	- -	- -
Manganese	0.05 (AO)	83	<0.002 – 0.41*	0.03	>0.02
Potassium	- -	85	2 – 10	- -	- -
Sodium	200 (AO)	85	8 – 45	118	>89
DOC	5 (AO)	68	0.6 – 2.2	3.2	>2.4
TDS	500 (AO)	86	262 – 588*	498.3	>496.5**
Dissolved Reactive Phosphorus	- -	68	<0.01 – 0.1	- -	- -

Notes:

Entered by: ETB
Checked by: ALC

mg/L – milligrams per Litre
n – Number of groundwater samples collected
AO – Aesthetic Objective
MAC – Maximum Acceptable Concentration
IMAC – Interim Maximum Acceptable Concentration
NC – Median concentration exceeds ODWQS hence it is not possible to calculate the RUPO
ODWQS – Ontario Drinking Water Quality Standards (2003)
* Maximum background concentration exceeds ODWQS
** Median background concentration is greater than 75% of the RUPO
[1] Background data obtained from monitors BR-13S and BR-13D
[2] ODWQS values presented relate specifically to non-health related parameters (i.e., aesthetic parameters) and health related parameters for which a MAC or IMAC has been established

The calculated RUPO concentrations (MECP Guideline B-7) and trigger concentrations for the *leachate indicator parameters* will be modified, as required, based on additional background groundwater quality data which will be obtained during future monitoring programs.

7.3 Landfill Leachate Quality

Landfill leachate quality is represented by monitoring well OV-7. During April and December, the groundwater quality in this monitor met the ODWQS with the exception of DOC, TDS, iron, and manganese. The groundwater quality at this location during 2022 was generally similar to monitoring sessions conducted since December 1992. Generally, parameter concentrations at this location are staying constant or decreasing slightly. In comparison to background conditions (maximum values at OV-13) for the overburden, all site-specific *leachate indicator parameters* at OV-7 were elevated above maximum background conditions except for chloride during the April 2022 monitoring session and dissolved reactive phosphorous during the April and December 2022 monitoring sessions.

The groundwater quality at OV-7 was also compared to PWQO in 2022. Parameter concentrations that exceeded their respective PWQO values in April and December include unionized ammonia, boron, cobalt, iron, and phosphorus.

7.4 Impact Evaluation Monitoring Wells

In Robinson (2005), it is presumed that the March-Oxford Formation is encountered by those wells located north and east of the waste disposal site, along Usborne Street (CAZ Area A and CAZ Area B), including BR-5 (deep and shallow), BR-6 (deep and shallow), BR-10, BR-11 and BR-12. Additionally, Robinson (2005) reports that monitoring wells BR-2, BR-3 and BR-4 were completed to similar elevations and may also intersect the March-Oxford Formation.

The following discussion of impact evaluation monitoring wells includes the monitoring wells which were included in the 2022 monitoring program which are not representative of background water or leachate quality. These monitoring wells include OV-9, OV-10, BR-1S, BR-1D, BR-3, BR-5S, BR-5D, BR-6S, BR-6D, BR-7S, BR-7D, BR-8S, BR-8D, BR-9S, BR-9D, BR-10, BR-11, BR-12, BR 08-1S, BR 08-1D, BR 08-2S, BR 08-2D, BR 08-3S, BR 08-3D. It should be noted that other monitoring wells exist at the site; however, they were not included in the 2022 monitoring program.

Table 3 summarizes the physical and chemical parameters with reported levels exceeding their respective trigger values; trends in groundwater quality; a comparison of the groundwater quality to background conditions and, a hydrogeological interpretation of the groundwater quality data from the impact evaluation monitors.

7.5 Piper Trilinear Plots

Piper trilinear diagrams of groundwater quality at all monitoring wells sampled in 2022 are provided in Figures 8 and 9 for spring and fall, respectively. The diagrams reveal a distinct plotting of presumed leachate-impacted monitoring wells including OV-7, BR-1S, BR-1D, and BR-6D. The leachate-impacted cluster for the fall monitoring session shows OV-10 plotting with BR-6D, BR-1D, and BR-1S instead of OV-7, with OV-7 plotting within the “background / undifferentiated cluster” (see below), which is unexpected as OV-7 represents landfill leachate quality. In the spring of 2022, BR-1S plotted outside of all clusters, but closest to the landfill leachate impacted cluster. A second cluster exists for monitoring wells BR-8D (spring), BR-9S , BR-11, BR-12, BR 08-2D, BR 08-3D (spring) and BR 08-3S, and OV-9 (fall). Since BR-8 and BR-9 are located within the area of wood waste (the borehole logs for these wells indicate the presence of between one and two metres of sawdust have been deposited in this area), and BR-11 and BR-12 are downgradient of the wood waste, this result supports the argument that the groundwater plume at the Usborne Street property line is at least partially impacted from the effects of wood waste. It also suggests that monitoring wells BR 08-2D, BR 08-3D and BR 08-3S installed in the CAZ in 2008 are also at least partially impacted by wood waste.

A third cluster, representing background or undifferentiated conditions is evident on both plots. Historically BR-6D, which is located on the Usborne Street property boundary down-gradient of both the landfill and the wood waste, and BR08-1D, which is located within the CAZ, plotted between this cluster and the cluster representing landfill leachate-impacted groundwater and supports the supposition of a combined (wood waste and landfill leachate related) source. Since 2010, BR-6D plots closer to or within (as in 2022) the leachate impacted cluster although its water quality of leachate-indicator parameters has not substantially changed in that time. Between 2016 and 2019, BR08-1D has plotted outside of and between the three identified clusters; in the spring and fall of 2022, BR08-1D and BR08-1S plotted within the background/undifferentiated cluster. BR-9S has historically plotted within the landfill leachate plus wood waste grouping and continued to do so in 2022.

In previous years, monitoring well OV-10 has plotted within the background/undifferentiated cluster but plotted within the presumed leachate impacted cluster during the fall monitoring session in 2022. Although this may be an outlier, it could be an indication of leachate impact at OV-10 as concentrations of some parameters have been increasing in recent years and it is interpreted that there may be some leachate impact observed at OV-10.

7.6 VOC Concentrations

The next scheduled VOC monitoring session is 2024.

7.7 Interpreted Extent of Groundwater Plume

Historically, groundwater quality down-gradient of the landfill site has been described by Robinson Consultants as being impacted by the landfill, industrial activities (rail and lumber activities) and/or road salting activities.

Based on historical results, historical tannin and lignin concentrations, the piper trilinear diagrams, the groundwater flow directions, and the 2022 monitoring activities, groundwater monitors OV-7, BR-1D, BR-1S have been interpreted to be impacted by landfill leachate. Groundwater monitors BR-5D, BR-5S, BR-6D, BR-6S, BR-8D, BR-8S, BR-9D, BR-9S, BR-12, BR 08-1D, BR 08-1S, BR 08-2S and BR 08-2D are interpreted to be impacted by wood waste deposited on the CAZ Areas, and/or by landfill leachate. It is also possible that groundwater monitors BR-5D, BR-5S, BR-6D, BR-6S and BR-12 are also influenced by road salting. Groundwater monitors BR-7D, BR-7S, BR-10, and BR-11 are interpreted to be impacted by road salt, wood waste, or other industrial activities on the CAZ lands, but not by landfill leachate. Groundwater monitors BR08-3D and BR08-3S are interpreted to be potentially impacted by landfill leachate, as well as wood waste or other industrial activities in the CAZ lands. BR08-3D and BR08-3S have historically been interpreted to not be impacted by landfill leachate due to low chloride concentration and based on their position on the piper plots; however, based on their location between the waste and locations further downgradient that are interpreted to be potentially leachate impacted, it is considered possible that landfill leachate is impacting groundwater at this location. It is noted that BR08-3D and BR08-3S are screened at a higher elevation than further downgradient wells BR-5D and BR-5S, respectively, that are interpreted to be potentially impacted by landfill leachate; this difference in elevation may also be contributing to differences in groundwater quality. It is noted that some additional parameters were observed to be increasing at BR-8S / BR-8D and at BR08-1S in 2022 as presented in Table 3; these trends will continue to be monitored.

As discussed in Section 5.3, recent groundwater elevations at OV-9 and OV-10 indicate there may be an eastward component of flow within the overburden, suggesting that OV-9 and OV-10 are downgradient of a portion of the landfill. OV-10 was previously interpreted to be only cross-gradient of the landfill, along with BR-3. The reason for elevated concentrations of several parameters at BR-3 and OV-10 could be associated with the landfill but additional groundwater elevation data is required to validate this. At OV-10, increasing trends have been reported for several leachate indicator parameters, including chloride, barium and sodium since 2006, iron,

potassium and ammonia since 2011, and manganese since 2012. Similar increasing trends are being observed at BR-3, including concentrations of ammonia, DOC, hardness, potassium, and TDS (overall), chloride and sodium since 2009 and manganese beginning to appear to be increasing. Although there are no increasing trends being observed at OV-9, with the exception of sodium concentrations, elevated concentrations of boron and sulphate were observed in 2022. It is interpreted that OV-9, OV-10, and BR-3 may be potentially impacted by landfill leachate. The samples collected from these groundwater monitors will be evaluated carefully in 2023 along with ongoing assessment of groundwater flow direction to assess on-going trends. An additional overburden and bedrock monitoring well was installed toward the south side of CAZ Area B in January 2023 to discern groundwater flow direction and possible landfill leachate impacts at the southern property boundary. Samples will be collected from these new wells during the 2023 monitoring program and reported on in the 2023 Annual Monitoring Report.

It is expected that concentrations of iron, manganese, TDS, and DOC are equally likely to originate from the wood waste as from the landfill leachate and that these parameters are particularly problematic as landfill leachate indicators, while the distribution of barium and boron in the shallow and deep monitors in the licensed landfill area, CAZ Area A and CAZ Area B (BR-1S, BR-1D, BR08-2S, BR08-2D, BR-8D, and others) suggested that these parameters may be better indicators of impact by landfill leachate. The low concentrations of barium and boron in BR-7D, BR-7S, BR-11, BR 08-3D and BR 08-3S, which are interpreted to be impacted by road salt, wood waste or other industrial activities on the CAZ lands but not by landfill leachate, are consistent with this interpretation.

A map showing the water wells within 500 metres from the landfill boundaries is provided (based on MECP water well records) on Figure 10. It is noted that there are no residential wells that are downgradient from the site.

8.0 GROUNDWATER COMPLIANCE ASSESSMENT

Groundwater compliance to MECP Guideline B-7 (MOEE, 1994a) is assessed on the basis of exceedances of the RUPO values and associated trigger values provided in the tables in Sections 7.2.1 and 7.2.2 at overburden and bedrock monitoring wells, respectively, that are located at or near the site boundary. Bedrock monitoring wells at the site boundary include BR-5D, BR-5S, BR-6D, BR-6S, BR-7D, BR-7S, BR-10, BR-11, and BR-12. Overburden monitoring wells at the site boundary include OV-10. With respect to the two 2022 monitoring rounds, they will be referred to herein as the spring round and fall round.

Leachate indicator parameters, iron, manganese and TDS in both the spring and fall sampling rounds exceeded their respective trigger concentrations from Section 7.2.1 at monitor OV-10. TDS has historically been detected in the background monitor at similar concentrations to the spring and fall concentrations in the groundwater from monitor OV-10. The concentration of iron in the spring and fall of 2022 at OV-10 was comparable to historical maximum concentrations in the background well. Concentrations of manganese that exceed the maximum concentration have been generally increasing since 2012, however are still lower than the historic concentrations at this location from 2000 and 2008. Trigger exceedances of TDS, iron and manganese have not previously been attributed to deteriorating groundwater quality due to the landfill. However, due to the increasing trends in some leachate indicator parameters observed at OV-10 and the more recent interpretation of groundwater flow direction, it is possible that these exceedances could be indicative of deteriorating groundwater quality. As stated in Section 7.7, a groundwater monitoring well was installed near the southern corner of CAZ Area B in January 2023to discern groundwater flow direction and possible landfill leachate impacts. Additional data will be obtained in 2023 and provided in the 2023 annual monitoring report.

Not including iron, manganese and TDS which are problematic *leachate indicator parameters* due to their presence in the background monitor, at least one *leachate indicator parameter* from Section 7.2.2 exceeded the trigger concentration in either the spring or fall round, or both of the spring and fall monitoring rounds in monitors, BR-5D, BR-6D, , BR-10, BR-11, and BR-12. It is interpreted that exceedances of trigger concentrations in monitors, BR-5D, BR-6D,and BR-12 result from the effect of the wood waste historically deposited on the CAZ lands north of the Canadian Pacific Rail line, road salting and/or the effect of the landfill. It is interpreted that exceedances of trigger concentrations in monitors BR-10 and BR-11 result from road salt, wood waste, or other industrial activities formerly undertaken on the CAZ lands, but not by landfill leachate, based on the piper plots. It is important to note that the leachate indicator parameters exceeding the trigger concentrations at these locations all have concentrations which are generally consistent, consistently variable or slightly decreasing over time, with the exception of concentrations of DOC at monitoring well BR-6D.

In accordance with ECA No. A412603, issued March 10, 2020, the 20221 data has been interpreted using 75% of the RUPO or the median background value to determine the trigger concentrations. The Town is taking actions to address groundwater compliance issues at the site which are discussed in Section 11.

9.0 SURFACE WATER QUALITY

Currently monitored surface water sampling stations are shown on Figure 2.

According to Robinson Consultants Inc. (1997b), the Arnprior Waste Disposal Site is drained by two watersheds to the Ottawa River. The northern watershed drains most of the landfill area. The watershed is drained by a small intermittent stream through a series of perennial ponds. This watershed has a step-like longitudinal profile with two base levels. One level is located down gradient of the Waste Disposal Site west of the railroad track. Surface water locations SW-2, SW-3, SW-4, SW-5 and SW-6 are located along this level which is controlled by a bedrock ledge. This level is followed downstream by another sill-like scarp to the Ottawa River. Surface water location SW-1 is located along this feature.

The northern watershed is characterized by the occurrence of a series of ponds on both sides of the railroad tracks and by a wetland area north and east of the tracks. Robinson reports that the wetland area behaves as a sink to numerous nutrients, metals and potential contaminants. Processes of the wetland area would include adsorption to settling sediments, plant adsorption, microbial activities and dilution effects.

In addition, the Ottawa River is monitored at locations SW-18 and SW-19 where water from the wetland is expected to possibly discharge to the river. In the case of station SW-19, the actual sampling location is approximately 5 metres upstream of the River. The additional upstream background sampling station for the Ottawa River (SW-26), which was added to the surface water sampling program in 2010, is located approximately 400 metres northwest (upstream) of SW-18.

The southern watershed is approximately twice as large as the northern watershed and approaches the southern boundary of the property. This watershed area is drained by an ephemeral stream (i.e., SW-10) that becomes an intermittent stream (i.e., SW-11 and SW-12) at the downgradient bedrock ledge, at the railroad tracks.

The results of the field and laboratory chemical and physical analyses conducted during the 2021 monitoring program are presented in Appendix C along with relevant PWQO (MOE, 1994b) and the data from previous monitoring sessions. Data from the 2013 monitoring session is provided in a separate table within Appendix C,

with the exception of the data from the background station (SW-10), which is included with all historical data in the main tables in Appendix C. Appendix D contains graphs of all leachate indicator parameter concentrations versus time for surface water sampling locations included in the 2022 monitoring program. These graphs are useful for ascertaining trends in the data but are not specifically referenced in the remainder of the report.

9.1 Flow Conditions

Flow conditions in surface water bodies can have an impact on the parameter concentrations measured and the interpretation of compliance. Stagnant water bodies present the opportunity for some *leachate indicator parameters* to increase for reasons potentially unrelated to landfill leachate effects. Statements regarding flow conditions and some observations at each surface water sampling station during the 2022 monitoring events are provided in the following table.

Sample Station		Surface Water Flow (2022)	Comments
SW-1	Apr	Approx. 11.85 L/s	Clear, no colour, no odour, no sediment
SW-1	Aug	Not measured	Clear, no colour, sulphur odour, no sediment
SW-1	Dec	Not measured	Clear, no colour, faint sulphur odour, no sediment, good flow with no defined flow path to be measured
SW-2	Apr	Not measured	Clear, no colour, no odour, no sediment, good flow
SW-2	Aug	Not measured	Clear, no colour, no odour, no sediment, little flow through culvert
SW-2	Dec	Not measured	Clear, no colour, no odour, no sediment
SW-10	Apr	Approx. 3 L/s	Clear, beige tinge, no odour, no sediment
SW-10	Aug	Dry	Dry
SW-10	Dec	Dry	Dry
SW-11	Apr	Approx. 8.85 L/s	Clear, no colour, no odour, no sediment
SW-11	Aug	Approx. 2.56 L/s	Clear, no colour, no odour, no sediment
SW-11	Dec	Approx. 7.156 L/s	Clear, no colour, no odour, no sediment
SW-12	Apr	Approx. 16 L/s	Clear, no colour, no odour, no sediment
SW-12	Aug	Approx. 3.6 L/s	Clear, no colour, no odour, no sediment
SW-12	Dec	Approx. 16.32 L/s	Clear, no colour, no odour, no sediment
SW-18	Apr	River, not measured	Clear, beige tinge, no odour, trace sediment
SW-18	Aug	River, not measured	Clear, beige tinge, no odour, no sediment
SW-18	Dec	River, not measured	Clear, beige tinge, no odour, no sediment
SW-19	Apr	Approx. 14.4 L/s	Clear, no colour, no odour, no sediment
SW-19	Aug	Dry	Dry
SW-19	Dec	Not measured	Clear, no colour, no odour, no sediment, good flow
SW-21	Apr	Not measured	Clear, no colour, no odour, no sediment, no measurable flow
SW-21	Aug	Dry	Dry
SW-21	Dec	Dry	Dry
SW-22	Apr	Not measured	Clear, no colour, no odour, trace sediment, no measurable flow

Sample Station		Surface Water Flow (2022)	Comments
SW-22	Aug	Dry	Dry
SW-22[1]	Dec	Not measured	Clear, beige tinge, organic odour,
SW-23	Apr	Not measured	Clear, no colour, no odour, no sediments, too shallow to measure flow, water pooling at culvert
SW-23	Aug	Dry	Dry
SW-23	Dec	Dry	Dry
SW-26	Apr	River, not measured	Clear, beige tinge, no odour, trace sediment
SW-26	Aug	River, not measured	Clear, beige tinge, no odour, no sediment
SW-26	Dec	River, not measured	Clear, beige tinge, no odour, no sediment

Notes:
[1]The presence of sediments within surface water sample SW-22 during the December monitoring session was inadvertently missed in the field notes.

Entered by: AYFH
Checked by: ETB

Photographs of sampling stations at the time of each sampling event have been included in Appendix E.

9.2 Quality Assurance/Quality Control

One blind surface water duplicate was analyzed during the spring, summer and fall surface water monitoring session in 2022 as part of the QA/QC protocol. In addition, the laboratory performs equipment blanks as an internal method of QA/QC. All laboratory QA/QC results for surface water were within acceptable tolerance limits in April, August, and December 2022.

Analytical results on blind sample duplicates are deemed to be outside of acceptable tolerance limits if the RPD between the original sample and its duplicate is greater than 50% and both analytical results are greater than 10 times the detection limit, or if the RPD is greater than 30% and both analytical results are greater than 20 times the detection limit. All parameter concentrations were within acceptable tolerance limits during the spring, summer, and fall monitoring sessions.

It was noted during the 2022 monitoring program that it is possible that the data that have been reported as “dissolved aluminum” historically may in fact have been total aluminum. This has been corrected (i.e., dissolved aluminum analyzed and reported) in 2022. Historic results for dissolved aluminum provided in Appendix C may be reported higher than actual historic dissolved aluminum concentrations.

9.3 Background Conditions and Revised PWQO Trigger Concentrations

Background surface water quality for the site is represented by the data available from SW-10 (south of the active landfill). There currently is no distinct background surface water source for the wetland to the north of the site and hence SW-10 is used to represent background for all surface water bodies around the site. Surface water quality at this station is characterized by repeated exceedances of the PWQOs for total phosphorus, aluminum and iron (including in April 2022). Occasional concentrations outside of the PWQOs for dissolved oxygen, cadmium, vanadium and zinc are noted in historical data and copper, cobalt, lead, phenols and silver have exceeded their respective PWQOs on one occasion. For comparison purposes, as discussed in Section 11, the surface water

quality has also been compared to the Canadian Council of Ministers of Environment (CCME) Water Quality Guideline for the Protection of Aquatic Life (CWQG) for boron and chloride (CCME, 2015). The background surface water quality does not exceed the CCME guideline for boron (1.5 mg/L) or the short-term exposure CCME guideline for chloride (640 mg/L). The background surface water quality often exceeds the CCME guideline for long-term exposure of chloride (120 mg/L). The parameter concentrations measured at SW-10 are generally consistent to slightly variable with time. In 2022, SW-10 was dry during the summer and fall monitoring events.

The background surface water quality for each of the *leachate indicator parameters* for background surface water station SW-10, compliance parameter concentrations and current trigger parameter concentrations are presented below. It should be noted that the following PWQO trigger concentrations deviate from the values used by Robinson Consultants Inc. but they are the same as in the 2005 Operations and Environmental Monitoring Report (Golder, 2006). In the 2013 Site Development, Operations and Environmental Monitoring Report (Jp2g, 2014), Jp2g recommended using the trigger mechanism currently in use, with the exception of changing the guideline for boron from the PWQO of 0.2 mg/L to the CCME guideline of 1.5 mg/L. Condition 20.2 of the ECA indicates that surface water quality at the site should be assessed with respect to PWQO. Since the use of the CCME guideline is acceptable to the MECP reviewer (Golder, 2015) it is presented and discussed in the following section but not used to assess trigger compliance. The MECP reviewer also recommended using the CCME guideline for chloride. For the same reasons, the CCME chloride criteria (for short-term and long-term exposure) are used for discussion, but not used to assess trigger compliance at the site. The chloride guideline should not be used on its own to make decisions about compliance of the site.

Condition 28.2 of ECA No. A412603 requires that within six (6) months of the receipt of comments on the submission mentioned in Condition 28.1 from the District Manager (see Section 11.1 of this Report), the Owner shall submit to the Director for approval an amendment application for an update to this ECA that will include details of the contingency plan to be implemented as approved by the District Manager and a proposed deadline for an update to the trigger mechanism.

Leachate Indicator Parameters	PWQO (mg/L)	n	Background Range[1] (mg/L)	75th Percentile Compliance for Parameters with PWQO (mg/L)	PWQO Trigger Parameter Concentration (higher of PWQO or 75th Percentile) or CCME Criteria (mg/L)
Alkalinity	75% Bkgd	32	118 – 370	283	<283[3]
Unionized Ammonia	0.02	31	<0.02 (2.0)**	NC	>0.02
Barium	- -	27	0.02 – 0.06	- -	- -
Boron	0.2 (1.5 [2])	27	<0.01 – 0.18	0.04	>0.2 (>1.5[2])
Chloride	640 [2] 120 [2]	33	10.7 – 422	160	>640[2] >120[2]
Iron	0.3	33	0.06 – 2.5*	0.74	>0.74
Hardness	- -	32	130 – 448	- -	- -
Manganese	- -	26	<0.005 – 0.16	- -	- -
Potassium	- -	32	3 – 8.4	- -	- -
Sodium	- -	32	0.5 – 206	- -	- -
DOC	- -	22	1.28 – 13	- -	- -
TDS	- -	33	163 – 1290	- -	- -
Total Phosphorus	0.03	31	0.06 – 0. 42 (1.01***)	0.19	>0.19

Notes:

Entered by: ALC
Checked by: ETB

mg/L – milligrams per Litre
n – Number of surface water samples collected
PWQO – Provincial Water Quality Objectives (1994b)
* Value exceeds the PWQO
** The value of 2.0 mg/L was obtained in November 1993 however the total ammonia concentration was 0.28 mg/L; therefore, the 2.0 mg/L appears to be an error and will not be included in the evaluation of trigger concentrations.
*** The value of 1.01 mg/L was obtained in May 1995 and appears to be an error and will not be included in the evaluation of trigger concentrations
NC – 75th percentile value not calculated because >50% of data for parameter are “non-detects”
[1] Background surface water quality based on SW-10
[2] CCME Water Quality Guidelines for the Protection of Aquatic Life for short term and long term exposure, respectively.
[3] The trigger value for alkalinity is based on the 75th percentile value at the background location.

The calculated surface water PWQO trigger parameter concentrations based on data available from surface water sampling stations SW-10 will be modified, as required, based on additional background surface water quality data which will be obtained during future monitoring programs.

9.4 Discussion

Table 4 summarizes the physical and chemical parameters with reported levels exceeding their respective trigger values based on PWQO; trends in surface water quality; a comparison of the surface water quality to background conditions; and, an interpretation of the surface water quality data.

9.4.1 Southern Ephemeral/Intermittent Stream

The southern watershed containing the ephemeral/intermittent stream is outside the southern boundary of the property. Based on the stream's location and water quality data, it is interpreted not to be impacted by landfill leachate. The concentrations of chloride and sodium at SW-11 and SW-12 have historically shown a very slight increasing trend over time. The concentrations of chloride and sodium are generally highest at upstream monitoring station SW-10, indicating that the source is not related to the landfill. Based on the elevated concentration of these parameters, it is considered that these results are likely related to road salting activities and/or industrial activities. While there were some parameters with elevated concentrations in the summer and/or fall of 2022 as noted in Table 4, the recent and historic water quality data for locations SW-10, SW-11 and SW-12 suggest a generally consistent water quality that is not being impacted by the landfill.

The concentrations of total phosphorus, aluminum and total iron were outside their respective PWQO during the April sampling session at SW-10 (SW-10 was dry in August and December). The concentration of total iron was outside the PWQO during all three sampling sessions at SW-11 and in the summer at SW-12. The concentration of unionized ammonia was outside the PWQO during the summer sampling session at SW-11 and SW-12. There were no other exceedances of the PWQO during the 2022 sampling sessions at SW-10, SW-11 or SW-12. There were no exceedances of the CCME guidelines for chloride (short-term and long-term exposure) or boron at these locations during 2022. Historical exceedances observed at these sampling locations may be natural or may be attributable to road salting activities and/or industrial activities.

9.4.2 Ponds/Wetland

All of the surface water sampling stations sampled within and on the periphery of the wetland (SW-1, SW-2, SW-21, SW-22 and SW-23) had one or more parameters that did not meet the PWQO (unionized ammonia, dissolved oxygen, total phosphorous, boron and/or iron) in 2022. There were no exceedances of the CCME guideline for boron or chloride (short-term and long-term exposure) at these locations during 2022. SW-23 was dry (or had insufficient volume to sample) during the spring and fall sampling sessions, SW-21 was dry (or had insufficient volume to sample) during the summer and fall sampling sessions, and SW-22 was dry (or had insufficient volume to sample) during the summer sampling session. Historically, an overall decreasing trend in dissolved oxygen has been observed from 2005 to 2016 at these locations, with the exception of SW-23 which has only been sampled three times since 2004 due to dry conditions. Reported concentrations of dissolved oxygen appear to be stabilizing or increasing at these locations based on the data from recent monitoring sessions (2017 to 2022). The PWQO exceedances observed at SW-1, SW-2, SW-21, SW-22 and SW-23 may be attributable to the landfill, historic industrial activities associated with the railway or lumber industries (i.e., the wood waste). As well, evaporation from the stagnant water within the wetland may be resulting in elevated parameter concentrations in surface water. Concentrations of other leachate indicator parameters at SW-2 are not observed to be increasing with the exception of boron and potassium which were interpreted in 2022 to be possibly increasing (concentrations remain within the historic range at this location at this time).

9.4.3 Ottawa River

Surface water sampling location SW-18 within the Ottawa River is interpreted not to be impacted by the landfill leachate, even though the concentration of aluminum and total iron were above the PWQO criteria during the spring and fall monitoring session in 2022. The background surface water sampling location SW-26 within the Ottawa River had similar water quality to SW-18 in 2022 with SW-26 water sample concentrations of aluminum outside the PWQO in the spring, and slightly below PWQO in the summer, and fall monitoring sessions, and concentration of total iron outside the PWQO concentration during the spring sampling session in 2022, as well as unionized ammonia exceeding the PWQO in the summer of 2022. There were no exceedances of the CCME guidelines for chloride (short-term and long-term exposure) or boron at either of these locations during 2022. As indicated in Table 4, several metals, as well as chloride, hardness and TDS, exceeded the historical maximum background concentration (at the river background location,SW-26) at SW-18 in the fall of 2022. The data will be evaluated in 2023 to determine if this could be a trend.

Water quality within the river is distinctly different than the ephemeral/intermittent stream and the ponds/wetland. Surface water sampling location SW-19, located approximately 5 metres upstream along a tributary which flows into the Ottawa River, is interpreted to possibly be impacted by landfill leachate. Total iron exceeded the PWQO during the fall sampling session in 2022. Although it is interpreted that SW-19 may be impacted by landfill leachate, dissolved oxygen, total phosphorous, boron and iron have periodically been outside the PWQO trigger concentrations at this location in the last number of years but in general water quality has remained consistent. SW-19 was dry (or had insufficient volume to sample) in summer 2022.

9.4.4 Beaver Dams

The concern with beaver dams at landfills is with the potential for failure, causing potentially leachate-impacted water and sediment to suddenly be released to downstream surface waters. For this reason, the extent of beaver activity within the wetland watershed was monitored during 2022, with emphasis on documenting the location and age of the beaver dams.

Beaver activity was noted upstream of sampling location SW-2 during the 2021 sampling sessions. Beaver activity in this area has been reported since 2014. Beaver activity was observed during the 2022 monitoring session, but there were no changes to existing dam features. Beaver activity will continue to be monitored during the 2023 monitoring program to determine the extent of the beaver activity and if steps need to be taken to control the activity.

10.0 SURFACE WATER COMPLIANCE ASSESSMENT

This section provides a surface water compliance assessment under MECP Policy 1 and Policy 2 (MOE, 1994b) based on the surface water PWQO trigger mechanism developed for the Arnprior Waste Disposal Site as outlined in Section 9.3.

For the purpose of this surface water quality compliance assessment, the PWQO and the surface water triggers are applied to surface water sampling stations SW-1 and SW-2. SW-1 is located where the northern wetland flows off the landfill site CAZ and SW-2 is located near the inlet of the northern wetland. The point of compliance at SW-2 was added in the 2008 Annual Report (Golder, 2009), as recommended by the MECP, to provide an earlier warning further upstream of potential impacts by landfill site contaminants to the receiving surface water regime. The trigger parameters include alkalinity, boron, iron, total phosphorus and unionized ammonia. Iron and total phosphorus represent Policy 2 parameters and the remaining parameters are Policy 1 parameters. Chloride will be compared to the CCME guideline for comparison purposes since there is not a PWQO for chloride.

At surface water sampling station SW-2, leachate indicator parameters unionized ammonia, total iron and boron exceeded the PWQO trigger concentrations during either the spring (unionized ammonia and boron) or summer (total iron) monitoring session in 2022. No other PWQO trigger concentrations were exceeded in 2022 at surface water sampling station SW-2. Boron and total iron exceeded the respective PWQO trigger concentration at surface water sampling station SW-1 during the summer monitoring session in 2022. The concentrations of unionized ammonia, boron and total iron exceeding the trigger concentrations at SW-1 and SW-2 in 2022 were within the historical concentrations at these locations, however total iron was noted as being elevated relative to recent concentrations in the summer of 2022 (returning to concentrations below the PWQO trigger in the fall). Note that the CCME criteria for chloride and boron were not exceeded at SW-1 or SW-2 in 2022. A review of the 2022 surface water concentrations indicate that contingency measures are not required at this time. As discussed in Section 9.4.2, the PWQO exceedances observed at SW-1 and SW-2 may be attributable to the landfill, historic industrial activities associated with the railway or lumber industries (i.e., the wood waste). As well, evaporation from the stagnant water within the wetland may be resulting in elevated parameter concentrations in surface water. While leachate indicator parameter concentrations have been observed to be variable over time at SW-1 and SW-2, increasing trends are not being observed.

11.0 MECP CORRESPONDENCE

11.1 Groundwater Compliance

As discussed in the 2020 Annual Monitoring Report (Golder, 2021), a revised ECA for the site was received on March 10, 2020. Condition 28.1 of the revised ECA A412603 required that by no later than June 30, 2020, the Town shall submit to the District Manager contingency measures to address groundwater compliance at the Site. This deadline was subsequently changed to December 31, 2020, following submission of a “Request for Pandemic Related Temporary Regulatory Relief (Alternate Arrangement) for Waste Disposal Sites and Waste Management System” by the Town dated June 15, 2020.

In a letter dated December 3, 2020, Golder provided the District Manager with the Town’s preferred contingency option to address the groundwater compliance issue. It is considered that the submission of this letter fulfills the requirements of Condition 28.1. This letter is provided in Appendix F.

Groundwater comments (dated April 16, 2021) and surface water comments (dated April 23, 2021) on the 2020 Annual Monitoring Report (Golder, 2021) and on the contingency measures presented in the December 3, 2020 letter were received from MECP on May 19, 2021. Section 11.2 of the 2021 Annual Monitoring Report (Golder, 2022) provides a response to the comments. In providing the response, the MECP Environmental Officer stated that the MECP agrees that obtaining a “right of first refusal” to purchase the downgradient groundwater rights may comply with the requirements in the Reasonable Use Guideline (RUG) (Guideline B-7) (given that there are currently no groundwater users downgradient from the Site), but that the MECP will require a detailed proposal that includes the legal instruments to be used to obtain these rights before the MECP could provide a definite response. Comments and the covering email are provided in Appendix F.

Subsequently, a call was held on November 3, 2021 between the MECP, the Town, the Town’s legal counsel and Golder to discuss progress on resolving groundwater compliance concerns at the Site, including communications that had been had with the downgradient property owner. A summary of this call is provided in Appendix F. As a result of this meeting, it was agreed that the Town and their legal counsel would provide a list to the MECP of possible legal options that would involve registration on title of the property to restrict groundwater use, and that the MECP would review and identify which options would be acceptable prior to further engagement with the

downgradient property owner so as not to spend time on an option with the downgradient property owner that would be unacceptable to the MECP.

As requested in the November 3, 2021 call, in an email from MECP Environmental Officer Thandeka Ponalo dated November 18, 2021, it was confirmed that the six month deadline to fulfill Condition 28.2 of ECA No. A412603 had not been triggered by the comments received in May 2021. This email is provided in Appendix F.

11.2 Groundwater and Surface Water Comments

Groundwater comments and surface water comments on the 2020 Annual Monitoring Report (Golder, 2021) and on the contingency measures presented in the December 3, 2020 letter were received from MECP on May 19, 2021. These comments were addressed in the 2021 Annual Monitoring Report (Golder, 2022). Comments on the 2021 Annual Monitoring Report were not received by the Town in 2022.

12.0 PROPOSED 2023 ENVIRONMENTAL MONITORING PROGRAM AND ACTIVITIES

12.1 Objectives

The objectives of the 2023 environmental monitoring program are:

- To comply with the annual monitoring and reporting requirements stipulated in Conditions 20 and 27 of Certificate of Approval No. A412603.
- To continue to monitor background groundwater and surface water quality; leachate quality; groundwater quality immediately downgradient of the landfilled area; and surface water quality at various locations in the vicinity of the site.
- To assess site compliance with site-specific trigger levels relating to groundwater and surface water impacts due to landfill leachate-related impacts.

12.2 Groundwater Component

The groundwater monitoring program proposed for 2023 is provided in Table 5 and is the same as the monitoring program completed in 2022, with the inclusion of the new groundwater monitoring wells installed in 2023.

12.3 Surface Water Component

The proposed 2023 surface water monitoring program is provided in Table 6. There are no proposed changes from the 2022 program.

12.4 Landfill Gas Component

Jp2g recommended monitoring landfill gas from on-site groundwater monitoring wells. Due to the construction of the groundwater monitoring wells and the location of the water table, monitoring the groundwater monitoring wells will not provide information on the lateral migration of landfill gas. Landfill gas monitoring from on-site groundwater monitoring wells is not recommended for 2023.

12.5 Site Activities

Beaver activity at the site will be documented with field notes and photographs where appropriate. A groundwater monitor condition survey will be carried out in the spring and fall of 2023.

12.6 Compliance Related Activities

Trigger mechanisms and contingency measures were proposed in the 2013 Site Development, Operations and Environmental Monitoring Report (Jp2g, 2014). The recommended contingencies included installing groundwater monitoring wells on adjacent downgradient properties and/or acquiring additional CAZ. Given the historical land use around the site and known requirements of the existing property owner(s), this proposed contingency measure is not readily achievable.

Condition 28.1 of the revised ECA received on March 10, 2020 (see Section 11.2) required that by no later than June 30, 2020, the Town shall submit to the District Manager contingency measures to address groundwater compliance at the Site.

In a letter dated December 3, 2020, Golder provided the District Manager with the Town's preferred contingency option to address the groundwater compliance issue. It is considered that the submission of this letter fulfills the requirements of Condition 28.1. This is discussed further in Section 11.1.

As discussed in Section 2.5 of this report, the Town intends to enter into discussion with the MECP to determine how the fill beyond approved limits, which is now understood to consist of waste material, is to be managed.

13.0 LIMITATIONS AND USE OF REPORT

This report was prepared for the exclusive use of the Town of Arnprior. The report, which specifically includes all tables, figures and appendices, is based on data and information collected by WSP Canada Inc. (WSP) and is based solely on the conditions at the site at the time of the work, supplemented by historical information and data obtained by Golder and others as described in this report. Each of these reports must be read and understood collectively and can only be relied upon in their totality.

WSP has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements, or inaccuracies contained in the reports as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

The assessment of environmental conditions at this site has been made using the results of physical measurements and chemical analyses of liquids from a number of locations. The site conditions between sampling locations have been inferred based on conditions observed at borehole locations. Subsurface conditions may vary from these sampled locations.

The services performed, as described in this report, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this report, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. WSP accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this report.

The findings and conclusions of this report are valid only as of the date of this report. If new information is discovered in future work, including excavations, borings, or other studies, WSP should be requested to re-evaluate the conclusions of this report, and to provide amendments as required. The groundwater monitors installed during previous investigations by WSP or other consultants have been left in place. These groundwater monitors are the property of the Town of Arnprior and not WSP.

Signature Page

WSP Canada Inc.

Emily Bacon, M.Eng., P.Eng.
Civil Engineer

Andria Caletti, P.Eng.
Environmental Engineer

ETB/ALC/PLE/sg

https://golderassociates.sharepoint.com/sites/154884/project files/5 technical work/report/01_report/21500011-r-rev0-2022 arnprior wds amr - mar2023.docx

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Tables

Table 1 – Review of Conditions of Environmental Compliance Approval No. A412603

Condition No.	Item	Comments
1.1	The Owner shall ensure that any person authorized to carry out work on or operate any aspect of the Site is notified of the ECA and the conditions herein and shall take all reasonable measures to ensure the person complies with the same.	Understood
1.2	Any person authorized to carry out work on or operate any aspect of the Site shall comply with the conditions of this ECA.	Understood
2.1	Except as otherwise provided for in this ECA, the Site shall be designed, developed, constructed, operated, modified and maintained in accordance with the application for this ECA and the supporting documentation listed in Schedule "A".	Understood
3.1	The issuance of, and compliance with, this ECA does not: (a) relieve any person of any obligation to comply with any provision of the EPA or any other applicable statute, regulation or other legal requirement; or (b) limit in any way the authority of the Ministry to require certain steps be taken or to request that any further information related to compliance with this ECA be provided to the Ministry; unless a provision of this ECA specifically refers to the other requirement or authority and clearly states that the other requirement or authority is to be replaced or limited by this ECA.	Understood
4.1	The Owner or Operator remain responsible for any contravention of any other condition of this ECA or any applicable statute, regulation, or other legal requirement resulting from any act or omission that caused an adverse effect or impairment of air and/or water quality.	Understood
5.1	Any information requested by the Ministry concerning the Site and its operation under this ECA, including but not limited to any records required to be kept by this ECA shall be provided in a timely manner.	Understood
5.2	The receipt of any information by the Ministry or the failure of the Ministry to prosecute any person or to require any person to take any action, under this ECA or under any statute, regulation or subordinate legal instrument, in relation to the information, shall not be construed as: (a) an approval, waiver, or justification by the Ministry of any act or omission of any person that contravenes any condition of this ECA or any statute, regulation or other subordinate legal requirement; or (b) acceptance by the Ministry of the information's completeness or accuracy.	Understood
5.3	Any information related to this ECA and contained in Ministry files may be made available to the public in accordance with the provisions of the Freedom of Information and Protection of Privacy Act, R.S.O. 1990, C. F-31.	Understood
6.1	Where there is a conflict between a provision of any document, including the application, referred to in this ECA, and the conditions of this ECA, the conditions in this ECA shall take precedence.	Understood
6.2	Where there is a conflict between the application and a provision in any documents listed in Schedule "A", the application shall take precedence, unless it is clear that the purpose of the document was to amend the application and that the Ministry approved the amendment in writing.	Understood
6.3	Where there is a conflict between any two documents listed in Schedule "A", other than the application, the document bearing the most recent date shall take precedence.	Understood

Condition No.	Item	Comments
6.4	The conditions of this ECA are severable. If any condition of this ECA, or the application of any condition of this ECA to any circumstance, is held invalid or unenforceable, the application of such condition to other circumstances and the remainder of this ECA shall not be affected thereby.	Understood
7.1	Pursuant to Section 197 of the EPA , no person having an interest in the Site shall deal with the Site in any way without first giving a copy of this ECA to each person acquiring an interest in the Site as a result of the dealing.	Understood
7.2	In the event any land is acquired that will be included as part of the Site, two (2) copies of a completed Certificate of Requirement, containing a registerable description of the Site, shall be submitted to the Director for the Director's signature within sixty (60) calendar days of a notice being issued for the Site that incorporates the land into the ECA.	Understood
7.3	In the event any land is acquired that will be included as part of the Site as discussed in Condition 7.2 then the Certificate of Requirement shall be registered in the appropriate land registry office on title to the Site and a duplicate registered copy shall be submitted to the Director within ten (10) calendar days of receiving the Certificate of Requirement signed by the Director.	Understood
8.1	The Owner shall notify the Director , in writing, and forward a copy of the notification to the District Manager, within 30 days of the occurrence of any changes in the following information: ■ the ownership of the Site; ■ the Operator of the Site; ■ the address of the Owner or Operator; ■ the partners, where the Owner is or at any time becomes a partnership and a copy of the most recent declaration filed under the Business Names Act, R.S.O. 1990, c. B-17 shall be included in the notification; and ■ the name of the corporation where the owner is or at any time becomes a corporation, other than a municipal corporation, and a copy of the most current information filed under the Corporations Information Act, R.S.O. 1990, c. C-39 shall be included in the notification.	Understood
8.2	No portion of this Site shall be transferred or encumbered prior to or after closing of the Site unless the Director is notified in advance and is satisfied with the arrangements made to ensure that all conditions of this ECA will be carried out and that sufficient financial assurance is deposited with the Ministry to ensure that these conditions will be carried out.	Understood
9.1	No person shall hinder or obstruct a Provincial Officer from carrying out any and all inspections authorized by the EPA, OWRA or the PA, of any place to which this ECA relates, and without limiting the foregoing: ■ to enter upon the premises where the approved works are located, or the location where the records required by the conditions of this ECA are kept; ■ to have access to, inspect, and copy any records required to be kept by the conditions of this ECA; ■ to inspect the Site, related equipment and appurtenances; ■ to inspect the practices, procedures, or operations required by the conditions of this ECA; and ■ to sample and monitor for the purposes of assessing compliance with the terms and conditions of this ECA, or the EPA, OWRA or the PA.	Understood

Condition No.	Item	Comments
10.1	The service area from which the landfill receives waste shall be limited to the Town of Arnprior, Village of Braeside and the Township of McNab.	Understood
10.2	a) The hours of operation for the Site are: Monday through Saturday, 9:00 a.m. to 4:00 p.m. b) The Owner may change the hours of operation for the Site with the approval of the District Manager.	Understood
11.1	The Owner shall install a sign at the main entrance/exit to the Site on which is legibly displayed the following information: a) The name of the Site and Owner; b) the number of this Approval; c) the operating hours of the Site; d) a twenty-four (24) hour telephone number that can be used to reach the Owner in the event of a complaint or an emergency; e) the type of waste that is approved for receipt at the Site; f) a warning against unauthorized access; and g) a warning against dumping outside the Site.	Update to the sign is planned for spring of 2023 to correct operating hours
12.1	The Site shall be operated and maintained such that the vermin, vectors, dust, litter, odour, noise and traffic do not create a nuisance.	In Compliance
13.1	Burning of waste at the Site is prohibited.	Understood
13.2	Notwithstanding Condition 13.1, the burning of brush, trees and clean wood may be conducted at the Site in accordance with Section 4.21 and Item no. 3 of Appendix E of the Ministry's "Guidance Manual for Landfill Sites Receiving Municipal Waste" dated November 1993.	Understood
14.1	No waste shall be received, landfilled or removed from the Site unless Trained Personnel are present and supervises the operations during operating hours. Landfilling and waste diversion activities shall not be undertaken when Trained Personnel are not present to supervise these operations.	Understood
14.2	The Site shall be operated and maintained in a safe and secure manner. During non-operating hours, the Site entrance and exit gates shall be locked and the Site shall be secured against access by unauthorized persons.	In Compliance
15.1	A training plan specific to the Site shall be developed and implemented to ensure that all employees that operate the Site or carry out any activity required under this Approval are trained in the operation related to that activity.	In Compliance
16.1	If at any time the Owner receives complaints regarding the operation of the Site, the Owner shall respond to these complaints according to the following procedure: a) The Owner shall record and number each complaint, either electronically or in a log book, and shall include the following information: the nature of the complaint, the name, address and the telephone number of the complainant if the complainant will provide this information and the time and date of the complaint; b) The Owner, upon notification of the complaint, shall initiate appropriate steps to determine possible causes of the complaint, proceed to take the necessary actions to eliminate the cause of the complaint and forward a formal reply to the complainant; and c) The Owner shall complete and retain on-site a report written within one (1) week of the complaint date, listing the actions taken to resolve the complaint and any recommendations for remedial measures, and managerial or operational changes to reasonably avoid the recurrence of similar incidents.	Understood

Condition No.	Item	Comments
17.1	Any spills, fires and emergency situations at the Site resulting from activities approved under this ECA and with impacts to the environment or the health and safety of the public shall be forthwith reported directly to the Ministry's Spills Action Centre (1-800-268-6060) and shall be cleaned up immediately.	Understood
17.2	In addition, the Owner shall submit, to the District Manager a written report within three (3) business days of the emergency situation under Condition 17.1, outlining the nature of the incident, remedial measures taken, handling of waste generated as a result of the emergency situation and the measures taken to prevent future occurrences at the Site.	Understood
17.3	All wastes resulting from an emergency situation shall be managed and disposed of in accordance with Reg. 347.	Understood
17.4	All equipment and materials required to handle the emergency situations shall be: a) kept on hand at all times that waste landfilling and/or handling is undertaken at the Site; and b) adequately maintained and kept in good repair.	Understood
17.5	The Owner shall ensure that the emergency response personnel are familiar with the use of such equipment and its location(s).	Understood
18.1	A visual inspection of the entire Site and all equipment on the Site shall be conducted each day the Site is in operation to ensure that: a) the Site is secure; b) that the operation of the Site is not causing any nuisances including those from dust, odours, vectors, vermin, birds, litter, noise and traffic; c) that the operation of the Site is not causing any visual negative impacts on the environment or the health and safety of the public; and d) that the Site is being operated in compliance with this Approval. Any deficiencies discovered as a result of this inspection shall be remedied immediately, including temporarily ceasing operations at the Site if needed.	In compliance
18.2	A record of the inspections shall be kept in a daily log book that includes: a) the name of the person that conducted the inspection; b) the date and time of the inspection; c) the list of any deficiencies discovered; d) the recommendations for remedial action; and e) the date, time and description of actions taken.	In compliance
18.3	A record shall be kept in the daily log book of all refusals of waste shipments, the reason(s) for refusal, and the origin of the waste, if known.	In compliance

Condition No.	Item	Comments
19.1	A daily log shall be maintained in written or electronic format and shall include the following information: a) the type, date and time of arrival, hauler, and quantity (tonnes) of all waste and cover material received at the Site; b) the area of the Site in which waste disposal operations are taking place; c) a record of litter collection activities and the application of any dust suppressants; d) a record of the daily inspections; and e) a description of any out-of-service period of any control, treatment, disposal or monitoring facilities, the reasons for the loss of service, and action taken to restore and maintain service.	In compliance
20.1	By March 31st of each year, an annual monitoring report (the "Annual Report") shall be submitted to the Regional Director reporting the results of the monitoring carried out during the previous calendar year.	Understood
20.2	The Annual Report shall include but not be limited to the following information: a) the results and an interpretive analysis of the results of all leachate, groundwater, and surface b) water and monitoring, including an assessment of the need to amend the monitoring programs; c) an assessment of groundwater quality and compliance with Guideline B-7 and ODWO; d) an assessment of surface water quality and compliance with PWQO; e) an assessment of the operation and performance of all engineered facilities, the need to amend the design or operation of the Site, and the adequacy of and need to implement the contingency plans; f) site plans showing the existing contours of the Site; areas of landfilling operation during the reporting period; areas of intended operation during the next reporting period; areas of excavation during the reporting period; the progress of final cover, vegetative cover, and any intermediate cover application; facilities existing, added or removed during the reporting period; and site preparations and facilities planned for installation during the next reporting period; calculations of the volume of waste, daily and intermediate cover, and final cover deposited or placed at the Site during the reporting period and a calculation of the total volume of Site capacity used during the reporting period; g) a calculation of the remaining capacity of the Site and an estimate of the remaining Site life; h) a summary of the total annual quantity of waste received on a quarterly basis at the Site; i) a summary of any complaints received and the responses made; j) a discussion of any operational problems encountered at the Site and corrective action taken; k) any changes to the Design and Operations Report and the Closure Plan that have been approved by the Director since the last Annual Report; l) a report on the status of all monitoring wells and a statement as to compliance with Ontario Regulation 903; and m) any other information with respect to the Site which the Regional Director may require from time to time.	In compliance
21.1	The Site is approved for the landfilling of solid non-hazardous waste from domestic, commercial and industrial sources, and de-watered sewage sludge.	Understood

Condition No.	Item	Comments
21.2	Dewatered sludge shall be disposed in accordance with the following sub-conditions: a) sewage sludge shall be covered immediately following disposal and following incorporation into the active fill; b) no sewage sludge shall be disposed of at the tipping face of the landfill used by the general public; and c) access road and buffer areas shall be clear of any sludge material at all times.	Understood
21.3	The maximum amount of waste landfilled at the Site shall not exceed 12,000 tonnes per year.	In compliance
22.1	Waste shall only be landfilled within the confines of the 6.2 hectares fill area and final top waste contours approved under this ECA.	Understood
22.2	No waste shall be deposited at the Site after the final contours have been attained as shown on Figure 4 and Figure 5 of Item no. 11 of Schedule "A".	Understood
22.3	No additional waste shall be landfilled in the Fill Beyond Approved Limits area identified in Figure 5 of Item no. 11 of Schedule "A".	Understood
23.1	The minimum thickness of daily cover shall be 150 millimetres as indicated in Item no. 11 of Schedule "A".	Understood
23.2	A suitable stockpile of clean cover material, which shall be equivalent to 50% of the quantity of the required annual daily cover material shall be maintained at the Site as a contingency measure.	In compliance
23.3	The use of processed (chipped and/or mulched) wood as an alternative daily cover is allowed at the Site subject to the following sub-conditions: a) i. The source of all construction, demolition and woodwaste coming to the landfill Site shall be limited to within the approved service area. ii. Notwithstanding Condition 23.3 (a) (i) above, woodwaste suitable for chipping and/or mulching may be received from outside the approved service area provided it is within 100 kilometres of the Site. b) Stockpiling of waste shall be limited to wood or wood products with maximum dimensions of 30 metres by 15 metres by 10 metres. c) Stockpiles shall be located a minimum of 30 metres away from any forested area. d) Stockpiles shall be processed (chipped and/or mulched) once a year at a minimum, and shall not exceed the annual daily cover requirements of the Site by volume.	In compliance
24.1	The minimum thickness of intermediate cover shall be 300 millimetres as indicated in Item no. 11 of Schedule “A”.	Understood
24.2	The Site is approved to import up to 6,000 cubic metres of hydrocarbon contaminated (non-hazardous) soil to be used as an intermediate cover.	Understood
25.1	The maximum height of the peak/crown for the refuse and final cover shall not exceed 120.0 metres above the assumed elevation datum, as indicated in Figure 4 and Figure 5 of Item no. 11 of Schedule "A".	Understood
25.2	The final completed contours shall include 0.7 metre of final cover. This final cover shall consist of 0.6 metre of silt and/or clay overlain by 0.1 metre of topsoil or soil capable of sustaining vegetation.	Understood
26.1	Guideline B-7 levels are established on Pages 17 and 18 of Item no. 9 of Schedule "A". Trigger levels shall be 75% of the Guideline B-7 levels at the CAZ boundary.	Understood

Condition No.	Item	Comments
27.1	a) The Owner shall carry out the groundwater monitoring program in accordance with Item no. 11 of Schedule "A". b) Any proposed changes to the groundwater monitoring program shall be subject to the approval of the Regional Director.	Understood
27.2	a) The Owner shall carry out the surface water sampling program in accordance with Item no. 11 of Schedule "A". b) The surface water sampling program is subject to any changes to the OWRA, and/or to recommendations made by the Ministry. c) Any proposed changes to the surface water monitoring program shall be subject to the approval of the Regional Director.	Understood
28.1	By no later than June 30, 2020, the Owner shall submit to the District Manager contingency measures to address groundwater compliance at the Site.	Complete
28.2	Within six (6) months of the receipt of comments on the submission mentioned in Condition 28.1 from the District Manager, the Owner shall submit to the Director for approval an amendment application for an update to this ECA. The amendment application shall include: a) details of the contingency plan to be implemented as approved by the District Manager; and b) a proposed deadline for an update to the trigger mechanism.	Understood

Condition No.	Item	Comments
29.1	No less than one (1) year prior to the planned closure of the Site, the Owner shall submit to the Director for approval, with copies to the District Manager, a detailed Site closure plan pertaining to the termination of landfilling operations at this Site, post-closure inspection, maintenance and monitoring, and end use. The plan shall include the following: a) final contour plan; b) a description of the proposed end use of the Site; c) a description of the procedures for closure of the Site, including: i. advance notification of the public of the landfill closure; ii. posting of a sign at the Site entrance indicating the landfill is closed and identifying any alternative waste disposal arrangements; iii. completion, inspection and maintenance of the final cover and landscaping; iv. Site security; v. removal of unnecessary landfill-related structures, buildings and facilities; vi. final construction of any control, treatment, disposal and monitoring facilities for leachate, groundwater, surface water, stormwater and landfill gas; and vii. a schedule indicating the time-period for implementing sub-conditions (i) to (vi) above; d) descriptions of the procedures for post-closure care of the Site, including: i. operation, inspection and maintenance of the control, treatment, disposal and monitoring ii. facilities for leachate, groundwater, surface water, stormwater and landfill gas; iii. monitoring of Site settlement; iv. record keeping and reporting; and v. complaint contact and response procedures; e) an assessment of the adequacy of and need to implement the contingency plans for leachate; f) an assessment of the need for a landfill gas venting system in the final cover; and g) an updated estimate of the contaminating life span of the Site, based on the results of the monitoring programs to date.	Understood
29.2	The Site shall be closed in accordance with the closure plan as approved by the Director.	Understood
30.1	Waste diversion activities are hereby approved to be to be conducted at the Site in accordance with the Design and Operations Report listed in Item no. 11 of Schedule "A".	Understood

Table 2 – Groundwater Elevations

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) April 30, 2008	Ground-water Elev. (m) April 30, 2008	Ground-water Depth (mbTOP) November 27, 2008	Ground-water Elev. (m) November 27, 2008	Ground-water Depth (mbTOP) April 24, 2009	Ground-water Elev. (m) April 24, 2009	Ground-water Depth (mbTOP) November 27, 2009	Ground-water Elev. (m) November 27, 2009
BR-1S	85.04	85.40	2.20	83.20	2.31	83.09	3.03	82.37	3.14	82.26
BR-1D	85.04	85.36	8.61	76.75	8.84	76.52	7.78	77.58	7.84	77.52
BR-3	89.63	89.86	2.51	87.35	2.665	87.20	2.10	87.76	2.175	87.69
BR-5S	83.95	84.39	6.87	77.52	7.68	76.71	6.87	77.52	6.91	77.48
BR-5D	83.95	84.37	7.74	76.63	7.91	76.46	6.96	77.41	6.995	77.38
BR-6S	82.06	82.79	6.67	76.12	7.26	75.53	6.17	76.62	6.23	76.56
BR-6D	82.06	82.77	6.46	76.31	7.07	75.70	6.54	76.23	6.62	76.15
BR-7S	79.69	80.76	4.9	75.86	5.02	75.74	4.64	76.12	4.71	76.05
BR-7D	79.69	80.76	4.76	76.00	4.88	75.88	4.5	76.26	4.53	76.23
BR-8S	85.17	85.90	3.17	82.73	3.19	82.71	2.63	83.27	2.665	83.24
BR-8D	85.17	85.95	3.66	82.29	3.49	82.46	3.00	82.95	3.045	82.91
BR-9S	84.80	85.61	2.58	83.03	2.68	82.93	2.09	83.52	2.135	83.48
BR-9D	84.80	85.80	9.17	76.63	9.53	76.27	8.865	76.94	8.90	76.90
BR-10	80.63	81.57	2.33	79.24	2.38	79.19	2.28	79.29	2.34	79.23
BR-11	82.38	83.37	3.67	79.70	3.65	79.72	3.06	80.31	3.115	80.26
BR-12	83.20	84.46	1.37	83.09	1.53	82.93	1.23	83.23	1.295	83.17
BR-13S	107.15	107.87	17.93	89.94	18.02	89.85	17.43	90.44	17.61	90.26
BR-13D	107.15	107.86	19.86	88.00	19.985	87.88	20.30	87.56	20.38	87.48
OV-2	*85.14*	*85.90*	0.83	85.07	1.02	84.88	0.75	85.15	0.81	85.09
OV-4	*108.65*	*109.22*	18.41	90.81	18.56	90.66	18.2	91.02	18.26	90.96
OV-5	*89.73*	*90.12*	2.62	87.50	3.04	87.08	2.84	87.28	2.90	87.22
OV-7	86.46	87.20	2.96	84.24	3.07	84.13	2.12	85.08	2.16	85.04
OV-9	87.00	87.67	1.01	86.66	1.11	86.56	0.96	86.71	1.085	86.59
OV-10	87.02	88.49	1.115	87.38	1.195	87.30	1.05	87.44	1.17	87.32
OV-13	107.15	107.75	17.29	90.46	17.43	90.32	17.16	90.59	17.31	90.44
BR 08-1S	82.23	83.06	---	---	1.67	---	1.25	---	1.31	---
BR 08-1D	82.23	83.02	---	---	3.12	---	5.16	---	5.20	---
BR 08-2S	86.27	87.03	---	---	4.34	---	3.64	---	3.695	---
BR 08-2D	86.27	86.99	---	---	4.65	---	4.06	---	4.115	---
BR 08-3S	85.41	86.26	---	---	3.28	---	2.64	---	2.70	---
BR 08-3D	85.41	86.35	---	---	4.12	---	3.85	---	3.91	---

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) May 17, 2010	Ground-water Elev. (m) May 17, 2010	Ground-water Depth (mbTOP) November 29, 2010	Ground-water Elev. (m) November 29, 2010	Ground-water Depth (mbTOP) May 9, 2011	Ground-water Elev. (m) May 9, 2011	Ground-water Depth (mbTOP) November 29, 2011	Ground-water Elev. (m) November 29, 2011
BR-1S	85.04	85.40	3.76	81.64	3.72	81.68	3.61	81.79	3.84	81.56
BR-1D	85.04	85.36	7.97	77.39	7.91	77.45	7.84	77.52	8.07	77.29
BR-3	89.63	89.86	2.46	87.40	2.41	87.45	2.38	87.48	2.62	87.24
BR-5S	83.95	84.39	7.61	76.78	7.66	76.73	7.29	77.10	7.69	76.70
BR-5D	83.95	84.37	7.95	76.42	8.10	76.27	7.31	77.06	7.43	76.94
BR-6S	82.06	82.79	7.47	75.32	7.32	75.47	6.72	76.07	7.44	75.35
BR-6D	82.06	82.77	7.28	75.49	7.18	75.59	6.43	76.34	7.41	75.36
BR-7S	79.69	80.76	5.54	75.22	5.59	75.17	4.86	75.90	5.83	74.93
BR-7D	79.69	80.76	5.43	75.33	5.50	75.26	4.84	75.92	5.75	75.01
BR-8S	85.17	85.90	3.62	82.28	3.60	82.30	3.46	82.44	3.70	82.20
BR-8D	85.17	85.95	3.39	82.56	3.34	82.61	3.24	82.71	3.45	82.50
BR-9S	84.80	85.61	2.75	82.86	2.71	82.90	2.62	82.99	2.31	83.30
BR-9D	84.80	85.80	9.61	76.19	9.555	76.25	9.45	76.35	9.63	76.17
BR-10	80.63	81.57	2.39	79.18	2.34	79.23	2.30	79.27	2.33	79.24
BR-11	82.38	83.37	3.84	79.53	3.80	79.57	3.67	79.70	2.97	80.40
BR-12	83.20	84.46	1.78	82.68	1.73	82.73	1.23	83.23	1.36	83.10
BR-13S	107.15	107.87	17.98	89.89	18.4	89.47	17.55	90.32	18.44	89.43
BR-13D	107.15	107.86	23.15	84.71	21.97	85.89	20.18	87.68	25.04	82.82
OV-2	*85.14*	*85.90*	0.98	84.92	0.92	84.98	0.90	85.00	0.99	84.91
OV-4	*108.65*	*109.22*	18.40	90.82	18.34	90.88	18.29	90.93	18.45	90.77
OV-5	*89.73*	*90.12*	3.04	87.08	3.00	87.12	2.94	87.18	3.18	86.94
OV-7	86.46	87.20	2.36	84.84	2.315	84.89	2.28	84.92	2.51	84.69
OV-9	87.00	87.67	1.20	86.47	1.17	86.50	1.10	86.57	1.16	86.51
OV-10	87.02	88.49	1.195	87.30	1.16	87.33	1.09	87.41	2.11	86.38
OV-13	107.15	107.75	17.54	90.21	18.06	89.69	17.30	90.45	17.90	89.85
BR 08-1S	82.23	83.06	1.96	---	1.92	---	1.53	---	1.98	---
BR 08-1D	82.23	83.02	6.57	---	6.515	---	6.01	---	6.40	---
BR 08-2S	86.27	87.03	4.25	---	3.76	---	3.53	---	3.02	---
BR 08-2D	86.27	86.99	4.53	---	4.21	---	3.98	---	4.69	---
BR 08-3S	85.41	86.26	3.36	---	3.04	---	2.77	---	3.02	---
BR 08-3D	85.41	86.35	5.06	---	4.90	---	4.74	---	5.05	---

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) May 6, 2012	Ground-water Elev. (m) May 6, 2012	Ground-water Depth (mbTOP) November 12, 2012	Ground-water Elev. (m) November 12, 2012	Ground-water Depth (mbTOP) June 2013	Ground-water Elev. (m) June 2013	Ground-water Depth (mbTOP) October 2013	Ground-water Elev. (m) October 2013
BR-1S	85.04	85.40	4.13	81.27	4.52	80.88	3.44	81.96	3.67	81.73
BR-1D	85.04	85.36	8.42	76.94	8.59	76.77	8.20	77.16	d.i.	---
BR-3	89.63	89.86	3.19	86.67	3.20	86.66	5.32	84.54	6.14	83.72
BR-5S	83.95	84.39	7.67	76.72	8.19	76.20	7.67	76.72	7.74	76.65
BR-5D	83.95	84.37	8.03	76.34	8.22	76.15	8.45	75.92	8.92	75.45
BR-6S	82.06	82.79	7.31	75.48	7.52	75.27	7.39	75.40	n.m.	---
BR-6D	82.06	82.77	7.16	75.61	7.39	75.38	7.32	75.45	n.m.	---
BR-7S	79.69	80.76	5.61	75.15	5.80	74.96	5.53	75.23	6.00	74.76
BR-7D	79.69	80.76	5.50	75.26	5.70	75.06	5.50	75.26	5.95	74.81
BR-8S	85.17	85.90	3.96	81.94	4.22	81.68	3.12	82.78	3.65	82.25
BR-8D	85.17	85.95	3.80	82.15	4.03	81.92	3.47	82.48	3.93	82.02
BR-9S	84.80	85.61	3.11	82.50	3.48	82.13	2.60	83.01	3.16	82.45
BR-9D	84.80	85.80	9.93	75.87	10.16	75.64	10.14	75.66	10.50	75.30
BR-10	80.63	81.57	2.41	79.16	2.53	79.04	2.35	79.22	2.48	79.09
BR-11	82.38	83.37	3.86	79.51	3.88	79.49	3.30	80.07	3.74	79.63
BR-12	83.20	84.46	1.60	82.86	2.00	82.46	1.45	83.01	1.90	82.56
BR-13S	107.15	107.87	18.30	89.57	18.33	89.54	18.35	89.52	19.06	88.81
BR-13D	107.15	107.86	20.80	87.06	20.01	87.85	23.81	84.05	26.61	81.25
OV-2	*85.14*	*85.90*	1.38	84.52	1.46	84.44	0.84	85.06	1.15	84.75
OV-4	*108.65*	*109.22*	18.84	90.38	18.99	90.23	18.55	90.67	14.15[1]	95.07[1]
OV-5	*89.73*	*90.12*	3.33	86.79	3.66	86.46	3.71	86.41	4.30	85.82
OV-7	86.46	87.20	2.69	84.51	2.88	84.32	3.16	84.04	3.42	83.78
OV-9	87.00	87.67	1.20	86.48	1.29	86.38	1.62	86.05	dry	---
OV-10	87.02	88.49	1.27	87.22	1.40	87.09	2.42	86.07	2.98	85.51
OV-13	107.15	107.75	17.78	89.97	17.94	89.81	17.90	89.85	18.44	89.31
BR 08-1S	82.23	83.06	2.01	---	2.93	---	1.72	---	1.98	---
BR 08-1D	82.23	83.02	6.53	---	6.39	---	5.03	---	5.14	---
BR 08-2S	86.27	87.03	3.90	---	4.07	---	3.98	---	4.55	---
BR 08-2D	86.27	86.99	4.49	---	4.56	---	4.75	---	5.23	---
BR 08-3S	85.41	86.26	3.29	---	3.31	---	3.19	---	3.81	---
BR 08-3D	85.41	86.35	5.45	---	5.96	---	5.56	---	6.53	---

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) May 30, 2014	Ground-water Elev. (m) May 30, 2014	Ground-water Depth (mbTOP) November 17, 2014	Ground-water Elev. (m) November 17, 2014	Ground-water Depth (mbTOP) May 4, 2015	Ground-water Elev. (m) May 4, 2015	Ground-water Depth (mbTOP) November 15, 2015	Ground-water Elev. (m) November 15, 2015
BR-1S	85.04	85.40	3.23	82.17	3.31	82.09	3.20	82.20	3.43	81.97
BR-1D	85.04	85.36	9.60	75.76	9.67	75.69	9.54	75.82	9.79	75.57
BR-3	89.63	89.86	1.61	88.25	1.69	88.17	1.58	88.28	1.83	88.03
BR-5S	83.95	84.39	7.68	76.71	7.74	76.65	7.60	76.79	7.99	76.40
BR-5D	83.95	84.37	7.73	76.64	7.75	76.62	7.61	76.76	8.02	76.35
BR-6S	82.06	82.79	7.06	75.73	7.09	75.70	6.99	75.80	7.54	75.25
BR-6D	82.06	82.77	6.80	75.97	6.86	75.91	6.75	76.02	7.40	75.37
BR-7S	79.69	80.76	5.17	75.59	5.23	75.53	5.22	75.54	5.77	74.99
BR-7D	79.69	80.76	5.07	75.69	5.10	75.66	4.99	75.77	5.69	75.07
BR-8S	85.17	85.90	3.02	82.88	3.07	82.84	3.00	82.90	3.38	82.52
BR-8D	85.17	85.95	3.40	82.55	3.39	82.56	3.31	82.64	3.70	82.25
BR-9S	84.80	85.61	2.58	83.03	2.63	82.98	2.53	83.08	2.92	82.69
BR-9D	84.80	85.80	10.00	75.80	10.01	75.79	9.895	75.91	10.19	75.61
BR-10	80.63	81.57	2.36	79.21	2.40	79.17	2.28	79.29	2.43	79.14
BR-11	82.38	83.37	3.82	79.55	3.83	79.54	3.74	79.63	3.51	79.86
BR-12	83.20	84.46	1.48	82.98	1.50	82.97	1.38	83.08	1.46	83.00
BR-13S	107.15	107.87	18.36	89.51	18.13	89.74	18.31	89.56	18.62	89.25
BR-13D	107.15	107.86	22.10	85.76	22.12	85.74	22.02	85.84	22.36	85.50
OV-2	*85.14*	*85.90*	0.86	85.04	0.94	84.96	0.88	85.02	1.30	84.60
OV-4	*108.65*	*109.22*	18.60	90.62	18.58	90.64	18.49	90.73	18.64	90.58
OV-5	*89.73*	*90.12*	3.80	86.32	3.76	86.36	3.64	86.48	3.79	86.33
OV-7	86.46	87.20	3.05	84.15	3.12	84.08	3.02	84.18	3.21	83.99
OV-9	87.00	87.67	1.60	86.07	dry	---	2.12	85.55	2.31	85.36
OV-10	87.02	88.49	2.10	86.39	2.15	86.34	2.09	86.40	2.34	86.15
OV-13	107.15	107.75	17.96	89.79	18.00	89.75	17.89	89.86	18.04	89.71
BR 08-1S	82.23	83.06	1.80	---	1.80	---	1.72	---	1.99	---
BR 08-1D	82.23	83.02	5.20	---	5.26	---	5.20	---	5.43	---
BR 08-2S	86.27	87.03	4.01	---	4.04	---	3.94	---	4.09	---
BR 08-2D	86.27	86.99	4.69	---	4.70	---	4.60	---	4.77	---
BR 08-3S	85.41	86.26	3.20	---	3.18	---	3.12	---	3.25	---
BR 08-3D	85.41	86.35	5.99	---	6.06	---	6.00	---	6.14	---

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) April 18, 2016	Ground-water Elev. (m) April 18, 2016	Ground-water Depth (mbTOP) October 29, 2016	Ground-water Elev. (m) October 29, 2016	Ground-water Depth (mbTOP) May 23, 2017	Ground-water Elev. (m) May 23, 2017	Ground-water Depth (mbTOP) November 21, 2017	Ground-water Elev. (m) November 21, 2017
BR-1S	85.04	85.40	2.66	82.74	3.47	81.93	2.70	82.70	2.99	82.41
BR-1D	85.04	85.36	8.92	76.44	9.48	75.88	8.90	76.46	8.15	77.21
BR-3	89.63	89.86	4.20	85.66	5.95	83.91	4.28	85.58	4.41	85.45
BR-5S	83.95	84.39	6.93	77.46	7.71	76.68	7.19	77.20	7.65	76.74
BR-5D	83.95	84.37	6.96	77.41	8.59	75.78	7.35	77.02	7.83	76.54
BR-6S	82.06	82.79	6.89	75.90	7.72	75.07	6.52	76.27	7.25	75.54
BR-6D	82.06	82.77	6.60	76.17	7.62	75.15	6.81	75.96	7.02	75.75
BR-7S	79.69	80.76	4.81	75.95	6.00	74.76	5.00	75.76	5.54	75.22
BR-7D	79.69	80.76	4.77	75.99	5.91	74.85	4.87	75.89	5.39	75.37
BR-8S	85.17	85.62	2.30	83.32	3.04	82.58	2.48	83.14	2.66	82.96
BR-8D	85.17	85.53	2.37	83.16	3.13	82.40	2.56	82.97	2.74	82.79
BR-9S	84.80	85.61	2.08	83.53	3.11	82.50	2.26	83.35	2.36	83.25
BR-9D	84.80	85.80	9.12	76.68	9.81	75.99	8.94	76.86	9.09	76.71
BR-10	80.63	81.57	2.23	79.34	2.47	79.10	2.27	79.30	2.29	79.28
BR-11	82.38	83.37	3.66	79.71	3.35	80.02	3.70	79.67	3.64	79.73
BR-12	83.20	84.46	1.28	83.18	1.81	82.65	1.34	83.12	1.32	83.14
BR-13S	107.15	107.87	18.02	89.85	18.66	89.21	18.40	89.47	18.44	89.43
BR-13D	107.15	107.86	21.28	86.58	22.19	85.67	21.31	86.55	21.40	86.46
OV-2	*85.14*	*85.90*	1.01	84.89	2.28	83.62	1.11	84.79	0.78	85.12
OV-4	*108.65*	*109.22*	17.05	92.17	17.84	91.38	16.17	93.05	16.27	92.95
OV-5	*89.73*	*90.12*	2.85	87.27	4.11	86.01	2.90	87.22	3.10	87.02
OV-7	86.46	87.20	2.14	85.06	3.04	84.16	2.09	85.11	3.06	84.14
OV-9	87.00	87.67	0.95[2]	86.72[2]	1.99[2]	85.68[2]	0.94[2]	---[2]	1.17	86.63
OV-10	87.02	88.49	1.58	86.91	2.61	85.88	1.64	86.85	1.84	86.65
OV-13	107.15	107.75	16.16	91.59	16.91	90.84	16.08	91.67	16.18	91.57
BR 08-1S	82.23	83.06	1.54	---	2.11	---	1.67	---	1.79	---
BR 08-1D	82.23	83.02	1.51	---	2.09	---	1.65	---	1.77	---
BR 08-2S	86.27	87.03	3.08	---	3.84	---	3.03	---	3.19	---
BR 08-2D	86.27	86.99	4.00	---	4.91	---	4.05	---	4.20	---
BR 08-3S	85.41	86.26	2.78	---	3.66	---	2.98	---	3.11	---
BR 08-3D	85.41	86.35	4.76	---	5.13	---	4.70	---	4.85	---

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) May 15, 2018	Ground-water Elev. (m) May 15, 2018	Ground-water Depth (mbTOP) October 26, 2018	Ground-water Elev. (m) October 26, 2018	Ground-water Depth (mbTOP) May 29, 2019	Ground-water Elev. (m) May 29, 2019	Ground-water Depth (mbTOP) November 13, 2019	Ground-water Elev. (m) November 13, 2019
BR-1S	85.04	85.40	3.04	82.36	3.06	82.34	8.01	77.39	8.72	76.68
BR-1D	85.04	85.36	7.36	78.00	7.30	78.06	8.11	77.25	8.81	76.55
BR-3	89.63	89.86	4.77	85.09	4.83	85.03	7.98	81.88	8.40	81.46
BR-5S	83.95	84.39	7.15	77.24	7.70	76.69	6.58	77.81	7.72	76.67
BR-5D	83.95	84.37	7.24	77.13	8.29	76.08	6.57	77.80	7.95	76.42
BR-6S	82.06	82.79	6.76	76.03	7.56	75.23	6.17	76.62	7.36	75.43
BR-6D	82.06	82.77	6.37	76.40	7.35	75.42	5.71	77.06	7.12	75.65
BR-7S	79.69	80.76	4.78	75.98	5.79	74.97	5.39	75.37	5.62	75.14
BR-7D	79.69	80.76	4.63	76.13	5.66	75.10	5.26	75.50	5.47	75.29
BR-8S	85.17	85.62	2.85	82.77	3.88	81.74	2.38	83.24	2.88	82.74
BR-8D	85.17	85.53	2.9	82.63	4.01	81.52	2.35	83.18	2.87	82.66
BR-9S	84.80	85.61	2.29	83.32	3.01	82.60	2.09	83.52	2.72	82.89
BR-9D	84.80	85.80	8.90	76.90	9.28	76.52	8.31	77.49	8.81	76.99
BR-10	80.63	81.57	2.3	79.27	2.44	79.13	2.09	79.48	2.34	79.23
BR-11	82.38	83.37	3.8	79.57	3.90	79.47	3.59	79.78	1.86	81.51
BR-12	83.20	84.46	1.43	83.03	1.83	82.63	1.24	83.22	2.10	82.36
BR-13S	107.15	107.87	18.38	89.49	18.40	89.47	18.29	89.58	18.89	88.98
BR-13D	107.15	107.86	21.21	86.65	21.30	86.56	22.01	85.85	23.11	84.75
OV-2	*85.14*	*85.90*	0.78	85.12	1.04	84.86	0.77	85.13	1.11	84.79
OV-4	*108.65*	*109.22*	16.26	92.96	16.30[4]	92.92	16.21	93.01	--[5]	--[5]
OV-5	*89.73*	*90.12*	3.22	86.90	2.63[4]	87.49	2.48	87.64	--[5]	--[5]
OV-7	86.46	87.20	2.99	84.21	2.93	84.27	2.64	84.56	3.11	84.09
OV-9	87.00	87.67	1.29	86.51	1.26	86.54	1.10	86.70	1.39	86.41
OV-10	87.02	88.49	1.9	86.59	1.95	86.54	1.72	86.77	1.96	86.53
OV-13	107.15	107.75	16.29	91.46	16.24	91.51	16.06	91.69	16.28	91.47
BR 08-1S[3]	82.23	83.06	1.63	81.43	1.69	81.37	1.50	81.56	1.99	81.07
BR 08-1D[3]	82.23	83.02	1.6	81.42	1.66	81.36	1.42	81.60	1.89	81.13
BR 08-2S[3]	86.27	87.03	3.00	84.03	3.11	83.92	1.93	85.10	2.19	84.84
BR 08-2D[3]	86.27	86.99	4.09	82.90	4.32	82.67	3.86	83.13	3.99	83.00
BR 08-3S[3]	85.41	86.26	3.02	83.24	3.31	82.95	2.74	83.52	2.97	83.29
BR 08-3D[3]	85.41	86.35	4.58	81.77	5.19	81.16	4.08	82.27	4.21	82.14
BR-18S[3]	85.63	86.50					5.44	81.06	6.01	80.49
BR-18D[3]	85.64	86.45					5.61	80.84	6.12	80.33

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) May 05, 2020	Ground-water Elev. (m) May 05, 2020	Ground-water Depth (mbTOP) October 28, 2020	Ground-water Elev. (m) October 28, 2020	Ground-water Depth (mbTOP) April 28, 2021	Ground-water Elev. (m) April 28, 2021	Ground-water Depth (mbTOP) November 22, 2021	Ground-water Elev. (m) November 22, 2021
BR-1S	85.04	85.40	2.85	82.55	8.92	76.48	8.10	77.30	7.41	77.99
BR-1D	85.04	85.36	7.49	77.87	8.33	77.03	7.92	77.44	8.71	76.65
BR-3	89.63	89.86	4.30	85.56	5.40	84.46	5.66	84.20	5.60	84.26
BR-5S	83.95	84.39	7.30	77.09	7.80	76.59	7.53	76.86	7.75	76.64
BR-5D	83.95	84.37	7.33	77.04	8.18	76.19	7.88	76.49	8.15	76.22
BR-6S	82.06	82.79	6.89	75.90	7.50	75.29	7.38	75.41	7.58	75.21
BR-6D	82.06	82.77	6.53	76.24	7.26	75.51	7.10	75.67	7.53	75.24
BR-7S	79.69	80.76	5.06	75.70	5.72	75.04	5.58	75.18	5.52	75.24
BR-7D	79.69	80.76	4.90	75.86	5.59	75.17	5.42	75.34	5.75	75.01
BR-8S	85.17	85.62	2.33	83.29	3.25	82.37	3.04	82.58	2.97	82.66
BR-8D	85.17	85.53	2.36	83.17	2.28	83.25	3.08	82.45	2.99	82.54
BR-9S	84.80	85.61	2.09	83.52	2.80	82.81	2.52	83.09	2.84	82.77
BR-9D	84.80	85.80	8.97	76.83	9.75	76.05	9.42	76.38	8.92	76.88
BR-10	80.63	81.57	2.30	79.27	2.36	79.21	2.16	79.41	2.38	79.19
BR-11	82.38	83.37	3.33	80.04	1.56	81.81	1.38	81.99	1.40	81.97
BR-12	83.20	84.46	1.28	83.18	3.12	81.34	2.91	81.55	3.49	80.97
BR-13S	107.15	107.87	18.38	89.49	18.99	88.88	19.00	88.87	19.14	88.73
BR-13D	107.15	107.86	22.44	85.42	23.21	84.65	23.08	84.78	23.28	84.58
OV-2	*85.14*	*85.90*	1.22	84.68	1.10	84.80	0.60	85.30	1.29	84.61
OV-4	*108.65*	*09.22*	16.94	92.28	--[6]	--[6]	--[6]	--[6]	--[6]	--[6]
OV-5	*89.73*	*90.12*	3.08	87.04	4.10	86.02	3.70	86.42	4.18	85.94
OV-7	86.46	87.20	2.88	84.32	3.24	83.96	3.07	84.13	3.21	83.99
OV-9	87.00	87.67	1.20	86.60	1.60	86.20	1.49	86.31	1.85	85.95
OV-10	87.02	88.49	1.80	86.69	2.74	85.75	2.58	85.91	2.87	85.62
OV-13	107.15	107.75	15.79	91.96	16.30	91.45	16.16	91.59	16.34	91.41
BR 08-1S[3]	82.23	83.06	1.64	81.42	2.08	80.98	1.99	81.07	2.17	80.89
BR 08-1D[3]	82.23	83.02	1.60	81.42	2.04	80.98	1.91	81.11	2.13	80.89
BR 08-2S[3]	86.27	87.03	1.90	85.13	2.30	84.73	2.18	84.85	2.24	84.79
BR 08-2D[3]	86.27	86.99	3.83	83.16	4.11	82.88	4.00	82.99	4.03	82.96
BR 08-3S[3]	85.41	86.26	2.69	83.57	3.03	83.23	2.94	83.32	3.11	83.15
BR 08-3D[3]	85.41	86.35	4.20	82.15	4.28	82.07	4.14	82.21	4.31	82.04
BR-18S[3]	85.63	86.50	5.68	80.82	7.16	79.34	7.01	79.49	7.21	79.29
BR-18D[3]	85.64	86.45	5.89	80.56	7.38	79.07	7.12	79.33	7.43	79.02

Monitoring Well	Ground Surface Elev. (m)	Top of Pipe Elev. (m)	Ground-water Depth (mbTOP) April 24, 2022	Ground-water Elev. (m) April 24, 2022	Ground-water Depth (mbTOP) December 11, 2022	Ground-water Elev. (m) December 11, 2022
BR-1S	85.04	85.40	2.70	82.70	2.06	83.34
BR-1D	85.04	85.36	7.70	77.66	8.23	77.13
BR-3	89.63	89.86	3.93	85.93	5.08	84.78
BR-5S	83.95	84.39	7.25	77.14	7.72	76.67
BR-5D	83.95	84.37	7.23	77.14	8.20	76.17
BR-6S	82.06	82.79	6.47	76.32	7.52	75.27
BR-6D	82.06	82.77	6.85	75.92	7.30	75.47
BR-7S	79.69	80.76	4.99	75.77	5.75	75.01
BR-7D	79.69	80.76	4.82	75.94	5.82	74.94
BR-8S	85.17	85.62	2.27	83.35	2.75	82.87
BR-8D	85.17	85.53	2.30	83.23	2.93	82.60
BR-9S	84.80	85.61	2.05	83.56	2.75	82.86
BR-9D	84.80	85.80	8.96	76.84	9.78	76.02
BR-10	80.63	81.57	2.30	79.27	2.34	79.23
BR-11	82.38	83.37	3.68	79.69	3.77	79.60
BR-12	83.20	84.46	1.28	83.18	1.65	82.81
BR-13S	107.15	107.87	18.52	89.35	18.61	89.26
BR-13D	107.15	107.86	27.89	79.97	27.95	79.91
OV-2	*85.14*	*85.90*	0.70	85.20	0.92	84.98
OV-4	*108.65*	*109.22*	--[6]	--[6]	--[6]	--[6]
OV-5	*89.73*	*90.12*	2.98	87.14	2.91	87.22
OV-7	86.46	87.20	2.87	84.33	2.70	84.50
OV-9	87.00	87.67	1.18	86.62	1.20	86.61
OV-10	87.02	88.49	1.68	86.81	1.69	86.80
OV-13	107.15	107.75	18.22	89.53	18.38	89.37
BR 08-1S[3]	82.23	83.06	1.58	81.48	1.66	81.40
BR 08-1D[3]	82.23	83.02	1.55	81.47	1.70	81.32
BR 08-2S[3]	86.27	87.03	1.90	85.13	2.09	84.94
BR 08-2D[3]	86.27	86.99	3.79	83.20	4.52	82.47
BR 08-3S[3]	85.41	86.26	2.76	83.50	3.52	82.74
BR 08-3D[3]	85.41	86.35	4.34	82.01	4.88	81.47
BR-18S[3]	85.63	86.50	5.83	80.67	7.15	79.35
BR-18D[3]	85.64	86.45	5.57	80.88	7.39	79.06

Notes:

Created by: AYFH
Checked by: ETB

Italics Based on the 1997 Robinson Report.
--- No value.
mbTOP Metres below top of pipe elevation.
d.i. data incorrect
n.m. not measured

[1] Unusually high groundwater elevation reading in 2013 at groundwater monitor OV-4 is considered to be a result of a typographical error as the elevations in subsequent monitoring sessions have returned to within normal ranges

[2] OV-9 found to be damaged in fall 2016; well replaced in summer of 2017 and surveyed in 2019. GW elevations considered unreliable between fall of 2016 and fall of 2017.

[3] BR08 and BR-18 well series surveyed in January 2019.

[4] The depth to groundwater reported at OV-4 during the fall 2018 and fall 2019 monitoring session is more consistent with historical data from monitoring well OV-5 and vice versa. While it is not possible to confirm, for the purposes of this report, it is assumed that these wells were switched. Groundwater level measurement for OV-5 has not been used in determining groundwater flow direction during the fall monitoring session.

[5] During the November 2019 monitoring session, there was some confusion in the field around the association of groundwater level measurements to groundwater monitors, resulting in it not being possible to rely on the measurements recorded at OV-4 and OV-5. As such, groundwater levels at OV-4 and OV-5 in the fall of 2019 have not been included in this report.

[6] Monitoring well OV-4 is blocked.

Table 3 – Interpretation of 2022 Groundwater Quality Data

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
OVERBURDEN WELLS				
OV-7	- barium (A, D) - boron (D) - chloride (D) - DOC (A, D) - iron (A, D) - manganese (A, D) - sodium (A, D) - TDS (A, D)	▪ Parameter concentrations are relatively consistent. ▪ Overall decreasing trend in alkalinity and TDS since 2000, with lowest concentration of alkalinity since 1999 in spring 2022. ▪ Previously reported decreasing trend in chloride appear to be stabilizing. ▪ Increasing trend of phosphorous from 2000 to 2009. Concentrations stable to decreasing since 2009. ▪ Overall slight decreasing trend in boron concentrations. ▪ Recent near historical high concentration in sulphate in spring 2022 (returned to non-detectable concentration in December 2022). ▪ Recent elevated concentration of aluminum in December 2022. ▪ Historical minimum concentration of DOC, Nickel, and Sodium in spring 2022.	- ammonia (A, D) - barium (A, D) - boron (A, D) - chloride (D) - DOC (A, D) - hardness (A, D) - iron (A, D) - manganese (A, D) - potassium (A, D) - sodium (A, D) - TDS (A, D)	▪ Monitoring well OV-7 is located near the northern corner of the licensed fill area and represents the landfill leachate quality. It is located approximately 55 metres east of the northern limit of the licensed fill area. ▪ Groundwater quality at monitoring well OV-7 is interpreted to be impacted by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
OV-9	- DOC (A, D) - TDS (D)	▪ Parameter concentrations relatively consistent over time. ▪ Variable concentrations of total phosphorus. ▪ Previously decreasing concentration of alkalinity, barium, DOC, hardness and potassium appear to be stabilizing. ▪ Overall increasing trend in sodium concentrations since 2008. ▪ Increasing trend in the concentration of sulphate since 2017. ▪ Previously reported historical high concentration of ammonia in spring 2021 returned to within historical ranges in 2022. ▪ Historical high concentration of boron in spring and fall 2021 remained elevated in 2022.	- ammonia (A) - boron (A, D) - DOC (A, D) - sodium (A, D)	▪ Monitoring well OV-9 is located approximately 100 metres east of the eastern licensed fill corner. ▪ Groundwater quality at monitoring well OV-9 is interpreted to be potentially impacted by landfill leachate. ▪ Monitoring well OV-9 was found to be damaged in the fall of 2016 and was repaired in the summer of 2017.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
OV-10	- iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Overall increasing trend in chloride since 2006 has been decreasing since 2018. ▪ Overall increasing trend in sodium concentrations since 2006; historical high concentration of sodium in spring 2022 (similar to historic high reported between 2019 and 2021). ▪ Previously increasing concentrations of ammonia have been decreasing since historic high reported in 2019. ▪ Previously increasing trend in barium, iron, and potassium concentrations have remained stable or are slightly decreasing since 2017-2018. ▪ Increasing trend in manganese since 2012 has remained stable since 2017. ▪ Decreasing trend in concentration of cobalt since 2017 (previously variable to increasing trend). ▪ Historic high field conductivity reported in fall 2021 remained elevated in 2022. ▪ Historical high detectable concentration of molybdenum in spring 2022.	- ammonia (A, D) - manganese (A, D) - sodium (A, D)	▪ Monitoring well OV-10 is located approximately 150 metres east of the eastern licensed fill corner. ▪ OV-10 is interpreted to be potentially impacted by landfill leachate however increasing trends will be monitored carefully.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BEDROCK WELLS				
BR-1D (*deep*)	- barium (A, D) - boron (A, D) - chloride (A, D) - DOC (A, D) - iron (A, D) - manganese (A, D) - sodium (A, D) - TDS (A, D)	▪ Previously decreasing trends in concentrations of alkalinity, ammonia, chloride, DOC, and total phosphorus appear to be stabilizing since 2014. Concentrations of total phosphorus appear to be slightly increasing since 2017, but remain within historic ranges. ▪ Decreasing trend in field-measured conductivity. ▪ Previously reported elevated concentration of nickel generally decreasing since about 2017 to within historic concentrations ▪ Previously reported elevated concentrations of manganese and cobalt generally returning to within historic concentrations. Concentrations are generally decreasing since about 2015, with a historic low concentration of cobalt in April 2022. ▪ Previously variable sulphate concentrations appear to be decreasing since 2017. Concentrations of sulphate were comparable to lower concentrations observed between 2000 and 2008. ▪ Slight increasing trend in iron concentrations since 2014. ▪ Barium concentrations increasing since 2016 with historic high concentration of barium reported in fall 2022. ▪ Aluminum concentrations increasing since 2018.	- ammonia (A, D) - barium (A, D) - boron (A, D) - chloride (A, D) - DOC (A, D) - hardness (A, D) - iron (A, D) - potassium (A, D) - sodium (A, D) - TDS (A, D)	▪ Monitoring well BR-1D is located approximately 50 metres east of the northern limit of the licensed fill area. ▪ Groundwater quality at monitoring well BR-1D is interpreted to be impacted by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-1S (*shallow*)	- barium (A, D) - boron (A, D) - chloride (D) - DOC (A, D) - iron (A, D) - manganese (A, D) - sodium (A, D) - TDS (A, D)	▪ Slight increasing trend in barium concentrations over time appears to be stabilizing. ▪ Slight increasing trend in boron and sodium concentrations over time. ▪ General increasing trend in concentrations of ammonia over time with historical high concentration in December 2022. ▪ Previously reported increasing trend in potassium appears to be stabilizing. ▪ Increasing trend in the concentration of total phosphorus, but within historical concentrations. ▪ Concentration of magnesium slightly elevated since 2014 compared to historic concentrations. ▪ Elevated field conductivity reported in 2020 remained elevated in 2021 and 2022. ▪ Concentration of chloride was non-detect in April 2022. ▪ Other parameter concentrations generally consistent over time.	- ammonia (A, D) - barium (A, D) - boron (A, D) - chloride (D) - DOC (A, D) - hardness (A, D) - iron (A, D) - potassium (A, D) - sodium (A, D) - TDS (A, D)	▪ Monitoring well BR-1S is located approximately 50 metres east of the northern limit of the licensed fill area. ▪ Groundwater quality at monitoring well BR-1S is interpreted to be impacted by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-3	- barium (A) - DOC (A, D) - iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Previously observed decreasing trends in concentrations of alkalinity and barium since 2010 appear to be stabilizing and/or returning to concentrations reported prior to 2010. ▪ Previously observed decreasing and stabilizing trend in concentrations of manganese appear to be slightly increasing. ▪ Overall increasing trend in concentrations of ammonia, hardness, potassium and TDS. Previously reported historical high of hardness in fall 2021 returned to within historic levels in 2022. ▪ Previously increasing trend in DOC appears to be stabilizing. ▪ Increasing trend in chloride and sodium since 2009. Historical high concentration of sodium in spring of 2021 returned to within historical concentration ranges in 2022. ▪ Historical high field conductivity measured in fall 2021 and spring 2022 ▪ Detectable concentration of cobalt in fall 2021 and spring of 2022, previously detected in 2016. ▪ Elevated concentration of iron (spring 2022) and total phosphorus (fall 2022) compared to recent historical concentrations.	- ammonia (A, D) - barium (A) - boron (D) - chloride (A, D) - DOC (A, D) - hardness (A, D) - iron (A) - potassium (A) - sodium (A) - TDS (A, D)	▪ Monitoring well BR-3 is located approximately 120 metres south of the eastern limit of the licensed fill area. ▪ BR-3 has previously been reported as being hydraulically up-gradient of the landfill site and interpreted not to be impacted by landfill leachate. BR-3 is now interpreted as being hydraulically cross-gradient or slightly downgradient of a small portion of the landfill. Due to recent increasing trends of some leachate indicator parameters, it is possible that BR-3 may be possibly impacted by landfill leachate. This interpretation and increasing trends will continue to be monitored carefully in the future.
BR-5D (*deep*)	- barium (A) - DOC (A) - iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Parameter concentrations are generally consistent with time with the exception of some variability in ammonia and historic iron concentrations. ▪ Concentration of DOC and TDS generally decreasing. Historical low concentration of DOC in 2022.	- ammonia (A, D) - barium (A) - DOC (A) - hardness (D)	▪ Monitoring well BR-5D is located approximately 250 metres northeast of the landfill, immediately adjacent to Usborne Street. ▪ Groundwater quality at monitoring well BR-5D is interpreted to be impacted by road salt, the wood waste deposited in CAZ area B, and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-5S (*shallow*)	- none	▪ Parameter concentrations are generally consistent with some variability in historic concentrations of iron, ammonia and total phosphorus. Concentrations of phosphorus more variable since about 2019. ▪ Slight decreasing concentration in TDS since 2012. ▪ Slight increasing trend in sodium and chloride with highest concentration of chloride since 2005 reported in fall of 2021 remaining slightly elevated in 2022. ▪ Previously reported elevated concentration of sulphate in spring 2021 returned to within historical concentrations in 2022. ▪ Detectable concentration of dissolved reactive phosphorous in fall of 2022. Previous detected concentration reported in 2017.	- hardness (A, D)	▪ Monitoring well BR-5S is located approximately 250 metres northeast of the landfill, immediately adjacent to Usborne Street. ▪ Groundwater quality at monitoring well BR-5S is interpreted to be impacted by road salt, the wood waste deposited in CAZ area B, and/or by landfill leachate.
BR-6D (*deep*)	- barium (D) - DOC (D) - iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Parameter concentrations are generally consistent with time. ▪ Decreasing trend in concentrations of sulphate, TDS and cobalt. Historical low concentrations of sulphate (fall 2022) and cobalt (spring and fall 2022). ▪ DOC concentrations (previously interpreted to be decreasing) appear to be stabilizing or increasing. ▪ Historic low field conductivity reported in fall 2021, returned to within historical levels in 2022	- ammonia (A, D) - barium (A, D) - DOC (A, D) - iron (A, D) - sodium (A, D)	▪ Monitoring well BR-6D is located approximately 270 metres northeast of the landfill, immediate adjacent to Usborne Street. ▪ Groundwater quality at monitoring well BR-6D is interpreted to be impacted by the wood waste deposited in CAZ area B, road salt and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-6S (*shallow*)	- manganese (A, D) - TDS (D)	▪ Parameter concentrations are generally consistent with time. ▪ Previously reported decreasing trend in concentrations of DOC and TDS appear to be stabilizing. ▪ Slight increasing trend in concentrations of barium and potassium appears to be stabilizing.	- hardness (A, D)	▪ Monitoring well BR-6S is located approximately 270 metres northeast of the landfill, immediately adjacent to Usborne Street. ▪ Groundwater quality at monitoring well BR-6S is interpreted to be impacted by the wood waste deposited in CAZ area B, road salt and/or by landfill leachate.
BR-7D (*deep*)	- iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Parameter concentrations are generally consistent with time. ▪ Variable iron concentrations over time. ▪ Previously reported decreasing concentrations of magnesium since 2015 appear to be stabilizing. ▪ Slight overall decreasing trend in sulphate concentrations. ▪ Previously reported historic low measurement of field conductivity in spring and fall 2021 returned to within historic ranges in 2022.	- chloride (A, D) - hardness (A, D) - sodium (A, D) - TDS (D)	▪ Monitoring well BR-7D is located approximately 400 metres north of the northern limit of the licensed fill area, immediately adjacent to Usborne Street. ▪ Groundwater quality at monitoring well BR-7D is interpreted to be impacted by road salt, wood waste or other industrial activities on the CAZ lands, but not by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-7S (*shallow*)	- TDS (A, D)	▪ Parameter concentrations are generally consistent with time. ▪ Variable manganese and iron concentrations over time. ▪ Decreasing trend in sulphate and TDS concentrations over time. ▪ Previously reported decreasing trend in DOC shows appears to be stabilizing. ▪ Very slight increasing trend of sodium concentrations. ▪ Previously reported historic low measurement of field conductivity in spring and fall 2021 returned to within historic levels in 2022. ▪ Detectable concentration of dissolved reactive phosphorus in spring 2022.	- hardness (A) - sodium (A, D)	▪ Monitoring well BR-7S is located approximately 400 metres north of the northern limit of the licensed fill area, immediately adjacent to Usborne Street. ▪ Groundwater quality at monitoring well BR-7S is interpreted to be impacted by road salt, wood waste or other industrial activities on the CAZ lands, but not by landfill leachate.
BR-8D (*deep*)	- barium (A, D) - DOC (A, D) - iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Some variability in ammonia, and total phosphorus concentrations. ▪ Slight increasing trend in alkalinity and hardness (magnesium), with historic high concentrations reported in 2022 (historic high concentrations also reported in 2020 and 2021). ▪ Previously increasing trend in concentrations of chloride over time appears to be stabilizing. However a historical high chloride concentration was reported in fall 2022. ▪ Slight increasing trend in concentrations of barium, and sodium over time with historic high concentration of barium (discounting outlier in barium concentrations from 2002) in fall 2022. ▪ Previously reported increasing trend in the concentration of potassium over time appears to be stabilizing.	- boron (A, D) - barium (A, D) - DOC (A, D) - hardness (A, D) - iron (A, D) - TDS (A, D)	▪ Monitoring well BR-8D is located approximately 150 metres north of the northern limit of the licensed fill area. ▪ Groundwater quality at monitoring well BR-8D is interpreted to be impacted by the wood waste deposited in CAZ areas A and B, and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-8S (*shallow*)	- DOC (A, D) - iron (D) - manganese (A, D) - TDS (A, D)	▪ Parameter concentrations are generally consistent to slightly variable over time. ▪ Historic high concentration of alkalinity in fall 2022 with a slight increasing trend since 2011. ▪ Increasing trend in hardness (since 2014), calcium (since 2019) and magnesium (since 2019). Historical high concentration of hardness, calcium and magnesium in spring and fall 2022. ▪ Possible increasing trend in concentrations of chloride, and field measured conductivity. ▪ Slight decreasing trend in DOC over time. ▪ Concentrations of sulphate were elevated in 2022, with historical high concentration of sulphate reported in spring 2022. ▪ Increasing trend in sodium concentrations since 2017 with historical high reported in spring 2022. ▪ Concentrations of iron have been low or non-detect in spring monitoring sessions compared to the same year fall monitoring session since 2017. ▪ Historical high of conductivity in fall 2022.	- ammonia (D) - DOC (A, D) - hardness (A, D) - iron (D) - TDS (A, D)	▪ Monitoring well BR-8S is located approximately 150 metres north of the northern limit of the licensed fill area. ▪ Groundwater quality at monitoring well BR-8S is interpreted to be impacted by the wood waste deposited in CAZ areas A and B, and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-9D (*deep*)	- boron (A, D) - DOC (A, D) - iron (A, D) - manganese (D)	▪ Parameter concentrations are generally consistent to slightly variable. ▪ Generally increasing trend in concentrations of chloride and sodium. ▪ Previously reported historical high concentration of chloride and sodium in spring 2021 returned to typical historical concentrations in 2022. ▪ Previously reported decreasing trend in concentrations of DOC since 2009 appears to be stabilizing. ▪ Slight increasing trend in concentrations of nickel between 2014 and 2020 appears to be stabilizing. ▪ Historical low concentration of TDS in 2022. ▪ Detectable concentration of dissolved reactive phosphorus in fall 2022.	- boron (A, D) - DOC ((A, D) - hardness (A, D)	▪ Monitoring well BR-9D is located approximately 150 metres northeast of the landfill. ▪ Groundwater quality at monitoring well BR-9D is interpreted to be impacted by the wood waste deposited in CAZ area B, and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-9S (*shallow*)	- DOC (A, D) - iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Parameter concentrations are generally consistent to slightly variable over time. ▪ Historical high concentrations of sulphate in spring 2018, spring 2020, and spring 2021. Sulphate concentrations generally consistent prior to 2012; since 2012, concentrations are generally higher in the spring and low in the fall, and there is an increasing trend. ▪ Following a historical high concentration of chloride in 2020, significantly elevated historical high concentration of chloride reported in fall 2021. Chloride concentration reported in fall 2022 was below the reported concentration in fall of 2021, but remained elevated compared to historic range of chloride concentrations. ▪ Historical high concentration of hardness in spring 2022 (calcium and magnesium slightly elevated). ▪ Historical low concentration of boron in spring 2022. ▪ Historical high field conductivity in spring 2022.	- ammonia (D) - DOC (A, D) - hardness (A, D) - iron (A, D) - manganese (A, D) - TDS (D)	▪ Monitoring well BR-9S is located approximately 150 metres northeast of the landfill. ▪ Groundwater quality at monitoring well BR-9S is interpreted to be impacted by the wood waste deposited in CAZ area B, and/or by landfill leachate.
BR-10	- iron (A, D) - DOC (D) - manganese (A, D)	▪ Parameter concentrations are generally consistent over time. ▪ Slight decreasing trend in concentrations of TDS. ▪ Concentrations of aluminum were detected in the spring and fall of 2020 and 2021, and the spring of 2022 which had not previously been detected since 2007.	- ammonia (A, D) - boron (A, D) - DOC (D) - iron (A, D) - sodium (A, D)	▪ Monitoring well BR-10 is located approximately 550 metres northwest of the northern limit of the licensed fill area, immediately adjacent to Usborne Street and near Braeside boat launch. ▪ Groundwater quality at monitoring well BR-10 is interpreted to be impacted by road salt, wood waste or other industrial activities on the CAZ lands, but not by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-11	- DOC (D)	▪ Parameter concentrations are generally consistent to variable over time, with some parameters having higher concentrations reported in the fall compared to spring in recent years. ▪ Following a historical high or elevated concentrations of cobalt, manganese, and iron in fall 2018, concentrations remained elevated in the fall compared to spring. New historical high concentrations for iron and manganese were reported in fall 2021. Concentrations for all three parameters were non-detect in 2022. ▪ Previously reported historical high concentration of ammonia in fall 2019 returned to historical concentrations in the spring of 2020 but was elevated in the fall of 2020 and 2021. Concentrations of ammonia in 2022 returned to within typical historic concentrations. ▪ Historical high concentration of chloride in spring 2021, returned to within historic ranges in 2022. ▪ Historical high concentration of sulphate in fall 2021 returned to within historic concentrations in 2022. ▪ Historical low concentration of TDS in spring 2022. ▪ Concentration of total phosphorus in fall 2022 is a recent historic low. Historically, the concentration of total phosphorous was non-detect on one occasion in 2003.	- DOC (D)	▪ Monitoring well BR-11 is located approximately 320 metres north of the northern limit of the licensed fill area. ▪ Groundwater quality at monitoring well BR-11 is interpreted to be impacted by road salt, wood waste or other industrial activities on the CAZ lands, but not by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR-12	- DOC (A, D) - iron (A, D) - manganese (A, D)	▪ Parameter concentrations are generally consistent over time with some variability in DOC, sulphate, ammonia and total phosphorus concentrations. ▪ Historical high concentration of ammonia reported in spring 2021 returned to within historical ranges in 2022. ▪ Previous decreasing trends in concentrations of boron and cobalt show signs of stabilizing with higher concentrations reported in the fall compared to spring. ▪ Historical high concentration of hardness and calcium reported in fall of 2022. Concentration of alkalinity elevated in fall of 2022 compared to recent years (since 2018).	- DOC (A, D) - hardness (D) - iron (D) - manganese (A, D)	▪ Monitoring well BR-12 is located approximately 230 metres northeast of the landfill. ▪ Groundwater quality at monitoring well BR-12 is interpreted to be impacted by the wood waste deposited in CAZ area B, road salt, and/or by landfill leachate.
BR 08-1D	- barium (D) - boron (D) - DOC (A, D) - iron (A, D) - manganese (A, D) - TDS (A, D)	▪ Variable concentrations of total phosphorous and chloride, with historical high concentration of chloride in fall 2021 and fall of 2022. ▪ Previously reported historical high concentration of phosphorous in spring 2021 returned to within historic ranges in 2022. ▪ Historical high concentration of alkalinity, conductivity, hardness, calcium and magnesium reported in fall 2022. ▪ Previous variable iron concentrations over time have stabilized in recent years. ▪ Historical high concentration of ammonia in spring 2021 and spring 2022. Previously reported historical high concentration of manganese returned to within historical ranges in 2022.	- ammonia (A, D) - barium (D) - boron (D) - DOC (A, D) - hardness (A, D) - iron (D) - potassium (A, D) - TDS (D)	▪ Monitoring well BR 08-1D is located approximately 200 metres north of the landfill. ▪ Groundwater quality at monitoring well BR 08-1D is interpreted to be impacted by the wood waste deposited in CAZ area A, and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR 08-1S	- barium (A, D) - boron (D) - DOC (A, D) - iron (A, D) - manganese (A) - TDS (A, D)	▪ Very slight increasing trend in alkalinity and ammonia over time with historical high concentration of alkalinity in spring 2021. Alkalinity remained elevated in 2022, just below the historical high in spring 2021. Recent historic high concentration of ammonia in spring 2022. ▪ Slight increasing trend in concentrations of hardness, conductivity, and calcium with historical high concentration in fall 2022. Historical high concentration of calcium and magnesium in fall 2022. ▪ Decreasing trend in concentrations of total phosphorus since 2014 with historical low concentration in fall 2021 and fall 2022. ▪ Concentrations of sodium appear to be slightly increasing with historical high concentration in fall 2022. ▪ Historical high measurement of lab conductivity in spring 2021 and spring and fall of 2022. ▪ Historical high concentration of barium in fall of 2021 increased to another historical high in fall 2022. ▪ Historical high concentration of potassium in fall 2022. ▪ Recent historical high concentrations of DOC, iron and nickel in fall 2022.	- ammonia (A, D) - barium (A, D) - boron (A, D) - DOC (A, D) - hardness (A, D) - iron (D) - potassium (A, D)) - sodium (D) - TDS (A, D)	▪ Monitoring well BR 08-1S is located approximately 200 metres north of the landfill. ▪ Groundwater quality at monitoring well BR 08-1S is interpreted to be impacted by the wood waste deposited in CAZ area A, and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR 08-2D	- DOC (A, D) - iron (A, D) - manganese (D) - TDS (D)	▪ Parameter concentrations are generally consistent over time. ▪ Overall decreasing trend in concentrations of barium since 2012 are stabilizing. ▪ Ammonia concentrations remained low in 2022 at similar concentrations to the historical low reported in spring 2020. ▪ Alkalinity concentrations appear to be slightly increasing with slight decrease in concentrations in 2022. ▪ Increasing trend in concentrations of chloride. ▪ Historical high lab and field conductivity in fall 2021 returned to within historic ranges in 2022. ▪ Historical high concentration of dissolved reactive phosphorous in spring 2021 returned to non-detectable concentrations in 2022. ▪ Historical high concentration of calcium in fall 2021 and spring 2022. ▪ Historical low of boron and manganese concentrations in 2022	- DOC (A, D) - hardness (A, D)	▪ Monitoring well BR 08-2D is located approximately 50 metres northeast of the landfill. ▪ Groundwater quality at monitoring well BR 08-2D interpreted to be impacted by the wood waste deposited in CAZ area B, and/or by landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR 08-2S	- DOC (A, D)	▪ Parameter concentrations are generally consistent over time ▪ Previously observed decreasing trend in concentrations of ammonia and manganese have stabilized (concentrations below detection limit). ▪ Historical low concentration of boron and potassium in spring 2022. ▪ Historical low concentration of chloride in fall 2021 returned to within historic levels in 2022. ▪ Historical low concentration of sodium in fall 2021 returned to within historic concentrations in 2022.	- DOC (A, D)	▪ Monitoring well BR 08-2S is located approximately 50 metres northeast of the landfill. ▪ Groundwater quality at monitoring well BR 08-2S is interpreted to be impacted by the wood waste deposited in CAZ area B, and/or by landfill leachate.
BR 08-3D	- iron (A, D) - manganese (D)	▪ Parameters are generally consistent over time. ▪ Previous decreasing trend in total phosphorous increasing. ▪ Decreasing trends in concentrations of DOC and TDS (historical low concentration in fall 2022) shows signs of stabilizing.	- none	▪ Monitoring well BR 08-3D is located approximately 100 metres northeast of the landfill. ▪ Groundwater quality at monitoring well BR 08-3D is interpreted to be impacted by wood waste or other industrial activities on the CAZ lands and potentially landfill leachate.

Monitoring Well	Parameters Exceeding or Outside Trigger Values in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions* in 2022	Hydrogeological Interpretation
BR 08-3S	- iron (A, D)	▪ Parameters are generally consistent over time. ▪ Concentrations of and molybdenum generally increasing over time. Historical high concentration of molybdenum in fall of 2020 and fall 2021 returned to within historic concentrations in 2022. ▪ Previously reported increasing trend in concentrations of manganese appears to be stabilizing. ▪ Slight decreasing trend in concentrations of DOC and TDS (historical low concentration of TDS in spring 2022). ▪ Historical low concentration of iron in fall 2021 returned to within historic concentrations in 2022. ▪ Historical low concentration of boron in spring 2022. ▪ Detectable concentration of aluminum in spring 2022.	- none	▪ Monitoring well BR 08-3S is located approximately 100 metres northeast of the landfill. ▪ Groundwater quality at monitoring well BR 08-3S is interpreted to be impacted by wood waste or other industrial activities on the CAZ lands and potentially landfill leachate.

Notes:
ODWQS – Ontario Drinking Water Quality Standards, Objectives and Guidelines (Ministry of the Environment, 2003).

Prepared by: AYFH/ETB
Checked by: ALC/ETB

* Background conditions are represented by current and historical water quality at OV-13 in the overburden and at BR-13S and BR-13D in the bedrock, as presented in Sections 7.2.1 and 7.2.2, respectively. Alkalinity is not included.

A = April 2022
D = December 2022

Table 4 – Interpretation of 2022 Surface Water Quality Data

Surface Water Sampling Location	Parameters Outside PWQO Trigger Concentrations in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions[1] in 2022	Interpretation
SW-1	– boron (Aug) – Iron (Aug)	■ Parameter concentrations relatively consistent over time except as noted. ■ Variable concentrations of unionized ammonia and total phosphorus over time. ■ Previously reported decreasing trend in DO since 2005 is stabilizing. ■ Slight decreasing trend in TDS since 2007. ■ Overall slight increasing trend in sodium appears to be stabilizing. ■ Historical high concentration of ammonia reported in fall of 2020 returned to within historic concentrations in 2021 but was slightly elevated in the spring of 2022. ■ TSS and dissolved aluminum were elevated compared to recent historical concentrations in the summer of 2021. Concentrations of dissolved aluminum were within typical historic ranges in 2022. TSS was slightly elevated in the summer of 2022. ■ Recent historical high concentration of total phosphorus in summer 2022. ■ Concentration of iron (total and dissolved) was elevated compared to recent data in summer of 2022. ■ Concentration of potassium slightly elevated in spring 2022.	– barium (Apr, Aug, D) – boron (Apr, Aug) – manganese (Aug, D) – potassium (Apr, Aug,)	■ Surface water station SW-1 is located in the wetland downstream of the landfill. ■ SW-1 is located approximately 480 metres downstream of the landfill and is interpreted to possibly be impacted by the landfill or other industrial activities. ■ SW-1 represents one of two surface water points of compliance for the site.
SW-2	– boron (Apr) – Iron (Aug) – unionized ammonia (Apr)	■ Parameter concentrations relatively consistent over time. ■ Decreasing trend in DO from to 2005-2016 appears to be increasing or stabilizing. ■ Variable iron, unionized ammonia, total phosphorus, sulphate and manganese concentrations. ■ Possible increasing trend in concentrations of boron and potassium (recent historical high in spring 2022). In general, highest concentration of boron in recent years has occurred in the spring. ■ Historical high concentration of sulphate in fall 2022. ■ Decreasing trend in TDS concentrations since 2010 may be stabilizing.	– barium (Apr, Aug, D) – boron (Apr) – manganese (Aug, D) – potassium (Apr, Aug, D) – unionized ammonia (Apr)	■ Surface water station SW-2 is located in the wetland downstream of the landfill. ■ SW-2 is located approximately 250 metres downstream of the landfill and is interpreted to be impacted by the landfill and possibly by other industrial activities. ■ SW-2 represents one of two surface water points of compliance for the site.

Surface Water Sampling Location	Parameters Outside PWQO Trigger Concentrations in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions[1] in 2022	Interpretation
		■ Historical high concentration of ammonia in spring 2021 returned to within historical concentrations in 2022 (though was slightly elevated in the spring). ■ Recent historical low concentration of barium in fall 2022. ■ First detectable concentration of mercury and first exceedance of the PWQO in spring 2021. Mercury was non-detect in 2022.		
SW-11	– alkalinity (Apr, Aug[3])	■ Parameter concentrations relatively consistent over time. ■ Previously reported increasing trend in chloride and sodium has stabilized. ■ Variable iron concentrations. ■ Recent historical high concentration of unionized ammonia in summer 2022. ■ Recent elevated concentration of barium near historical high concentration level in fall 2022. ■ Historical high concentration of magnesium reported in summer and fall 2021, with similar concentrations in the summer and fall of 2022. ■ Historical high field conductivity measured in fall 2021 returned to within historic concentrations in 2022. ■ Historical high concentration of sulphate reported in fall 2021 returned to within historical concentrations in 2022. ■ Concentrations of dissolved aluminum in spring, summer and fall of 2022 were notably low compared to recent historical concentrations. ■ Historical low concentration of DOC reported in fall 2019, fall 2020, and fall 2021. Historical low concentration of DOC not reported in 2022, but concentration in the fall was slightly low compared to spring and summer concentrations. ■ First detectable concentration of mercury and first exceedance of the PWQO in spring 2021. Mercury was non-detect in 2022.	– barium (Aug, D)	■ Surface water station SW-11 is located in the ephemeral/intermittent stream upgradient of the landfill and downstream of River Road. ■ SW-11 is located upgradient approximately 260 metres southeast of the landfill, has similar water quality to SW-10 (which is the surface water background monitoring location) and is interpreted to not be impacted by the landfill.

Surface Water Sampling Location	Parameters Outside PWQO Trigger Concentrations in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions[1] in 2022	Interpretation
SW-12	– alkalinity (Apr)	■ Parameter concentrations relatively consistent over time. ■ Variable iron concentrations. ■ Slight decreasing trend in concentrations of DOC. ■ Elevated concentration of unionized ammonia in summer 2022. Elevated concentration of ammonia in summer and fall 2022. ■ Nitrate slightly elevated in fall of 2022. ■ Concentrations of dissolved aluminum in spring, summer and fall of 2022 were notably low (non-detect) compared to recent historical concentrations. ■ Historical high concentration of magnesium in summer 2022. ■ Elevated concentration of manganese in fall 2022. ■ Slightly elevated concentration of potassium in summer 2022. ■ Historical low DO in summer 2021 returned to within historical concentrations in 2022. ■ Historical high concentration of mercury in spring 2021 (also exceeding the PWQO). Previous detectable concentration was in spring 2001. Mercury was non-detect in 2022. ■ First detectable concentration of hexavalent chromium in summer 2021 (non-detect in fall 2021). Hexavalent chromium was non-detect in 2022.	– barium (Apr, Aug, D)	■ Surface water station SW-12 is located in the ephemeral/intermittent stream near the landfill and adjacent to Usborne Street. ■ SW-12 is located approximately 400 metres from the landfill, has similar water quality to SW-10 (which is the surface water background monitoring location) and is interpreted to not be impacted by the landfill.
SW-18[2]	– alkalinity (Aug[3]) – iron (Apr) – total phosphorus (Apr)	■ Parameter concentrations relatively consistent over time with the exception of an inexplicable spike in concentrations in December 2003. ■ Decreasing trend in sulphate since 2015 appears to be stabilizing. ■ Historic high concentration of unionized ammonia in spring 2020 remained elevated in spring 2021 and fall 2021, but concentrations were more typical in 2022. ■ Historical high concentration of ammonia nitrogen in fall 2021. Ammonia concentrations have been significantly higher in 2020 and 2021, and were elevated in fall 2022.	– Barium (D) – Boron (D) – Chloride (D) – Hardness (D) – Potassium (D) – Sodium (D) – TDS (D)	■ Surface water station SW-18 is located in the Ottawa River downgradient of the landfill near Braeside boat launch. ■ SW-18 is interpreted to not be impacted by the landfill.

Surface Water Sampling Location	Parameters Outside PWQO Trigger Concentrations in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions[1] in 2022	Interpretation
		■ Detectable concentration of lead and zinc in fall 2021 were detected again in spring 2022. Previously detected in spring 2018 and summer 2016, respectively. ■ Elevated concentration of alkalinity in fall 2022. ■ First detectable concentration of hexavalent chromium in fall 2022. ■ Slightly elevated concentration of nickel in fall 2022.		

Surface Water Sampling Location	Parameters Outside PWQO Trigger Concentrations in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions[1] in 2022	Interpretation
SW-19 (location was dry during August)	– none	■ Parameter concentrations relatively consistent over time. ■ Variable iron, manganese, and sulphate. ■ Slight decreasing trend in concentrations of TDS. ■ Lead concentrations were non-detectable in 2022 after historical high concentration of lead in summer 2021. ■ Detectable concentration of zinc in fall 2022.	– barium (Apr, D) – potassium (Apr)	■ Surface water station SW-19 is located in a tributary, approximately 5 metres upstream of the Ottawa River. ■ SW-19 is interpreted to be possibly impacted by landfill leachate.
SW-21 (location was dry during August and December)	- none	■ Parameter concentrations relatively consistent over time. ■ Previously interpreted decreasing trend in DO since 2005 appears to be stabilizing. ■ Variable iron, total phosphorus, manganese, and sulphate. ■ Elevated concentration of unionized ammonia in spring 2022. ■ Elevated concentration of total phosphorous in fall 2021 returned to within historical concentrations in spring 2022. ■ Historical low concentration of DOC in 2021 returned to within historical concentrations in spring 2022.	– barium (Apr) – boron (Apr) – potassium (Apr)	■ Surface water station SW-21 is located in the wetland downstream of the landfill. ■ SW-21 is located approximately 400 metres downstream of the landfill and is interpreted to possibly be impacted by the landfill and/or industrial activities.
SW-22 (location was dry during August)	– none	■ Parameter concentrations relatively consistent over time. ■ Variable unionized ammonia, iron, manganese and nitrate. ■ Previously reported decreasing trend in DO since 2005 appears to be stabilizing. ■ Recent high concentration of sulphate in spring 2022. ■ Historical high concentration of ammonia in spring 2021 returned to within historical concentrations in 2022. ■ Detectable concentration of mercury in spring 2021 (also exceeding PWQO). Previous detectable concentration in June 1997. Mercury was non-detect in 2022.	– barium (Apr, D) – potassium (Apr) – manganese (D)	■ Surface water station SW-22 is located in the wetland downstream of the landfill. ■ SW-22 is located approximately 280 metres downstream of the landfill and is interpreted to possibly be impacted by the landfill and/or industrial activities.

Surface Water Sampling Location	Parameters Outside PWQO Trigger Concentrations in 2022	Trend(s)	Leachate Indicator Parameters Exceeding Background Conditions[1] in 2022	Interpretation
SW-23 (location was dry during August and December)	- alkalinity (Apr)	■ Location has been dry since 2004, with the exception of spring 2016, 2020 and 2022; therefore, it is not possible to determine trends in parameter concentrations at this location. ■ Historical data suggests generally consistent concentrations with the exception of a decrease in December 2003. Parameter concentrations in spring 2016, 2020 and 2022 are generally within historical ranges or slightly lower. ■ Historical low concentration of dissolved oxygen in summer 2022.	– Barium (Apr)	■ Surface water station SW-23 is in the wetland downgradient of the landfill. ■ SW-23 represents an alternate point of compliance when flow at SW-1 is obstructed. ■ SW-23 is located approximately 650 metres downstream of the landfill and is historically interpreted to possibly be impacted by the landfill or industrial activities.
SW-26[2]	- unionized ammonia (Aug) - iron (Apr)	■ Parameter concentrations relatively consistent over time. ■ Historical high concentration of alkalinity in fall 2022. ■ Previously reported historical high concentrations of unionized ammonia and ammonia nitrogen in 2020 have remained slightly elevated in 2021 and 2022. ■ First detectable concentration of mercury and first exceedance of the PWQO in spring 2021. Mercury was non-detect in 2022.	– n/a	■ Surface water station SW-26 is located in the Ottawa River approximately 400 m upstream of station SW-18 (near Braeside boat launch). ■ SW-26 is interpreted to not be impacted by the landfill.

Notes:

Prepared by: AYFH/ALC

Checked by: ETB/ALC

PWQO – Provincial Water Quality Objectives (Ministry of the Environment, 1994b).

[1] Background conditions are represented by current and historical water quality at surface water station SW-10 as presented in Section 9.3. Alkalinity is not included.

[2] Background conditions and trigger values determined by current and historical water quality at surface water station SW-26 (background station for Ottawa River).

[3] While the concentration of alkalinity was outside of the trigger concentration at this location during this monitoring session, it should be noted that the concentration of alkalinity at this location could not be assessed with respect to the PWQO concentration (based on 75% of the concentration of alkalinity at the background location), as the background location (SW-10) was dry during this monitoring session.

Apr = April 2022
Aug = August 2022
D = December 2022

Table 5 – Proposed 2023 Groundwater Monitoring Program

1.0 MONITORING SESSIONS

1.1 Water Level and Quality Monitoring

Spring (April/May)

Fall (October/November)

2.0 GROUNDWATER SAMPLING LOCATIONS

2.1 Sampling Locations

OV-7, OV-9, OV-10, OV-13

BR-1S, BR-1D, BR-3, BR-5S, BR-5D, BR-6S, BR-6D, BR-7S, BR-7D, BR-8S, BR-8D, BR-9S, BR-9D, BR-10, BR-11, BR-12, BR-13S, BR-13D, BR08-1S, BR08-1D, BR08-2S, BR08-2D, BR08-3S, BR08-3D

New Groundwater Monitors: OV-23, BR-23S, BR-23D

2.2 Field QA/QC

two duplicates per sampling event

one field blank for VOCs on years when VOCs are evaluated (next scheduled sampling date is 2024)

3.0 FIELD MEASURED PARAMETERS

groundwater levels in all accessible monitoring wells

temperature, conductivity, pH

4.0 LABORATORY MEASURED PARAMETERS

calcium, magnesium, sodium, potassium, aluminum, barium, beryllium, boron, cadmium, chromium, cobalt, iron, lead,

manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, zinc

hardness (calculated from laboratory calcium and magnesium analyses)

alkalinity, TDS, chloride, sulphate

ammonia, total phosphorus, DOC

dissolved reactive phosphorus

VOCs at OV-7 and BR-1S every 5 years (next scheduled sampling date is 2024)

Special Note for Parameters with Established Ontario Drinking Water Quality Standards, Objectives and Guidelines
All laboratory analyses on groundwater samples will be performed by a private analytical laboratory and the method detection limits (MDLs) for the specific analyses should be commensurate with the standards established in the Provincial Water Quality Objectives or the Ontario Drinking Water Quality Standards, Objectives and Guideline, whichever is lower.

Table 6 – Proposed 2023 Surface Water Sampling Program

1.0 MONITORING SESSIONS

1.1 Water Quality Monitoring

Spring (April/May)

Summer (July/August)

Fall (October/November)

2.0 SURFACE WATER SAMPLING STATIONS

2.1 Sampling Stations

Ephemeral/Intermittent Stream to the South of the Site: SW-10, SW-11, SW-12

Wetland North of the Site: SW-1, SW-2, SW-21, SW-22, SW-23

Ottawa River: SW-18, SW-19, SW-26

2.2 Field QA/QC

one duplicate per sampling event

3.0 FIELD MEASURED PARAMETERS

temperature, conductivity, pH, dissolved oxygen

flow measurements or description of flow conditions

representative photographs

4.0 LABORATORY MEASURED PARAMETERS

calcium, magnesium, sodium, potassium, aluminum, barium, beryllium, boron, cadmium, chromium (hexavalent and total), cobalt, iron (total and dissolved), lead, manganese, mercury, molybdenum, nickel, selenium, silver, vanadium, zinc

hardness (calculated from laboratory calcium and magnesium analyses)

alkalinity, TDS, chloride, sulphate, BOD, nitrate, TSS

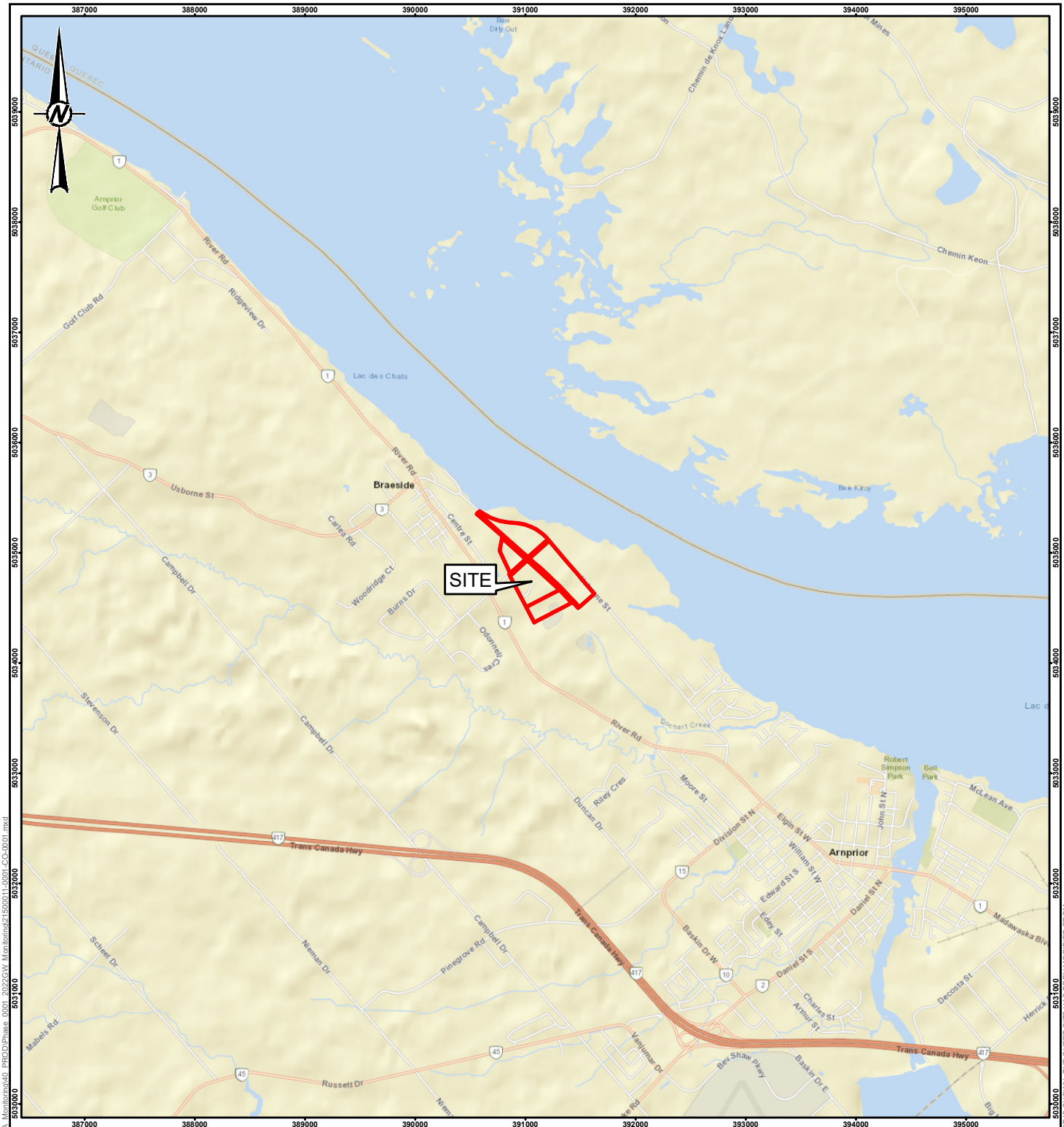
ammonia, total phosphorus, DOC

unionized ammonia (calculated from laboratory ammonia and field temperature and pH)

chromium III (calculated from laboratory total and hexavalent chromium)

Special Note for Parameters with Established Provincial Water Quality Criteria
All laboratory analyses on surface water samples will be performed by a private analytical laboratory and the method detection limits (MDLs) for the specific analyses should be commensurate with the standards established in the Provincial Water Quality Objectives or the Ontario Drinking Water Standards/Objectives, whichever is lower.

Figures



LEGEND

SITE

0 500 1,000 2,000

1:50,000 METRES

NOTE(S)

ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28
2. SERVICE LAYER CREDITS: SOURCES: ESRI, HERE, GARMIN, USGS, INTERMAP, INCREMENT P, NRCAN, ESRI JAPAN, METI, ESRI CHINA (HONG KONG), ESRI KOREA, ESRI (THAILAND), NGCC, (C) OPENSTREETMAP CONTRIBUTORS, AND THE GIS USER COMMUNITY

CLIENT

CORPORATION OF THE TOWN OF ARNPRIOR

PROJECT

2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING ARNPRIOR WASTE DISPOSAL SITE

TITLE

KEY PLAN

CONSULTANT

wsp

YYYY-MM-DD	2023-02-10
DESIGNED	ETB
PREPARED	ABD
REVIEWED	ALC
APPROVED	PLE

PROJECT NO.	PHASE	REV.	FIGURE
21500011	0001	0	1

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OTTAWA RIVER

TEMBEC

ATTENUATION ZONE

COUNTY ROAD No 3 - USBORNE STREET

TEMBEC
PART 4 PLAN 49R-12219

BM #805168

SW-19

TEMBEC

BR-11

SW-20

BR-7S, BR-7D
TBM #7

CAZ AREA A

BR-8S, BR-8D

BR-6S, BR-6D
TBM #6

BR-12

BR-5S, BR-5D
TBM #8

SW-12

BR-9S, BR-9D

CAZ AREA B

BR08-3S, BR08-3D

BR-18S, BR-18D

TEMBEC
REMAINDER PART 1 PLAN 49R-12219

OV-23, BR-23S, BR-23D

REGISTERED PLAN No. 26

300m±

SW-18

BOAT LAUNCH

SW-17

SW-1

BR-10

SW-21

SW-22

BR08-1S, BR08-1D

BR-08-2S, BR08-2D

CANADIAN PACIFIC RAILWAY

SW-4

SW-2

SW-11

SW-23

WETLAND

SW-3

SW-5

SW-6

OV-2

TBM #1

FENCE LINE

OV-11

30 m BUFFER

OV-9

REGISTERED PLAN No. 44

TBM #3

TBM #2

BR-1S, BR-1D

CAZ AREA C

ROAD ALLOWANCE BETWEEN LOTS 10 AND 11

30 m BUFFER

BR-2

2022 SURVEY LIMITS

LICENSED LANDFILL

CAZ AREA D

OV-10

OV-8

30 m BUFFER

FILL AREA

30m BUFFER ZONE

OV-5

BR-3
TBM #5

ATTENUATION ZONE

30 m BUFFER

TBM #4

LICENSED FILL AREA BOUNDARY

OV-4

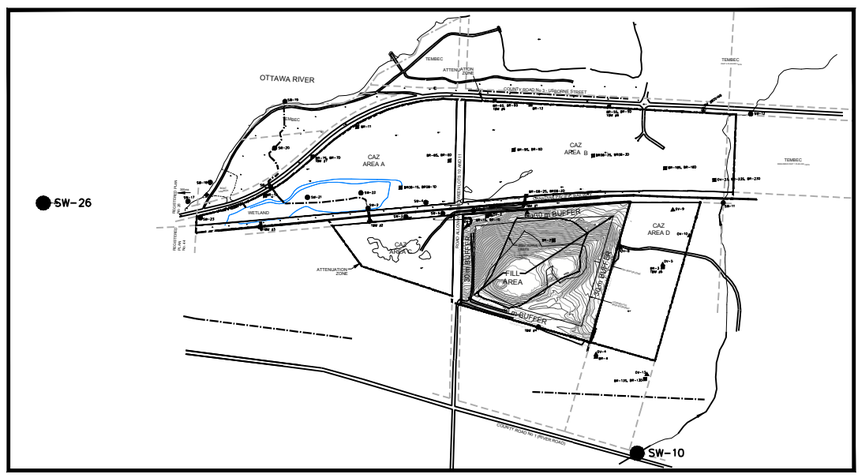
BR-4

OV-13

BR-13S, BR-13D

SW-10

SW-26



		AREA (HECTARES)	
		SUBTOTAL	TOTAL
CONTAMINANT ATTENUATION ZONE (CAZ)	AREA A	8.9	30.8
	AREA B	12.8	
	AREA C	3.4	
	AREA D	5.7	
LANDFILLING SITE	BUFFER AREA	3.4	9.6
	FILL AREA	6.2	
TOTAL AREA			40.4

0 100 200
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LEGEND

- BR-1 BEDROCK MONITORING STATION
- SW-6 SURFACE WATER MONITORING STATION
- OV-7 OVERBURDEN MONITORING STATION
- MW23GS MONITORING WELL
- TBM #6 TEMPORARY BENCHMARK
- TOPOGRAPHICAL CONTOURS (2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021 AND 2022 COMBINED SURVEYS)

REFERENCE(S)

1. BASE PLAN SUPPLIED IN DIGITAL FORMAT BY J.L. RICHARDS
2. TOPOGRAPHICAL CONTOURS BEYOND THE EXTENT OF THE 2014 TO 2022 SURVEYS SUPPLIED IN DIGITAL FORMAT BY JP2G CONSULTANTS INC.
3. LANDFILL TOPOGRAPHICAL CONTOURS GENERATED FROM GOLDER ASSOCIATES LTD. / WSP CANADA INC. COMBINED SURVEY FROM 2013 TO 2022.
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

CONSULTANT
wsp

YYYY-MM-DD	2023-02-06
PREPARED	ABD/JG
DESIGN	ETB
REVIEW	ALC
APPROVED	PLE

PROJECT
2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING , ARNPRIOR WASTE DISPOSAL SITE

TITLE
SITE PLAN

PROJECT No.	CONTROL	Rev.	FIGURE
21500011	0001	A	2

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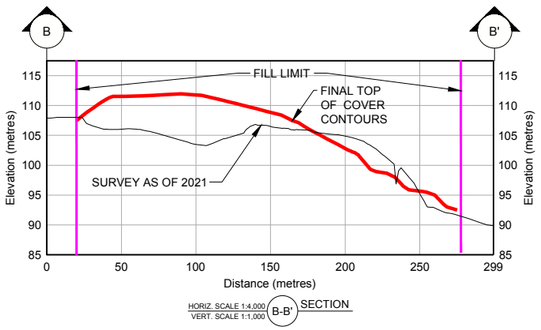

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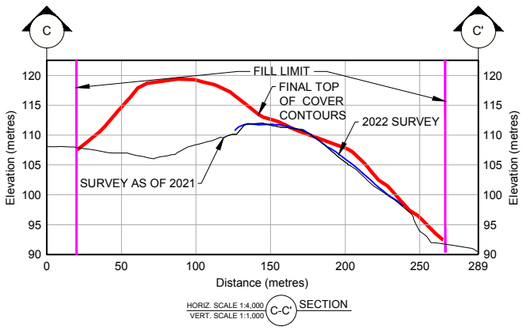

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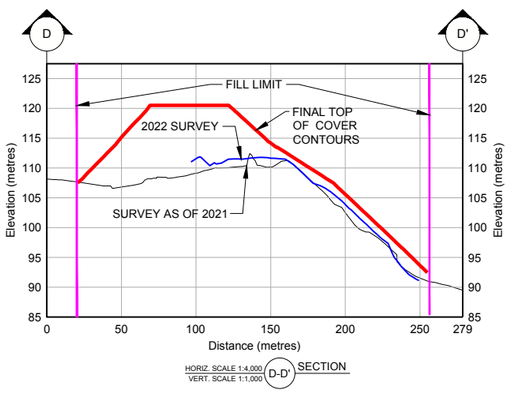

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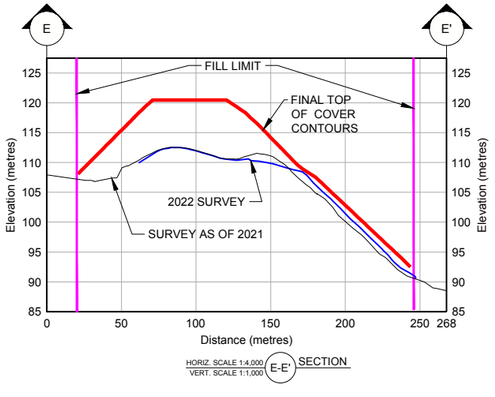

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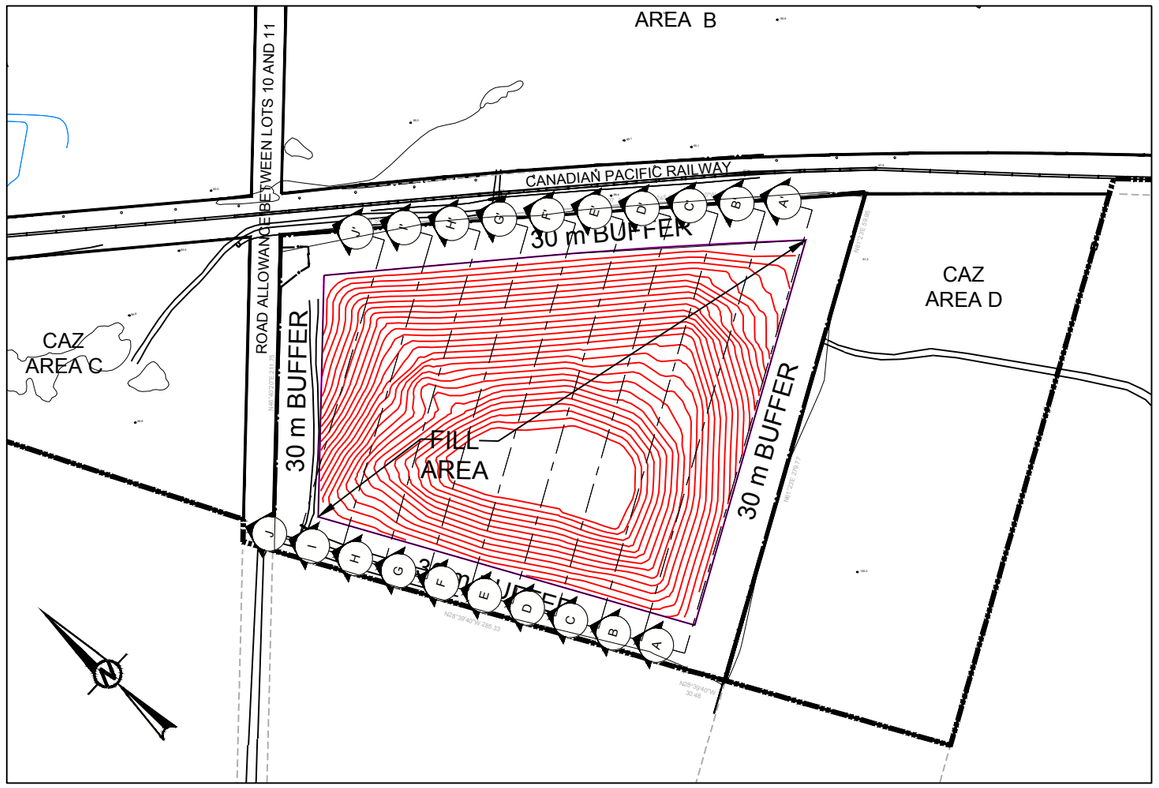

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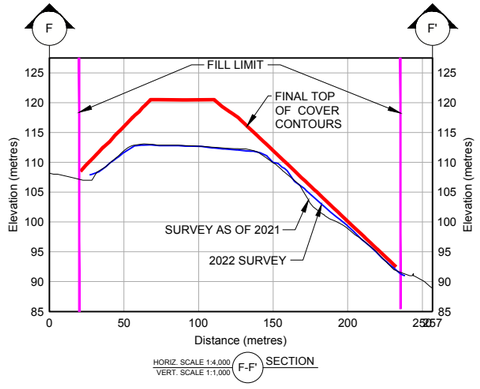

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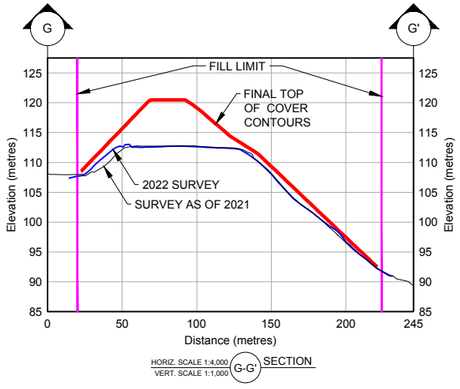

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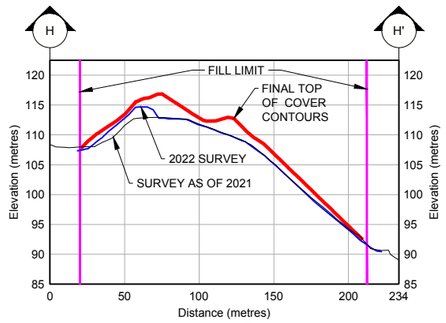

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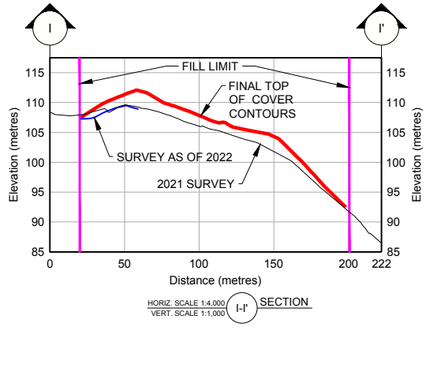

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VERT. SCALE 1:1,000
I-I' SECTION

LEGEND

- PROPOSED FILL LIMITS
- SURVEY AS OF 2021
- 2022 SURVEY LIMIT
- FINAL TOP OF COVER CONTOURS

? ?' SECTION LINE LOCATION REFER TO FIGURE 3

REFERENCE(S)

1. BASE PLAN SUPPLIED IN DIGITAL FORMAT BY J.L. RICHARDS
2. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28.
3. 2022 TOPOGRAPHIC SURVEY BY WSP CANADA INC. DATED DECEMBER 20, 2022.
4. TOPOGRAPHIC SURVEYS FROM 2014, 2015, 2016, 2017, 2018, 2019, 2020 AND 2021 BY GOLDER ASSOCIATES LTD.
5. 2013 TOPOGRAPHIC SURVEY BY JP2G CONSULTANTS INC IN 2013 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING REPORT.

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1:4,000 METRES

0 25 50
1:1,000 METRES

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

CONSULTANT
wsp

YYYY-MM-DD	2023-02-06
PREPARED	ABD/JG
DESIGN	ETB
REVIEW	ALC
APPROVED	PLE

PROJECT
2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING , ARNPRIOR WASTE DISPOSAL SITE

TITLE
CROSS SECTIONS

PROJECT No.	CONTROL	Rev.	FIGURE
21500011	0001	A	3

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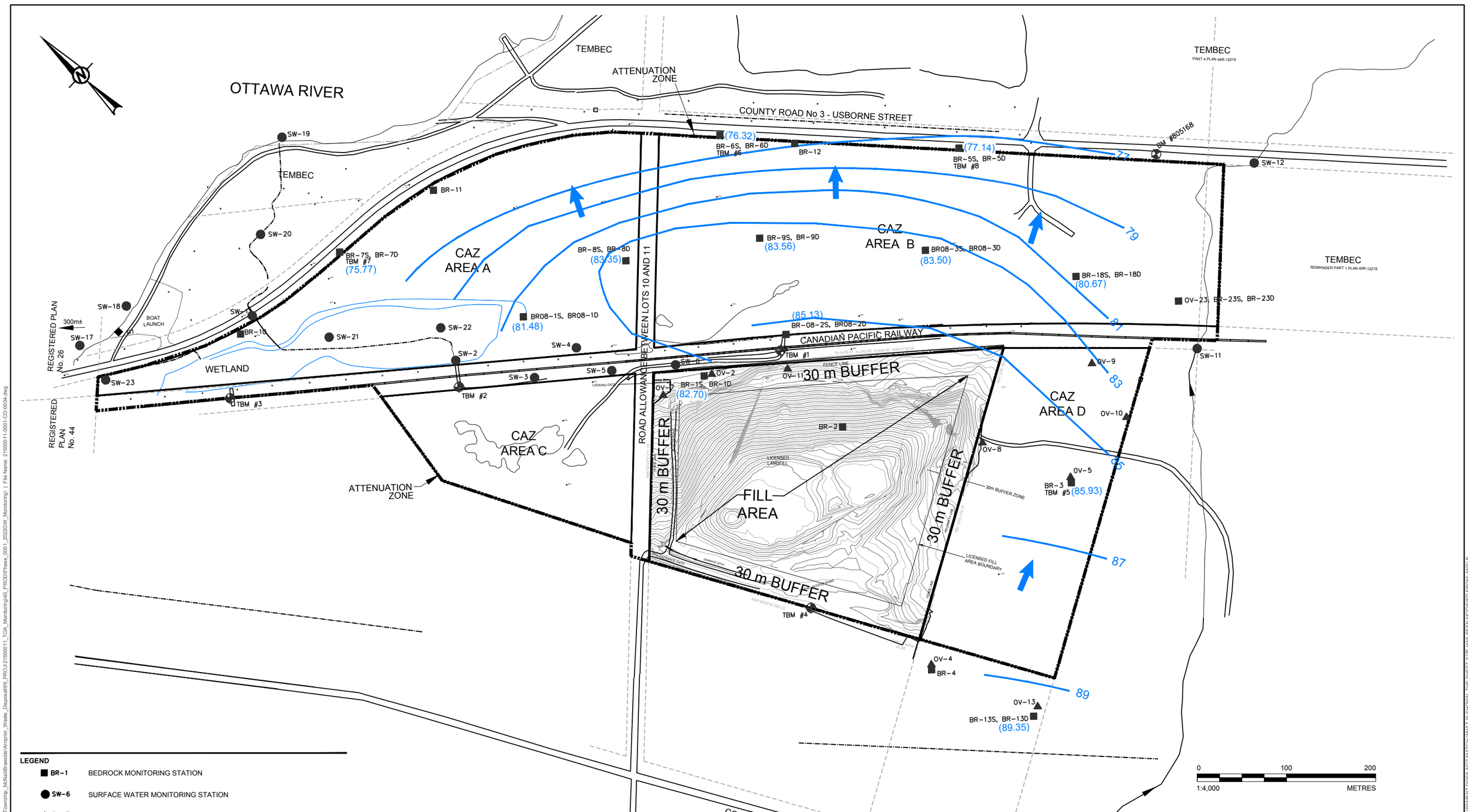

LEGEND

BR-1	BEDROCK MONITORING STATION
SW-6	SURFACE WATER MONITORING STATION
OV-7	OVERBURDEN MONITORING STATION
TBM #6	TEMPORARY BENCHMARK
	TOPOGRAPHICAL CONTOURS (2013, 2014, 2015, 2016, 2017, 2018, 2019,2020, 2021 AND 2022 COMBINED SURVEYS)
	INTERPRETED GROUNDWATER FLOW DIRECTION
(85.18)	GROUNDWATER ELEVATION (APRIL 2022)
120	INTERPRETED GROUNDWATER ELEVATION CONTOUR

REFERENCE(S)

1. BASE PLAN SUPPLIED IN DIGITAL FORMAT BY J.L. RICHARDS
2. TOPOGRAPHICAL CONTOURS BEYOND THE EXTENT OF THE 2014 TO 2022 SURVEYS SUPPLIED IN DIGITAL FORMAT BY JP2G CONSULTANTS INC.
3. LANDFILL TOPOGRAPHICAL CONTOURS GENERATED FROM GOLDER ASSOCIATES LTD. / WSP CANADA INC. COMBINED SURVEY FROM 2013 TO 2022.
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

CONSULTANT

YYYY-MM-DD	2023-03-16
PREPARED	ABD/JG
DESIGN	ETB
REVIEW	ALC
APPROVED	PLE

PROJECT
2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING , ARNPRIOR WASTE DISPOSAL SITE

TITLE
SHALLOW BEDROCK GROUNDWATER FLOW DIRECTIONS (APRIL 2022)

PROJECT No.	CONTROL	Rev.	FIGURE
21500011	0001	A	4

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

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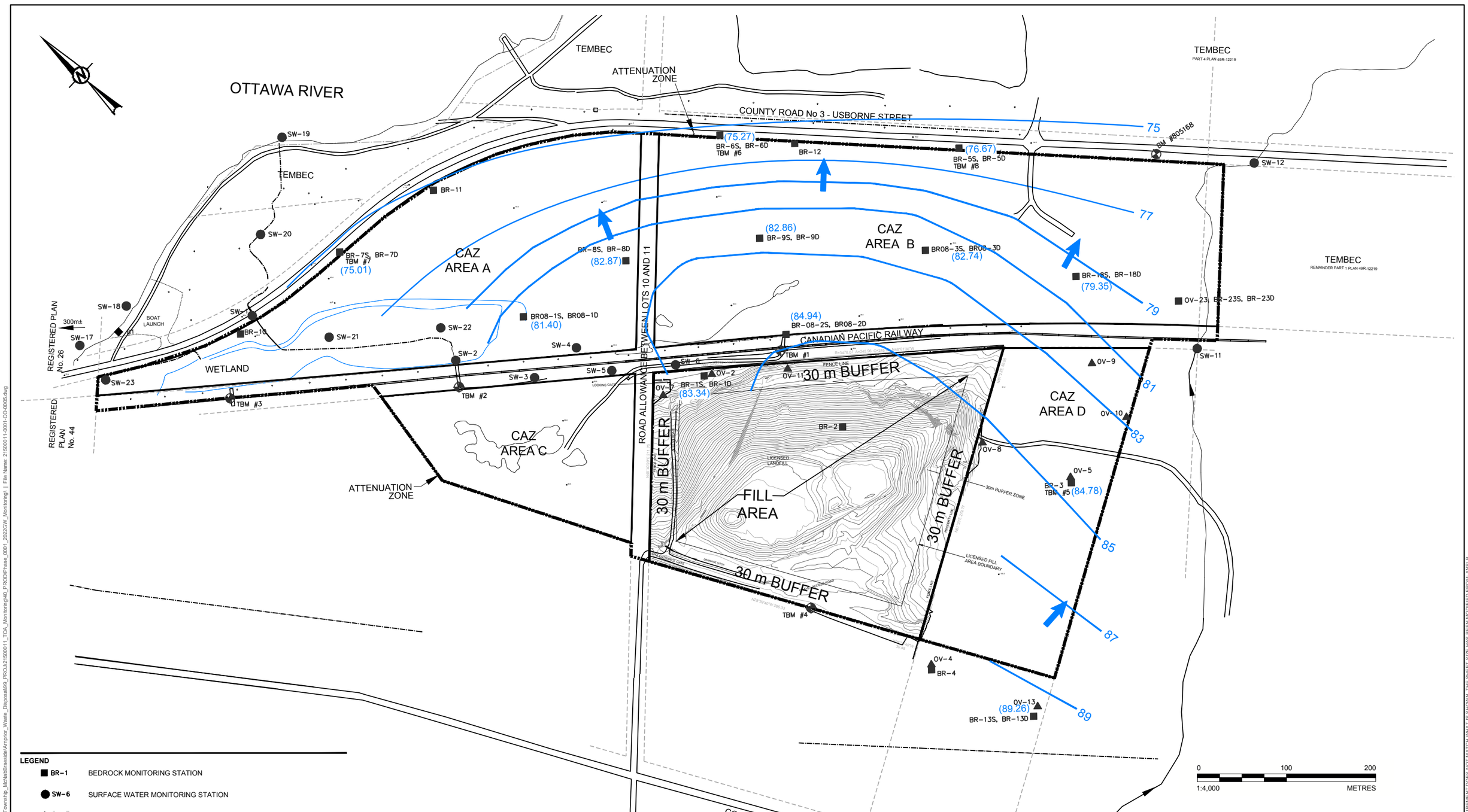

LEGEND

BR-1	BEDROCK MONITORING STATION
SW-6	SURFACE WATER MONITORING STATION
OV-7	OVERBURDEN MONITORING STATION
TBM #6	TEMPORARY BENCHMARK
	TOPOGRAPHICAL CONTOURS (2013, 2014, 2015, 2016, 2017, 2018, 2019,2020, 2021 and 2022 COMBINED SURVEYS)
	INTERPRETED GROUNDWATER FLOW DIRECTION
(85.18)	GROUNDWATER ELEVATION (DEC. 2022)
120	INTERPRETED GROUNDWATER ELEVATION CONTOUR

REFERENCE(S)

1. BASE PLAN SUPPLIED IN DIGITAL FORMAT BY J.L. RICHARDS
2. TOPOGRAPHICAL CONTOURS BEYOND THE EXTENT OF THE 2014 TO 2022 SURVEYS SUPPLIED IN DIGITAL FORMAT BY JP2G CONSULTANTS INC.
3. LANDFILL TOPOGRAPHICAL CONTOURS GENERATED FROM GOLDER ASSOCIATES LTD. / WSP CANADA INC. COMBINED SURVEY FROM 2013 TO 2022.
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

CONSULTANT

YYYY-MM-DD	2023-03-16
PREPARED	ABD/JG
DESIGN	ETB
REVIEW	ALC
APPROVED	PLE

PROJECT
2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING , ARNPRIOR WASTE DISPOSAL SITE

TITLE
SHALLOW BEDROCK GROUNDWATER FLOW DIRECTIONS (DECEMBER 2022)

PROJECT No.	CONTROL	Rev.	FIGURE
21500011	0001	A	5

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

Path: \\golder.gds\complexdata\office\Ontario\SIM\Clients\Township_McNabBraeside\Arnprior_Waste_Disposal\99_PROJ\215000111_TOA_Monitoring\40_PROD\Phase_0001_2022GW_Monitoring\ | File Name: 215000111-0001-CO-0005.dwg

OTTAWA RIVER

TEMBEC

ATTENUATION ZONE

COUNTY ROAD No 3 - USBORNE STREET

TEMBEC
PART 4 PLAN 49R-12219

SW #805168

SW-19

SW-12

TEMBEC

BR-11

SW-20

BR-7S, BR-7D
TBM #7

CAZ
AREA A

BR-8S, BR-8D

BR-6S, BR-6D
TBM #6

BR-12

BR-5S, BR-5D
TBM #8

BR-9S, BR-9D

CAZ
AREA B

BR08-3S, BR08-3D

BR-18S, BR-18D

TEMBEC
REMAINDER PART 1 PLAN 49R-12219

OV-23, BR-23S, BR-23D

REGISTERED PLAN No. 26

300m±

SW-18

BOAT LAUNCH

SW-17

SW-16

BR-10

SW-21

SW-22

BR08-1S, BR08-1D

BR-08-2S, BR08-2D

CANADIAN PACIFIC RAILWAY

SW-4

SW-2

SW-11

WETLAND

SW-23

SW-3

SW-5

SW-6

(85.20)

(84.33)

OV-2

OV-7

BR-1S, BR-1D

TBM #1

OV-11

FENCE LINE

30 m BUFFER

TBM #3

TBM #2

ROAD ALLOWANCE BETWEEN LOTS 10 AND 11

REGISTERED PLAN No. 44

CAZ
AREA C

OV-9
(86.62)

CAZ
AREA D

OV-10
(86.81)

BR-2

LICENSED LANDFILL

OV-8

(87.14)

OV-5

BR-3
TBM #5

30m BUFFER ZONE

30 m BUFFER

30 m BUFFER

FILL
AREA

LICENSED FILL AREA BOUNDARY

ATTENUATION ZONE

TBM #4

(blocked)

OV-4

BR-4

(89.53)

OV-13

BR-13S, BR-13D

85

87

89

0 100 200
1:4,000 METRES

LEGEND

BR-1	BEDROCK MONITORING STATION
SW-6	SURFACE WATER MONITORING STATION
OV-7	OVERBURDEN MONITORING STATION
TBM #6	TEMPORARY BENCHMARK
	TOPOGRAPHICAL CONTOURS (2013, 2014, 2015, 2016, 2017, 2018, 2019,2020, 2021 AND 2022 COMBINED SURVEYS)
	INTERPRETED GROUNDWATER FLOW DIRECTION
(85.18)	GROUNDWATER ELEVATION (APRIL 2022)
120	INTERPRETED GROUNDWATER ELEVATION CONTOUR

REFERENCE(S)

1. BASE PLAN SUPPLIED IN DIGITAL FORMAT BY J.L. RICHARDS
2. TOPOGRAPHICAL CONTOURS BEYOND THE EXTENT OF THE 2014 TO 2022 SURVEYS SUPPLIED IN DIGITAL FORMAT BY JP2G CONSULTANTS INC.
3. LANDFILL TOPOGRAPHICAL CONTOURS GENERATED FROM GOLDER ASSOCIATES LTD. / WSP CANADA INC. COMBINED SURVEY FROM 2013 TO 2022.
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

CONSULTANT
wsp

YYYY-MM-DD	2023-03-16
PREPARED	ABD/JG
DESIGN	ETB
REVIEW	ALC
APPROVED	PLE

PROJECT
2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING , ARNPRIOR WASTE DISPOSAL SITE

TITLE
OVERBURDEN GROUNDWATER FLOW DIRECTION (APRIL 2022)

PROJECT No.	CONTROL	Rev.	FIGURE
21500011	0001	A	6

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

0

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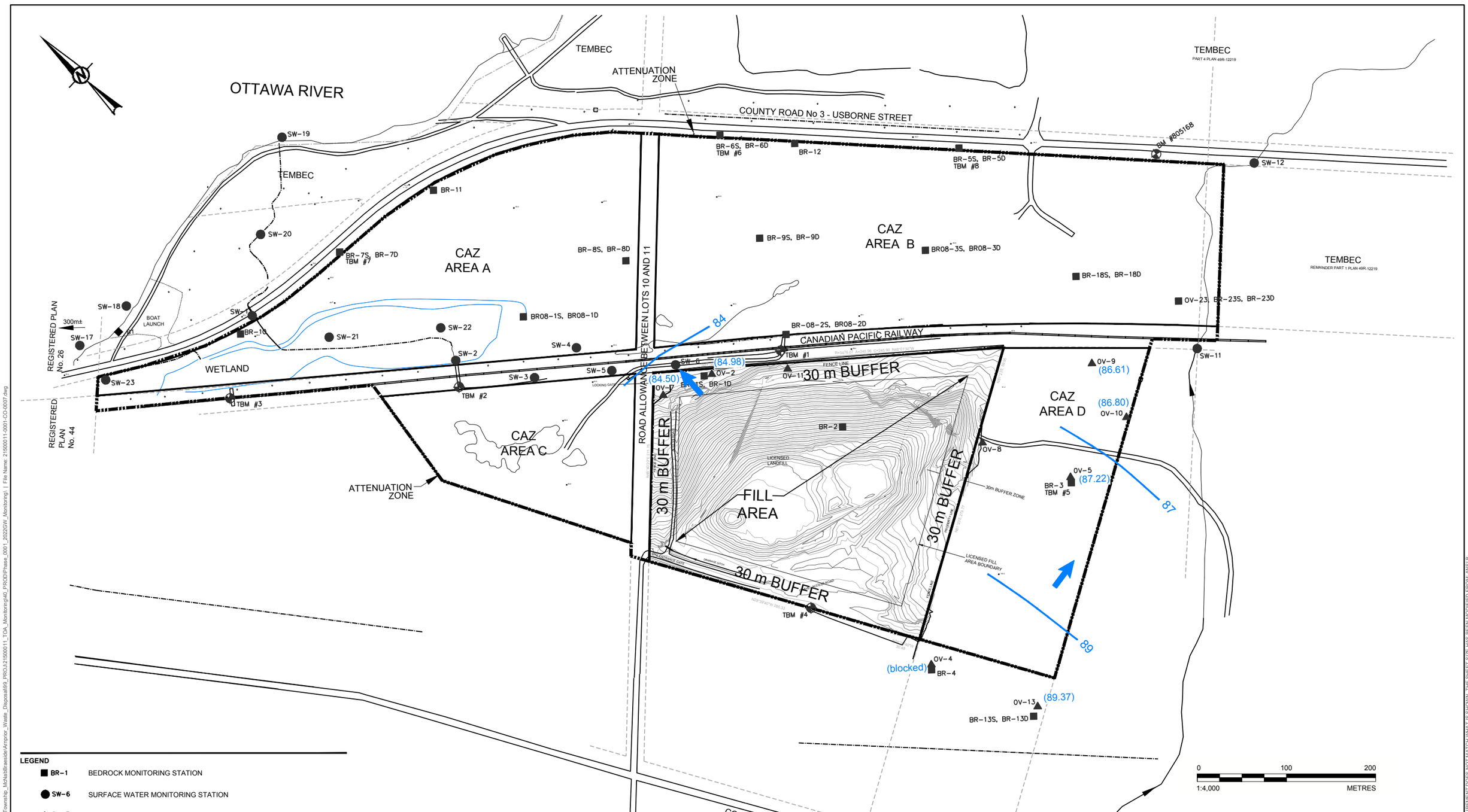

LEGEND

BR-1	BEDROCK MONITORING STATION
SW-6	SURFACE WATER MONITORING STATION
OV-7	OVERBURDEN MONITORING STATION
TBM #6	TEMPORARY BENCHMARK
	TOPOGRAPHICAL CONTOURS (2013, 2014, 2015, 2016, 2017, 2018,2019, 2020, 2021 AND 2022 COMBINED SURVEYS)
	INTERPRETED GROUNDWATER FLOW DIRECTION
(85.18)	GROUNDWATER ELEVATION (DEC. 2022)
120	INTERPRETED GROUNDWATER ELEVATION CONTOUR

REFERENCE(S)

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3. LANDFILL TOPOGRAPHICAL CONTOURS GENERATED FROM GOLDER ASSOCIATES LTD. / WSP CANADA INC. COMBINED SURVEY FROM 2013 TO 2022.
4. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

CONSULTANT

YYYY-MM-DD	2023-03-16
PREPARED	ABD/JG
DESIGN	ETB
REVIEW	ALC
APPROVED	PLE

PROJECT
2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING , ARNPRIOR WASTE DISPOSAL SITE

TITLE
OVERBURDEN GROUNDWATER FLOW DIRECTIONS (DECEMBER 2022)

PROJECT No.	CONTROL	Rev.	FIGURE
21500011	0001	A	7

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

25 mm

0

Path: \\golder.gds\complexdata\office\Ontario\SIM\Clients\Township_McNabBraeside\Arnprior_Waste_Disposal\99_PROJ\21500011_TOA_Monitoring\40_PROD\Phase_0001_2022GW_Monitoring\ | File Name: 21500011-0001-CO-0007.dwg

FIGURE 8: PIPER TRILINEAR DIAGRAM – GROUNDWATER – APRIL 2022

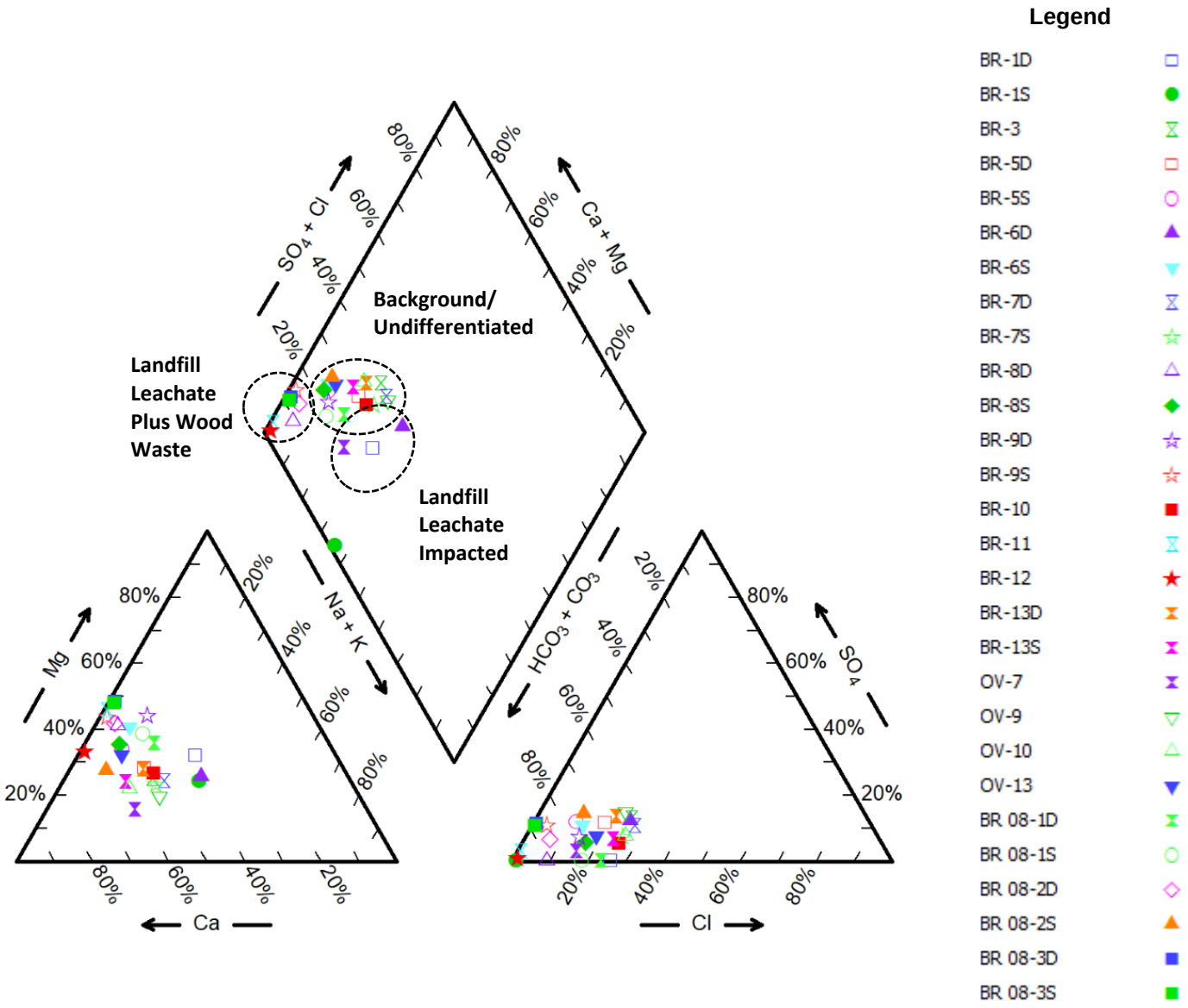
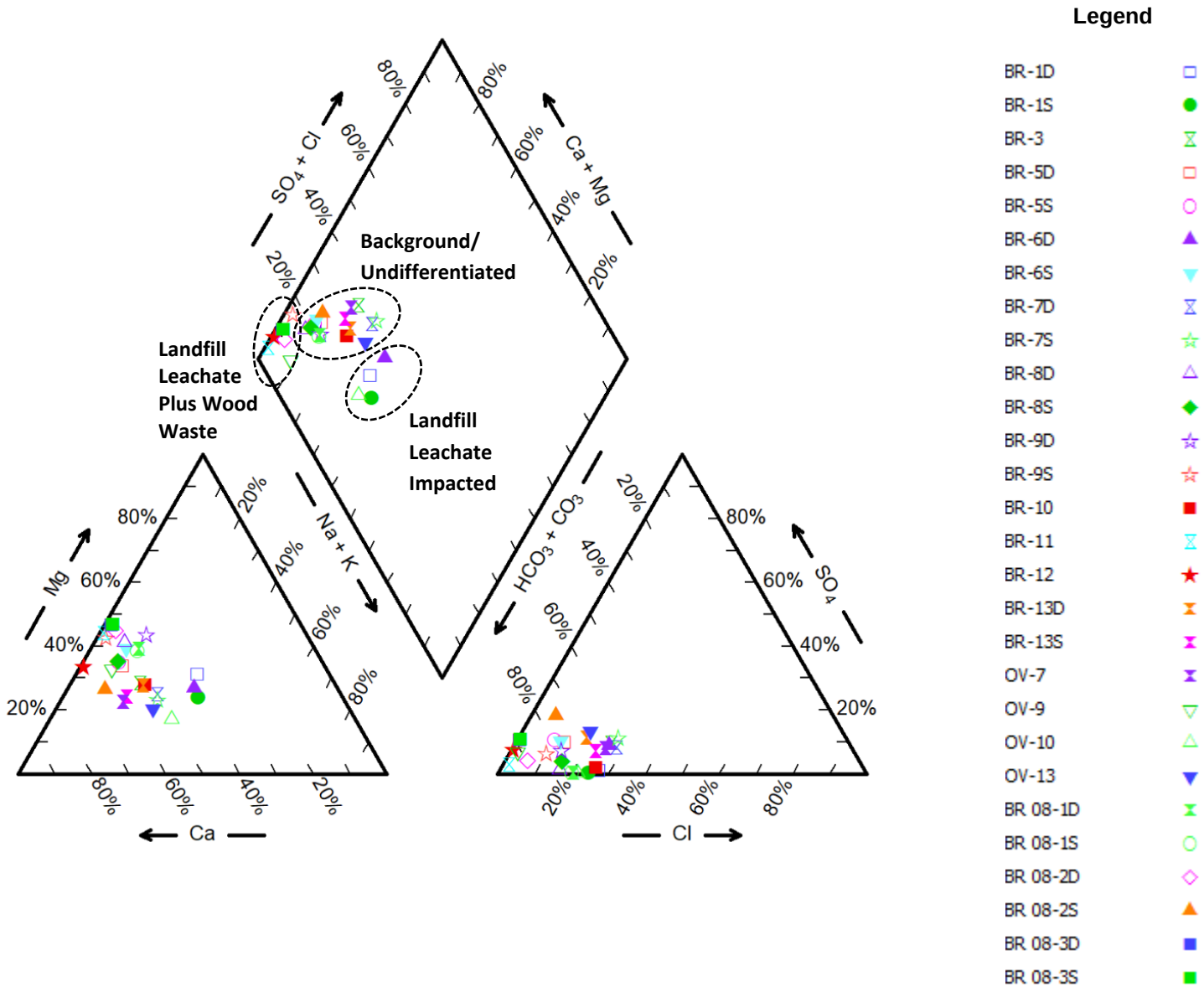
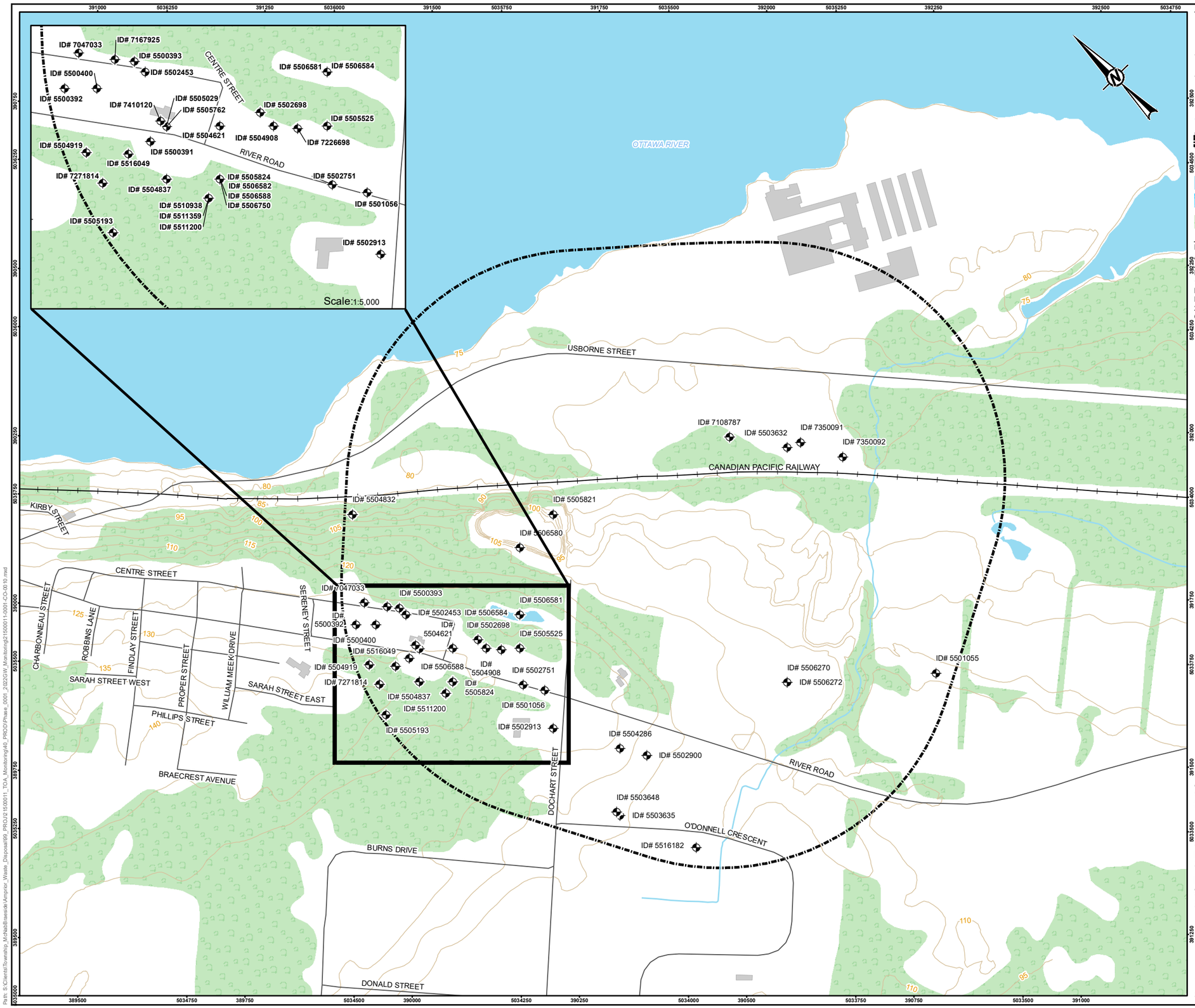


FIGURE 9: PIPER TRILINEAR DIAGRAM – GROUNDWATER – DECEMBER 2022





LEGEND

- MECP WWIS WATER WELL LOCATION
- ROADWAY
- RAILWAY
- CONTOUR, metres
- WATERCOURSE
- 500 m BUFFER
- BUILDING
- WATERBODY
- WETLAND
- WOODED AREA

NOTE(S)

ALL LOCATIONS ARE APPROXIMATE

REFERENCE(S)

1. LAND INFORMATION ONTARIO (LIO) DATA PRODUCED BY GOLDER ASSOCIATES LTD. UNDER LICENCE FROM ONTARIO MINISTRY OF NATURAL RESOURCES AND FORESTRY, © QUEENS PRINTER 2014
2. PROJECTION: TRANSVERSE MERCATOR DATUM: NAD 83
COORDINATE SYSTEM: UTM ZONE 18 VERTICAL DATUM: CGVD28

0 80 160 320
1:8,000 METRES

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

PROJECT
2022 SITE DEVELOPMENT, OPERATIONS AND ENVIRONMENTAL MONITORING ARNPRIOR WASTE DISPOSAL SITE

TITLE
LOCATION OF RESIDENTIAL WELLS WITHIN 500M OF LANDFILL BOUNDARY

CONSULTANT

YYYY-MM-DD	2023-02-10
DESIGNED	ETB
PREPARED	ABD
REVIEWED	ALC
APPROVED	PLE

PROJECT NO.	PHASE	REV.	FIGURE
21500011	0001	A	**10**

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: 25mm

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APPENDIX A

Report of Analyses, Bureau Veritas Laboratories (Provided on USB)

APPENDIX B

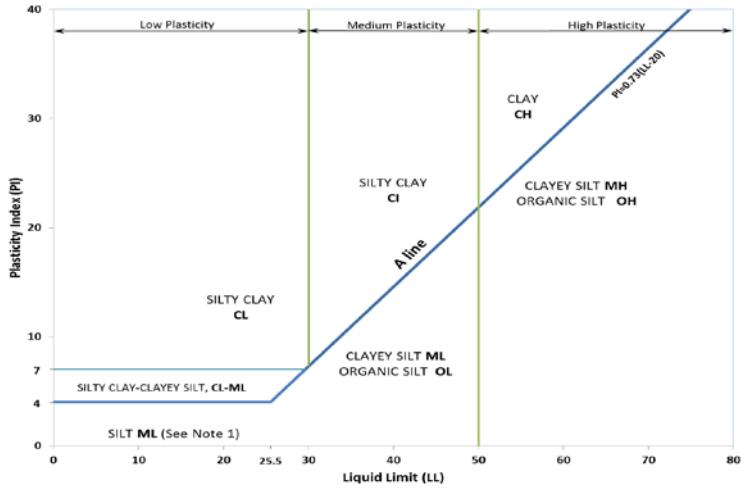
Borehole Logs

METHOD OF SOIL CLASSIFICATION

The Golder Associates Ltd. Soil Classification System is based on the Unified Soil Classification System (USCS)

Organic or Inorganic	Soil Group	Type of Soil		Gradation or Plasticity	$Cu = \frac{D_{60}}{D_{10}}$	$Cc = \frac{(D_{30})^2}{D_{10} x D_{60}}$	Organic Content	USCS Group Symbol	Group Name
INORGANIC (Organic Content ≤30% by mass)	COARSE-GRAINED SOILS (>50% by mass is larger than 0.075 mm)	GRAVELS (>50% by mass of coarse fraction is larger than 4.75 mm)	Gravels with ≤12% fines (by mass)	Poorly Graded	<4	≤1 or ≥3	≤30%	GP	GRAVEL
				Well Graded	≥4	1 to 3		GW	GRAVEL
			Gravels with >12% fines (by mass)	Below A Line	n/a			GM	SILTY GRAVEL
				Above A Line	n/a			GC	CLAYEY GRAVEL
		SANDS (≥50% by mass of coarse fraction is smaller than 4.75 mm)	Sands with ≤12% fines (by mass)	Poorly Graded	<6	≤1 or ≥3		SP	SAND
				Well Graded	≥6	1 to 3		SW	SAND
			Sands with >12% fines (by mass)	Below A Line	n/a			SM	SILTY SAND
				Above A Line	n/a			SC	CLAYEY SAND

Organic or Inorganic	Soil Group	Type of Soil	Laboratory Tests	Field Indicators					Organic Content	USCS Group Symbol	Primary Name
				Dilatancy	Dry Strength	Shine Test	Thread Diameter	Toughness (of 3 mm thread)			
INORGANIC (Organic Content ≤30% by mass)	FINE-GRAINED SOILS (≥50% by mass is smaller than 0.075 mm)	SILTS (Non-Plastic or PI and LL plot below A-Line on Plasticity Chart below)	Liquid Limit <50	Rapid	None	None	>6 mm	N/A (can't roll 3 mm thread)	<5%	ML	SILT
				Slow	None to Low	Dull	3mm to 6 mm	None to low	<5%	ML	CLAYEY SILT
				Slow to very slow	Low to medium	Dull to slight	3mm to 6 mm	Low	5% to 30%	OL	ORGANIC SILT
			Liquid Limit ≥50	Slow to very slow	Low to medium	Slight	3mm to 6 mm	Low to medium	<5%	MH	CLAYEY SILT
				None	Medium to high	Dull to slight	1 mm to 3 mm	Medium to high	5% to 30%	OH	ORGANIC SILT
		CLAYS (PI and LL plot above A-Line on Plasticity Chart below)	Liquid Limit <30	None	Low to medium	Slight to shiny	~ 3 mm	Low to medium	0% to 30% **(see Note 2)**	CL	SILTY CLAY
			Liquid Limit 30 to 50	None	Medium to high	Slight to shiny	1 mm to 3 mm	Medium		CI	SILTY CLAY
			Liquid Limit ≥50	None	High	Shiny	<1 mm	High		CH	CLAY
HIGHLY ORGANIC SOILS (Organic Content >30% by mass)		Peat and mineral soil mixtures							30% to 75%	PT	SILTY PEAT, SANDY PEAT
		Predominantly peat, may contain some mineral soil, fibrous or amorphous peat							75% to 100%		PEAT



Note 1 – Fine grained materials with PI and LL that plot in this area are named (ML) SILT with slight plasticity. Fine-grained materials which are non-plastic (i.e. a PL cannot be measured) are named SILT.
Note 2 – For soils with <5% organic content, include the descriptor "trace organics" for soils with between 5% and 30% organic content include the prefix "organic" before the Primary name.

Dual Symbol — A dual symbol is two symbols separated by a hyphen, for example, GP-GM, SW-SC and CL-ML.
For non-cohesive soils, the dual symbols must be used when the soil has between 5% and 12% fines (i.e. to identify transitional material between "clean" and "dirty" sand or gravel.
For cohesive soils, the dual symbol must be used when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart (see Plasticity Chart at left).

Borderline Symbol — A borderline symbol is two symbols separated by a slash, for example, CL/CI, GM/SM, CL/ML.
A borderline symbol should be used to indicate that the soil has been identified as having properties that are on the transition between similar materials. In addition, a borderline symbol may be used to indicate a range of similar soil types within a stratum.

ABBREVIATIONS AND TERMS USED ON RECORDS OF BOREHOLES AND TEST PITS

PARTICLE SIZES OF CONSTITUENTS

Soil Constituent	Particle Size Description	Millimetres	Inches (US Std. Sieve Size)
BOULDERS	Not Applicable	>300	>12
COBBLES	Not Applicable	75 to 300	3 to 12
GRAVEL	Coarse Fine	19 to 75 4.75 to 19	0.75 to 3 (4) to 0.75
SAND	Coarse Medium Fine	2.00 to 4.75 0.425 to 2.00 0.075 to 0.425	(10) to (4) (40) to (10) (200) to (40)
SILT/CLAY	Classified by plasticity	<0.075	< (200)

MODIFIERS FOR SECONDARY AND MINOR CONSTITUENTS

Percentage by Mass	Modifier
>35	Use 'and' to combine major constituents (*i.e.,* SAND and GRAVEL)
> 12 to 35	Primary soil name prefixed with "gravelly, sandy, SILTY, CLAYEY" as applicable
> 5 to 12	some
≤ 5	trace

PENETRATION RESISTANCE

Standard Penetration Resistance (SPT), N:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) required to drive a 50 mm (2 in.) split-spoon sampler for a distance of 300 mm (12 in.). Values reported are as recorded in the field and are uncorrected.

Cone Penetration Test (CPT)

An electronic cone penetrometer with a 60° conical tip and a project end area of 10 cm^2 pushed through ground at a penetration rate of 2 cm/s. Measurements of tip resistance (q_t), porewater pressure (u) and sleeve frictions are recorded electronically at 25 mm penetration intervals.

Dynamic Cone Penetration Resistance (DCPT); N_d:

The number of blows by a 63.5 kg (140 lb) hammer dropped 760 mm (30 in.) to drive uncased a 50 mm (2 in.) diameter, 60° cone attached to "A" size drill rods for a distance of 300 mm (12 in.).

PH: Sampler advanced by hydraulic pressure
PM: Sampler advanced by manual pressure
WH: Sampler advanced by static weight of hammer
WR: Sampler advanced by weight of sampler and rod

SAMPLES

AS	Auger sample
BS	Block sample
CS	Chunk sample
DD	Diamond Drilling
DO or DP	Seamless open ended, driven or pushed tube sampler – note size
DS	Denison type sample
GS	Grab Sample
MC	Modified California Samples
MS	Modified Shelby (for frozen soil)
RC	Rock core
SC	Soil core
SS	Split spoon sampler – note size
ST	Slotted tube
TO	Thin-walled, open – note size (Shelby tube)
TP	Thin-walled, piston – note size (Shelby tube)
WS	Wash sample

SOIL TESTS

w	water content
PL , w_p	plastic limit
LL , w_L	liquid limit
C	consolidation (oedometer) test
CHEM	chemical analysis (refer to text)
CID	consolidated isotropically drained triaxial test[1]
CIU	consolidated isotropically undrained triaxial test with porewater pressure measurement[1]
D_R	relative density (specific gravity, Gs)
DS	direct shear test
GS	specific gravity
M	sieve analysis for particle size
MH	combined sieve and hydrometer (H) analysis
MPC	Modified Proctor compaction test
SPC	Standard Proctor compaction test
OC	organic content test
SO_4	concentration of water-soluble sulphates
UC	unconfined compression test
UU	unconsolidated undrained triaxial test
V (FV)	field vane (LV-laboratory vane test)
γ	unit weight

1. Tests anisotropically consolidated prior to shear are shown as CAD, CAU.

NON-COHESIVE (COHESIONLESS) SOILS

Compactness[2]

Term	SPT 'N' (blows/0.3m)[1]
Very Loose	0 to 4
Loose	4 to 10
Compact	10 to 30
Dense	30 to 50
Very Dense	>50

1. SPT 'N' in accordance with ASTM D1586, uncorrected for the effects of overburden pressure.
2. Definition of compactness terms are based on SPT 'N' ranges as provided in Terzaghi, Peck and Mesri (1996). Many factors affect the recorded SPT 'N' value, including hammer efficiency (which may be greater than 60% in automatic trip hammers), overburden pressure, groundwater conditions, and grainsize. As such, the recorded SPT 'N' value(s) should be considered only an approximate guide to the soil compactness. These factors need to be considered when evaluating the results, and the stated compactness terms should not be relied upon for design or construction.

Field Moisture Condition

Term	Description
Dry	Soil flows freely through fingers.
Moist	Soils are darker than in the dry condition and may feel cool.
Wet	As moist, but with free water forming on hands when handled.

COHESIVE SOILS

Consistency

Term	Undrained Shear Strength (kPa)	SPT 'N'[1,2] (blows/0.3m)
Very Soft	<12	0 to 2
Soft	12 to 25	2 to 4
Firm	25 to 50	4 to 8
Stiff	50 to 100	8 to 15
Very Stiff	100 to 200	15 to 30
Hard	>200	>30

1. SPT 'N' in accordance with ASTM D1586, uncorrected for overburden pressure effects; approximate only.
2. SPT 'N' values should be considered ONLY an approximate guide to consistency; for sensitive clays (e.g., Champlain Sea clays), the N-value approximation for consistency terms does NOT apply. Rely on direct measurement of undrained shear strength or other manual observations.

Water Content

Term	Description
w < PL	Material is estimated to be drier than the Plastic Limit.
w ~ PL	Material is estimated to be close to the Plastic Limit.
w > PL	Material is estimated to be wetter than the Plastic Limit.

LIST OF SYMBOLS

Unless otherwise stated, the symbols employed in the report are as follows:

I. GENERAL

π	3.1416
ln x	natural logarithm of x
$\log_{10}$	x or log x, logarithm of x to base 10
g	acceleration due to gravity
t	time

II. STRESS AND STRAIN

γ	shear strain
Δ	change in, e.g. in stress: $\Delta\sigma$
ε	linear strain
ε_v	volumetric strain
η	coefficient of viscosity
υ	Poisson's ratio
σ	total stress
σ'	effective stress ($\sigma' = \sigma - u$)
σ'_{vo}	initial effective overburden stress
$\sigma_1, \sigma_2, \sigma_3$	principal stress (major, intermediate, minor)
σ_{oct}	mean stress or octahedral stress $= (\sigma_1 + \sigma_2 + \sigma_3)/3$
τ	shear stress
u	porewater pressure
E	modulus of deformation
G	shear modulus of deformation
K	bulk modulus of compressibility

III. SOIL PROPERTIES

(a) Index Properties

$\rho(\gamma)$	bulk density (bulk unit weight)*
$\rho_d(\gamma_d)$	dry density (dry unit weight)
$\rho_w(\gamma_w)$	density (unit weight) of water
$\rho_s(\gamma_s)$	density (unit weight) of solid particles
γ'	unit weight of submerged soil ($\gamma' = \gamma - \gamma_w$)
D_R	relative density (specific gravity) of solid particles ($D_R = \rho_s / \rho_w$) (formerly G_s)
e	void ratio
n	porosity
S	degree of saturation

* Density symbol is ρ. Unit weight symbol is γ where $\gamma = \rho g$ (i.e. mass density multiplied by acceleration due to gravity)

(a) Index Properties (continued)

w	water content
w_l or LL	liquid limit
w_p or PL	plastic limit
I_p or PI	plasticity index = $(w_l - w_p)$
NP	non-plastic
w_s	shrinkage limit
I_L	liquidity index = $(w - w_p) / I_p$
I_C	consistency index = $(w_l - w) / I_p$
e_{max}	void ratio in loosest state
e_{min}	void ratio in densest state
I_D	density index = $(e_{max} - e) / (e_{max} - e_{min})$ (formerly relative density)

(b) Hydraulic Properties

h	hydraulic head or potential
q	rate of flow
v	velocity of flow
i	hydraulic gradient
k	hydraulic conductivity (coefficient of permeability)
j	seepage force per unit volume

(c) Consolidation (one-dimensional)

C_c	compression index (normally consolidated range)
C_r	recompression index (over-consolidated range)
C_s	swelling index
C_α	secondary compression index
m_v	coefficient of volume change
c_v	coefficient of consolidation (vertical direction)
c_h	coefficient of consolidation (horizontal direction)
T_v	time factor (vertical direction)
U	degree of consolidation
σ'_p	pre-consolidation stress
OCR	over-consolidation ratio = σ'_p / σ'_{vo}

(d) Shear Strength

τ_p, τ_r	peak and residual shear strength
ϕ'	effective angle of internal friction
δ	angle of interface friction
μ	coefficient of friction = tan δ
c′	effective cohesion
c_u, s_u	undrained shear strength ($\phi = 0$ analysis)
p	mean total stress $(\sigma_1 + \sigma_3)/2$
p′	mean effective stress $(\sigma'_1 + \sigma'_3)/2$
q	$(\sigma_1 - \sigma_3)/2$ or $(\sigma'_1 - \sigma'_3)/2$
q_u	compressive strength $(\sigma_1 - \sigma_3)$
S_t	sensitivity

Notes: 1 $\tau = c' + \sigma' \tan \phi'$

2 shear strength = (compressive strength)/2

LITHOLOGICAL AND GEOTECHNICAL ROCK DESCRIPTION TERMINOLOGY

WEATHERINGS STATE

Fresh: no visible sign of rock material weathering.

Faintly weathered: weathering limited to the surface of major discontinuities.

Slightly weathered: penetrative weathering developed on open discontinuity surfaces but only slight weathering of rock material.

Moderately weathered: weathering extends throughout the rock mass but the rock material is not friable.

Highly weathered: weathering extends throughout rock mass and the rock material is partly friable.

Completely weathered: rock is wholly decomposed and in a friable condition but the rock and structure are preserved.

BEDDING THICKNESS

Description	Bedding Plane Spacing
Very thickly bedded	Greater than 2 m
Thickly bedded	0.6 m to 2 m
Medium bedded	0.2 m to 0.6 m
Thinly bedded	60 mm to 0.2 m
Very thinly bedded	20 mm to 60 mm
Laminated	6 mm to 20 mm
Thinly laminated	Less than 6 mm

JOINT OR FOLIATION SPACING

Description	Spacing
Very wide	Greater than 3 m
Wide	1 m to 3 m
Moderately close	0.3 m to 1 m
Close	50 mm to 300 mm
Very close	Less than 50 mm

GRAIN SIZE

Term	Size*
Very Coarse Grained	Greater than 60 mm
Coarse Grained	2 mm to 60 mm
Medium Grained	60 microns to 2 mm
Fine Grained	2 microns to 60 microns
Very Fine Grained	Less than 2 microns

Note: * Grains greater than 60 microns diameter are visible to the naked eye.

CORE CONDITION

Total Core Recovery (TCR)
The percentage of solid drill core recovered regardless of quality or length, measured relative to the length of the total core run.

Solid Core Recovery (SCR)
The percentage of solid drill core, regardless of length, recovered at full diameter, measured relative to the length of the total core run.

Rock Quality Designation (RQD)
The percentage of solid drill core, greater than 100 mm length, as measured along the centerline axis of the core, relative to the length of the total core run. RQD varies from 0% for completely broken core to 100% for core in solid segments.

DISCONTINUITY DATA

Fracture Index
A count of the number of naturally occuring discontinuities (physical separations) in the rock core. Mechanically induced breaks caused by drilling are not included.

Dip with Respect to Core Axis
The angle of the discontinuity relative to the axis (length) of the core. In a vertical borehole a discontinuity with a 90^{o} angle is horizontal.

Description and Notes
An abbreviation description of the discontinuities, whether naturally occurring separations such as fractures, bedding planes and foliation planes and mechanically separated bedding or foliation surfaces. Additional information concerning the nature of fracture surfaces and infillings are also noted.

Abbreviations

JN	Joint	PL	Planar
FLT	Fault	CU	Curved
SH	Shear	UN	Undulating
VN	Vein	IR	Irregular
FR	Fracture	K	Slickensided
SY	Stylolite	PO	Polished
BD	Bedding	SM	Smooth
FO	Foliation	SR	Slightly Rough
CO	Contact	RO	Rough
AXJ	Axial Joint	VR	Very Rough
KV	Karstic Void		
MB	Mechanical Break		

PROJECT: 08-1122-0198

RECORD OF DRILLHOLE: 08-1

SHEET 1 OF 1

LOCATION: See Site Plan

DRILLING DATE: July 9 & 10, 2008

DATUM:

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling Co. Ltd.

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	FLUSH COLOUR % RETURN	RECOVERY TOTAL CORE %	RECOVERY SOLID CORE %	R.Q.D. %	FRACT. INDEX PER 0.3	DISCONTINUITY DATA DIP w.r.t. CORE AXIS	DISCONTINUITY DATA TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec	DIAMETRAL POINT LOAD INDEX (MPa)	NOTES WATER LEVELS INSTRUMENTATION
0		Bedrock Surface														
	Hand Dug / Rotary Drill HW Casing	Weathered, shaley LIMESTONE		0.00												Protective casing with cement seal
1		Slightly weathered, grey and grey brown LIMESTONE with siltstone layers, very thinly bedded		0.76	1		100									
2		Slightly weathered to fresh, grey and grey brown interbedded SHALE, SILTSTONE and LIMESTONE		1.60	2	71	20									Bentonite Seal
3																Silica Sand
4					3	84	20									
5					4	109	0									32mm Diam PVC #10 Slot Screen B
6	Rotary Drill HQ Core	Fresh, grey, dark grey to black and grey to green interbedded SHALE, SILTSTONE and LIMESTONE		6.12												
7					5	76	0									Bentonite Seal
8		Fresh, grey and dark grey to black, interbedded SHALE and LIMESTONE		7.65	6	84	0									
9																Silica Sand
10					7	97	0									32mm Diam PVC #10 Slot Screen A
11		Fresh, grey and dark grey shaley LIMESTONE		10.62	8	97	0									
12		End of Drillhole		12.14												
13																
14																
15																

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED: A.W.

MIS-RCK 001 0811220198-2000.GPJ GAL-MISS.GDT 1/23/09 S.L.

PROJECT: 08-1122-0198

RECORD OF DRILLHOLE: 08-2

SHEET 1 OF 1

LOCATION: See Site Plan

DRILLING DATE: July 11, 2008

DATUM:

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: CME 55

DRILLING CONTRACTOR: Marathon Drilling Co. Ltd.

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR, % RETURN / FLUSH	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
0	Hand Dug	Bedrock Surface														
	Rotary Drill / HW Casing	Sand and gravel (FILL)		0.00												Protective casing with cement seal
1		Moderately weathered SANDSTONE		0.76												
		Slightly weathered, grey brown and grey shaley LIMESTONE, some thin mud seams		1.11	1		100									
2		Fresh, dark grey, grey green and light grey brown, interbedded SHALE, SILTSTONE and LIMESTONE		1.73	2	102	0									Bentonite Seal
3																Silica Sand
4					3	104	0									
5					4	125	0									32mm Diam PVC #10 Slot Screen B
6	Rotary Drill / HQ Core															
		Fresh, grey and dark grey, interbedded SHALE and LIMESTONE, small vugs at 6.40 to 6.58m depth		6.27	5	147	0									
7																
8					6	104	0									Bentonite Seal
9																Silica Sand
10					7		0									
11		Fresh, grey and dark grey, shaley LIMESTONE, becoming dolomitic LIMESTONE, occasional calcite nodules		10.69												32mm Diam PVC #10 Slot Screen A
12					8	130	0									
		End of Drillhole		12.25												
13																
14																
15																

MIS-RCK 001 0811220198-2000.GPJ GAL-MISS.GDT 1/23/09 S.L.

DEPTH SCALE

1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED: A.W.

PROJECT: 08-1122-0198

RECORD OF DRILLHOLE: 08-3

SHEET 1 OF 2

LOCATION: See Site Plan

DRILLING DATE: July 14, 2008

DATUM:

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Water Well Rig

DRILLING CONTRACTOR: Stanton Drilling Inc.

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (mm/m)	FLUSH	COLOUR, % RETURN	RECOVERY: TOTAL CORE % (80 60 40 20)	RECOVERY: SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
0		Bedrock Surface															
		Grey LIMESTONE and SHALE		0.00													Protective casing with cement seal
1																	
2																	Bentonite Seal
3																	Silica Sand
4																	
5																	38mm Diam PVC #10 Slot Screen B
6																	
7																	
8	Air Rotary Drill																Bentonite Seal
9																	
10																	Silica Sand
11																	
12																	
13																	38mm Diam PVC #10 Slot Screen A
14																	
15		CONTINUED NEXT PAGE															

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.

CHECKED: A.W.

MIS-RCK 001 0811220198-2000.GPJ GAL-MISS.GDT 1/23/09 S.L.

PROJECT: 08-1122-0198

RECORD OF DRILLHOLE: 08-3

SHEET 2 OF 2

LOCATION: See Site Plan

DRILLING DATE: July 14, 2008

DATUM:

INCLINATION: -90° AZIMUTH: ---

DRILL RIG: Water Well Rig

DRILLING CONTRACTOR: Stanton Drilling Inc.

FR/FX-FRACTURE F-FAULT SM-SMOOTH FL-FLEXURED BC-BROKEN CORE
CL-CLEAVAGE J-JOINT R-ROUGH UE-UNEVEN MB-MECH. BREAK
SH-SHEAR P-POLISHED ST-STEPPED W-WAVY B-BEDDING
VN-VEIN S-SLICKENSIDED PL-PLANAR C-CURVED

DEPTH SCALE METRES	DRILLING RECORD	DESCRIPTION	SYMBOLIC LOG	ELEV. / DEPTH (m)	RUN No.	PENETRATION RATE (m/min)	COLOUR % RETURN / FLUSH	RECOVERY TOTAL CORE % (80 60 40 20)	RECOVERY SOLID CORE % (80 60 40 20)	R.Q.D. % (80 60 40 20)	FRACT. INDEX PER 0.3 (5 10 15 20)	DISCONTINUITY DATA: DIP w.r.t. CORE AXIS (0 30 60 90)	DISCONTINUITY DATA: TYPE AND SURFACE DESCRIPTION	HYDRAULIC CONDUCTIVITY K, cm/sec (10^{-6} 10^{-5} 10^{-4} 10^{-3})	DIAMETRAL POINT LOAD INDEX (MPa) (2 4 6)	NOTES WATER LEVELS INSTRUMENTATION
		--- CONTINUED FROM PREVIOUS PAGE ---														
15	Air Rotary Drill	Grey LIMESTONE and SHALE														
16		End of Drillhole		15.85												
17																
18																
19																
20																
21																
22																
23																
24																
25																
26																
27																
28																
29																
30																

DEPTH SCALE
1 : 75

Golder Associates

LOGGED: P.A.H.
CHECKED: A.W.

MIS-RCK 001 0811220198-2000.GPJ GAL-MISS.GDT 1/23/09 S.L.

Robinson Consultants

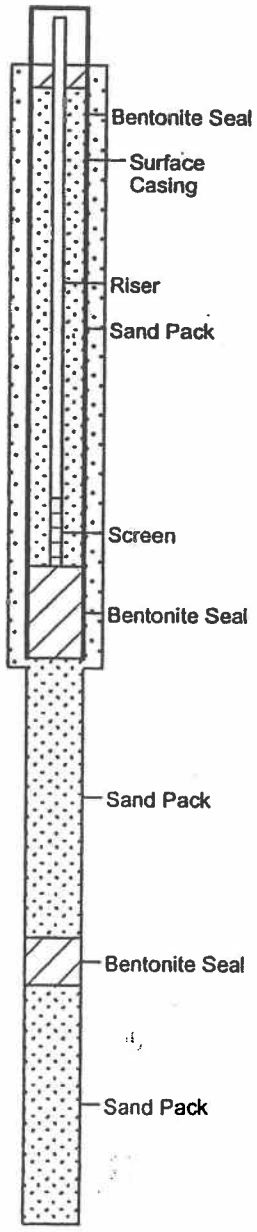
LOG OF BORING OV-13

Municipality of The Town of Arnprior
Arnprior Landfill Site
Part Lot 10 Concession 13
Township of McNab

Date Completed : Nov, 2001
Hole Diameter : 15 cm
Drilling Method : ODEX
Sampling Method : Grab
Company Rep. : A Buzza

Depth in Metres	Surf. Elev.	GRAPHIC	USCS	DESCRIPTION
0	0		ML	Top Soil
				Clayey Loam
5	-5		SC	
10	-10			
15	-15		SW	Fine And Medium Sand Becoming Coarser With Depth.
20	-20			
			SL	Fractured Bedrock (Shale)
25	-25		LS	Limestone (Dark Grey)
				Limestone (Light Grey)
30	-30		LC	
35	-35			
				Well Termination
40	-40		LC	
45	-45			
50	-50			
55				

Well: OV-13



06-19-2002 C:\MTECH46\ov-13.bor

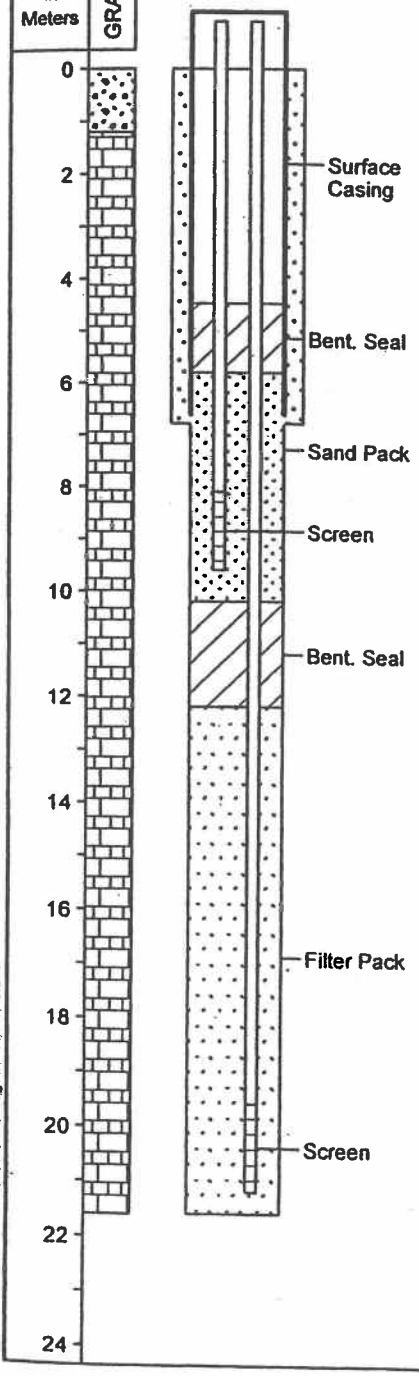
Robinson Consultants

LOG OF BORING BR-5

Town of Amprior Waste Disposal Site
Lot 10
Concession 13
McNabb Township

Date Drilled : 1994
Equipment : Rotary
Surface Elevation : 84.2
Bi level Date : July 2000

Wells: BR-5S, BR-5D
Elev.: 84.6



DESCRIPTION
Sand and Gravely topsoil
Limestone

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Robinson Consultants

LOG OF BORING BR-7

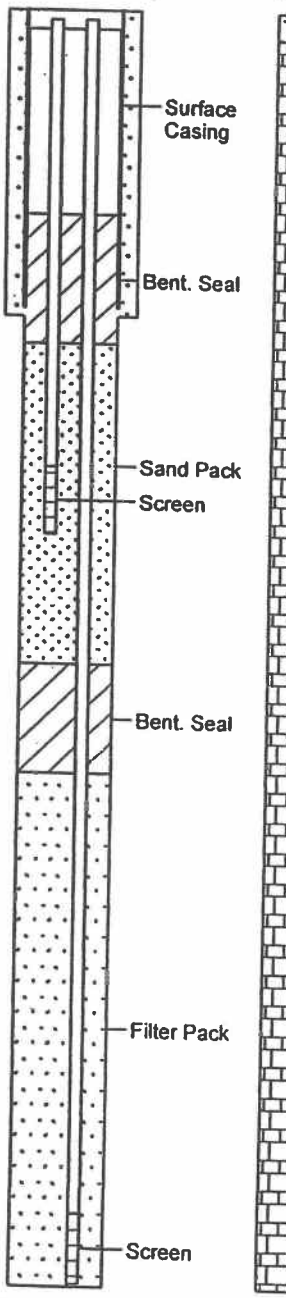
Town of Arnprior Waste Disposal Site
Lot 10
Concession 13

McNabb Township

Date Drilled	: 1994
Equipment	: Rotary
Surface Elevation	: 80.05
Bi level Date	: July 2000

Wells: BR-7S, BR-7D

Elev.: 80.98



Depth in Meters	GRAPHIC	USCS	DESCRIPTION
0		GP	Sand and Graveert
2			Limestone
4			
6			
8			
10			
12			
14		LS	
16			
18			
20			
22			
24			
26			
28			

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Robinson Consultants

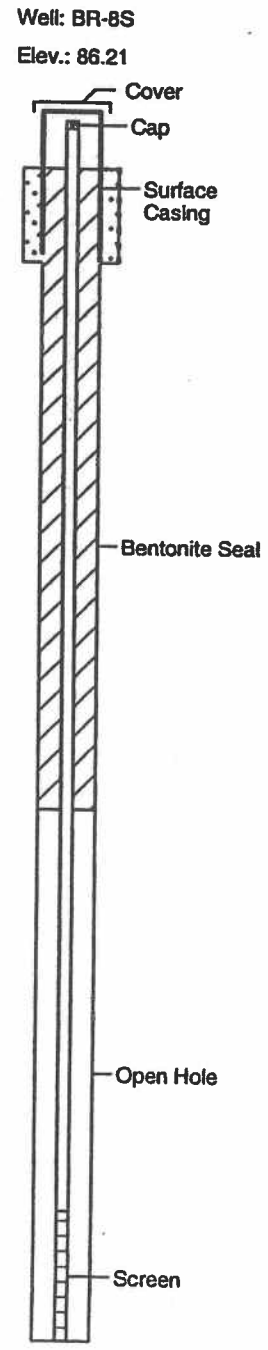
LOG OF BORING BR-8 D

Town of Amprior Waste Disposal Site
Part Lot 10
Concession 13
McNab Township

Date Drilled : November 1998
Drilling Company : OGS
Drilling Method : Diamond Drill
Hole Diameter : 228mm
Logged By : AB

Depth in Meters	DESCRIPTION
0	Sawdust
2	Weathered Bedrock
3	Competent Bedrock

GRAPHIC



Well Construction Information

WELL CONSTRUCTION

Date Completed	: November 1998
Hole Diameter	: 228mm
Drill Method	: Diamond Drill

WELL CASING

Material	: PVC
Diameter	: 38mm
Joints	: Flush Threaded

WELL SCREEN

Material	: PVC
Diameter	: 38mm
Joints	: Flush Thread
Opening	: 10 Slot
SAND PACK	: Washed Sand
ANNULAR SEALS	: Bentonite slurry

NOTES

11-24-1999 c:\mtech46\acel\geol\8896\br-8d.bor

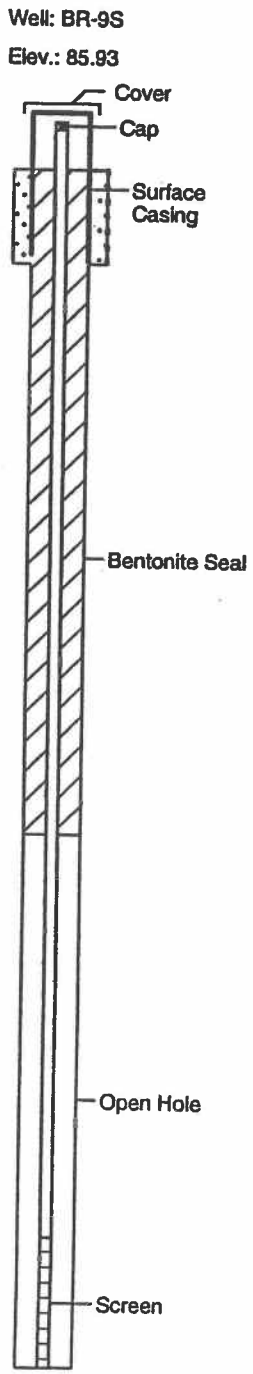
Robinson Consultants

LOG OF BORING BR-9 D

Town of Amprior Waste Disposal Site
Part Lot 10
Concession 13
McNab Township

Date Drilled : November 1998
Drilling Company : OGS
Drilling Method : Diamond Drill
Hole Diameter : 228mm
Logged By : WO

Depth in Meters	DESCRIPTION	GRAPHIC
0	Sawdust	
1	Sand and Gravel Fill	
2	Organic	
	Weathered Bedrock	
3	Competent Bedrock	
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		



Well Construction Information

WELL CONSTRUCTION

Date Completed	: November 1998
Hole Diameter	: 228mm
Drill Method	: Diamond Drill

WELL CASING

Material	: PVC
Diameter	: 38mm
Joints	: Flush Threaded

WELL SCREEN

Material	: PVC
Diameter	: 38mm
Joints	: Flush Thread
Opening	: 10 Slot
SAND PACK	: Washed Sand
ANNULAR SEALS	: Bentonite slurry

NOTES

11-24-1999 c:\mtech46\acel\geo\8898\br-9d.bor

Robinson Consultants

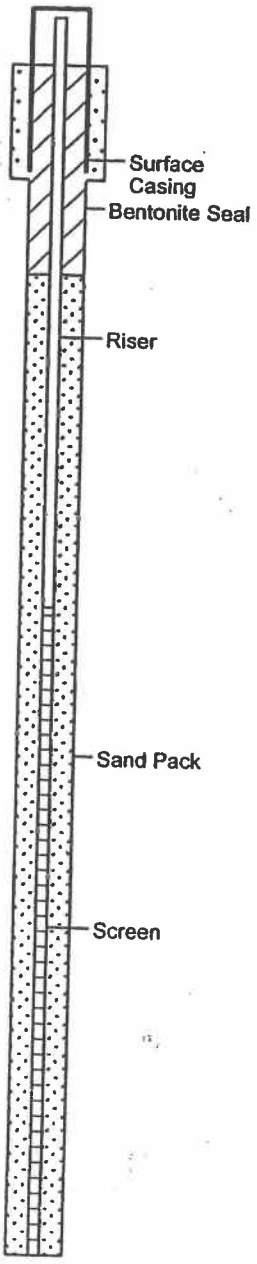
LOG OF BORING BR-11

Municipality of The Town of Arnprior
Arnprior Landfill Site
Part Lot 10 Concession 13
Township of McNab

Date Completed : Sept. 2001
Hole Diameter : 7cm
Drilling Method : Core Drilling
Sampling Method : Grab
Company Rep. : A Townsend

Depth in Metres	Surf. Elev.	GRAPHIC	USCS	DESCRIPTION
0	0.		ML	Top Soil
				Fractured Bedrock (Limestone)
1	-1			
2	-2			
3	-3		LC	
4	-4			
5	-5			
6				

Well: BR-11



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Robinson Consultants

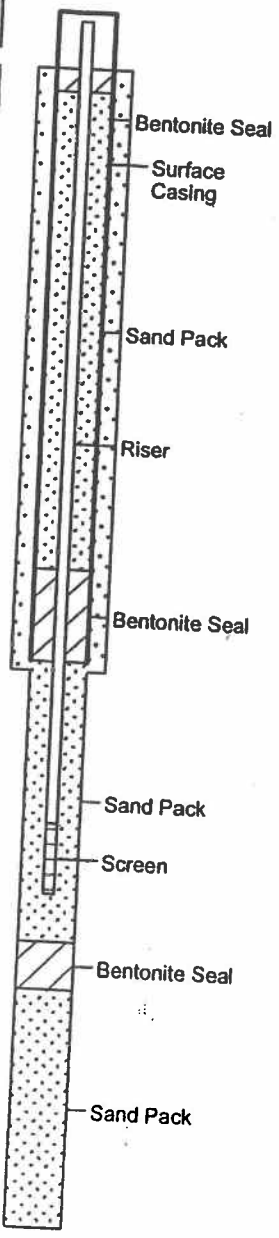
LOG OF BORING BR-13S

Municipality of The Town of Arnprior
Arnprior Landfill Site
Part Lot 10 Concession 13
Township of McNab

Date Completed : Nov, 2001
Hole Diameter : 15 cm
Drilling Method : ODEX
Sampling Method : Grab
Company Rep. : A Buzza

Depth in Metres	Surf. Elev.	GRAPHIC	USCS	DESCRIPTION
0	0		ML	Top Soil
				Clayey Loam
5	-5		SC	
10	-10			
15	-15		SW	Fine And Medium Sand Becoming Coarser With Depth.
20	-20			
			SL	Fractured Bedrock (Shale)
25	-25		LS	Limestone (Dark Grey)
				Limestone (Light Grey)
30	-30		LC	
35	-35			
				Well Termination
40	-40		LC	
45	-45			
50	-50			
55				

Well: BR-13S



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PROJECT: 1401322

RECORD OF BOREHOLE: BR-18D

SHEET 1 OF 3

LOCATION: N 5034656.8 ;E 391416.6

BORING DATE: October 30, 2018

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE		85.64 0.00							
0	Air Percussion										Bentonite Seal
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE
1 : 50

GOLDER

LOGGED: JS
CHECKED: ALC

PROJECT: 1401322

RECORD OF BOREHOLE: BR-18D

SHEET 2 OF 3

LOCATION: N 5034656.8 ;E 391416.6

BORING DATE: October 30, 2018

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
11											
12											
13											
14											Bentonite Seal
15	Air Percussion										
16											
17											
18											
19											Silica Sand 50 mm Diam. PVC #10 Slot Screen
20		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JS

CHECKED: ALC

PROJECT: 1401322

RECORD OF BOREHOLE: BR-18D

SHEET 3 OF 3

LOCATION: N 5034656.8 ;E 391416.6

BORING DATE: October 30, 2018

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20		*--- CONTINUED FROM PREVIOUS PAGE ---*									
21	Air Percussion										50 mm Diam. PVC #10 Slot Screen
22											
23											
24											
25											
26											
27											
28											
29											
30											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: JS

CHECKED: ALC

PROJECT: 1401322

RECORD OF BOREHOLE: BR-18S

SHEET 1 OF 2

LOCATION: N 5034656.1 ;E 391414.7

BORING DATE: October 5, 2018

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE		85.63 0.00									
1													
2													
3													Bentonite Seal
4													
5	Air Percussion												
6													
7													Silica Sand
8													
9													50 mm Diam. PVC #10 Slot Screen
10		*CONTINUED NEXT PAGE*											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CA

CHECKED: ALC

PROJECT: 1401322

RECORD OF BOREHOLE: BR-18S

SHEET 2 OF 2

LOCATION: N 5034656.1 ;E 391414.7

BORING DATE: October 5, 2018

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. +, rem V. ⊕, Q - ●, U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp, W, Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10	Air Percussion	*--- CONTINUED FROM PREVIOUS PAGE ---*									Silica Sand
11											
12											
13											Bentonite Seal
14											
15											
16											
17											
18											
19											
20											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CA

CHECKED: ALC

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23D

SHEET 1 OF 5

LOCATION: N 5034554.8 ;E 391475.3

BORING DATE: January 10, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0		GROUND SURFACE		86.19 0.00							
0	Air Percussion										Bentonite Seal
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE
1 : 50

GOLDER

LOGGED: CA
CHECKED:

MIS-BHS 001 21465820.GPJ GAL-MIS.GDT 3/17/23 ZS

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23D

SHEET 2 OF 5

LOCATION: N 5034554.8 ;E 391475.3

BORING DATE: January 10, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*									
11											
12											
13											
14											
15	Air Percussion										Bentonite Seal
16											
17											
18											
19											
20		*CONTINUED NEXT PAGE*									

DEPTH SCALE
1 : 50

WSP GOLDER

LOGGED: CA

CHECKED:

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23D

SHEET 3 OF 5

LOCATION: N 5034554.8 ;E 391475.3

BORING DATE: January 10, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20		*--- CONTINUED FROM PREVIOUS PAGE ---*									
21											
22											
23											
24											
25	Air Percussion										Bentonite Seal
26											
27											
28											
29											
30		*CONTINUED NEXT PAGE*									

DEPTH SCALE
1 : 50

WSP GOLDER

LOGGED: CA
CHECKED:

MIS-BHS 001 21465820.GPJ GAL-MIS.GDT 3/17/23 ZS

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23D

SHEET 4 OF 5

LOCATION: N 5034554.8 ;E 391475.3

BORING DATE: January 10, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
30		*--- CONTINUED FROM PREVIOUS PAGE ---*									
31											
32											Bentonite Seal
33											
34											
35	Air Percussion										Silica Sand
36											
37											
38											50 mm Diam. PVC #10 Slot Screen
39											
40		*CONTINUED NEXT PAGE*									

DEPTH SCALE

1 : 50

WSP GOLDER

LOGGED: CA

CHECKED:

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23D

SHEET 5 OF 5

LOCATION: N 5034554.8 ;E 391475.3

BORING DATE: January 10, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	SOIL PROFILE: STRATA PLOT	SOIL PROFILE: ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
40		*--- CONTINUED FROM PREVIOUS PAGE ---*									50 mm Diam. PVC #10 Slot Screen
41											
42											
43											
44											
45											
46											
47											
48											
49											
50											

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CA

CHECKED:

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23S

SHEET 1 OF 3

LOCATION: N 5034554.6 ;E 391476.6

BORING DATE: January 6, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
0	Air Percussion	GROUND SURFACE		86.16 0.00							Bentonite Seal
1											
2											
3											
4											
5											
6											
7											
8											
9											
10		*CONTINUED NEXT PAGE*									

DEPTH SCALE
1 : 50

WSP GOLDER

LOGGED: CA

CHECKED:

MIS-BHS 001 21465820.GPJ GAL-MIS.GDT 3/17/23 ZS

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23S

SHEET 2 OF 3

LOCATION: N 5034554.6 ;E 391476.6

BORING DATE: January 6, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
10		*--- CONTINUED FROM PREVIOUS PAGE ---*											
11													
12													
13													
14													Bentonite Seal
15	Air Percussion												
16													
17													
18													
19													Silica Sand 50 mm Diam. PVC #10 Slot Screen
20		*CONTINUED NEXT PAGE*											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: CA
CHECKED:

PROJECT: 21465820

RECORD OF BOREHOLE: BH-23S

SHEET 3 OF 3

LOCATION: N 5034554.6 ;E 391476.6

BORING DATE: January 6, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
20		*--- CONTINUED FROM PREVIOUS PAGE ---*									
21	Air Percussion										50 mm Diam. PVC #10 Slot Screen
22											
23											
24											
25											
26											
27											
28											
29											
30											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: CA
CHECKED:

PROJECT: 1401322

RECORD OF BOREHOLE: OV-9(R)

SHEET 1 OF 1

LOCATION: N 5034576.6 ;E 391357.9

BORING DATE: September 29, 2017

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80)	SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3})	WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.85									
0	Hand Auger	Unsampled Overburden		0.00									Bentonite Seal
1													Silica Sand
2				84.65									32 mm PVC #10 Slot Screen
		End of Borehole		2.20									
		Note:											
		1. Reinstalled in 2017.											
3													
4													
5													
6													
7													
8													
9													
10													

DEPTH SCALE

1 : 50

GOLDER

LOGGED: CA

CHECKED: ALC

MIS-BHS 001 1401322.GPJ GAL-MIS.GDT 3/26/19 JM

PROJECT: 21465820

RECORD OF BOREHOLE: OV-23

SHEET 1 OF 1

LOCATION: N 5034554.4 ;E 391477.6

BORING DATE: January 9, 2023

DATUM: CGVD28

DEPTH SCALE METRES	BORING METHOD	SOIL PROFILE: DESCRIPTION	STRATA PLOT	ELEV. / DEPTH (m)	SAMPLES: NUMBER	SAMPLES: TYPE	SAMPLES: BLOWS/0.30m	DYNAMIC PENETRATION RESISTANCE, BLOWS/0.3m (20 40 60 80) / SHEAR STRENGTH Cu, kPa (nat V. + Q - ● / rem V. ⊕ U - ○) (20 40 60 80)	HYDRAULIC CONDUCTIVITY, k, cm/s (10^{-6} 10^{-5} 10^{-4} 10^{-3}) / WATER CONTENT PERCENT (Wp — W — Wl) (20 40 60 80)	ADDITIONAL LAB. TESTING	PIEZOMETER OR STANDPIPE INSTALLATION
		GROUND SURFACE		86.59							
0	Air Percussion			0.00							
1											
2											Bentonite Seal
3											
4											Silica Sand
5											
6											50 mm Diam. PVC #10 Slot Screen
7											
8											Native Sand
9											
10											

DEPTH SCALE
1 : 50

GOLDER

LOGGED: CA

CHECKED:

APPENDIX C

Results of Field and Laboratory Chemical and Physical Analyses (Provided on USB)

APPENDIX D

Graphs of Groundwater Monitoring and Surface Water Sampling Locations

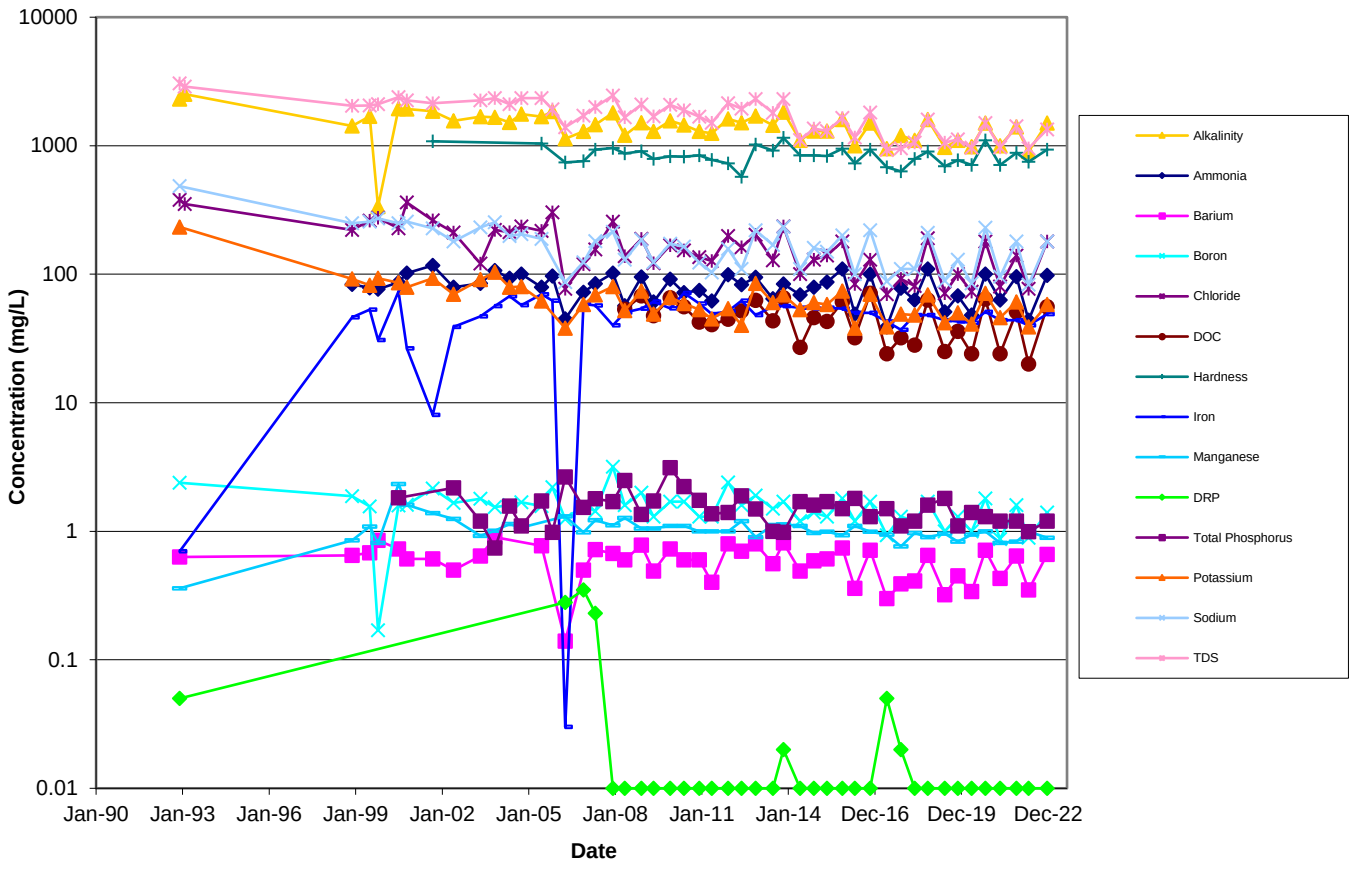


FIGURE D-I 1

Town of Arnprior

Waste Disposal Site

OV-7

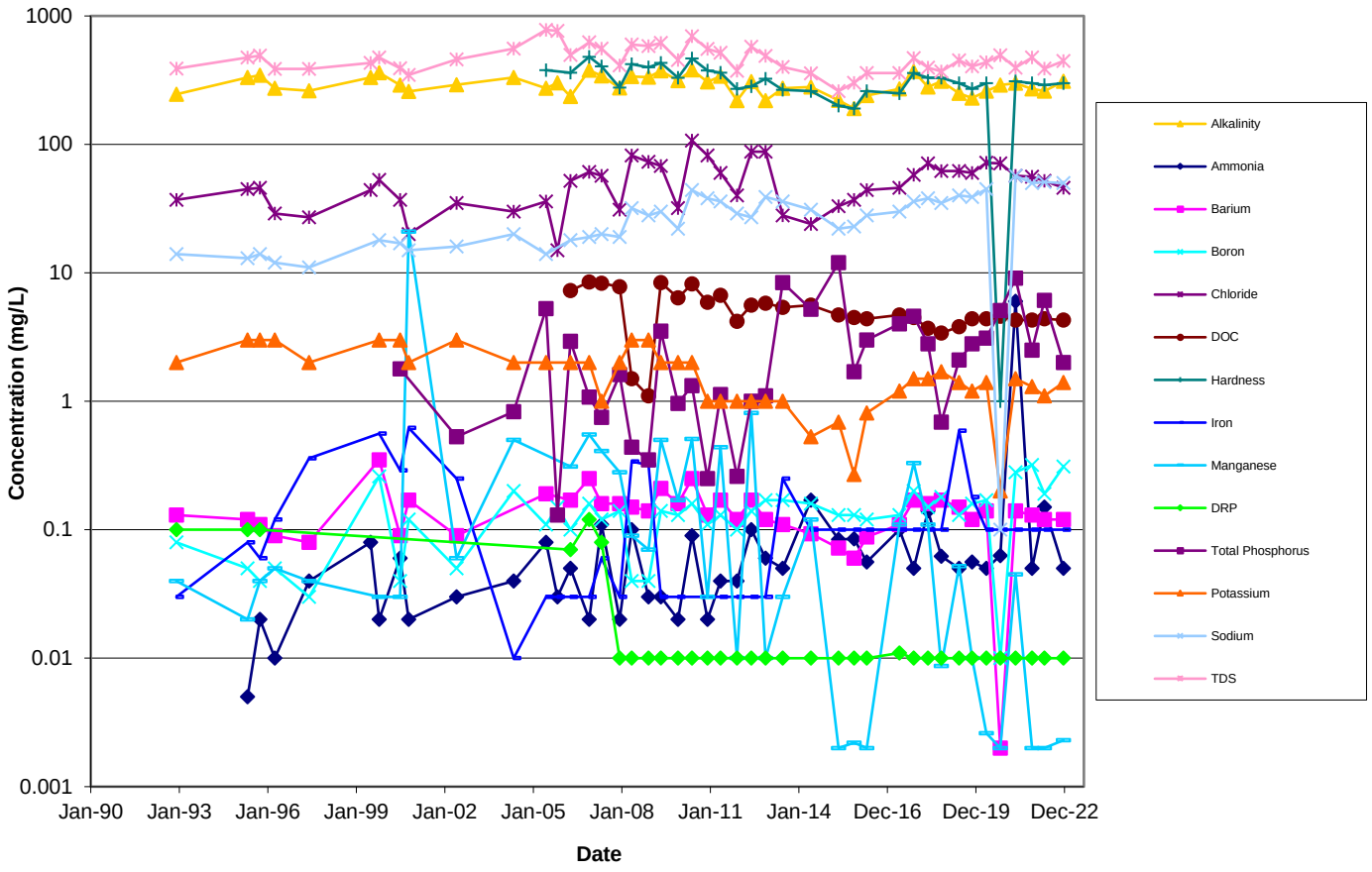


FIGURE D-I 2

Town of Arnprior

Waste Disposal Site

OV-9

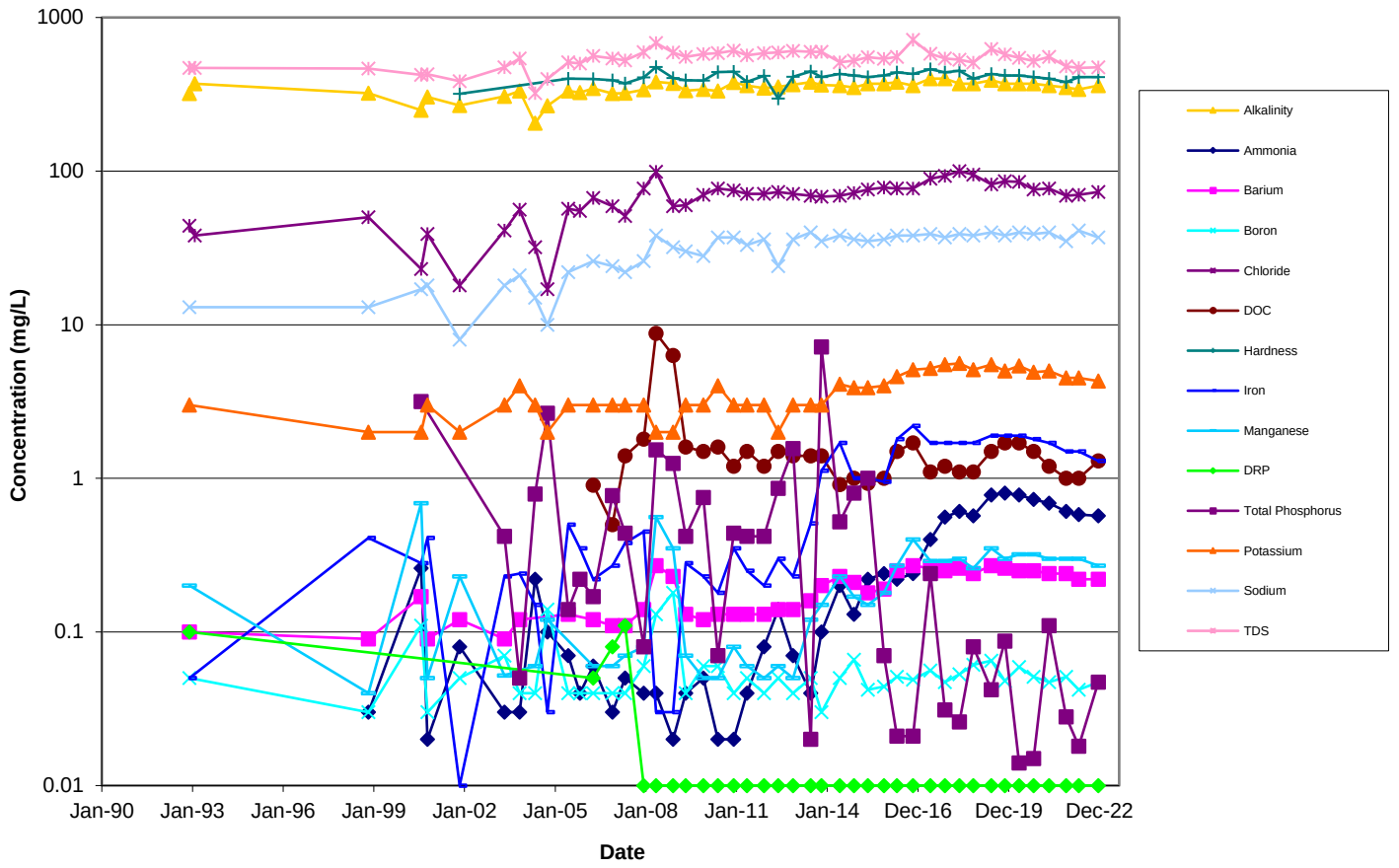


FIGURE D-I 3

Town of Arnprior

Waste Disposal Site

OV-10

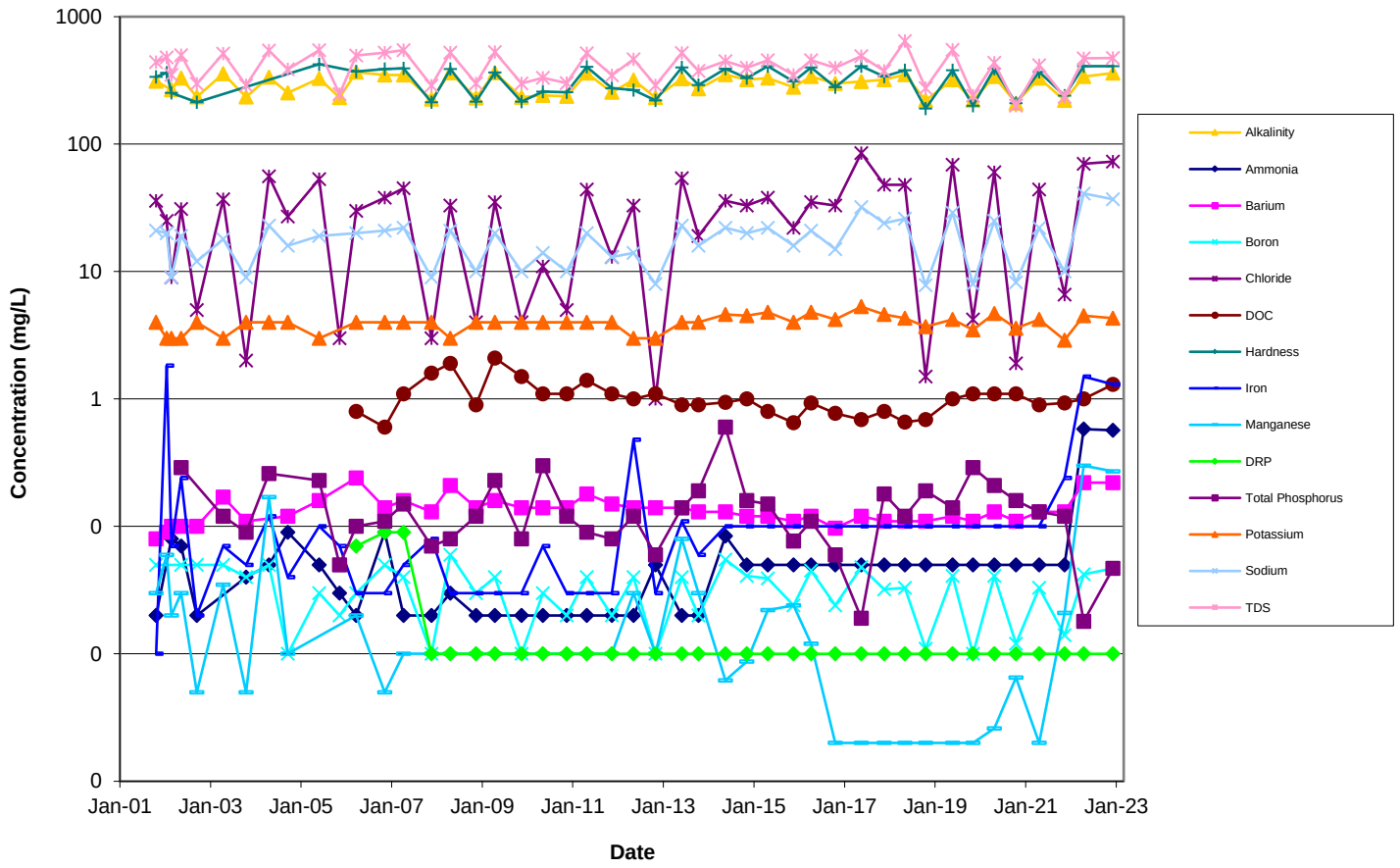


FIGURE D-I 4

Town of Arnprior

Waste Disposal Site

OV-13

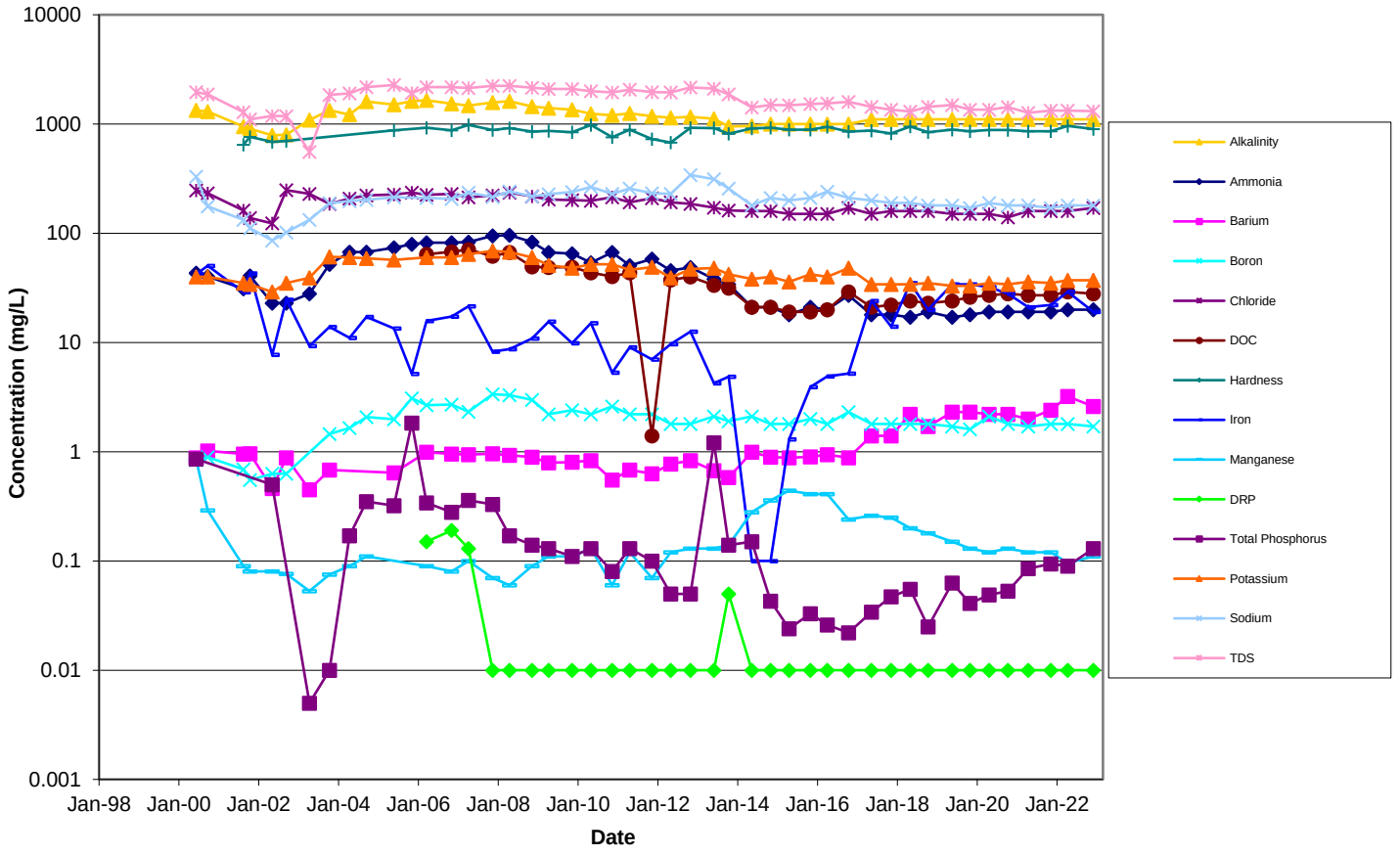


FIGURE D-I 5

Town of Arnprior

Waste Disposal Site

BR-1D

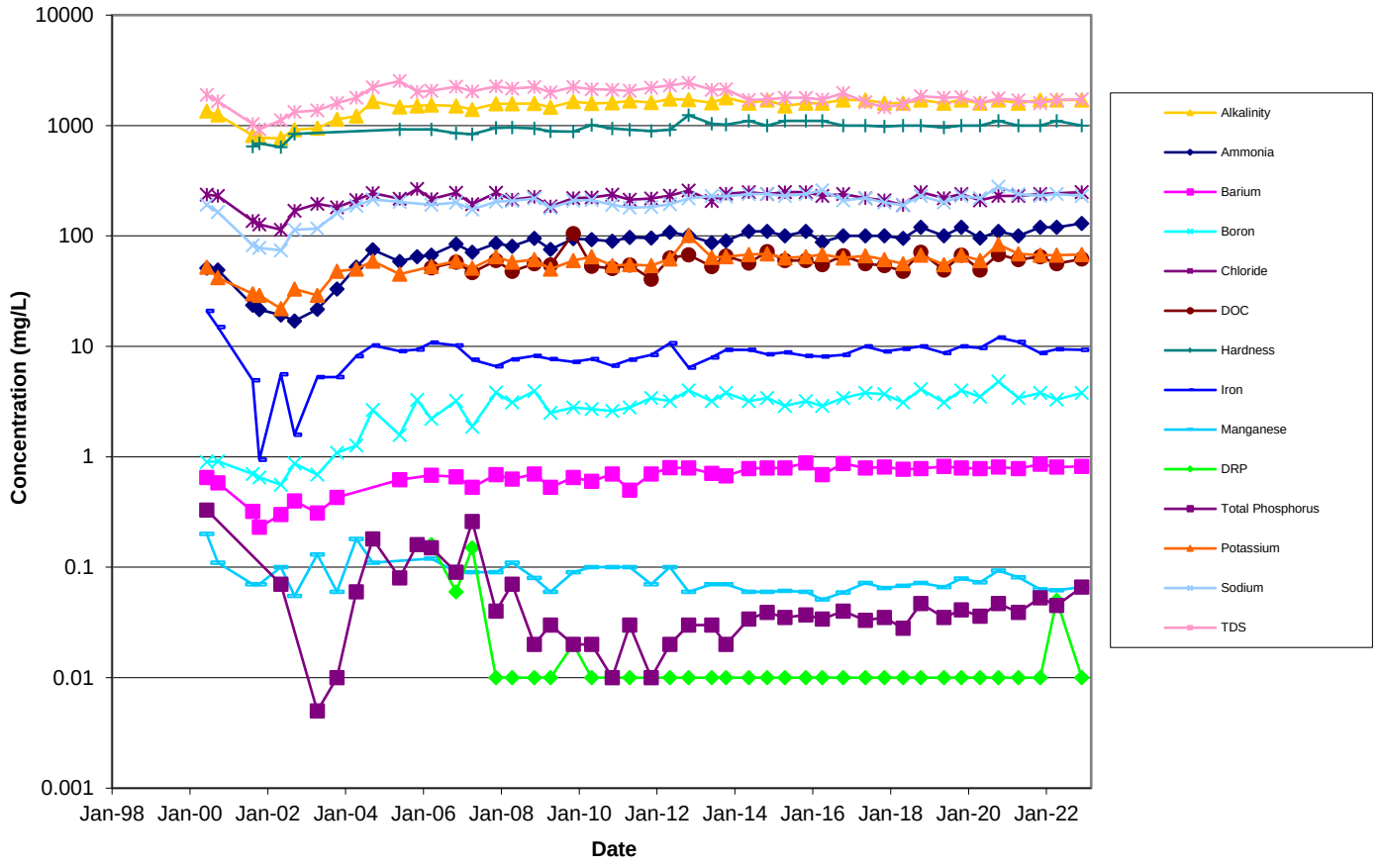


FIGURE D-I 6

Town of Arnprior

Waste Disposal Site

BR-1S

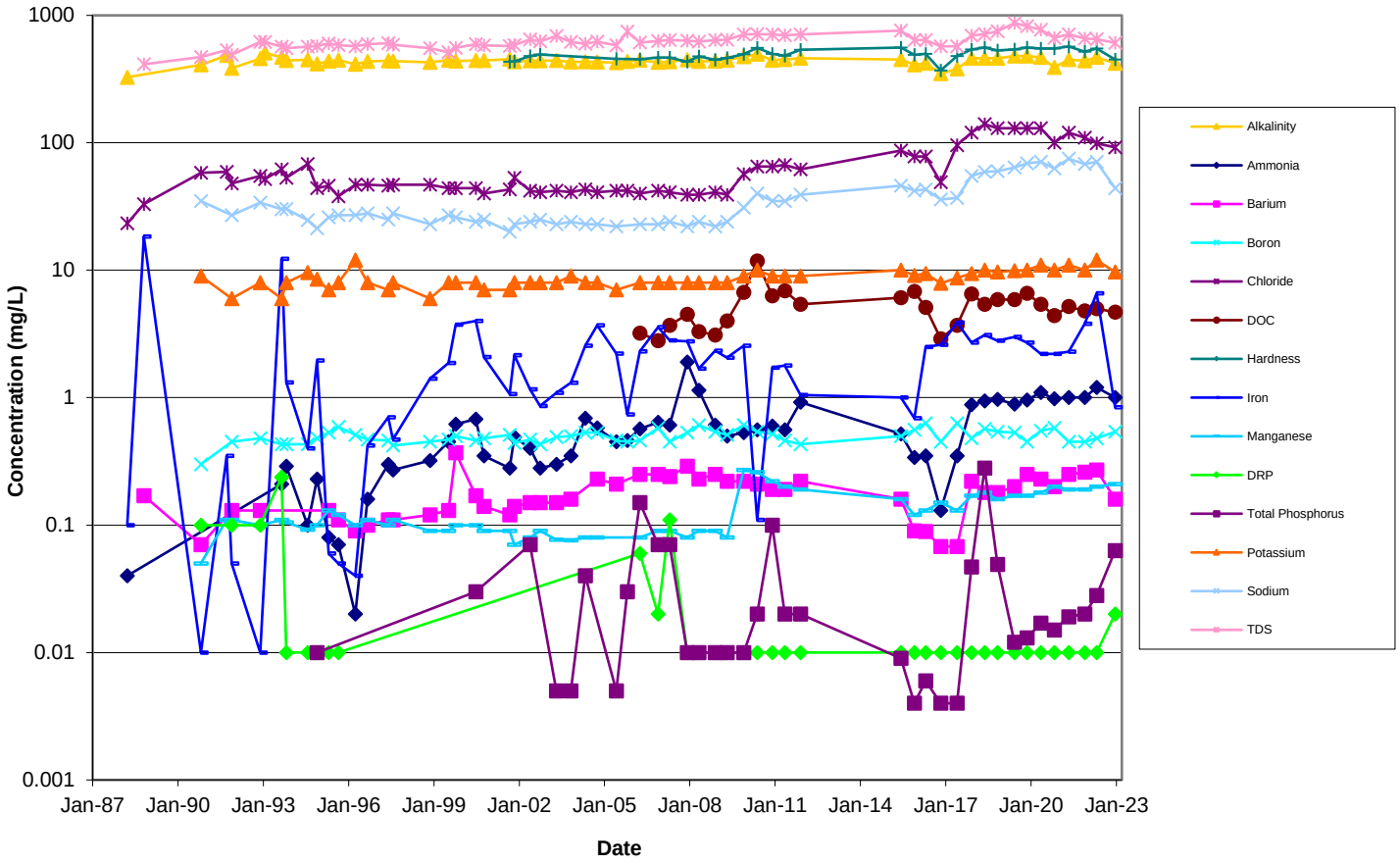


FIGURE D-I 7

Town of Arnprior

Waste Disposal Site

BR-3

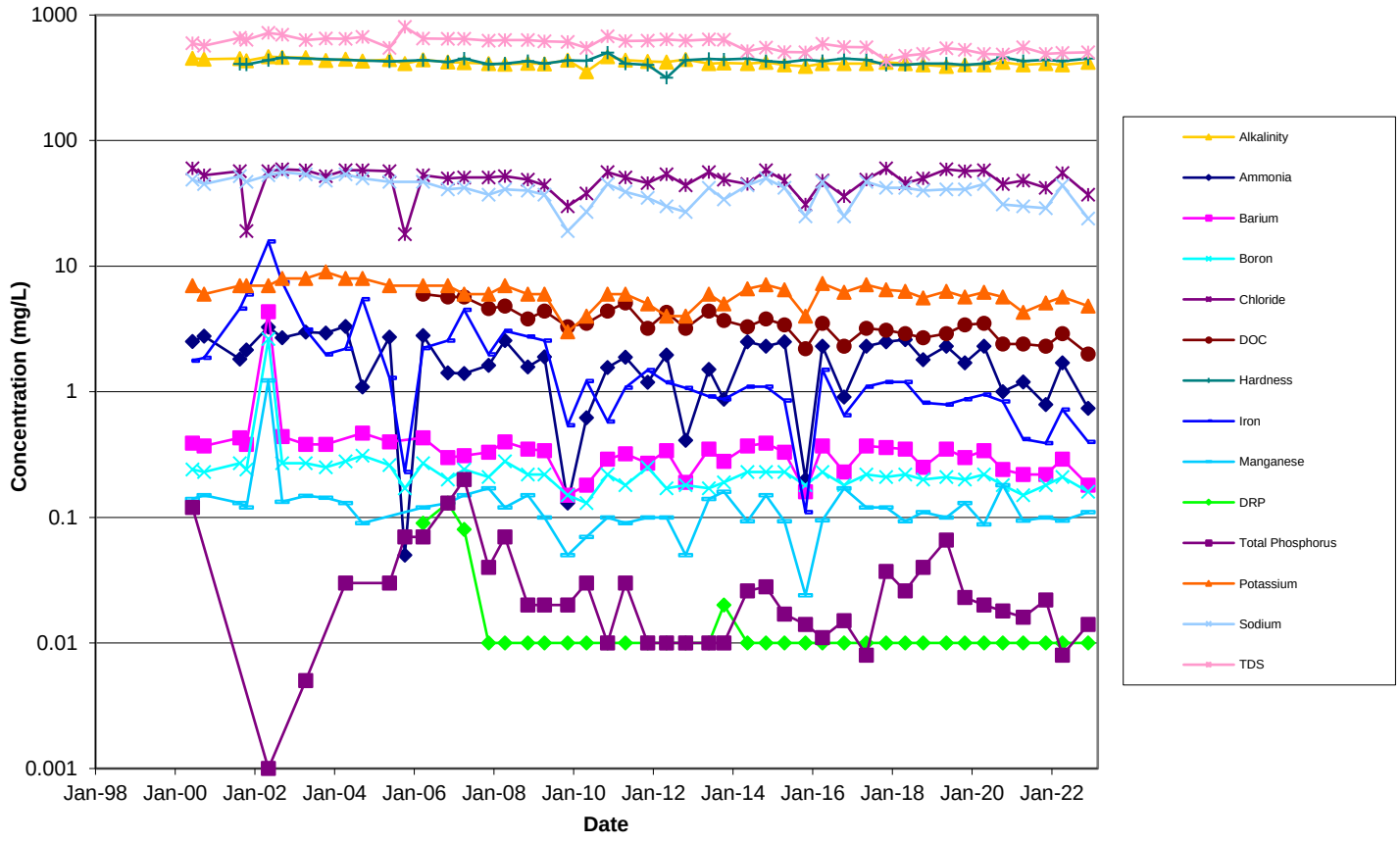


FIGURE D-I 8

Town of Arnprior

Waste Disposal Site

BR-5D

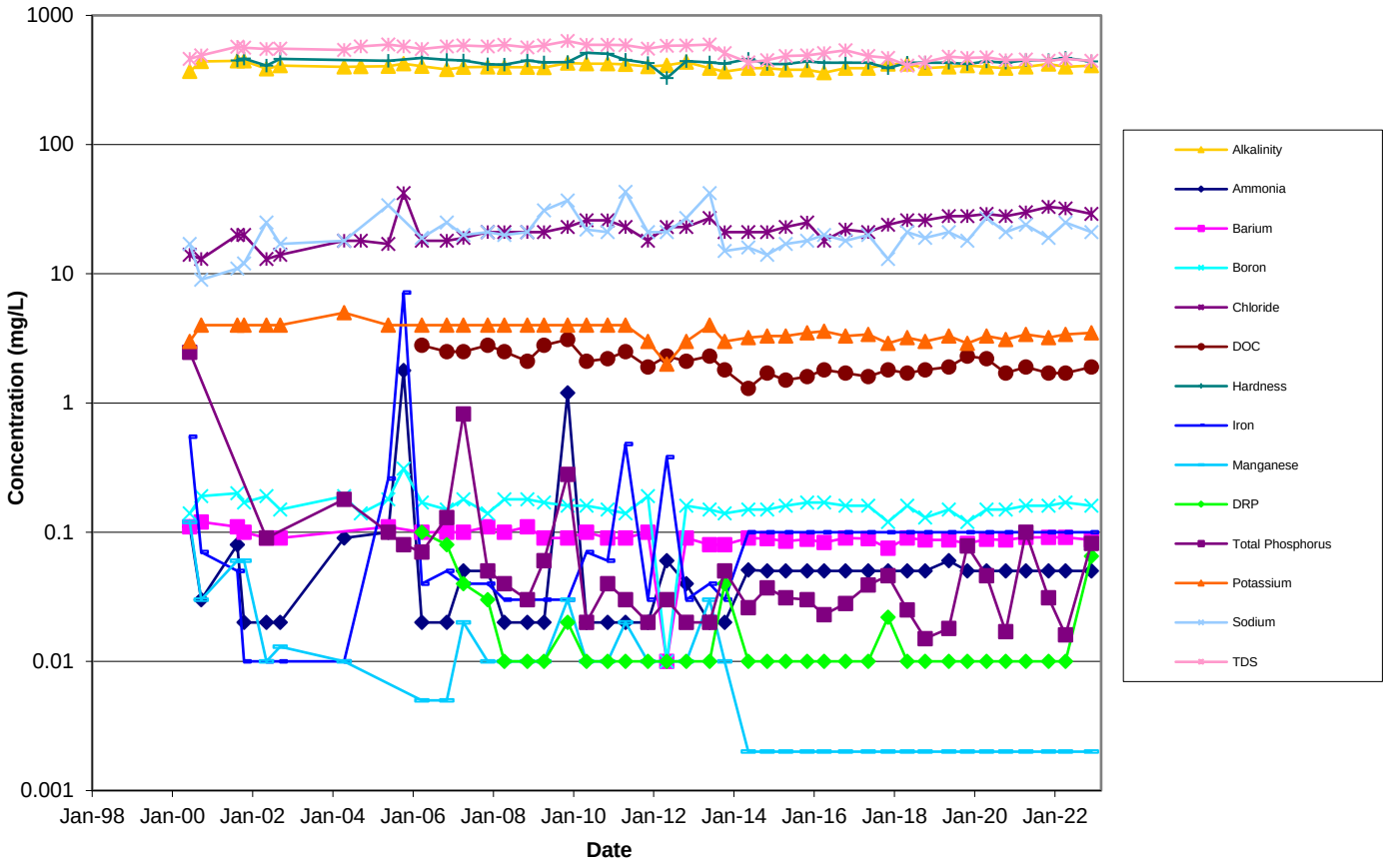


FIGURE D-I 9

Town of Arnprior

Waste Disposal Site

BR-5S

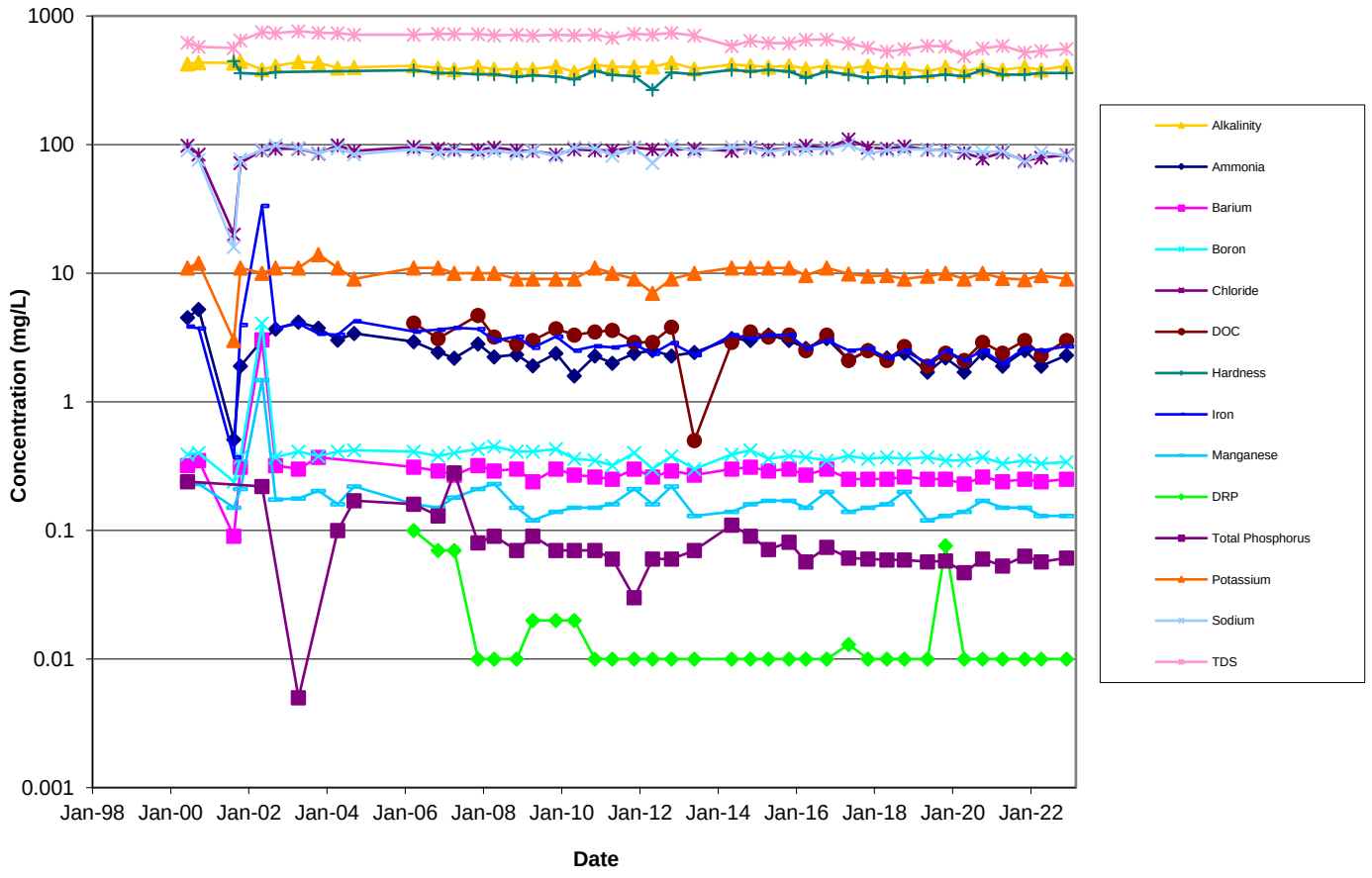


FIGURE D-I 10

Town of Arnprior

Waste Disposal Site

BR-6D

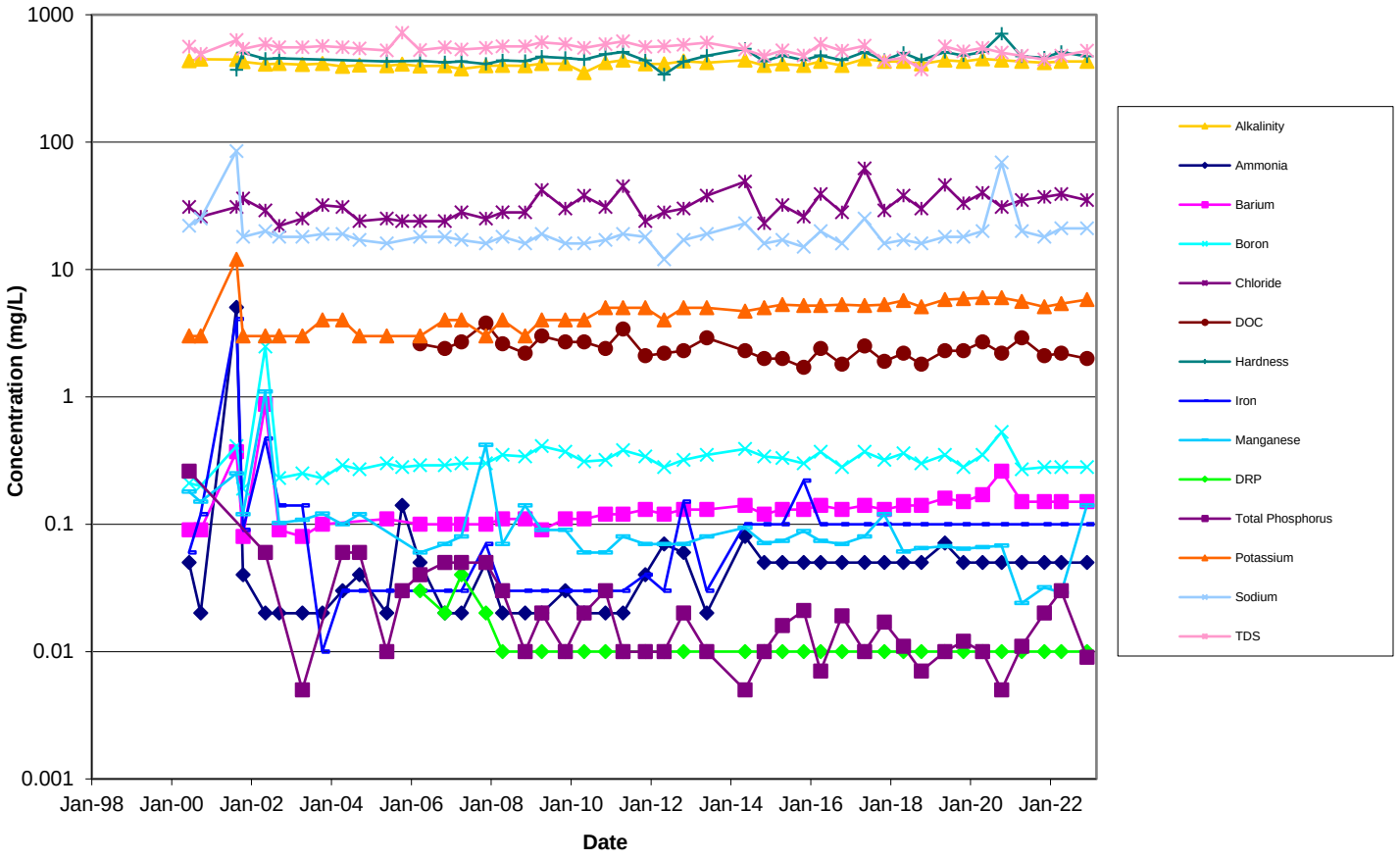


FIGURE D-I 11	**Town of Arnprior** **Waste Disposal Site** **BR-6S**	wsp

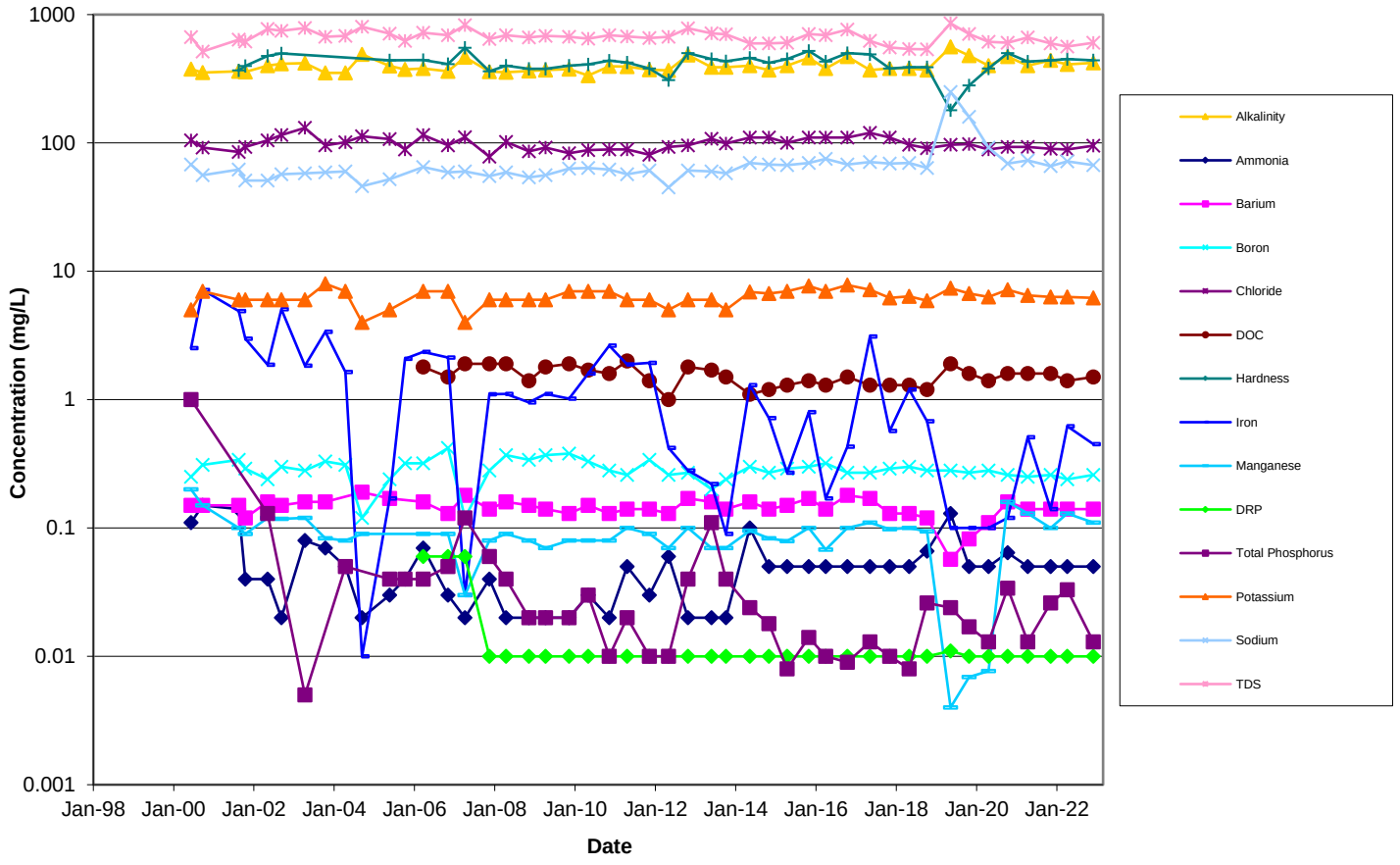


FIGURE D-I 12

Town of Arnprior

Waste Disposal Site

BR-7D

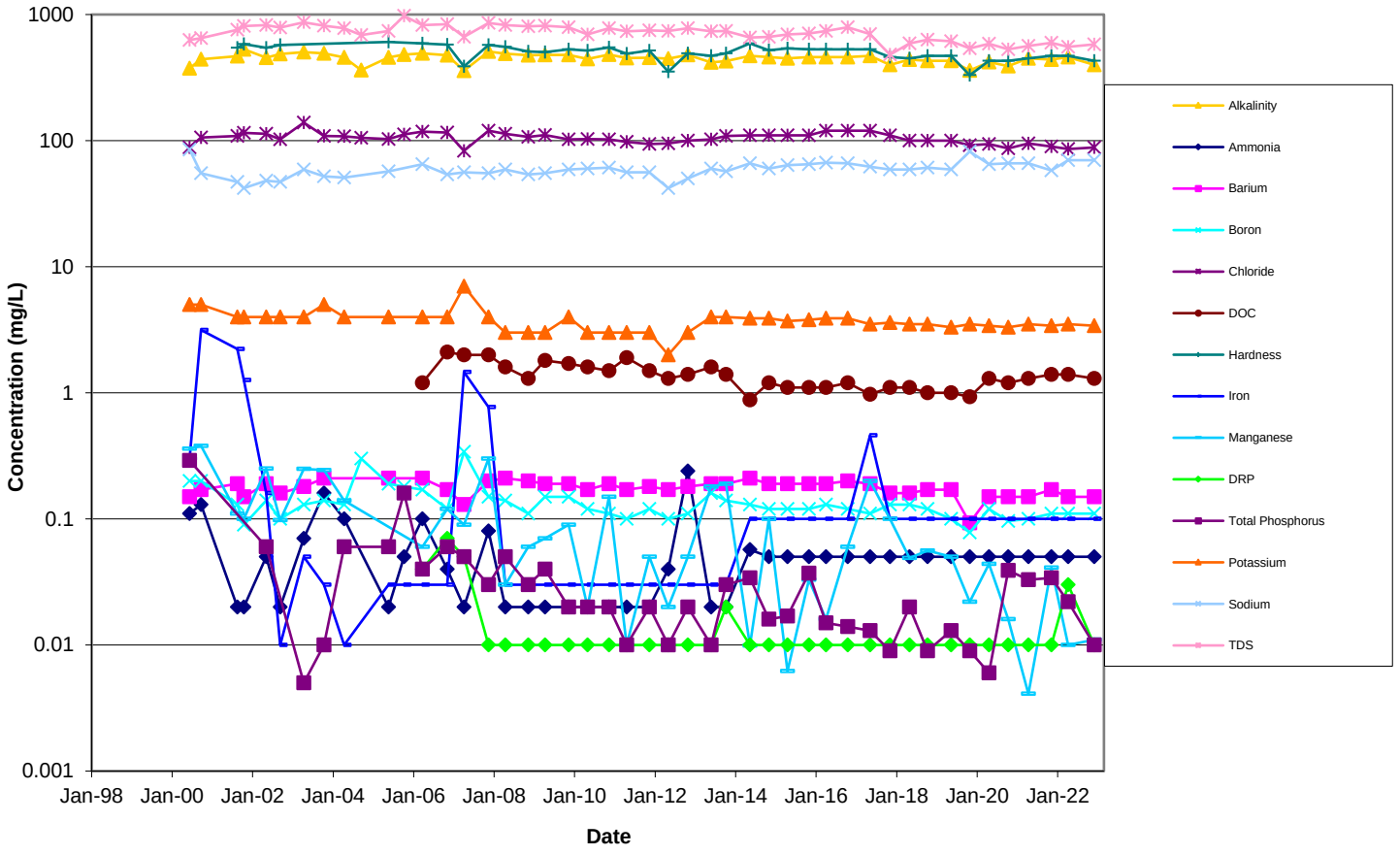


FIGURE D-I 13

Town of Arnprior

Waste Disposal Site

BR-7S

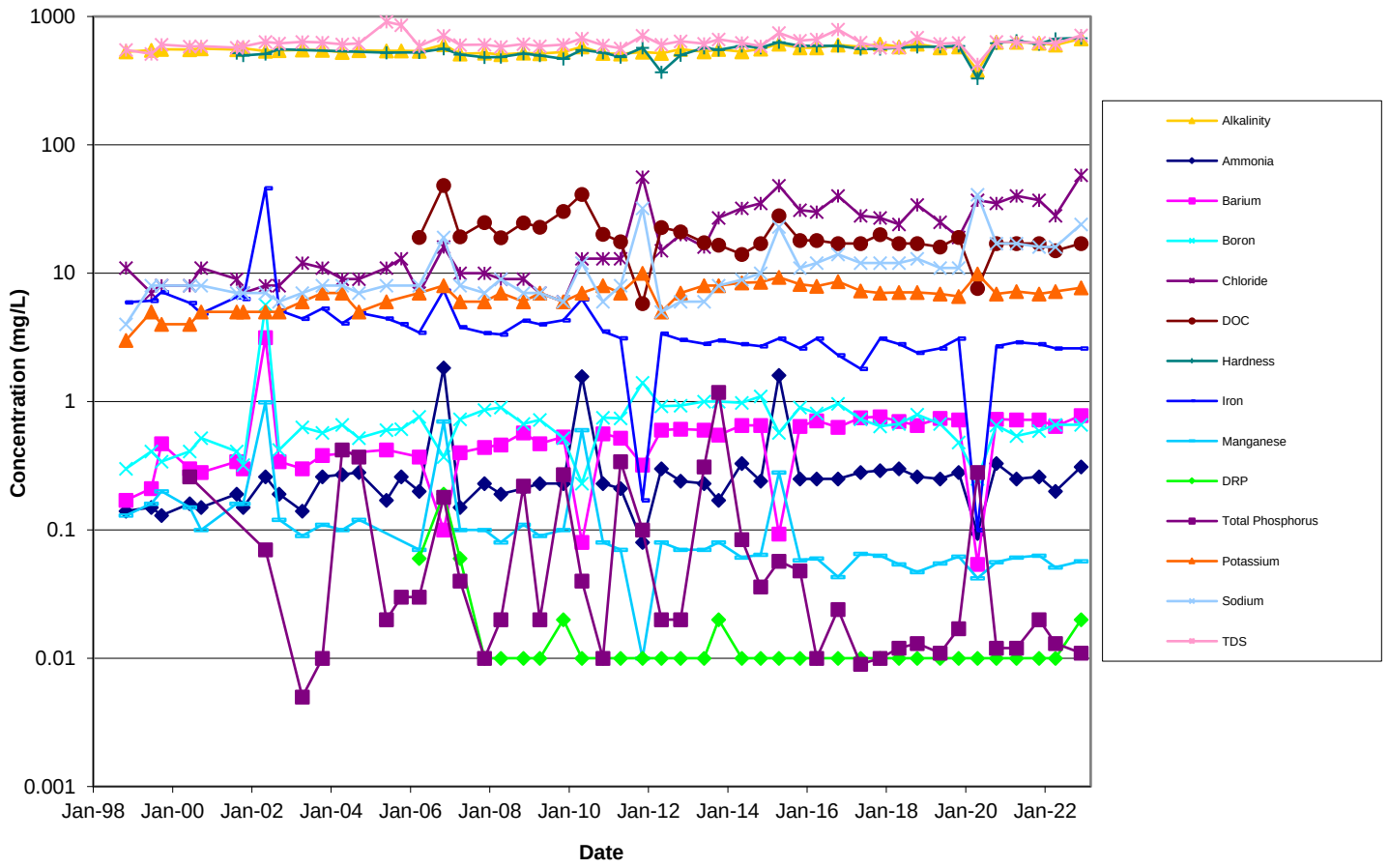


FIGURE D-I 14

Town of Arnprior

Waste Disposal Site

BR-8D

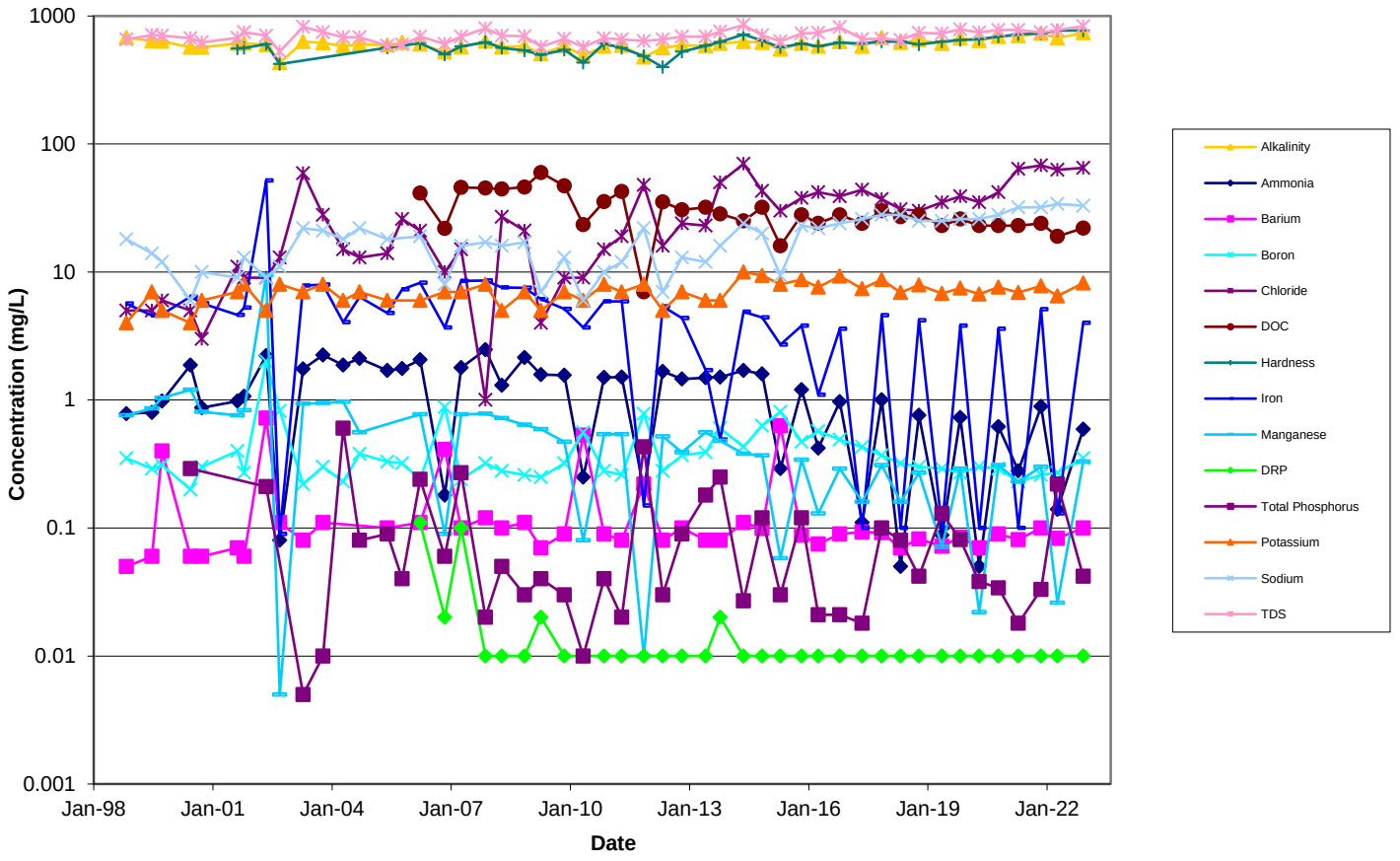


FIGURE D-I 15

Town of Arnprior

Waste Disposal Site

BR-8S

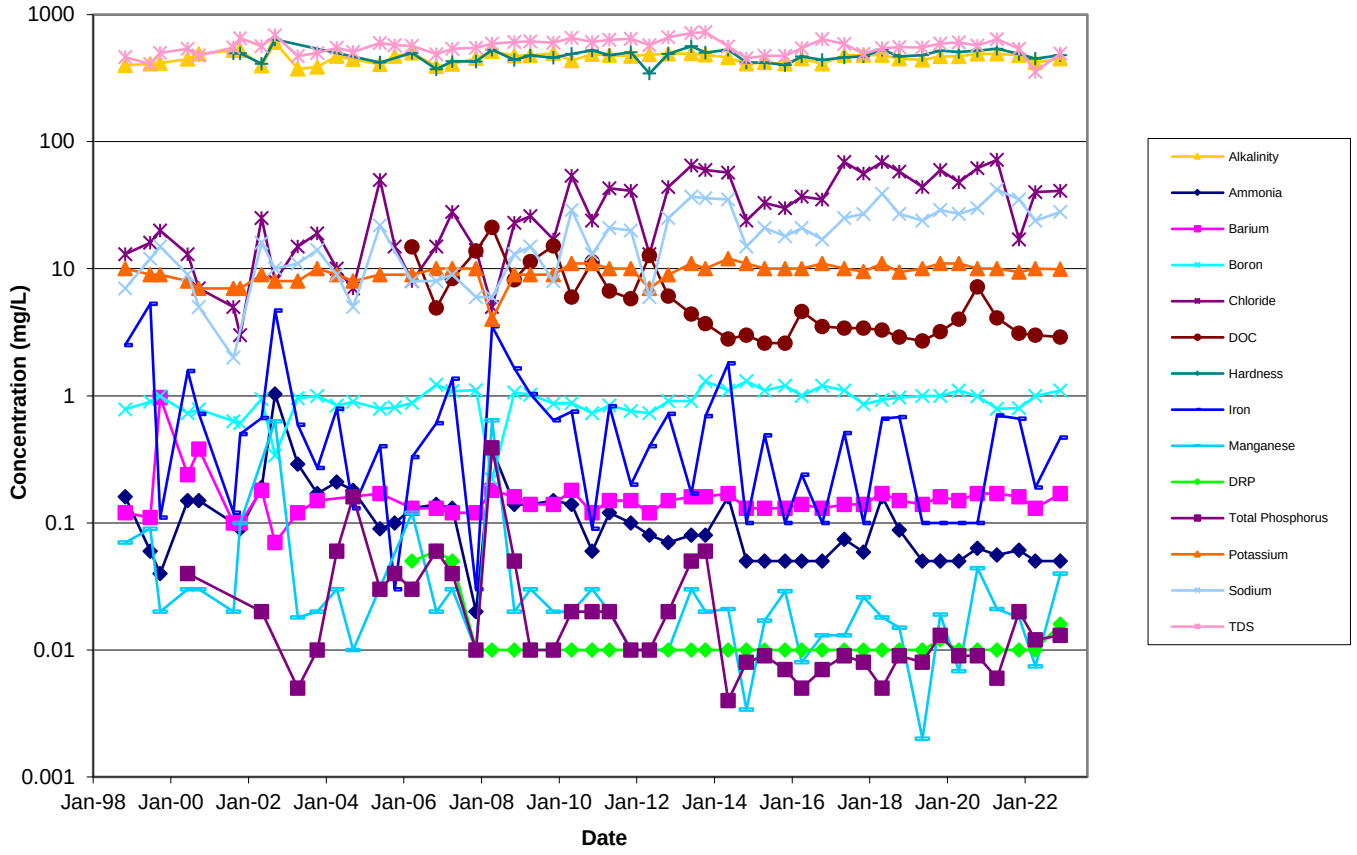


FIGURE D-I 16

Town of Arnprior

Waste Disposal Site

BR-9D

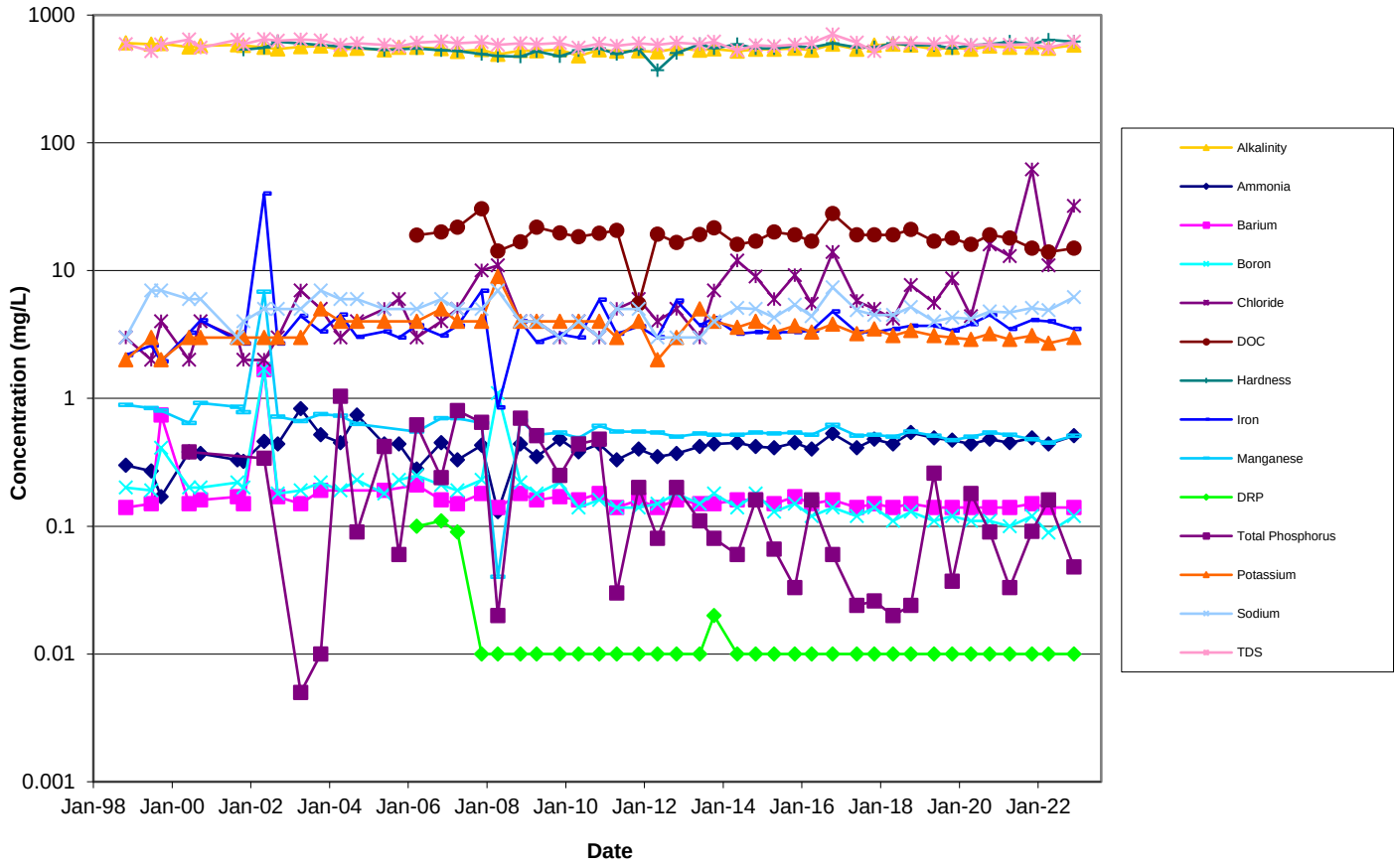


FIGURE D-I 17

Town of Arnprior

Waste Disposal Site

BR-9S

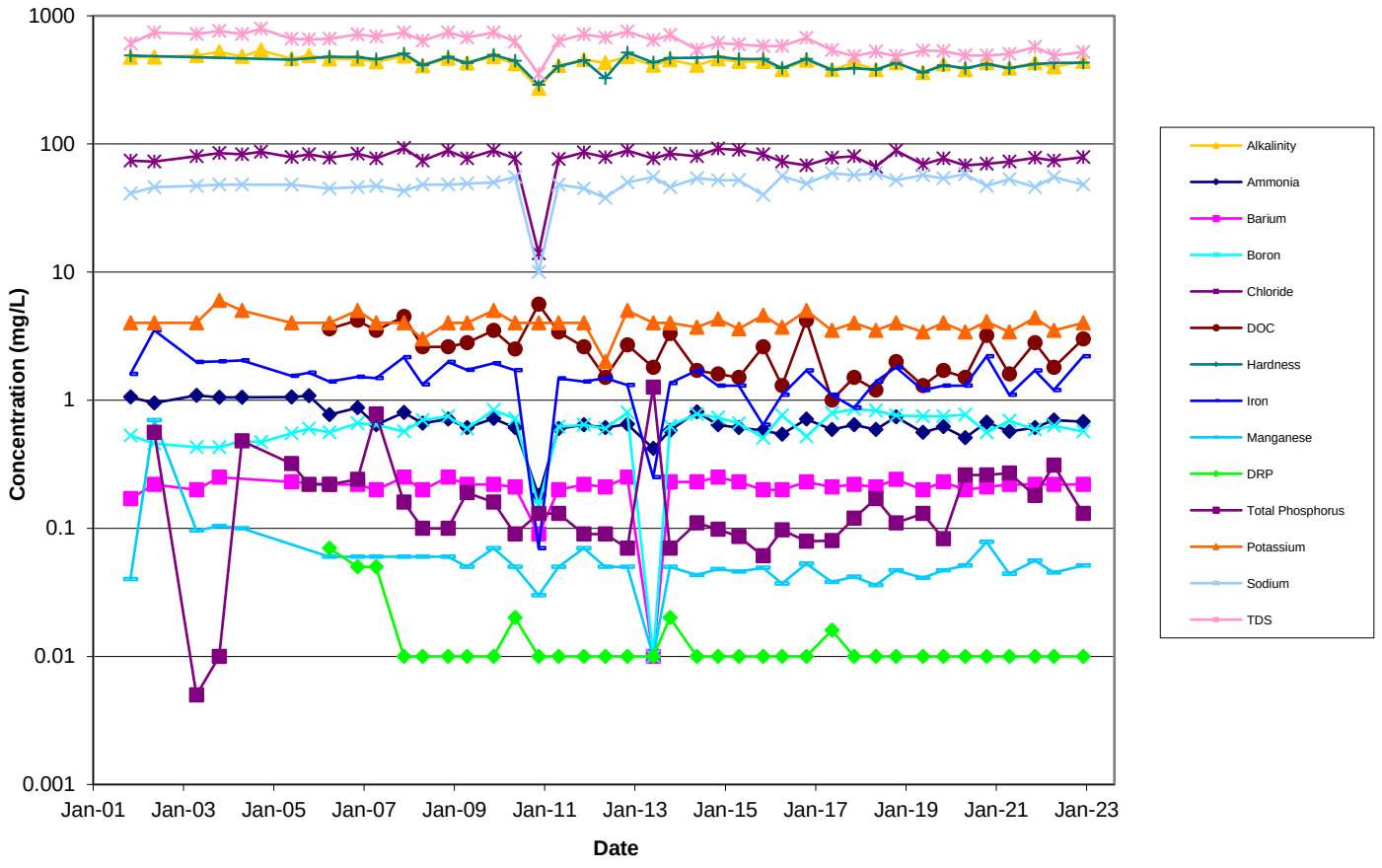


FIGURE D-I 18

Town of Arnprior

Waste Disposal Site

BR-10

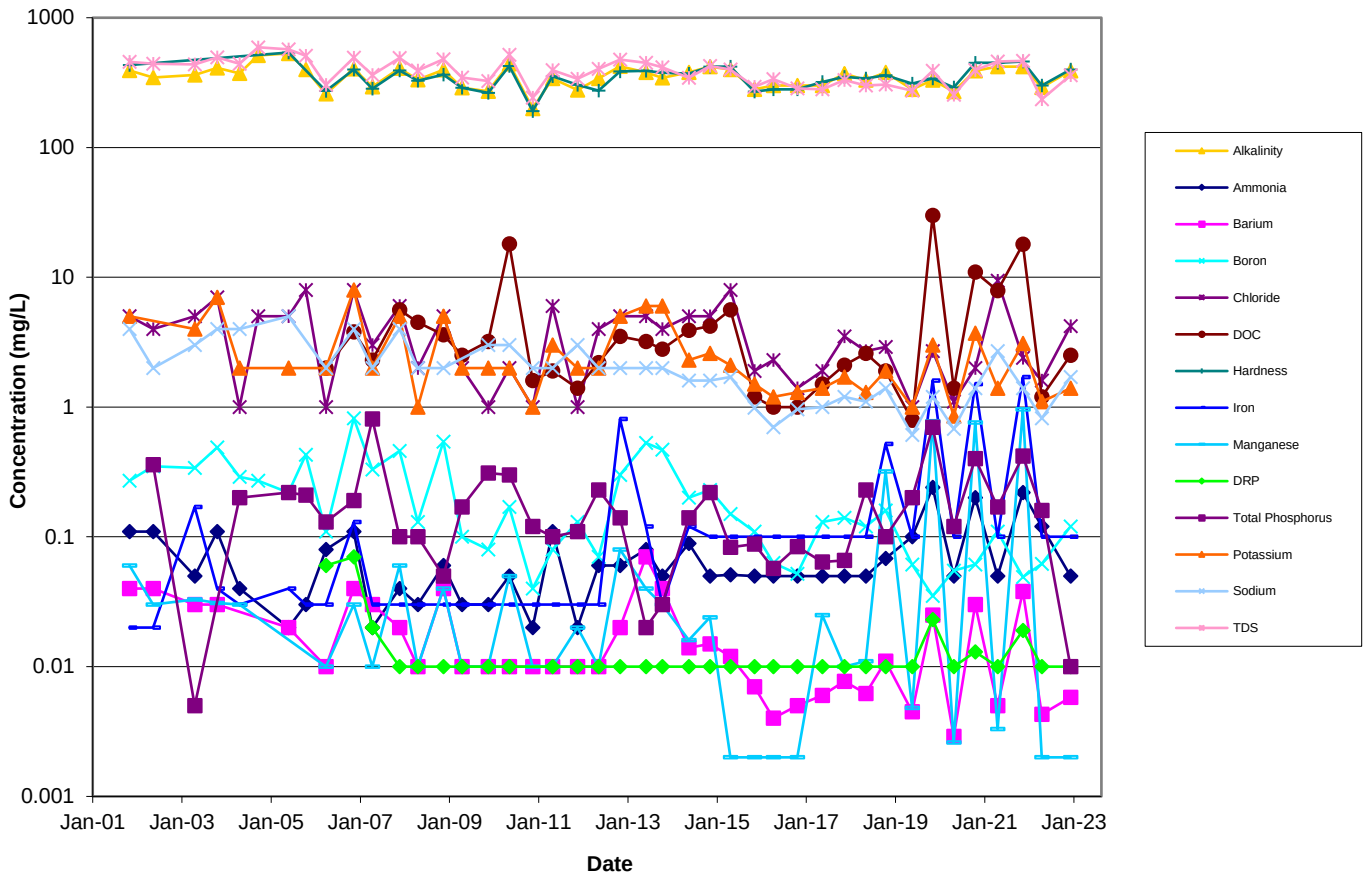


FIGURE D-I 19

Town of Arnprior

Waste Disposal Site

BR-11

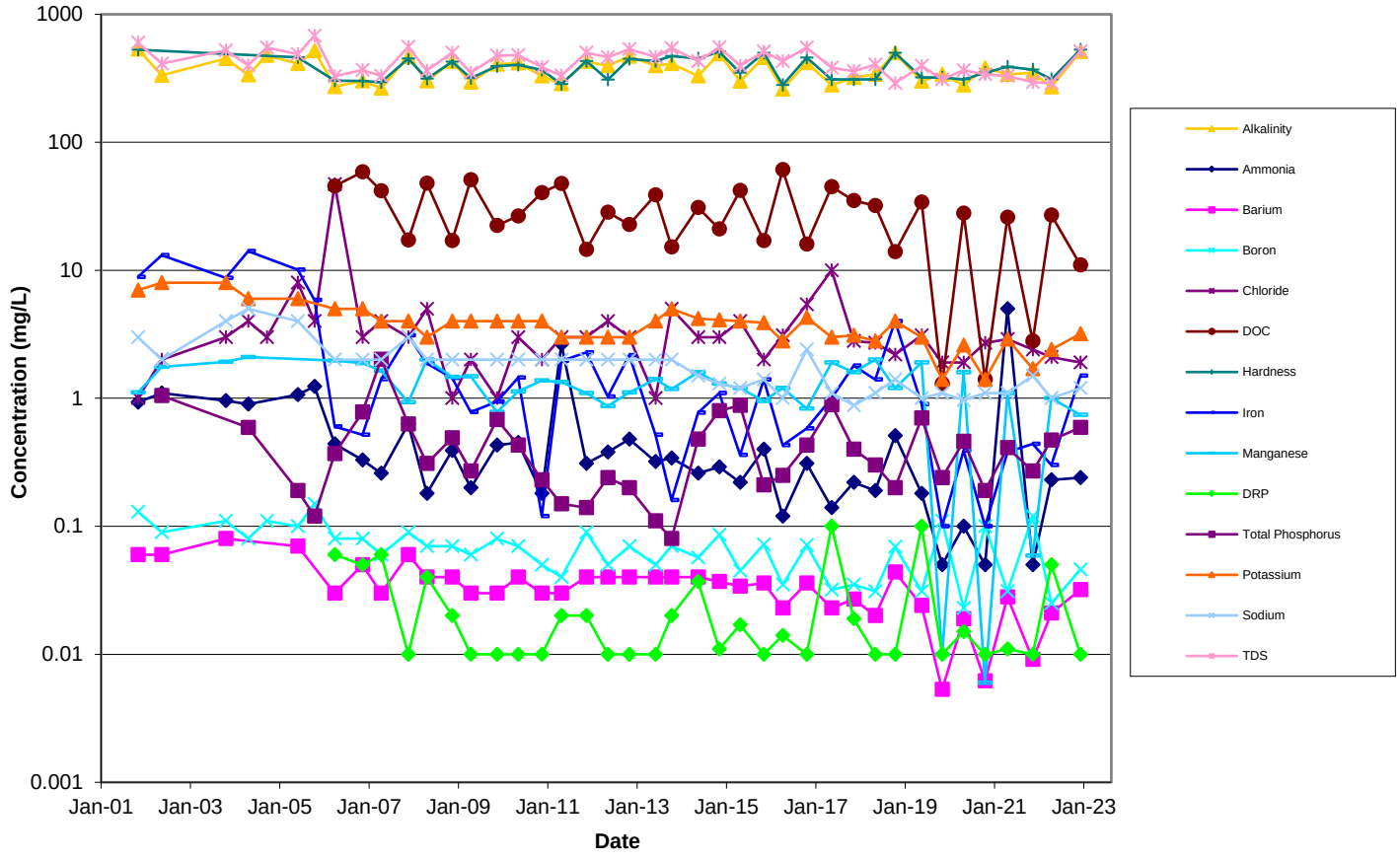


FIGURE D-I 20

Town of Arnprior

Waste Disposal Site

BR-12

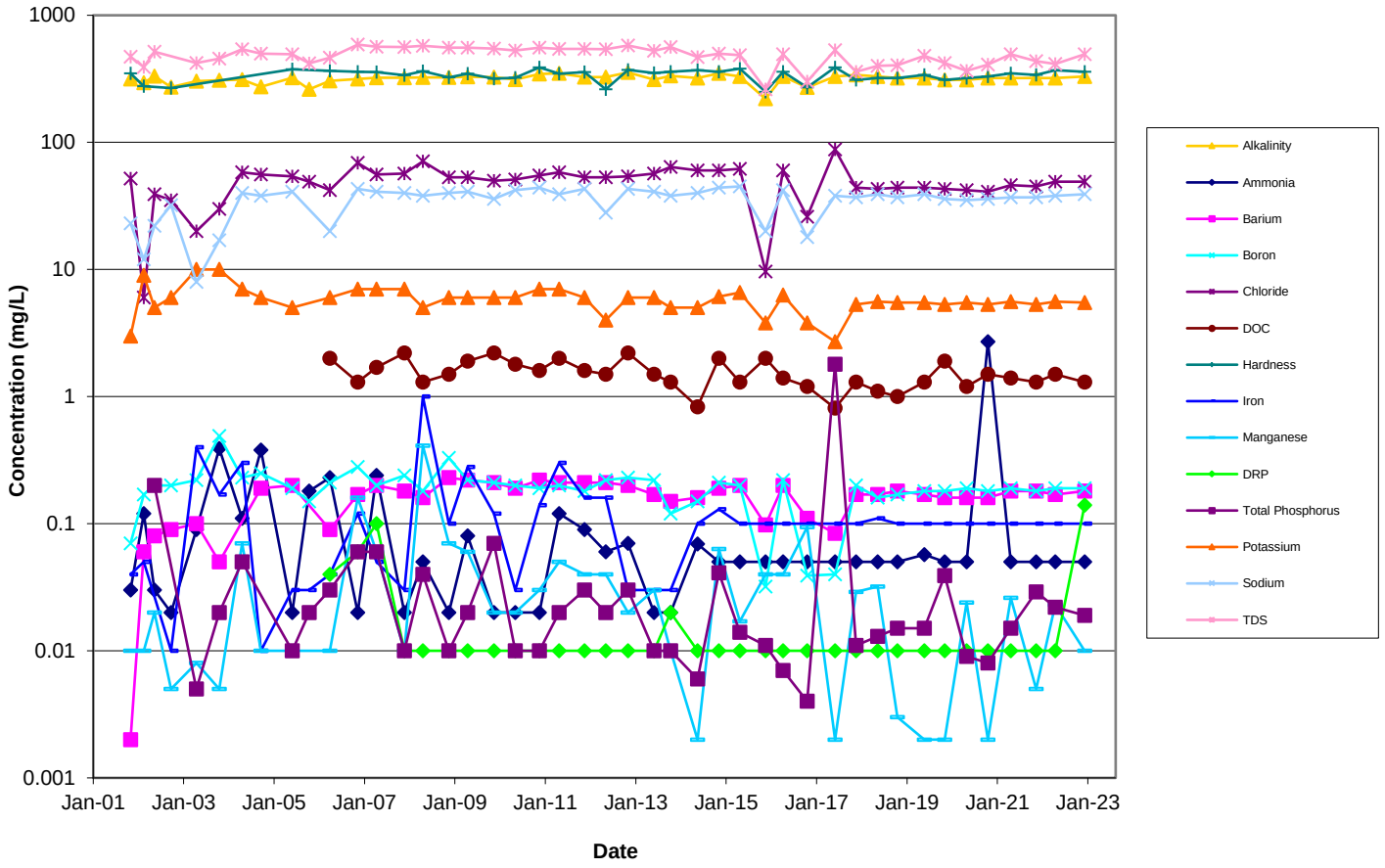


FIGURE D-I 21

Town of Arnprior

Waste Disposal Site

BR-13D

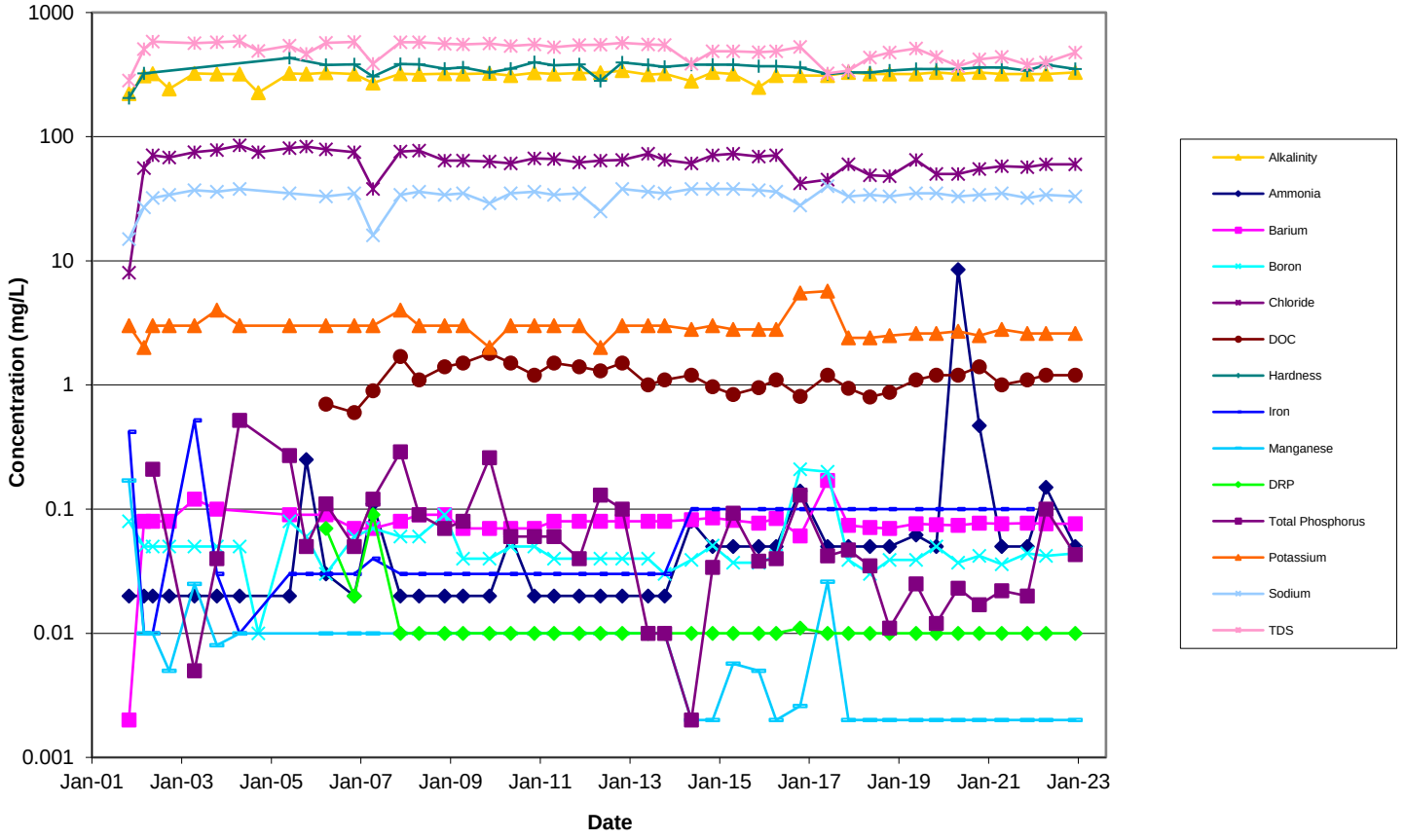


FIGURE D-I 22

Town of Arnprior

Waste Disposal Site

BR-13S

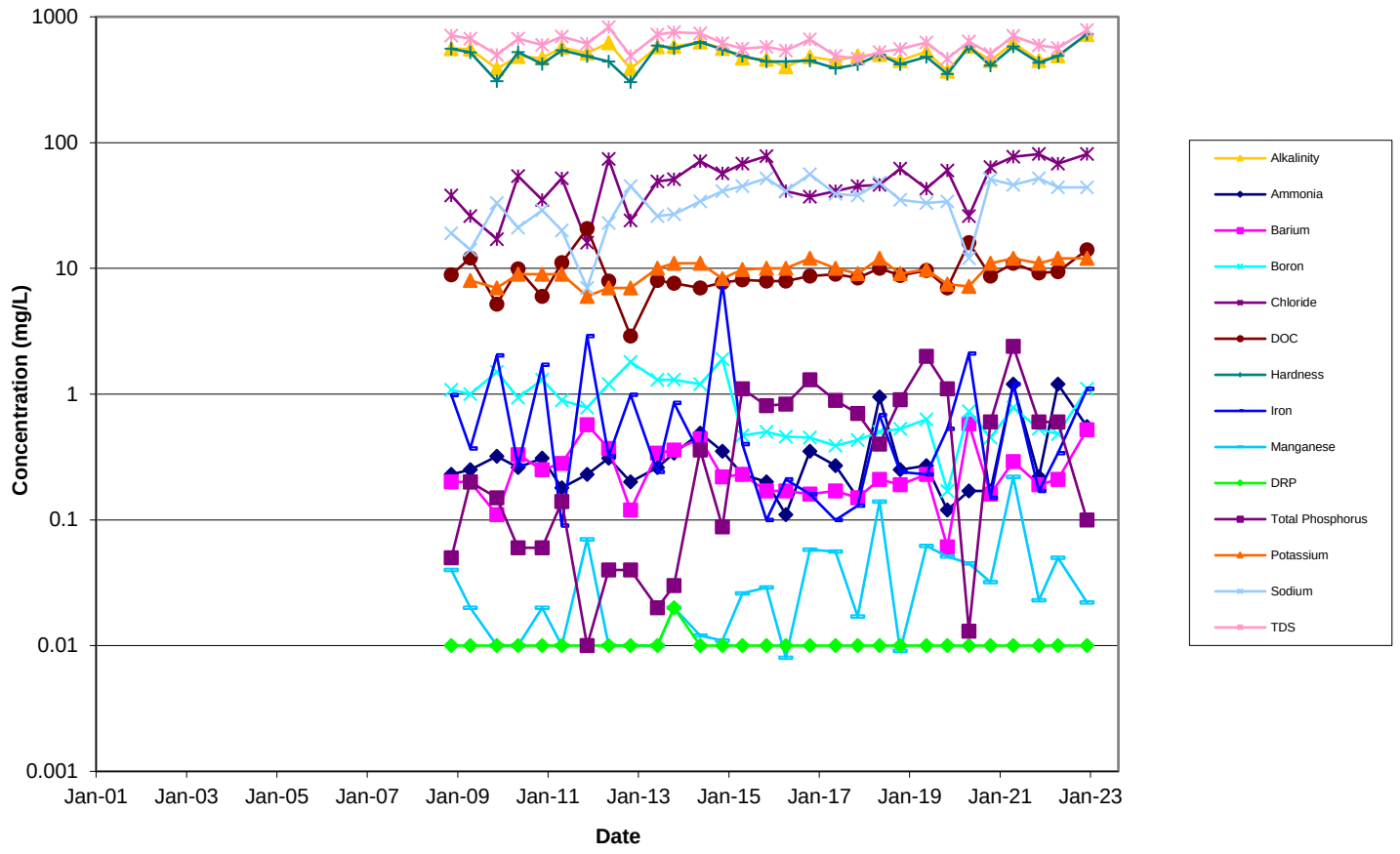


FIGURE D-I 23

Town of Arnprior

Waste Disposal Site

BR 08-1D

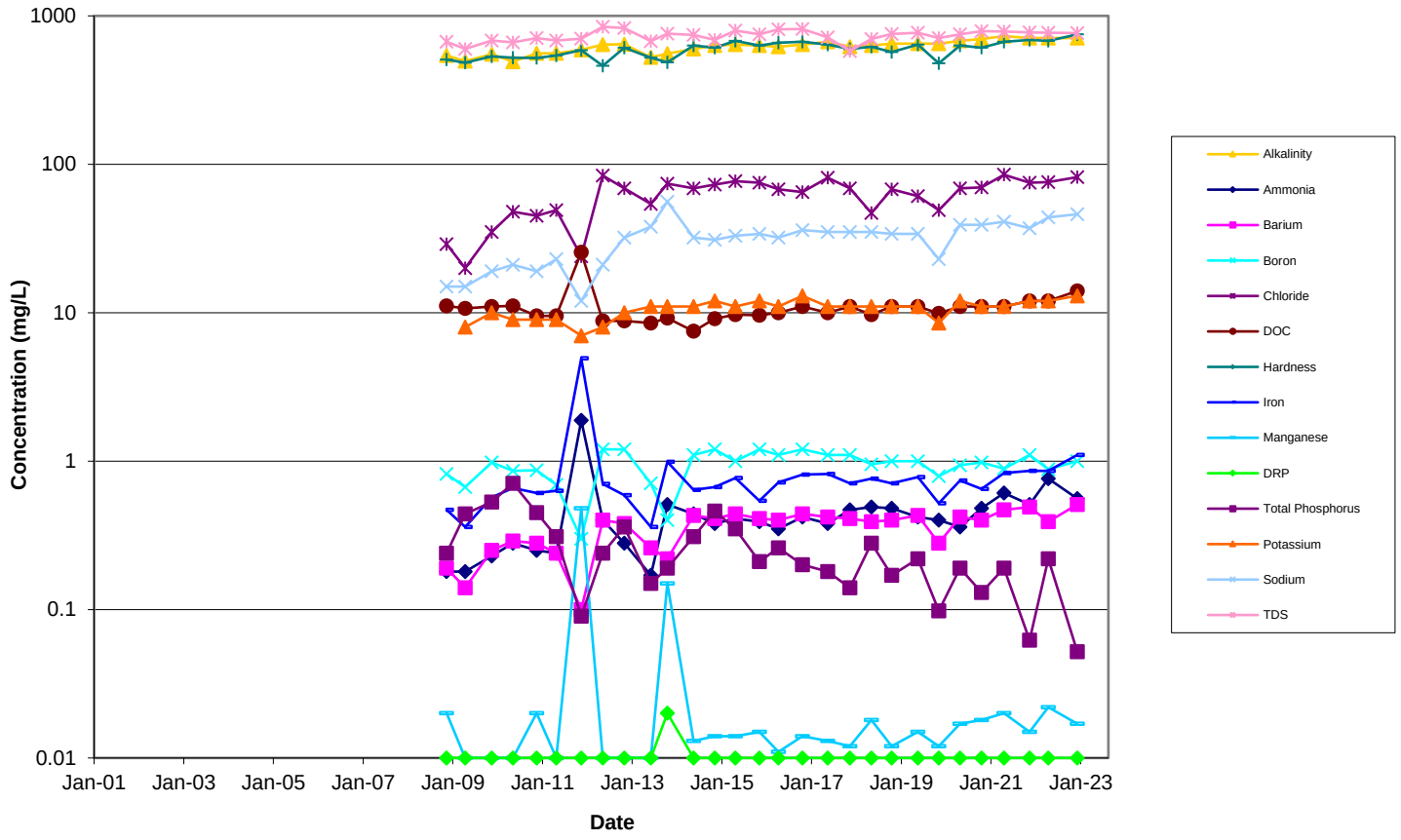


FIGURE D-I 24

Town of Arnprior

Waste Disposal Site

BR 08-1S

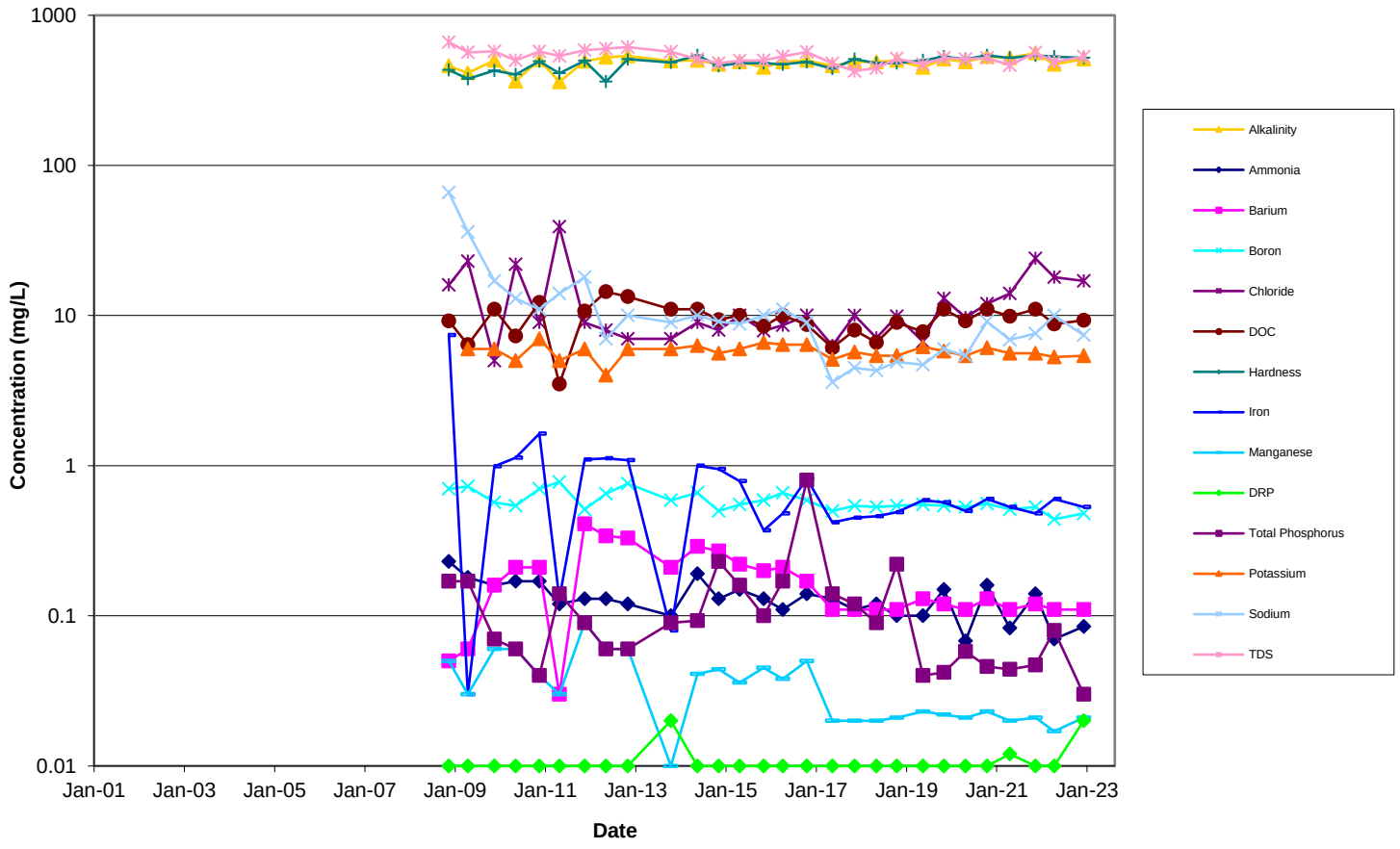


FIGURE D-I 25

Town of Arnprior

Waste Disposal Site

BR 08-2D

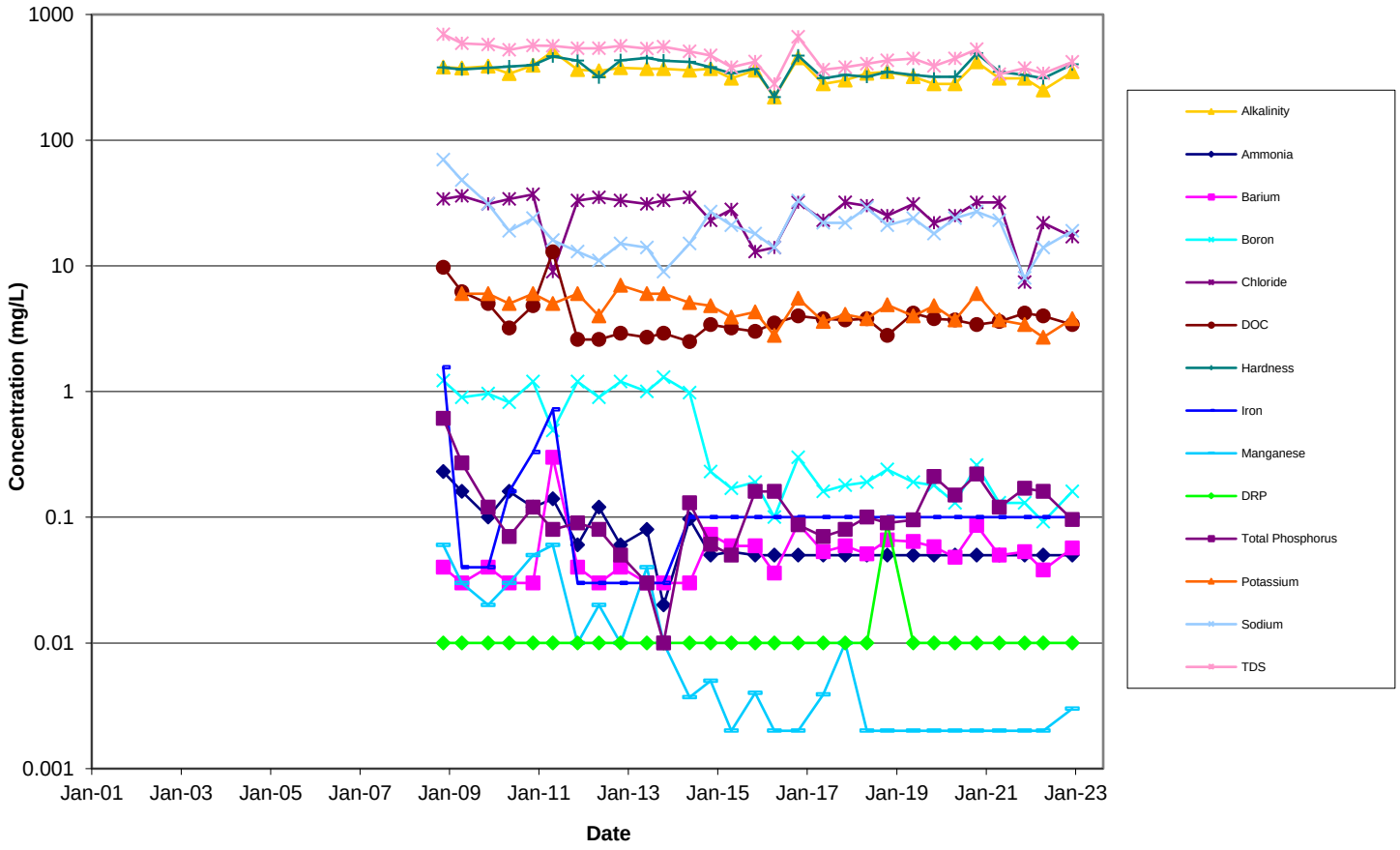


FIGURE D-I 26

Town of Arnprior

Waste Disposal Site

BR 08-2S

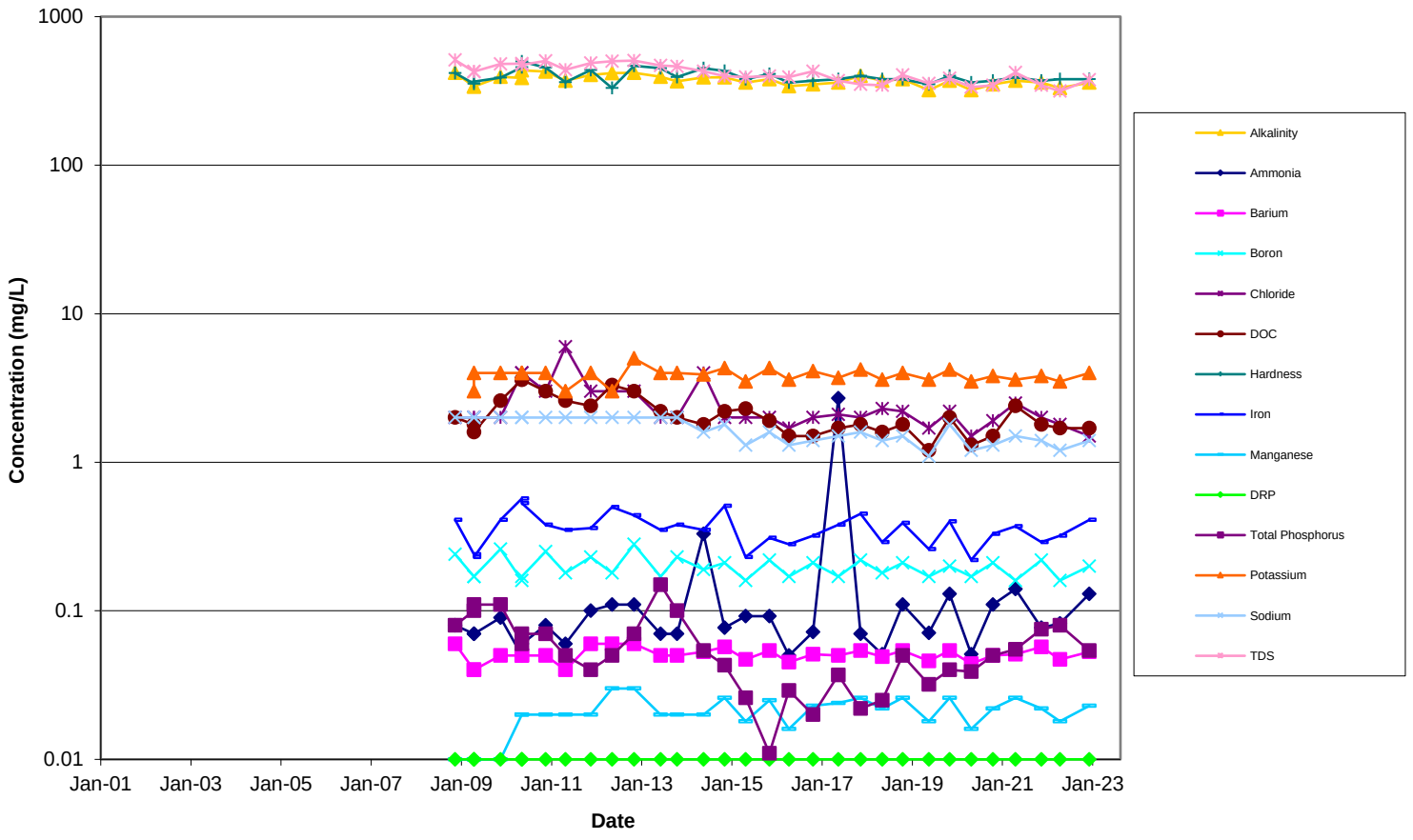


FIGURE D-I 27

Town of Arnprior

Waste Disposal Site

BR 08-3D

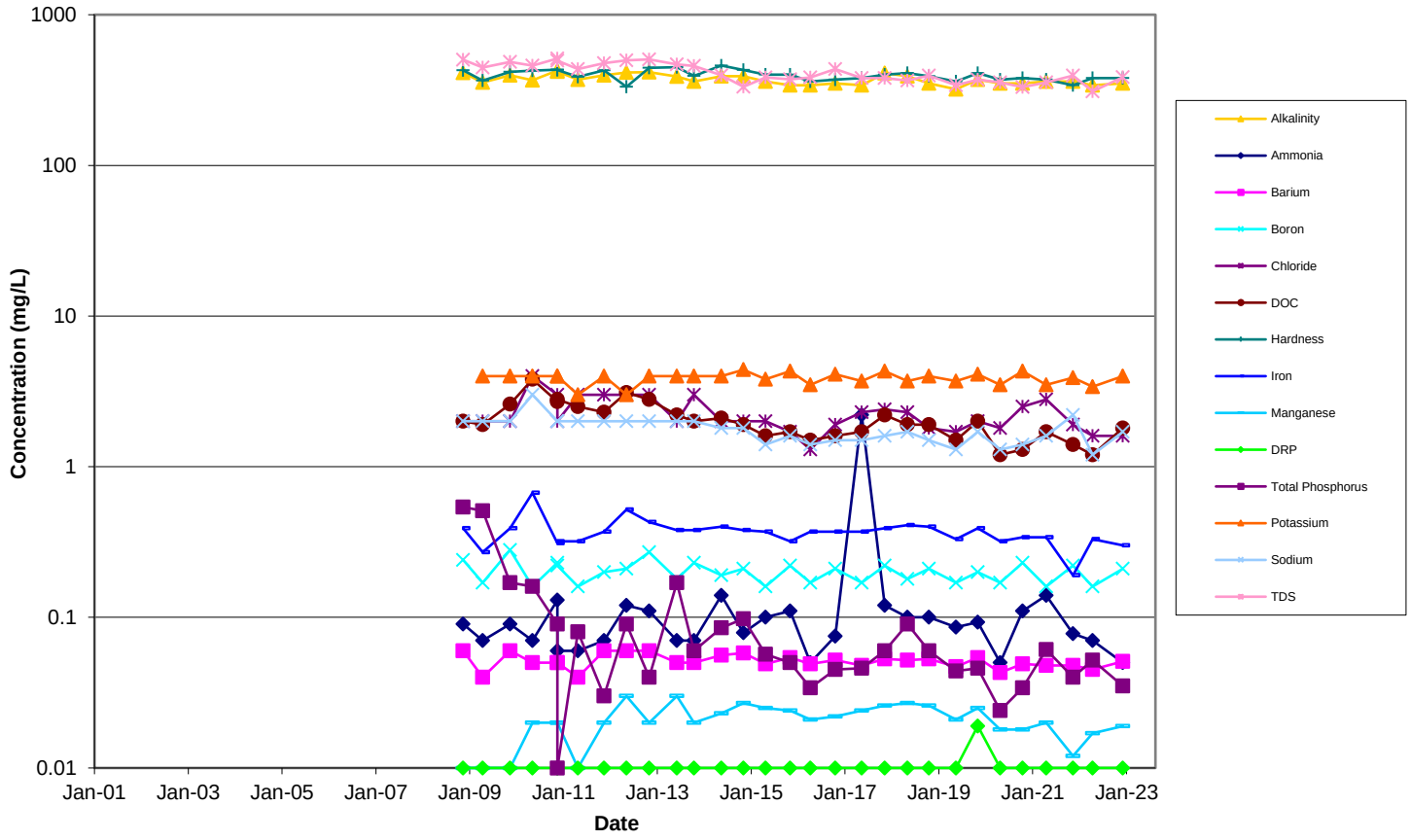


FIGURE D-I 28

Town of Arnprior

Waste Disposal Site

BR 08-3S

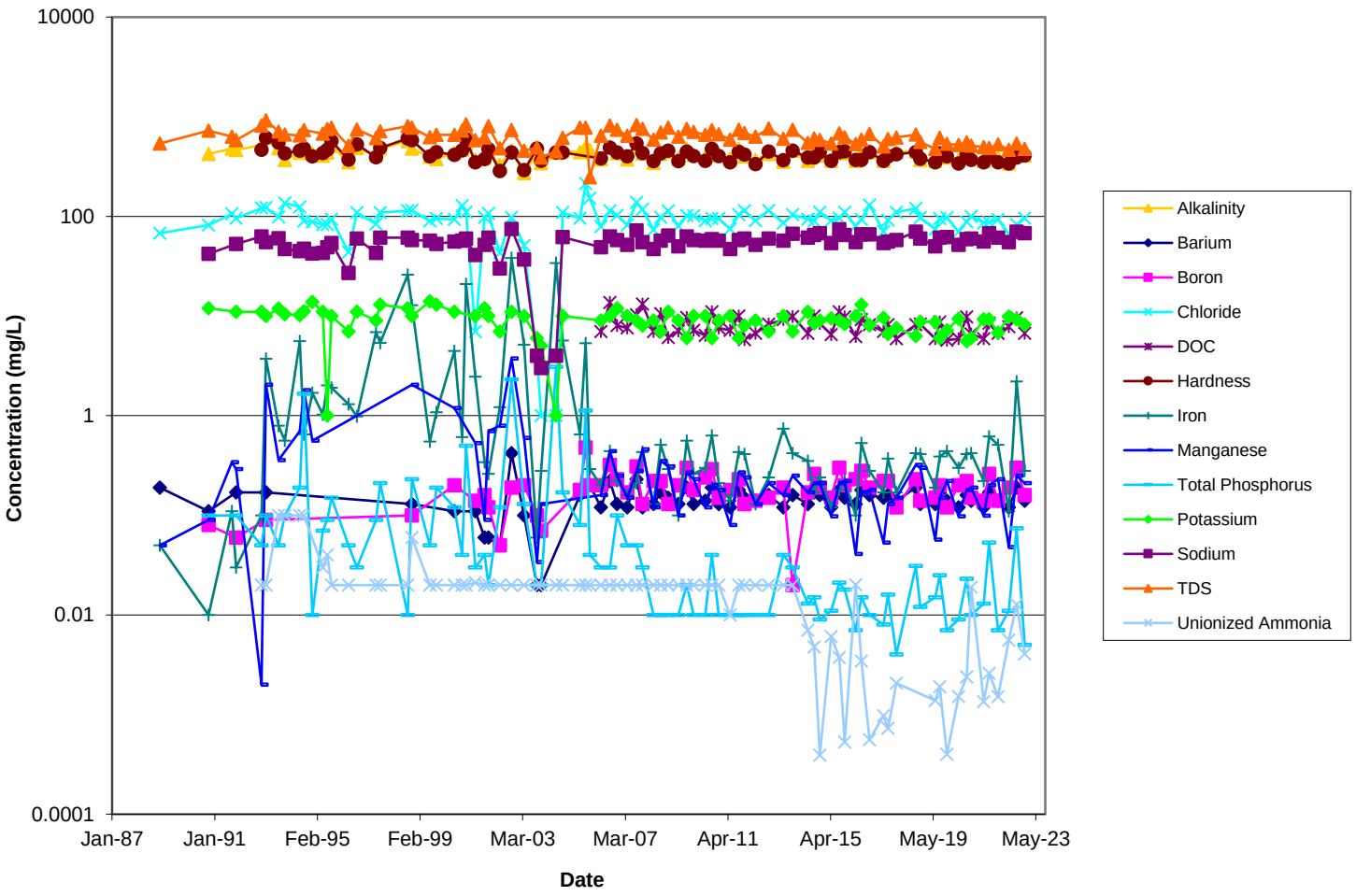


FIGURE D-II 1

Town of Arnprior

Waste Disposal Site

SW-1

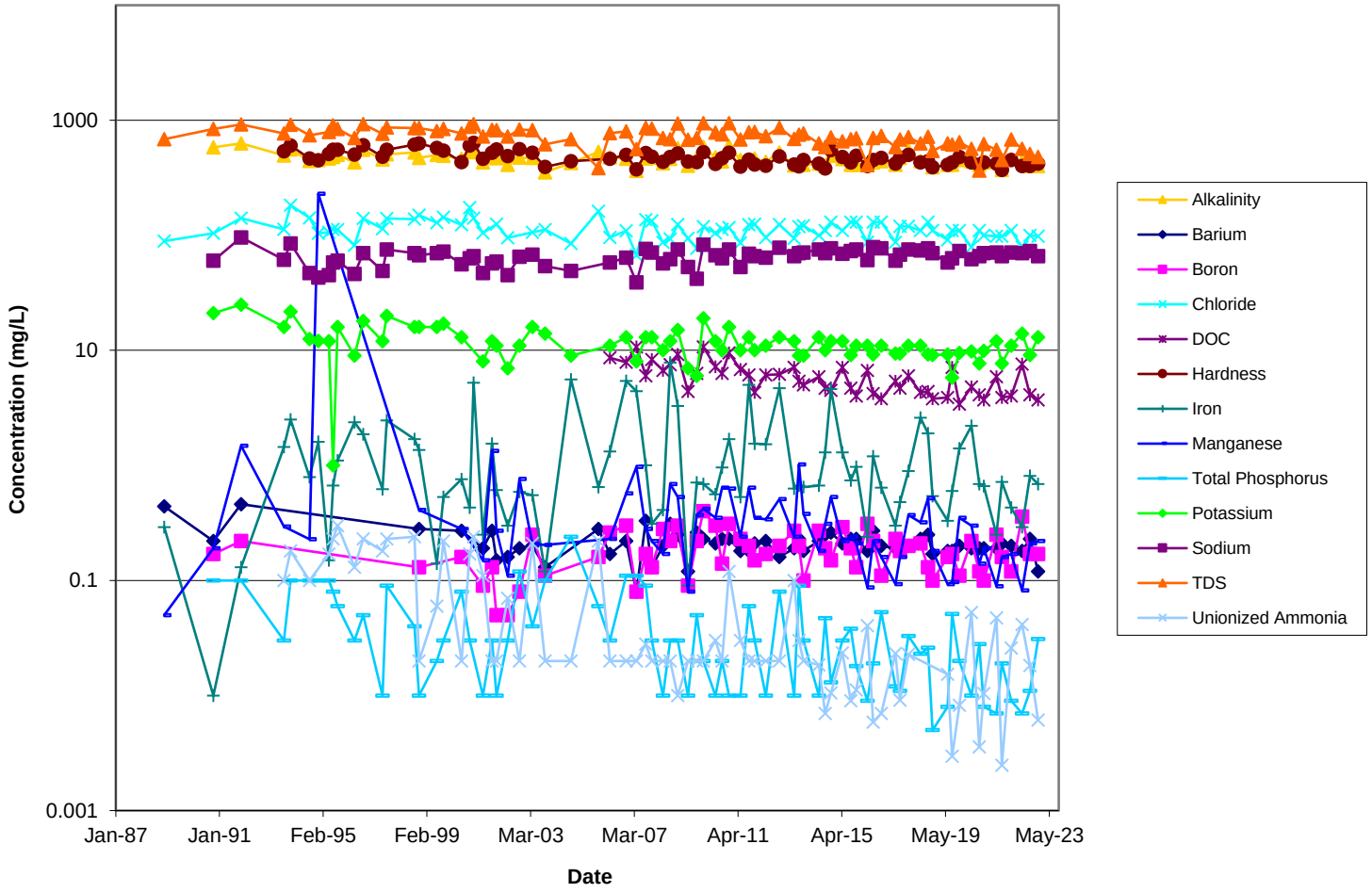


FIGURE D-II 2	**Town of Arnprior** **Waste Disposal Site** **SW-2**	wsp

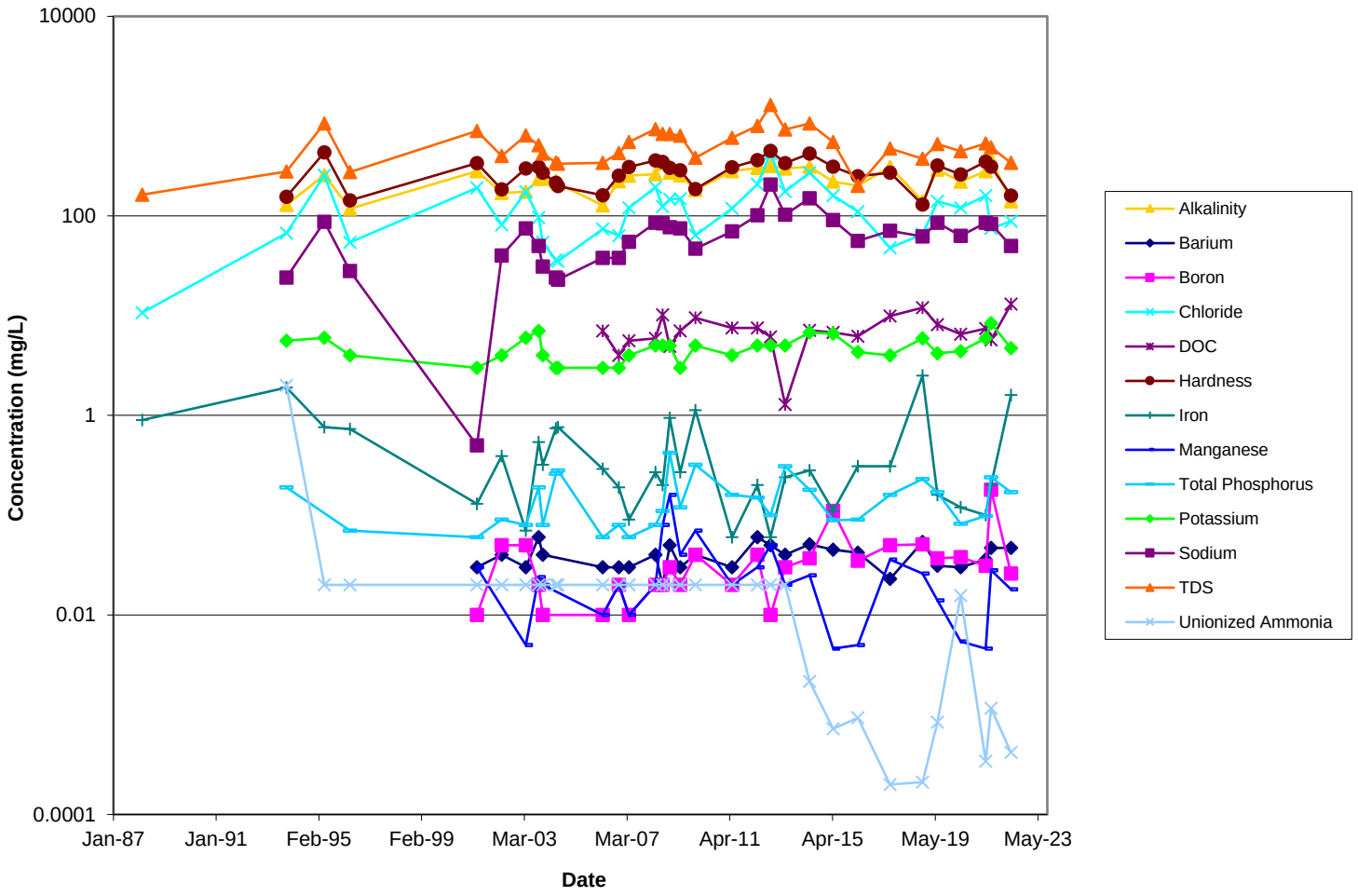


FIGURE D-II 3

Town of Arnprior

Waste Disposal Site

SW-10

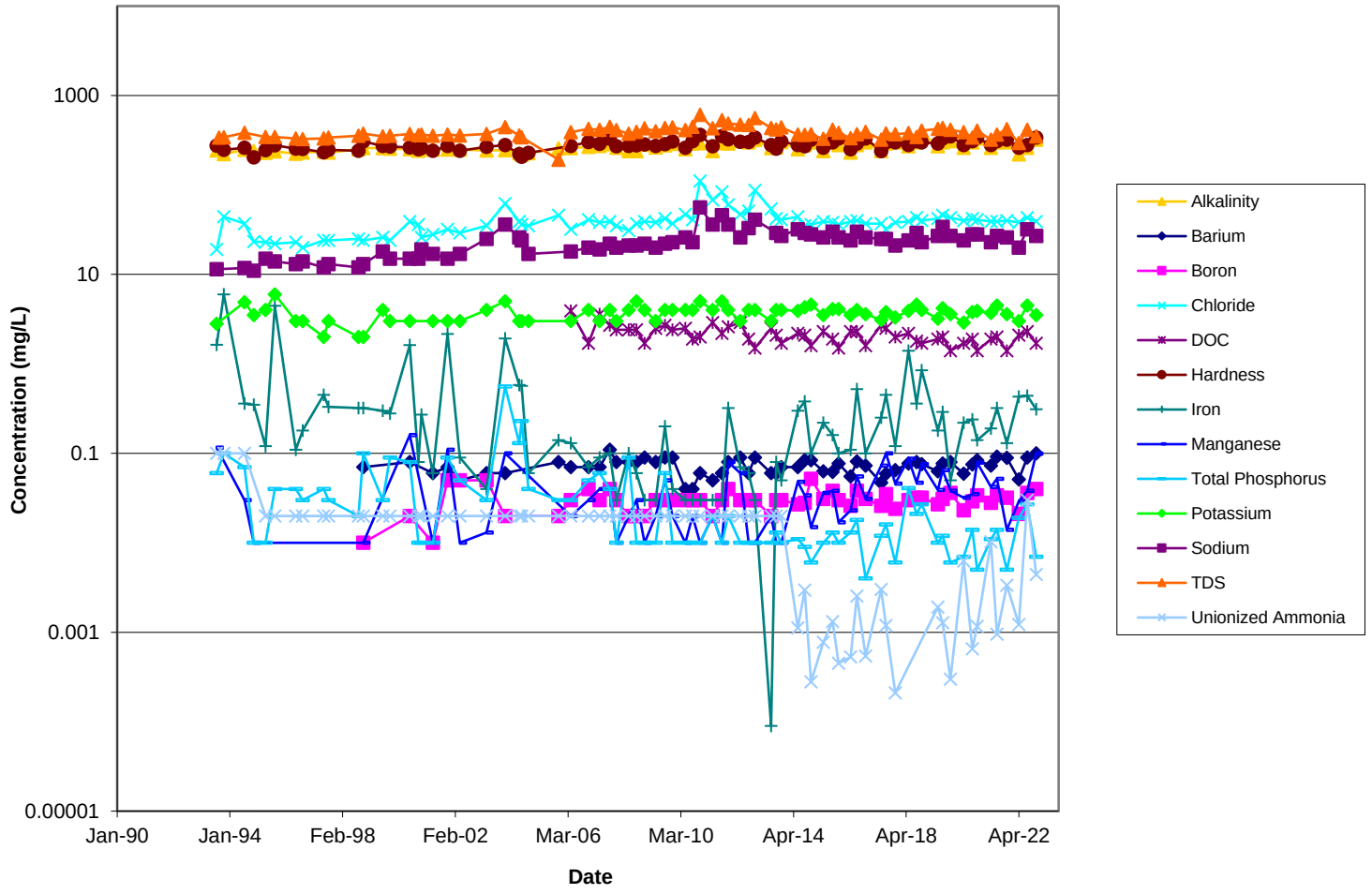


FIGURE D-II 4

Town of Arnprior

Waste Disposal Site

SW-11

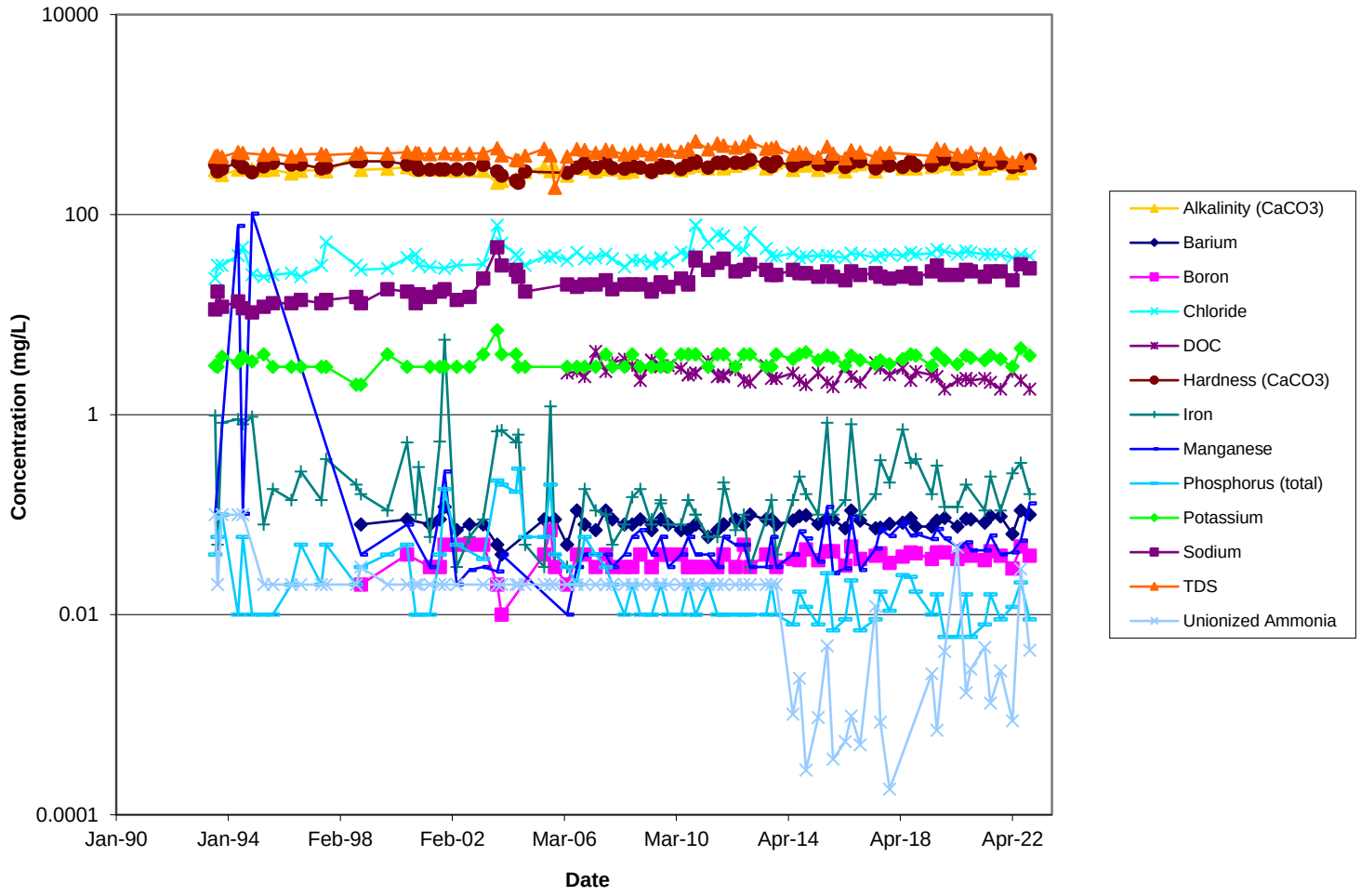


FIGURE D-II 5

Town of Arnprior

Waste Disposal Site

SW-12

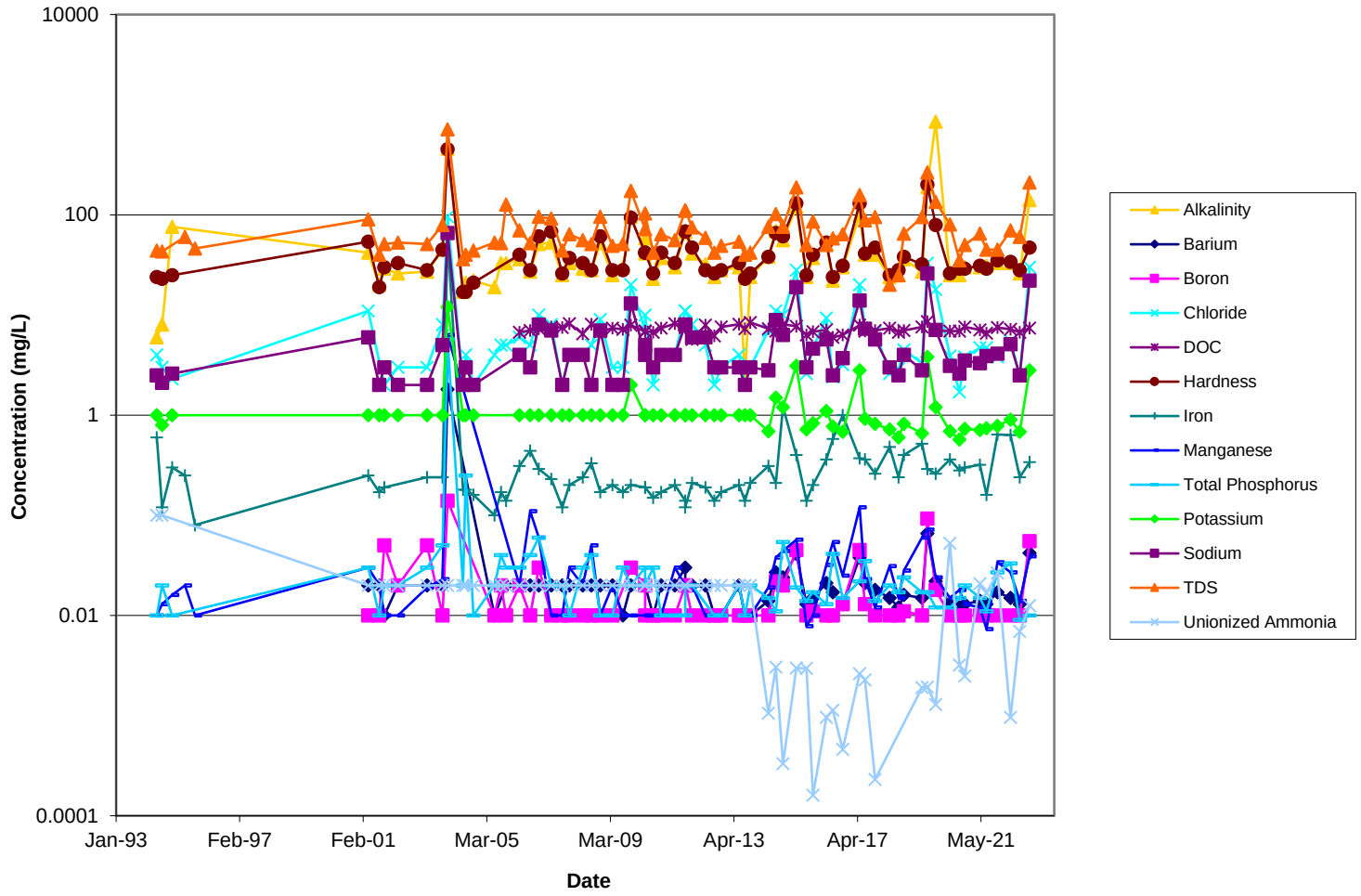


FIGURE D-II 6

Town of Arnprior

Waste Disposal Site

SW-18

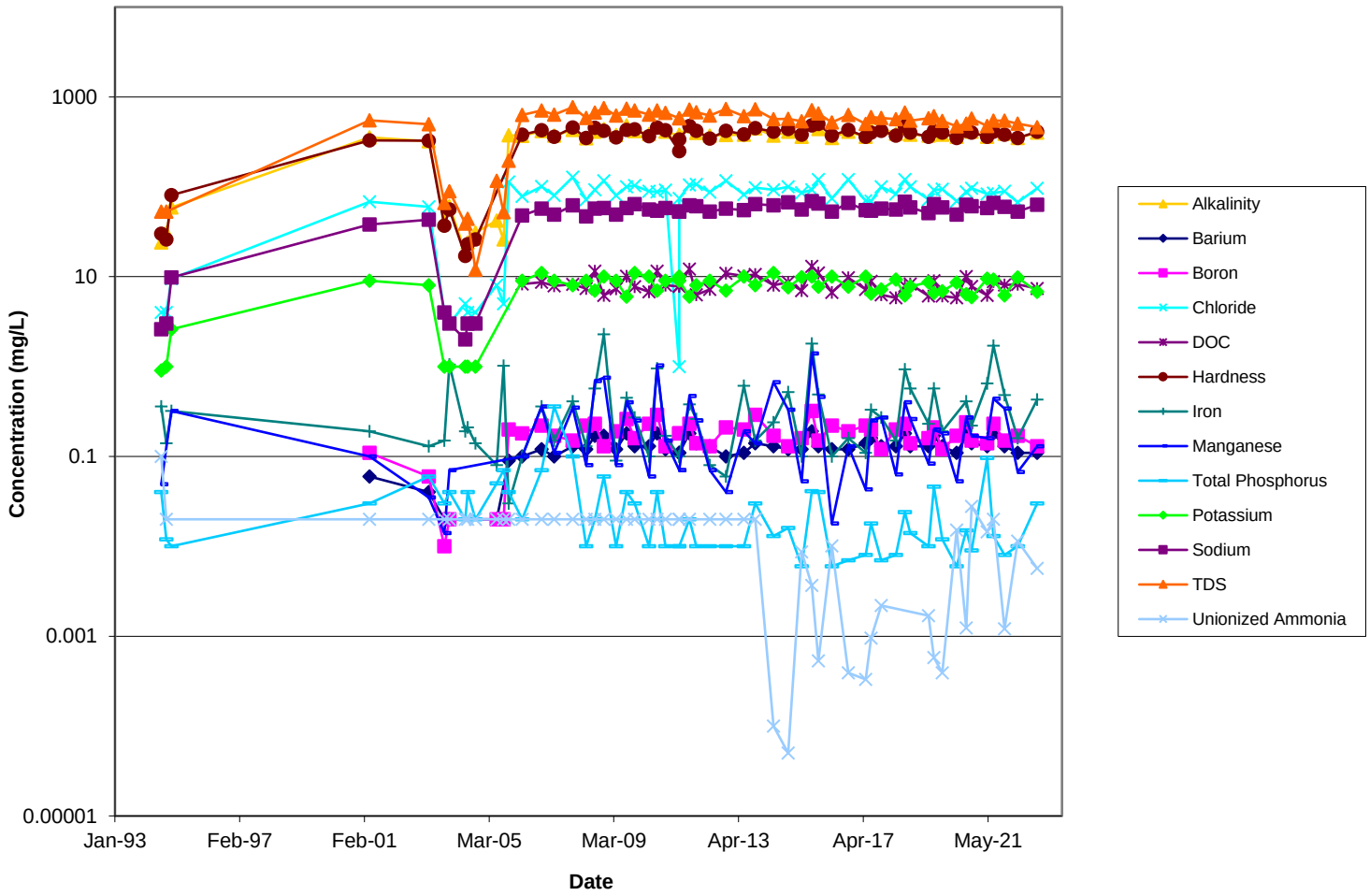


FIGURE D-II 7

Town of Arnprior

Waste Disposal Site

SW-19

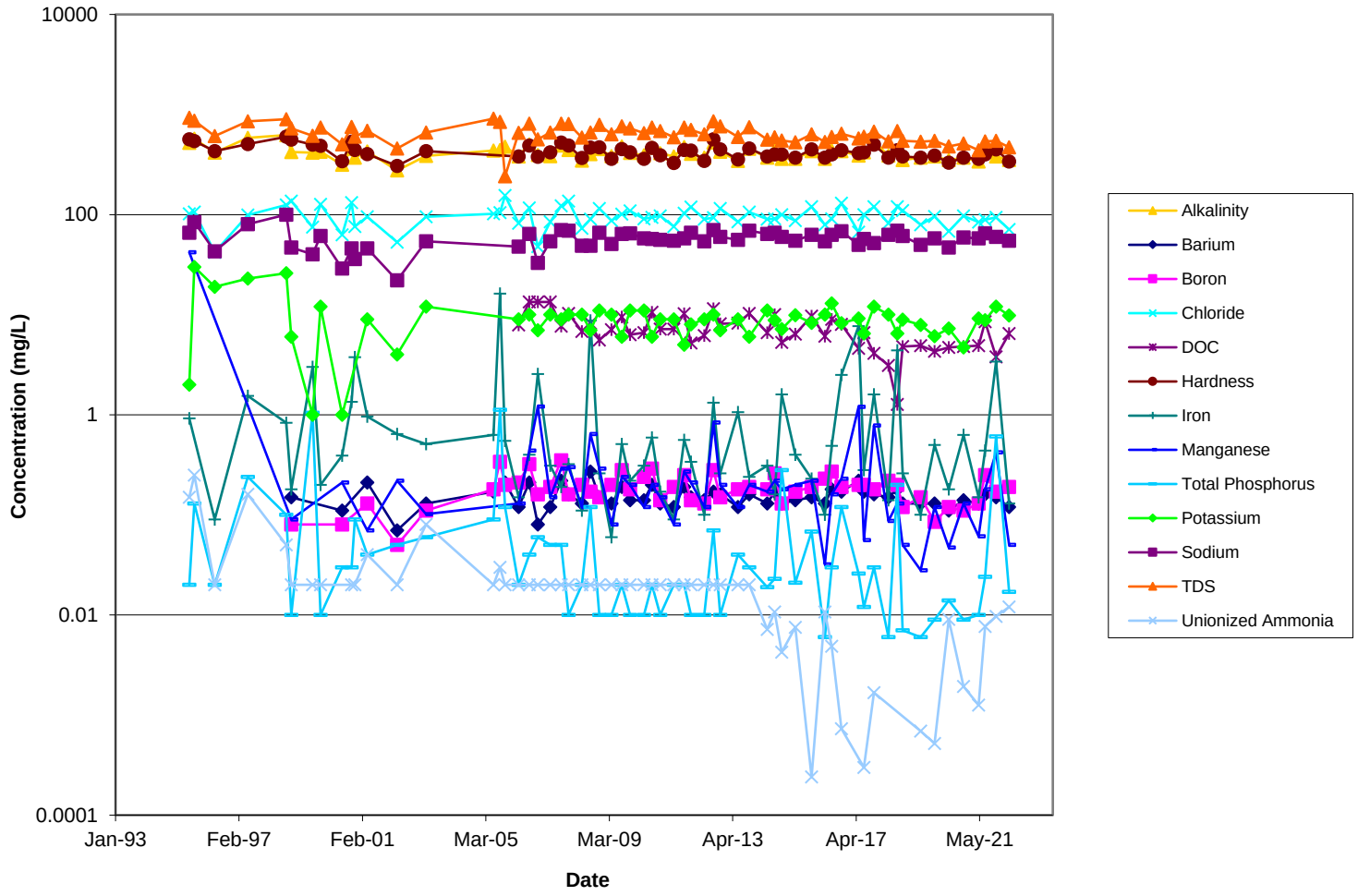


FIGURE D-II 8

Town of Arnprior

Waste Disposal Site

SW-21

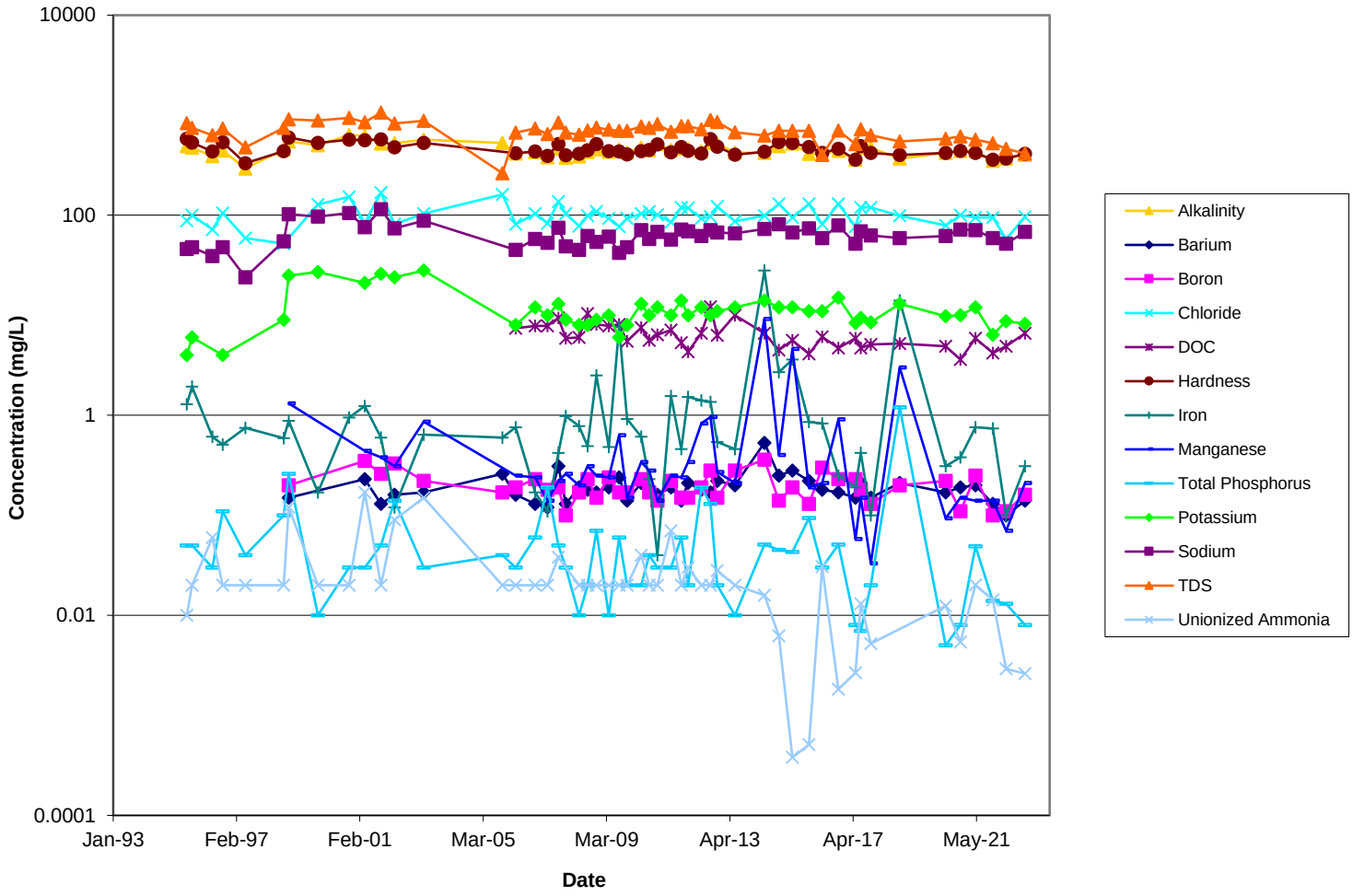


FIGURE D-II 9

Town of Arnprior

Waste Disposal Site

SW-22

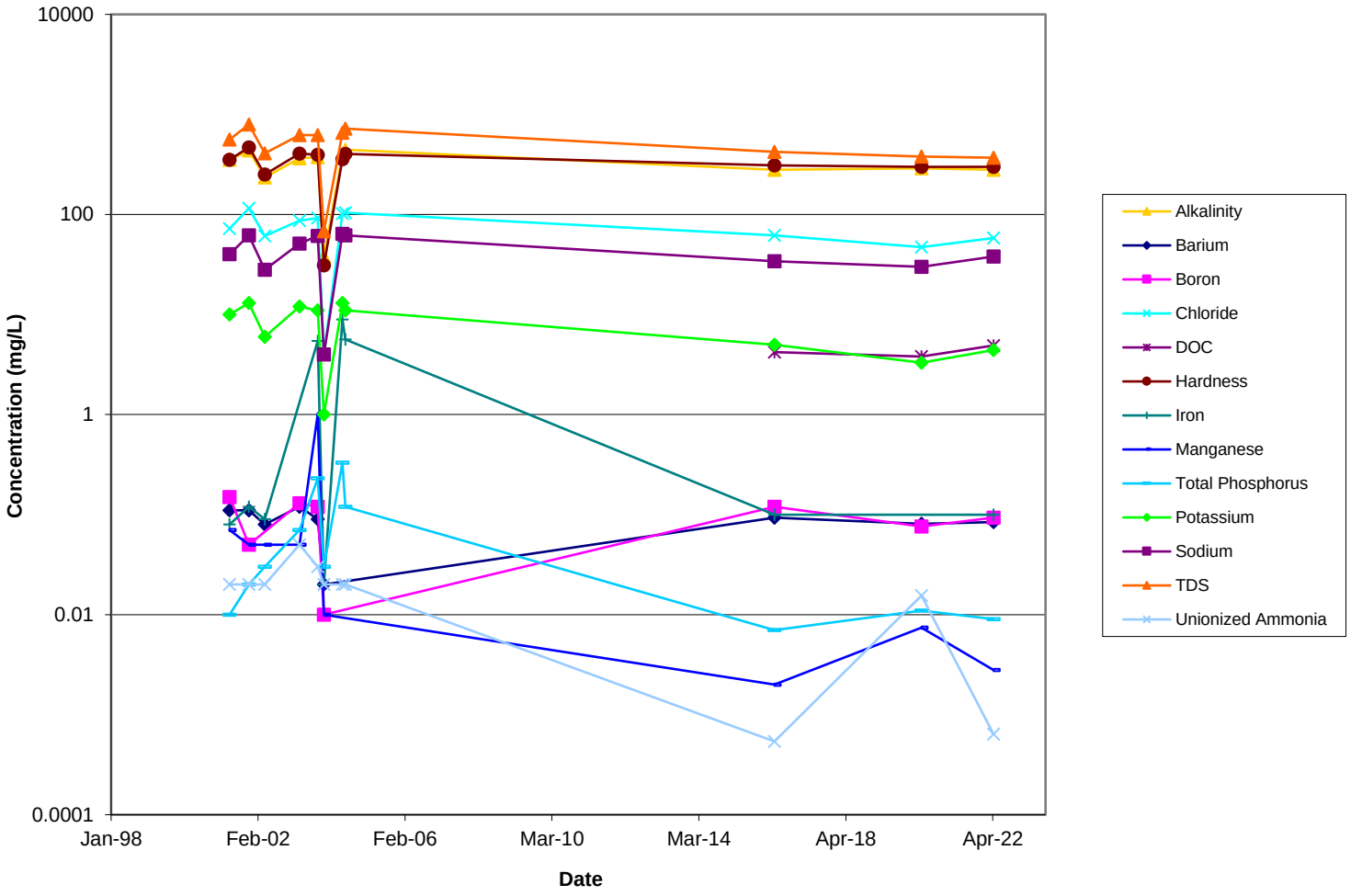


FIGURE D-II 10	**Town of Arnprior** **Waste Disposal Site** **SW-23**	wsp

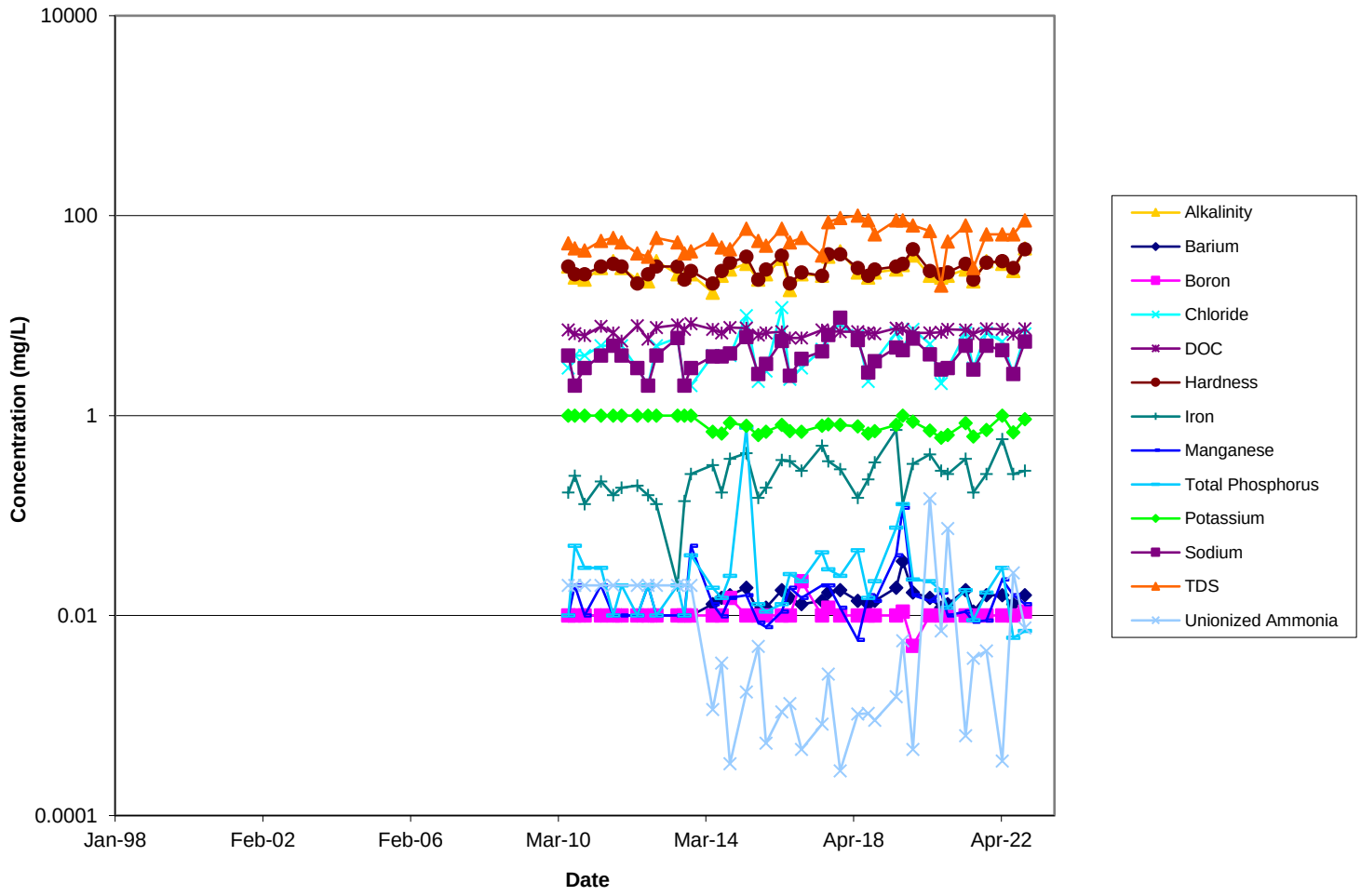


FIGURE D-II 11

Town of Arnprior

Waste Disposal Site

SW-26

APPENDIX E

Photographs of Surface Water Sampling Locations

SPRING SESSION

Photograph of SW-1 taken in April 2022

Photograph of SW-2 taken in April 2022

Photograph of SW-10 taken in April 2022 (left: downstream, right: upstream)

Photograph of SW-11 taken in April 2022 (left: downstream, right: upstream)

Photograph of SW-12 taken in April 2022

Photograph upstream SW-12 taken in April 2022

Photograph of SW-19 taken in April 2022

Photograph of SW-21 taken in April 2022

Photograph of SW-22 taken in April 2022

Photograph of SW-23 taken in April 2022

Photograph of SW-18 taken in April 2022

Photograph of upstream of SW-26 taken in April 2022

SUMMER SESSION

Photograph of SW-1 taken in August 2022

Photograph of SW-2 taken in August 2022

Photograph of SW-10 taken in August 2022

Photograph downstream of SW-10 taken in August 2022

Photograph of SW-11 taken in August 2022

Photograph downstream of SW-11 taken in August 2022

Photograph of SW-12 taken in August 2022

Photograph of SW-19 taken in August 2022

APPENDIX E
Photographs of Surface Water Sampling Stations and Beaver Activity

Photograph of upstream of SW-19 taken in August 2022

Photograph of SW-21 during the August 2022 monitoring session

APPENDIX E
Photographs of Surface Water Sampling Stations and Beaver Activity

Photograph of SW-22 during the August 2022 monitoring session

Photograph of SW-23 taken in August 2022

Photograph of SW-26 taken in August 2022

Photograph of upriver of SW-26 taken in August 2022

Photograph of SW-18 taken in August 2022

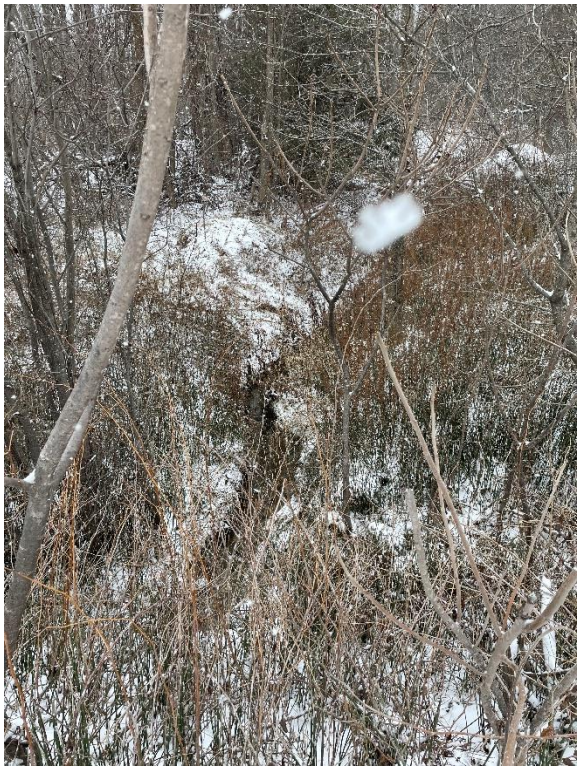
FALL SESSION

Photograph of SW-1 taken in December 2022

Photograph of SW-2 taken in December 2022

Photograph of SW-10 taken in December 2022

Photograph of SW-11 taken in December 2022



Photograph upstream of SW-11 taken in December 2022

Photograph of SW-12 taken in December 2022

Photograph looking upriver from SW-18 taken in December 2022

Photograph of SW-18 taken in December 2022

Photograph of SW-19 taken in December 2022

Photograph upstream of SW-19 taken in December 2022

Photograph of SW-21 taken in December 2022

Photograph of SW-22 taken in December 2022

Photograph of SW-23 taken in December 2022

APPENDIX E
Photographs of Surface Water Sampling Stations and Beaver Activity

Photograph of SW-26 taken in December 2022

Photograph downstream of SW-26 taken in December 2022

APPENDIX F

MECP Correspondence

December 3, 2020 Project No. 19134510

District Manager
Ministry of the Environment, Conservation and Parks
Ottawa District Office
2430 Don Reid Dr, Unit 103
Ottawa, ON
K1H 1E1

ARNPRIOR WASTE DISPOSAL SITE – GROUNDWATER COMPLIANCE CONTINGENCY PLAN

Dear District Manager,

Golder Associates Ltd. (Golder) is submitting this letter on behalf of the Town of Arnprior (Town). The purpose of this letter is to fulfill the requirements of Condition 28.1 of Environmental Compliance Approval (ECA) No. A412603 for the Arnprior Waste Disposal Site. Condition 28.1 states:

> *By no later than June 30, 2020, the Owner shall submit to the District Manager contingency measures to address groundwater compliance at the Site.*

It is noted that a request for pandemic related temporary regulatory relief was submitted to the Ministry of the Environment, Conservation and Parks (MECP) requesting a six month extension to the requirements of Condition 28.1. The request for pandemic related temporary regulatory relief is provided in Attachment A.

An Options Assessment was prepared by Golder to present and compare possible contingency options that the Town could consider to address the groundwater compliance issue identified by the MECP Groundwater Reviewer in March 23, 2018 comments on the 2016 Annual Monitoring Report for the Site. The Options Assessment is provided in Attachment B.

Following a review of the options assessment, the Town's municipal council resolved that the Town would further investigate Option 1 as described in the Options Assessment (Attachment B) as the preferred contingency option to bring the Arnprior Waste Disposal Site back into compliance with respect to groundwater.

As required by Condition 28.2 of ECA No. A412603, an amendment application to the ECA providing details of the contingency plan to be implemented and the proposed deadline for an update to the trigger mechanism shall be submitted within six months of receiving approval of the proposed contingency measure from the District Manager.

Golder Associates Ltd.
1931 Robertson Road, Ottawa, Ontario, K2H 5B7, Canada T: +1 613 592 9600 F: +1 613 592 9601

We trust that this letter and its attachments satisfy the requirements of Condition 28.1 of ECA No. A412603. Should you have any questions, please do not hesitate to contact the undersigned.

Golder Associates Ltd.

Andria Caletti, P.Eng.
Environmental Engineer

Trish Edmond, M.E.Sc., P.Eng.
Principal

ALC/PLE/sg
https://golderassociates.sharepoint.com/sites/119264/project files/5 technical work/mecp submission/19134510-l-awds gw compliance contingency plan.docx

CC: Deanna Nicholson, Town of Arnprior
Thandeka Ponalo, Environmental Officer, MECP

Attachments: Attachment A – Request for Pandemic Related Temporary Regulatory Relief
Attachment B – Options Assessment

ATTACHMENT A

Request for Pandemic Related Temporary Regulatory Relief

Ontario

Ministry of the Environment, Conservation and Parks

Request for Pandemic Related Temporary Regulatory Relief (Alternate Arrangement) for Waste Disposal Sites and Waste Management System

General Information and Instructions

General

Information requested in this form is collected under the authority of the *Environmental Protection Act,* R.S.O. 1990, c. E.19 (EPA) and the *Environmental Bill of Rights*,*1993*, S.O. 1993, c. 28, (EBR) and will be used to evaluate requests for relief regarding environmental compliance approvals (ECA) issued under Part II.1 of the EPA.

This form may **only** be used for requesting temporary relief (alternate arrangements) with the Ministry of the Environment, Conservation and Parks (ministry) for waste disposal site and waste management system ECAs during a pandemic event. If the ministry determines the activities requested are not related to operational activities resulting fom the COVID-19 emergency, the request will be returned.

Questions regarding the preparation or submission of this form or about the ministry's collection of information related to applying for an ECA, contact the Client Services and Permissions Branch by phone at 416-314-8001 or 1-800-461-6290 (toll free) or by e-mail at enviropermissions@ontario.ca.

Instructions

1. Applicants are responsible for ensuring that they complete the appropriate form for their request. Information about the required supporting documentation and technical requirements are available from the Client Services and Permissions Branch and from the local district office. You can find the local district office online at https://www.ontario.ca/environment-and-energy/ministry-environment-district-locator.
2. A complete request consists of:
   - A completed and signed request form
   - All required supporting documents and technical requirements identified in section 5 of this form, ministry guidance and the applications for Environmental Compliance Approvals regulation.
3. Submit a complete electronic copy of this request to enviropermissions@ontario.ca with the subject heading "PANDEMIC RELIEF ECA REQUEST – WASTE"
4. The applicant must also submit a copy of the request to the local ministry district office.

Information collected by the ministry is subject to the *Freedom Information and Protection of Privacy Act*, R.S.O. 1990, c. F.31. If the applicant is of the view that any part of the request is confidential on the grounds that such information constitutes a trade secret or scientific, technical, commercial, financial or labour relations information, please make this known now. Otherwise, the ministry may make the information available to the public without further notice to the applicant. It is an offence under the EPA to provide false or misleading information in this application and/or accompanying documents.

1. Applicant Information

1.1 Applicant Type

☐ Corporation ☐ Individual ☐ Federal Government ☒ Municipal Government
☐ Partnership ☐ Sole Proprietor ☐ Provincial Government ☐ Other _____

1.2 Applicant Name and Business

Applicant Name (legal name of individual or organization as evidenced by legal documents)
Corporation of the Town of Arnprior

Business Name ☒ same as legal name above

Primary North American Industry Classification System (NAICS) Code	Other NAICS Code
91391	

Business Activity Description
Lower Tier Muncipality

1.3 Applicant Physical Address

Unit Number	Street Number	Street Name
	105	Elgin St W

Concession/Rural Route	PO Box

City/Town	Province	Country	Postal Code
Arnprior	ON, Canada		K7S0A8

1.4 Applicant Mailing Address

▬ same as Applicant physical address above

Unit Number	Street Number	Street Name

Concession/Rural Route	PO Box

City/Town	Province	Country	Postal Code

1.5 Applicant Contact Name

Last Name	First Name	Title
Steckly	John	General Manager, Operations

Telephone Number	Mobile Number	Email Address
613-623-4231 ext 1831	613-314-7333	jsteckly@arnprior.ca

2. Technical Contact Information

2.1 Primary Technical Contact

☐ same as Applicant contact name above

Last Name	First Name
Nicholson	Deanna

Title	Company Name
Environmental Engineering Officer	Town of Arnprior

Telephone Number	Mobile Number	Email Address
613-623-4231 ext 1832		dnicholson@arnprior.ca

2.2 Secondary Technical Contact

Last Name	First Name
Caletti	Andria

Title	Company Name
Environmental Engineer	Golder Associates Ltd.

Telephone Number	Mobile Number	Email Address
613-592-9600 ext 3285		Andria_Caletti@golder.com

3. Project Site Address

☐ Mobile ☐ Truck Storage Yard Location ☐ Multi-Site Note: Provide site location(s) in a separate attachment, if necessary

Unit Number	Street Number	Street Name
	658	River Road

Municipality/Unorganized Township	County/District
McNab/Braeside	Renfrew

Concession and/or Rural Route	Ministry District Office (use the online district locator to find your local district office)
	Ottawa

4. Project Information

4.1.a. Project Type – Waste Disposal Site (check all that apply)

☒ Landfill Site ☐ Processing Site ☐ Thermal Treatment Site

☐ Transfer Site ☐ Composting Site

4.1.b. Project Type – Waste Management Systems (check all that apply)

☐ Liquid Industrial Waste and Hazardous Management System ☐ Hauled Sewage (Septage)

☐ Mobile Waste Processing

4.2 Name and Description

Project Name

ECA Condition 28.1 - Contingency Measures to address groundwater compliance.

Rationale for Relief Request - note, if the ministry determines the requested activities are not related to operational activities resulting fom the COVID-19 emergency, the request will be returned.

The Town of Arnprior has been operating under reduced capacity, including the closure of Arnprior Town Hall, since mid March due to Covid-19 restrictions. As such there were significant delays in the initiation and undertaking of this task (preparation of Contingency Measures report) due to Covid-19. The preparation of an Options Assessment report to identify and evaluate the contingency measures available to address groundwater compliance has since been initiated and significant progress has been made to date. However, it has been identified that consultation with affected parties and some additional engineering work is required before the report can be responsibly provided to the Town of Arnprior Council and MECP.

Summary Description of Relief Services - please use the table in section 4.3 of this form to summarize proposed changes to conditions of current approvals (or use the table as a separate attachment)

The Town requests a 6 month extension to the deadline stated in condition 28.1, to submit contingency measures. The current deadline is June 30, 2020. The Town requests a new deadline of December 31, 2020.

4.2 Request Type

☐ New ECA ☒ Amendment to existing ECA

4.3 Existing Approvals and Conditions (if amendment)

Separate list attached? ☐ Yes ☒ No

Current ECAs that may be amended by this request - only complete fields applicable to request

ECA Number	Date of Issuance (yyyy/mm/dd)	Condition No.	Description of Proposed Changes to Current Condition
A412603	2020/03/10	28.1	Extension of deadline to submit Contingency Measures from June 30, 2020 to December 31, 2020.

5. Checklist of Supporting Documentation

5.a. Waste Disposal Sites

For waste disposal sites, please ensure the following documentation is included with your request for relief activities:

- ☐ Proof of legal name
- ☐ List of current ECAs that may be amended
- ☐ Clear description of changes to conditions of current approval(s) [table in 4.3 of request form may be provided as a separate attachment]
- ☐ Concise Design and Operations Report to include the following information:
  - ☐ Clear description of processes (for each site, if multiple sites)
  - ☐ Clear description of relief activities requiring ministry approval
  - ☐ Site plan where waste will be handled, stored and/or processed
  - ☐ Description of mitigation measures to manage the waste (e.g. mandatory cleaning schedules for waste storage areas and equipment, covered leak proof containers to prevent off-site impacts), staff training
- ☐ Contingency plan that will be used to ensure relief activities are managed effectively to minimize adverse effects (e.g. spill, fire, other emergency situations)
- ☐ Complaint response protocols that will be used during temporary period/operation of relief activities

5.b. Waste Management Systems

For waste management systems, please ensure the following documentation is included with your request for relief activities:

- ☐ Proof of legal name
- ☐ List of current ECAs that may be amended
- ☐ List of waste types and classes to be hauled
- ☐ Clear description of changes to conditions of current approval(s) [table in 4.3 of request form may be provided as a separate attachment]
- ☐ Truck storage yard location(s)
- ☐ Letter of consent from land owner (if the applicant is not the owner of the truck storage location)
- ☐ Vehicle insurance
- ☐ Vehicle ownership

Please note: No fees are required in connection with this request.

6. Authorization

6.1 Statement of the Applicant

I am authorized and have legal authority to prepare and submit this request for the subject pandemic relief. I have reviewed the complete request and I have made all inquiries that are necessary to declare to the best of my knowledge, information and belief:

- The activities proposed in this request is considered a pandemic related relief activity.
- The information contained in this request is complete and accurate.
- The technical contact identified in this request has/have been authorized to prepare certain technical material, and act on behalf of the applicant to discuss this request with the ministry and to provide additional information about this request to the ministry on request.
- The information provided to Technical Contact in relation to the request is complete and accurate.

Name of Signing Authority

Last Name	First Name
Steckly	John

Title	Email Address
General Manager, Operations	jsteckly@arnprior.ca

Telephone Number	Mobile Number
613-623-4231 ext 1831	613-314-7333

Signature	Date (yyyy/mm/dd)
	2020/06/15

6.2 Statement of Technical Contacts

I have been authorized by the applicant to prepare the technical materials for the area(s) of responsibility identified in section 5 that are included in this request. I have reviewed those technical materials and I have made all inquiries that are necessary to declare to the best of my knowledge, information and belief:

- The technical materials contained in this request in respect of the area(s) of responsibility identified in section 5 are complete and accurate.
- I have the relevant education and experience necessary to provide this certification.

Name of Technical Contact

Last Name	First Name
Nicholson	Deanna

Title	Email Address
Environmental Engineering Officer	dnicholson@arnprior.ca

Telephone Number	Mobile Number
613-623-4231 ext 1832	

Signature	Date (yyyy/mm/dd)
Deanna Nicholson Digitally signed by Deanna Nicholson Date: 2020.06.15 13:51:52 -04'00'	2020/06/15

ATTACHMENT B

Options Assessment

TECHNICAL MEMORANDUM

DATE December 3, 2020 **Project No.** 19134510

TO Ms. Deanna Nicholson
Town of Arnprior

FROM Andria Caletti, P.Eng. **EMAIL** andria_caletti@golder.com

OPTIONS ASSESSMENT FOR THE TOWN OF ARNPRIOR WASTE DISPOSAL SITE COMPLIANCE ISSUE

1.0 INTRODUCTION

The Corporation of the Town of Arnprior (Town) owns and operates the Arnprior Waste Disposal Site (Site) under Environmental Compliance Approval (ECA) No. A412603. A revision to ECA No. A412603 was issued for the Site on March 10, 2020. As per Condition 28.1 of this ECA, the Town is required to submit contingency measures to address an existing and historic groundwater compliance issue at the Site prior to June 30, 2020. A request for pandemic related temporary regulatory relief was submitted to the MECP requesting a six month extension to this deadline. This memorandum will present and compare possible contingency options that the Town can consider to alleviate or remove entirely the groundwater compliance issue at the Site.

2.0 BACKGROUND

Comments on the 2016 Annual Monitoring Report for the Site dated March 23, 2018 were received from the Ministry of the Environment, Conservation and Parks (MECP) which addressed a non-compliance issue in regard to the Reasonable Use Guideline B-7 (MECP, 1994) at the northern boundary of the Site. Under Guideline B-7, groundwater quality on an adjacent property must not be degraded beyond 50 percent of the difference between background concentrations and established water quality criteria for aesthetic related parameters and 25 percent of the difference between background concentrations and established water quality criteria for health related parameters. The reasonable use performance objectives (RUPO) for the Site are based on the noted calculations using established background water quality and the Ontario Drinking Water Quality Standards (ODWQS). Generally, trigger levels are established for the Site which are based on 75 percent of the RUPO. The trigger concentrations are slightly lower than the RUPO to allow time to take action or implement contingencies if exceedances of the RUPO are anticipated. As identified in the March 23, 2018 comments, the Site is out of compliance with Guideline B-7 due to exceedances of the RUPO at some compliance monitoring wells located within bedrock at the northern Site property boundary. The Site compliance issue had previously been attributed to historical impacts on former Tembec Inc. property now owned by the Town (i.e., the existing contaminant attenuation zone) comingled with possible landfill related impacts, but not solely landfill related impacts

A subsequent meeting was held on June 22, 2018 between the Town, MECP and Golder to discuss the non-compliance issue. At that time, it was recommended by MECP that the Town should consider purchasing the downgradient groundwater rights to alleviate and remove the groundwater compliance issue. As an alternative to purchasing the downgradient groundwater rights, the establishment of a new background well was also discussed to help better understand the potential impact from historic activity on the former Tembec Inc. property versus the landfill and possibly substantively identify the former Tembec Inc. property as the source of (or significant

Golder Associates Ltd.
1931 Robertson Road, Ottawa, Ontario, K2H 5B7, Canada T: +1 613 592 9600 F: +1 613 592 9601

contributor to) the groundwater compliance issue. Two background wells (BR-18S and BR18-D) were subsequently drilled in an area expected to be upgradient of the landfill and in an area believed to be impacted by historical activities to help discern the differences between landfill impacts and historical impacts that could be contributing to groundwater quality at the Site boundary. Groundwater levels were obtained at the new background monitoring wells from October 2018 to August 2019, and sampling and analysis of groundwater from the new wells also occurred during this time period.

As discussed in the technical memorandum by Golder dated September 18, 2019, it was determined that using BR-18 as a background well was not effective in reducing or eliminating the Site compliance issue as it did not provide data that excluded the landfill as a potential source of the groundwater compliance issue. Golder subsequently discussed with the Town possible contingency options available to alleviate or remove the groundwater compliance issue through the undertaking of an options assessment. Further to a phone call held between the Town, Golder, and the MECP (District Office and Technical Support) on November 27, 2019, the MECP expressed their concurrence with the proposed undertaking of an options assessment. On March 10, 2020, ECA No. A412603 was re-issued and included Condition 28.1 requiring the Town to submit contingency measures to address the groundwater compliance issue at the Site to the MECP District Manager. The purpose of this options assessment is to provide a review of possible contingency measures to alleviate or remove the Site groundwater non-compliance for consideration by the Town in determining the contingency measures to be presented to the MECP District Manager per Condition 28.1.

3.0 POSSIBLE CONTINGENCY MEASURES TO ALLEVIATE OR REMOVE THE GROUNDWATER COMPLIANCE ISSUE

The possible contingency measures identified below provide a wide range of possible options to address the groundwater compliance issue at the Site. Some contingency measures have been removed from further detailed consideration based on general ability of the contingency measure to alleviate the compliance issue and/or the identification of significant concerns with the requirements for implementation. Contingency measures that are considered more likely to alleviate or remove the groundwater compliance issue and that could reasonably be implemented have been carried forward, developed with some additional details and assessed using a comparison matrix presented in Section 4.0.

The proposed contingency measures that have been considered include:

1) Extend the contaminant attenuation zone (through purchase of downgradient property and/or groundwater rights)
2) Pump and treat leachate-impacted groundwater
3) Early closure of the Site
4) Progressive installation of low permeability cover
5) Dig and dump waste and/or soil
6) Engineering of the base of the landfill for leachate collection
7) Tree system
8) Leachate recirculation
9) Construction of a physical barrier

3.1 Extend the Contaminant Attenuation Zone

Guideline B-7 (MECP, 1994) describes that the purpose of a contaminant attenuation zone (CAZ) is to allow the limited impairment of use of off-site property by means of easements or other methods without imposing the severe restrictions on land use which apply to the disposal site. In the CAZ, it is intended that contaminants will be naturally attenuated to levels compatible with the reasonable use of the adjacent property.

The Site already has four owned CAZ areas (Area A, B, C and D) comprising an area of approximately 31 hectares. The location of the CAZ areas are shown in Figure 1. The contingency option being considered could involve the purchasing of downgradient property or groundwater rights on the lands (or some portion of them) located to the north, east and northeast between the Site and the Ottawa River, presently privately owned. As Golder is aware that this land may have some potential for re-development it is suggested that purchasing the groundwater rights on the lands, by way of a groundwater easement, may be more affordable and palatable to the current owner than outright property purchase. Purchasing the groundwater rights allows the land to continue to be used for other purposes and does not fully sterilize the land. By purchasing the rights, the use of groundwater would be restricted for present and future property owners between the Site and the Ottawa River. By removing any potential for downgradient groundwater users, the Site would no longer be required to assess groundwater compliance based on impacts to groundwater at the current property boundary (i.e., groundwater quality at the point where it discharges off of the Site). Site compliance would instead be assessed in surface water in the Ottawa River, as agreed by the MECP during the June 22, 2018 meeting. This option may be costly depending on the development value of the land.

Groundwater quality on the privately owned downgradient property and impacts from historic activity on that property are not known to the Town, however it is known that a lumber mill and yard and associated activities was historically operated on the property.

Extending the CAZ via purchase of the groundwater rights was originally suggested by the MECP during early discussions about the groundwater compliance issue. This option will completely remove the groundwater compliance issue at the Site, and therefore has been carried forward to the comparison matrix.

A variation on this contingency option involves the initiation of a legal agreement with the current property owner that would give the Town the first right of refusal to purchase the groundwater rights in the event that the property were to be put up for sale, this could be considered as an alternative to immediately purchasing the downgradient land or groundwater rights. It is envisioned that compensation to the land owner would be required to secure this agreement. This variation on the option is discussed further in Section 4.1.

3.2 Pump and Treat Leachate-impacted Groundwater

Purge wells are a relatively common method to remove impacted water from the ground before it leaves a site and then subsequently treat the impacted water. Purge wells are most commonly used in locations where the impact to groundwater is in the overburden soils and can be more easily captured and controlled. Purge wells in bedrock, such as the rock at the Arnprior Landfill Site, are less favourable as fractures in the rock control groundwater flow and there is less certainty that the location (distal and depth) of individual purge wells are targeting the best location for groundwater capture. Further, to appropriately design a purge well system several test wells would need to be installed to identify the expected groundwater capture area and thus understand the number and spacing of wells required. To complete this options assessment Golder has relied upon existing Site information to conceptually project the requirements of a purge well system, noting that there is a fair amount of uncertainty in the projection unless or until test wells are completed. This contingency option is expected to

involve the installation of a series of purge wells (approximately 2 to 11 wells) to remove leachate-impacted groundwater for treatment. The purge wells would be installed within the existing CAZ in a configuration to capture the extent of the landfill leachate plume in the bedrock groundwater. It is conceived that this would consist of purge wells installed near the northern edge of the landfill (i.e., near to the source of contamination) and not at the property boundary (i.e., the compliance location) so as to reduce the amount of groundwater intercepted by the well from the off-Site privately owned downgradient property and/or the Ottawa River. It is acknowledged that potential impacts to the groundwater from historic activities not related to the landfill on the former Tembec Inc. property (now the existing CAZ owned by the Town) could also be collected by the purge well system.

Leachate-impacted groundwater that is pumped could be treated on-site or off-site. On-site treatment would require the development of a treatment facility and groundwater would need to be treated such that it could be released to the natural environment. It is Golder's experience that the level of treatment to achieve the required natural environment discharge quality can often be hard to achieve and expensive in on-site treatment facilities. Alternatively, the extracted leachate-impacted groundwater can be collected in a holding pond or tank, and transported off-site to a wastewater treatment facility for disposal. It is Golder's experience that this is typically more affordable than on-Site treatment noting that pre-treatment of impacted groundwater may be required to be accepted at the wastewater treatment plant. Also, the management of leachate-impacted groundwater may require a Municipal Class Environmental Assessment study.

This option may take several years before improvements in groundwater quality are observed at the property boundary that would relieve the groundwater compliance issue. As noted above, purge wells in bedrock may not alleviate the groundwater compliance issue at the property boundary if leachate-impacted groundwater is not fully captured due to fracture flow.

Further, this option at the Arnprior Landfill Site is complicated in that the off-Site groundwater on the privately owned downgradient property may also be impacted by historic activities. It is expected that the zone of influence of the purge well system will pull some groundwater from this property and the current groundwater quality on the neighbouring property is not presently known.

Costs associated with this contingency option include engineering design of the purge well system and possibly treatment or pre-treatment, capital installation costs of the purge wells, possibly capital costs of on-site treatment construction or holding tank construction and likely a Municipal Class Environmental Assessment for evaluation of options to manage groundwater impacted by leachate. Operational costs include ongoing pumping and treatment or transport for off-site treatment of groundwater. Ongoing pumping and treatment of impacted groundwater would be an operational cost for the contaminating lifespan of the landfill, which would conceivably be the current remaining capacity of the site (24 years) and an additional 25 to 50 years post-closure of the Site. Note that the contaminating lifespan is the time at which engineering support is no longer required and the leachate-impacted groundwater would not need to be pumped and could be left in the bedrock and not cause a groundwater compliance issue.

This option has been carried forward to the comparison matrix as it represents a feasible option with some potential for success to alleviate the groundwater compliance issue.

3.3 Early Closure of the Site

This contingency would consider the early closure of the Site. No additional waste would be accepted for landfilling at the Site, and closure would include the installation of either a permeable (soil) or low permeability (compacted clay, geosynthetic clay liner (GCL) or geomembrane) final cover over the landfill. Early site closure would require the preparation of a Closure Plan as required by Condition 29 in the ECA.

Capital costs would include engineering services for preparation of the Closure Plan and design of the final cover and construction costs for the final cover system estimated at several hundreds of thousands of dollars. Operational costs for the landfill would be significantly lower, reduced to the cost to continuing groundwater and surface water monitoring and occasional inspection and possible maintenance of the final cover system. Groundwater and surface water monitoring would likely be required for 20 to 50 years post closure based on preliminary contaminating lifespan estimates. The Town would need to find an alternate means of managing the waste generated by the Town that is received at the Site and an alternate waste management site will charge a tipping fee for disposal of the Town's waste.

This contingency option does not actively address the existing groundwater compliance issue. Based on Golder's experience, this is a long-term strategy that would take years, if not decades, before an improvement to groundwater quality at the property boundary would be observed. Early closure of the Site is, however, technically feasible to undertake and long-term could be a contingency measure acceptable to the MECP, or could be combined with a more immediate solution to achieve groundwater compliance if the downgradient lands are considered for groundwater use in the future. Therefore, this option has been carried forward to the comparison matrix.

3.4 Progressive Installation of Low Permeability Cover

This contingency option involves the progressive installation of a low permeability final cover as described in Section 3.3, however would not include closing the Site early; the final cover would be installed progressively over areas of the landfill that have reached capacity. As landfilling activities are progressed, the low permeability cover will be installed in phases as designated areas reach final approved elevations. It is noted that there is currently one small area located at the eastern edge of the landfill footprint at the Site that has reached capacity.

Capital costs would be similar to those described in Section 3.3, however the Town could continue to manage residential waste through disposal at the Site.

As with the approach described in Section 3.3, this contingency option does not actively address the existing groundwater compliance issue. This is a long-term strategy that would likely take decades before an improvement to groundwater quality at the property boundary would be observed. Therefore, this option has not been carried forward to the comparison matrix.

3.5 Dig and Dump Impacted Waste and/or Soil

The term "dig and dump" is an industry term for remediation projects whereby impacted material is dug up, removed and/or treated and dumped back in the same location following treatment or dumped at a new location if not treated. Generally speaking, if the material is not treated the dug up material is "dumped" at a landfill. This contingency option would involve the excavation of impacted soil from the existing CAZ and/or waste from the landfill, removal from the Site and disposal of the material at another licenced facility expected to be a landfill. Removal of waste as described would remove the source of leachate impacting groundwater but would not immediately affect groundwater quality at the property boundary (though improvements could be expected more

quickly than with an impermeable final cover and/or early closure of the Site, as the source of the leachate would be completely eliminated). However realistically this makes little sense to dig up a landfill to take the material to another landfill. The excavation and hauling of waste from the landfill would be expected to produce significant odours for the duration of the activity that could impact nearby residents and would require careful operational practices to mitigate. Other potential operational challenges with excavation of waste include issues with vermin due to exposed waste, and management of perched leachate if encountered. The Arnprior Waste Disposal Site is an older landfill and disposed materials, regulations as well as public perception have changed over time. All material unearthed would need to be disposed of appropriately in accordance with current regulations.

Removal of soil above the bedrock in the CAZ near the north property boundary could provide some improvement to groundwater quality, however would be a temporary solution without also removing the waste, since waste would continue to generate leachate that would over a longer period of time re-contaminate the groundwater. Further, the groundwater compliance issue has been observed in the bedrock at the property boundary; removal of the overburden soil at the property boundary is thus not expected to alleviate the groundwater compliance issue.

The capital costs associated with this contingency option include construction costs to excavate the waste, costs associated with hauling off-site, and the tipping fees at the licenced waste disposal facility. Tipping fees may be expensive. The Town would need to find an alternate means of managing the waste generated by the Town that is received at the Site. Although this option could alleviate compliance concerns more quickly than the options discussed in Section 3.3 and 3.4, it may still need to be combined with a more immediate option to achieve groundwater compliance if the downgradient lands are considered for groundwater use in the future. Due to the expense and logistical challenges associated, this contingency measure has not been included in the comparison matrix.

3.6 Engineering of the Base of the Landfill for Leachate Collection

The existing landfill at the Site is a natural attenuation landfill, meaning that it does not have any engineered features including engineered low permeability base or liner for leachate containment, nor a leachate collection system to remove leachate generated by the waste. With a natural attenuation landfill leachate is released to groundwater to be attenuated by natural process and/or dilution such that the RUPO is achieved prior to leachate-impacted groundwater reaching the property boundary. The Town could consider excavating the existing waste and building an engineered liner and leachate collection system at the base of the landfill. Leachate generated by future waste or re-landfilled existing waste would be captured by the leachate collection system rather than released to the groundwater.

This option would require systematic excavation of existing waste from the landfill in phases, and would involve similar logistical challenges such as odour, vermin, perched leachate management and disposal of waste materials as discussed in Section 3.5. Typically, the addition of engineering of landfill cells is an undertaking that is more easily adopted at landfill sites with undeveloped landfill cells where the excavated historic waste can be re-landfilled in a new, undeveloped landfill cell to allow the addition of a liner and leachate collection system. The Site does not have any undeveloped cells that could accept the excavated waste, and so a lateral area for waste processing would require approval from the MECP which would be challenging to get approved, if even possible. Alternatively some portion of landfilled waste from the Site would need to be hauled off-site to a licensed waste disposal facility to create the undeveloped cell area that could then be engineered with a liner and leachate collection system and start to move waste around in the landfill. Constraints with sending waste to another landfill are similar to the option discussed in Section 3.5.

Once the engineered liner and leachate collection system is installed, leachate that is generated from the re-landfilling of existing waste or landfilling of new waste would be collected through the leachate collection system. From there, the leachate would need to be treated prior to discharge to the natural environment. Treatment could occur on-site through the construction of an on-site treatment facility, or the leachate could be collected, hauled, and disposed at a wastewater treatment facility. Leachate treatment and collection would occur at minimum for the contaminating lifespan of the Site meaning until such time as the leachate could be released to the groundwater without exceeding the RUPO which is estimated to be 25 to 50 years post closure in this case. Considerations regarding on-Site and off-Site leachate treatment are presented in Section 3.2.

The capital costs associated with this contingency option include an engineering design for the liner and leachate collection system, engineering design of leachate treatment, pre-treatment and/or holding tanks or ponds, an ECA amendment, possibly a municipal class Environmental Assessment on leachate-impacted groundwater treatment and specialized construction of the designed components including the excavation of landfilled waste. There would be costs for hauling and disposal of some of the excavated waste at a licenced waste disposal facility to create the undeveloped landfill cell. Tipping fees may be expensive. Ongoing operation and maintenance costs associated with collection and treatment of leachate would be an operational cost for the contaminating lifespan of the landfill, which would be decades post-closure of the Site.

Although this option could alleviate compliance concerns more quickly than the options discussed in Section 3.3 and 3.4, it may still need to be combined with a more immediate option to achieve groundwater compliance if the downgradient lands are considered for groundwater use in the future. Due to logistical challenges associated with the engineering and the excessive anticipated capital and operational costs, this contingency measure has not been included in the comparison matrix.

3.7 Tree System

A passive installation of trees could be considered at the Site boundary where the groundwater compliance issue exists whereby a series of trees would be planted to uptake leachate-impacted groundwater. It is noted that such a planting would require appropriate soil to support tree growth. Sufficient land would need to be available to plant enough trees to accept the volume of groundwater requiring treatment. This system would not operate during the winter dormant period of the vegetation, and impacted groundwater would need to be otherwise managed. It is anticipated that this method would only be able to treat impacted groundwater in the overburden, leaving groundwater in the bedrock continuing to be impacted. Therefore, this contingency is not carried forward to the comparison matrix.

3.8 Leachate Recirculation

This contingency option involves the collection of leachate from the landfill or leachate-impacted groundwater from the downgradient groundwater and placing it within (typically at the top of) the landfill. This process increases the rate of waste decomposition thereby reducing the contaminating lifespan of the Site. There are many issues associated with leachate recirculation including odour issues and infrastructure and operational issues. This action would require the design and installation of a collection system for leachate, with the same issues associated with engineering and installation of a landfill liner and leachate collection system as outlined in Section 3.6 or alternatively collection of leachate-impacted groundwater as outlined in Section 3.2. Leachate recirculation has been undertaken in the Province of Ontario historically, but is currently not looked upon favorably by the MECP and would likely not be approved; Golder is not aware that this practice is currently being approved in the Province at this time other than on an emergency basis. Presently any approval by the MECP for leachate recirculation seems to be for short term, site specific situations and not longer term contingency or operational options. This option has not been carried forward to the comparison matrix.

3.9 Construction of a Physical Barrier

This contingency option would involve the construction of a physical barrier to minimize the migration of leachate-impacted groundwater. Groundwater flow at the Site is interpreted to be towards the Ottawa River, to the north, northeast and east. Thus, a physical barrier would need to be installed to restrict the groundwater movement in these directions. Physical barriers are typically installed in overburden soil often using geosynthetic clay liners. In bedrock, the only way to produce a physical barrier is to attempt to grout the fractures within the bedrock to lower the permeability of the bedrock. Given the highly fractured nature of the bedrock at the Arnprior Landfill Site and the proximity to the Ottawa River, creating a physical barrier in bedrock is not considered feasible. As the groundwater compliance issue is in the bedrock, a physical barrier is not a contingency option at this Site and this option is not carried forward to the comparison matrix.

3.10 Other Considerations

3.10.1 Combination of Options

Many of the options presented above could be implemented in combination although not all are considered viable when combined. For example, the Town could consider progressively placing low permeability cover while also implementing a purge well system to achieve groundwater compliance more efficiently. Trees could also be planted as a complementary measure. Should the Town wish to consider a combination of the above options, this can be further evaluated, however for the purpose of this assessment only those options considered individually viable and reasonably feasible are carried forward to the comparison matrix.

3.10.2 Change to Floodplain Elevation

Historic high floods from the Ottawa River were experienced in the spring of 2017 and 2019. While it is unknown what affect flooding had on the privately owned lands downgradient of the Site located along the Ottawa River, it is possible that continued flood occurrences could result in development restrictions on these lands (if the Township of McNab/Braeside were to raise the elevation of the floodplain) or could make development of these lands less desirable. It is understood that the Township of McNab/Braeside is not presently intending to raise the elevation of the flood plain. Should development ever be restricted due to a change in the elevation of the flood plain, it is recommended that the MECP be consulted to determine if this negates the need to implement a contingency measure as this could inherently restrict the ability to use the groundwater on the downgradient privately owned lands.

3.10.3 Alleviate or Remove Groundwater Compliance Issue

It is noted that purchasing downgradient groundwater rights will not improve the groundwater quality at the property boundary. However, only an acquisition of groundwater rights or purchase of property adjacent to the landfill will completely resolve and remove the existing groundwater compliance issue at the current property boundary. None of the other options presented remove the groundwater compliance issue but alleviate it.

4.0 COMPARISON OF OPTIONS

The three contingency options that have been carried forward for further description and to be evaluated in the comparison matrix include the purchase of downgradient groundwater rights or agreement to do so, the installation of purge wells for the collection and treatment of leachate-impacted groundwater, and the early closure of the Site as discussed in sections 3.1, 3.2 and 3.3, respectively. A more detailed assessment of these options is provided below. For each option an estimate of the capital costs has been provided where possible noting that in some instances there is just not sufficient information to provide this information. These cost estimates should not be used for budgeting purposes, but rather as “ballpark” estimates to compare financial implications of each option presented in this memorandum. Some thoughts on operation costs have also been identified again noting that in many instances there is insufficient information to provide this information.

On August 27, 2020, a call between the Town, Golder and the MECP (District Office and Groundwater Technical Reviewers) was held to discuss the three options. The purpose of this call was to solicit feedback from the MECP on the three potential contingency options so that initial comments from the MECP could be considered as part of this options assessment. General comments on the three options as discussed during the August 27, 2020 call are provided below.

4.1 Extend the Contaminant Attenuation Zone via Groundwater Easement

There is currently CAZ owned by the Town that is located downgradient of the landfill Site as shown on Figure 1, but not beyond Usborne Street. Purchasing the downgradient groundwater rights would extend the current CAZ areas north, northeast and east, between the current property boundary at Usborne Street and the Ottawa River. The land between Usborne Street and the Ottawa River is privately owned. As discussed in Section 3.1, by removing any potential for downgradient groundwater users, the Site would no longer be required to assess groundwater compliance based on impacts to groundwater at the property boundary (i.e., groundwater quality at the point where it discharges off of the Site) per MECP Guideline B-7. This contingency option would immediately resolve the groundwater compliance issue upon acquisition of the groundwater rights. The MECP has said that Site compliance would be assessed in the Ottawa River for this type of contingency; due to the large volume of the Ottawa River, it is generally considered that contaminant loading to the Ottawa River from the landfill Site would have minimal impact and future contingency measures would likely not be required. Removal of the requirement for groundwater compliance may result in a reduction to the groundwater monitoring program for the Site, and likely a slight increase in surface water monitoring requirements.

There is a large portion of land that is privately owned that fronts the Ottawa River, and the property has previously been the subject of interest for development opportunities in the last decade. Due to the desirability of this waterfront land, downgradient groundwater rights could be costly. Restricting development opportunities through acquisition of the groundwater rights (the property is not municipally serviced by the Township of McNab/Braeside) could become a political issue or an issue of public interest for the Town and the Township of McNab/Braeside. It is noted that parts of the privately owned property are interpreted to be hydrogeologically cross-gradient from the landfill, and groundwater in these areas are therefore considered to be unlikely to have been impacted by landfill leachate. It is considered that the groundwater rights on the entirety of the privately owned property may not need to be acquired in order to address the groundwater compliance issue. Thus, severing of the land such that groundwater rights can be acquired only in the areas considered to be potentially impacted by landfill leachate may be favorable to the Town and to the property owner.

The industrial activities historically carried out on the privately owned downgradient property included a lumber mill and lumber storage. Groundwater quality on the privately owned downgradient property and potential impacts from historic activity on this property are not known to the Town. It is possible that by purchasing the downgradient groundwater rights on the privately owned downgradient property, the Town of Arnprior may assume responsibility for impacts to groundwater resulting from historic contamination not related to the landfill; this could affect Site compliance if groundwater discharging to the Ottawa River is significantly impacted although again the large volume of the Ottawa River would be expected to mitigate this groundwater discharge. Monitoring of groundwater or surface water on the privately owned downgradient property prior to purchase of a groundwater easement has been discussed historically so that the Town could understand what they are purchasing and ensure it is a viable solution. Historically the Town has been told that monitoring could be conducted but results would need to remain private. Given the Town is a Municipal entity information collected by the Town, or by its consultants on behalf of the Town can always be requested under the Freedom of Information Act. This complicates understanding exactly what the Town would be purchasing.

This contingency option and the concerns noted above were generally discussed with the MECP during the call on August 27, 2020. It was generally acknowledged that this contingency option would alleviate groundwater compliance issues as described.

During the call, the Town and Golder inquired about a variation on the option to purchase the downgradient property or groundwater easement, specifically if a legal agreement with the current property owner of the downgradient land giving the Town first right of refusal to purchase the groundwater rights could be considered as an alternative to immediately purchasing the downgradient groundwater rights. It is envisioned that compensation to secure this type of agreement would be required. The MECP expressed that while a first right of refusal type agreement has not been used for this purpose before to their knowledge, this would meet the same intent as purchasing groundwater rights of limiting the use of downgradient groundwater. It was acknowledged by all that this could result in the required future purchase of the groundwater rights by the Town, however would delay the requirement to do so and is reasonable given that there are currently no groundwater users downgradient from the Site. The MECP agreed to discuss internally and advise the Town on whether such an agreement in principle would be acceptable, noting that there are details that would have to be considered on implementation. Subsequently, in an email dated October 6, 2020, the MECP Environmental Officer for the Site indicated that a review of this variation on the contingency option concluded that obtaining a right of first refusal to purchase the groundwater rights may comply with the requirements in Guideline B-7. They noted that before this were to be approved, the MECP will require a detailed proposal which includes the legal instruments to be used to obtain these rights so that they could review the legality of the option and provide a definite response.

At this time the cost of purchasing the downgradient groundwater rights on the downgradient property are unknown. The cost to secure a first right of refusal on the purchase of groundwater rights is also unknown.

4.2 Pump and Treat Leachate-Impacted Groundwater

As discussed in Section 3.2, this contingency option would involve the installation of purge wells to extract leachate-impacted groundwater for treatment. The goal of the purge well system would be to capture leachate-impacted groundwater from the fractured bedrock, creating an inward gradient towards the wells, thereby controlling and reducing the migration of leachate-impacted groundwater to the property boundary and beyond off the CAZ. Extracted leachate-impacted groundwater would be treated either on-site or off-site.

The option to collect and treat impacted groundwater to lower concentrations of parameters of concern at the property boundary was discussed with the MECP during the call held on August 27, 2020. It was discussed that this option would not provide an immediate solution (requiring time to implement (design and construct) and time before a decrease in concentrations at the property boundary would be observed). The MECP indicated that, because there are no existing groundwater users on the downgradient property, the time required to achieve compliance concentrations is less urgent than if there were existing downgradient groundwater users.
As discussed in greater detail in the following sections, Golder also noted to the MECP that the hydrogeological conditions (fractured bedrock and proximity to the Ottawa River) mean that this could not be guaranteed as a solution. Further, Golder noted to the MECP that the option to pump and treat would be a long-term and costly requirement for the Town, and that before this could even be pursued, additional studies would be required to assess the potential effectiveness. It was generally acknowledged that this long-term solution may require further action in the future should downgradient groundwater use be proposed (i.e., purchase of downgradient groundwater rights).

4.2.1 Purge Well Network

The design of this contingency would require a pumping test program with a computer model simulation to design the well arrangement in terms of spacing, radius of influence, and zone of capture and to estimate the volume of leachate-impacted groundwater to be collected. Conceptually, the purge wells would be installed in the upper bedrock, and, if placed near the northern edge of the waste, would have a higher likelihood of capturing leachate-impacted groundwater close to its source before it has migrated (horizontally and vertically) through the fractured bedrock network. Placement of the wells near the edge of the waste would also capture leachate from beneath the waste. Collected leachate-impacted groundwater would be transported to a treatment location, either off-site at a municipal wastewater treatment facility or private facility, or on-site. Treatment options are discussed in Section 4.2.2.

The purge wells should avoid drawing down the groundwater level so much as to draw in surface water from the Ottawa River. The average river elevation measured at the Lac des Chats measurement station upstream of the Site in the Ottawa River is 74.18 metres above sea level between 1950 and 2019 (ORRPB, 2020), about 1.4 metres below the average groundwater elevations at monitoring wells BR-6 and BR-7. The goal of the purge well system would therefore be to draw down the groundwater levels at monitoring wells BR-6 and BR-7 by no more than 1.4 metres. For the purposes of cost estimates for this contingency approach, the purge well system can be conceptualized to be located immediately downgradient of the CP Rail line and aligned parallel to it. The system would be located approximately 230 metres upgradient of monitoring well BR-6, and be distributed along a length of approximately 460 metres, which is the approximate width of the landfill on the northern side. Due to the lack of existing information on the depths and distribution of fracture zones within the bedrock, it has been assumed that a purge well depth of 10 metres will be sufficient to capture leachate-impacted groundwater from the shallow bedrock.

It should be noted that the purge wells are being conceptually designed to not capture water from the Ottawa River as this would be too much water to manage and would make this contingency unreasonable, but there is the possibility that the system may not capture all of the leachate-impacted groundwater either based on this limitation. A test well and computer modelling of results may be able to bring some greater certainty around this option and if what percentage is expected to be captured should positively influence compliance. Fractured flow in the bedrock also causes uncertainty regarding the reliability of this option.

No hydraulic conductivity, aquifer transmissivity or storativity information has been collected from the bedrock at the Site. As mentioned, a more detailed design of this contingency would require a pumping test program with a computer model simulation to design the well arrangement in terms of spacing, radius of influence, and zone of capture and to estimate the volume of leachate-impacted groundwater to be collected. Published geological mapping and borehole records from the Site monitoring wells suggest that dolostone of the Oxford Formation is present within the CAZ. Based on Golder's experience with wells installed in the Oxford Formation at other locations in Eastern Ontario, the transmissivity of this bedrock formation can range from approximately $6x10^{-5}$ m^2/s to $9x10^{-3}$ m^2/s.

This information was used to estimate the potential range in pumping rates required to capture leachate-impacted groundwater with a target amount of no more than 1.4 metres of cumulative drawdown at the evaluation point (monitoring well BR-6). The cumulative drawdown was calculated using the Cooper and Jacob equation using the range of aquifer transmissivity for the Oxford Formation, a storativity of $1x10^{-5}$ (general estimate for bedrock), and an estimated time of 6 months to achieve steady state conditions. Two scenarios were considered, for 2 and 11 equally-spaced purge wells, with the pumping rate varied to achieve no more than 1.4 metres of cumulative drawdown at the evaluation point. The estimated pumping rates required to achieve a drawdown of 1.4 m at the evaluation point (BR-6) under the high and low transmissivity scenarios is provided in Table 1, for a configuration with 2 and 11 wells.

Table 1: Pumping Rate required to achieve 1.4 m drawdown at BR-6

Number of Purge Wells	Purge Well Spacing (m)	High Transmissivity Scenario Cumulative Pumping Rate (L/day)	Low Transmissivity Scenario Cumulative Pumping Rate (L/day)
2	460	1,080,000	12,000
11	46	1,045,000	11,000

These preliminary estimates indicate that as little as two and up to eleven purge wells could be sufficient to reduce the groundwater elevation in the shallow bedrock such that migration of leachate-impacted groundwater off the CAZ should be minimized. Using the maximum estimate of purge wells would result in a smaller individual well pumping rate and more control over the purge well system. The estimated volume of leachate-impacted groundwater to be pumped ranges from 11 m^3/day to 1,080 m^3/day and is highly dependant on the aquifer transmissivity.

Once a purge well system is installed, it may take several years of monitoring to determine the optimum pumping rate to capture enough leachate-impacted groundwater to improve the groundwater quality at the boundary of the CAZ. This action is flexible in terms of adjusting/adding to the system depending on the results of on-going monitoring. The timeline to achieve a measurable impact would be highly dependant on the hydraulic properties of the shallow bedrock at the Site.

Achieving the maximum acceptable drawdown of 1.4 m at BR-6 would have the most significant effect on groundwater quality at the property boundary. This, however, would also likely draw groundwater from off-site to the north on Usborne Street or from the privately owned downgradient property. Not only does this increase the volume of water to be managed, but off-site impacts to groundwater from Usborne Street or from historic industrial activity on the privately owned downgradient property could also be drawn onto the property and into the vicinity of the compliance monitoring wells. There is a risk that this could worsen the groundwater quality at the compliance monitors and also change the quality of groundwater collected by the purge well requiring treatment, however the groundwater quality on the privately owned downgradient property is not currently known to the Town. To mitigate this risk, the Town could consider reducing the pumping rate to limit the potential to draw impacted groundwater from off-site activities onto the property, however this should be expected to result in a longer time period before the groundwater at the property boundary is compliant with Guideline B-7. This would also decrease the volume of water being extracted.

Approval Requirements and Cost

An opinion of probable cost for the capital expenditure to install 2 to 11 purge wells based on an assumed 460 to 46 metre well spacing along the CP Rail line and extending into the upper 10 metres of bedrock with leachate-impacted water collection into one or two 1,300 m^3 storage tank(s), and some piping or forcemain is approximately $200,000 to $450,000 excluding HST, depending on the pumping rate. Tree clearing costs have not been included. The implementation of the purge well system would require a technical amendment to the ECA for the Site, including hydrogeological studies and system design; associated costs are estimated at $130,000 to $250,000. It is noted that the cost for a test system and computer modelling is not included, as it would be a separate step in the process. It is unclear if a Permit to Take Water will be required, but would be determined during pre-consultation with the MECP; associated costs are not included. This estimate assumes that two phase power is available at the Site but if it isn't then a capital cost to get it to the Site would be required.

Costs to operate the purge well system would include power supply to continuously run the purge wells (highly variable depending on the number of purge wells that would be installed), administrative costs (i.e., Town staff to operate the system), system maintenance and repair, especially of the well screens and pumps handling the corrosive leachate-impacted water. The system would be required to operate for the duration of the landfill site life of approximately 24 years and for the contaminating lifespan of the Site, which would be 25 to 50 years after closure, seven days a week, 365 days a year. Storage capacity and/or a backup power supply would be needed in the event of power outages. Golder generally doesn't operate leachate collection systems but assists with troubleshooting, maintenance and compliance. Leachate-impacted water collection and treatment operational costs are discussed in Section 4.2.2.

4.2.2 Treatment Options

Treatment of leachate impacted groundwater is required before it can be discharged to the natural environment. There are two options to consider for treatment: on-Site or off-Site of the Arnprior Waste Disposal Site. Selection of on-Site or off-Site treatment of the leachate-impacted groundwater is expected to require a Municipal Class Environmental Assessment.

Off-Site Treatment

Golder is unaware of local private wastewater treatment facilities that would be close enough to Arnprior for economical use and receipt of the leachate-impacted groundwater. As such, for purposes of this assessment it is assumed that off-Site treatment means at the Town's wastewater treatment facility. It is noted that the total current capacity of the Town's wastewater treatment facility (the Water Pollution Control Centre, ECA No. 8537-7Y6SGZ) is 9,700 m^3 per day noting that the current available capacity of the wastewater treatment facility is reported by the Town staff to be 4,170 m^3 per day (i.e., 43% of the total capacity). The predicted ranges in pumped leachate-impacted groundwater for the purge well system are 11 m^3/day to 1,080 m^3/day, seven days a week, 365 days a year. Presently Golder has contemplated a small amount of holding capacity on the Site but schedule and availability of the Water Pollution Control Centre will need to be evaluated moving forward, i.e., how often is the facility open and available to receive leachate-impacted water. This would dictate how many truckloads would be required a day as well as on-Site storage capacity requirements in tanks. It is noted at the anticipated high transmissivity of the bedrock approximately 1,080 m^3 of leachate-impacted water per day would require treatment (i.e., 11% of the Town's facility's existing capacity). This is a significant proportion of the existing Water Pollution Control Centre capacity and could make this option not as feasible or undesirable as this capacity needs to be reserved for future Town growth.

If the leachate-impacted groundwater will be treated off-Site at the Town's wastewater treatment facility, the impacted groundwater would need to meet the criteria set out in the Town's sewer-use by-law (Town of Arnprior, bylaw No. 6227-13) unless otherwise agreed and permitted. As discussed in Section 4.2.1, if the purge wells are operated such that the maximum acceptable drawdown of 1.4 m at BR-6 is achieved, groundwater from off-Site to the north on Usborne Street or from the privately owned downgradient property may be drawn onto the Site and extracted through the purge wells for treatment, including groundwater that has been impacted by Usborne Street or from historic industrial activity on the privately owned downgradient property. There is a risk that off-site impacts to groundwater could worsen the groundwater quality being extracted through the purge wells for treatment, however the groundwater quality on the privately owned downgradient property is not currently known to the Town.

Historically there have been some parameters within the leachate monitoring wells at the Site that exceed Schedule A Table 1 of the Town's sewer-use by-law criteria on one or more occasion, namely TKN, cadmium, chromium, cobalt, manganese, benzene, 1,3,5-trimethylbenzene and toluene. Since the purge wells are proposed to be located within 100 m downgradient from the edge of the landfill, they will draw groundwater from within a radius of influence that includes the most leachate-impacted groundwater and it is possible that the groundwater quality will exceed the criteria presently or in the future. Should the purged groundwater not meet the criteria for discharge to the Town's wastewater treatment facility, a pre-treatment system could be constructed on-site such that impacted groundwater could be treated to the point of meeting the applicable criteria prior to being accepted at the wastewater treatment facility. The pre-treatment approach would depend on the parameters of concern to meet the wastewater treatment facility. The on-site pre-treatment system would be required to be operated until groundwater quality improves to within the sewer-use by-law criteria. The wastewater treatment facility may implement or request discharge analysis of the leachate-impacted groundwater, pre-treated or not, to

demonstrate it meets the Town's sewer-use by-law requirements. It is conceivable that the wastewater treatment facility could need this analysis for each day or week, therefore possibly needing the holding tank on Site to be larger to enable more controlled, batch discharge.

On-Site Treatment

Alternatively, discharge to a surface water body may be achievable through on-site treatment. A treatment facility would need to be approved through the Ontario Water Resources Act and constructed to treat leachate-impacted groundwater to acceptable criteria set out by the MECP. Acceptance criteria for discharge to the natural environment would be more stringent than the Town's sewer-use by-law criteria and therefore may require a more robust treatment facility compared to pre-treatment for disposal at the wastewater treatment facility; this is again highly dependent on the parameters of concern, and should be expected to operate through the contaminating lifespan of the landfill (i.e., decades after closure). It is Golder's experience that the level of treatment to achieve the required natural environment discharge quality can often be hard to achieve and expensive in on-site treatment facilities. The process of getting MECP approval for this type of system is also arduous. It can be expected that the MECP would request treated leachate-impacted groundwater to be not acutely toxic and meet provincial water quality objectives for the protection of surface water.

A significantly increased water treatment and surface water monitoring program can be expected as a requirement of this option.

Based on Golder's experience with other landfill sites in Ontario we would always recommend treatment at a municipal wastewater treatment facility over construction of an on-Site facility as it has always proven to be a more easily attained approval with lower capital and operation costs. As such on-Site treatment is not further considered in this memo.

Approval Requirements and Cost

It is anticipated that a Municipal Class Environmental Assessment would be required to assess leachate-impacted groundwater treatment options, but that the end result would be treatment off-Site at the Town's Water Pollution Control Centre. The capital cost of the Municipal Class Environmental Assessment has not been provided but is likely small in comparison to other approvals required. Discharging impacted groundwater directly at the Town's wastewater treatment facility would incur hauling fees for the approximate 5 km distance. Generally, tanker trucks can hold 30,000 L that would mean for the range in bedrock aquifer transmissivity that 1 to over 30 trucks would be required a day assuming operation 365 days per year. One could assume at the higher transmissivity it would advisable that the Town purchase their own tanker trucks; these trucks have their own capital and operational cost that has not been included. There could also be fees related to the cost of discharging to the wastewater treatment facility, a cost that could be negotiated internally by the Town. Based on an assumed fee of $1.00 per cubic metre per Schedule B of the Town's sewer-use by-law, the high transmissivity scenario with well spacing of 460 metres, a total of 1,080 m^3 would require treatment each day compared to the 12 m^3 in the low transmissivity scenario. This could cost in the range of $4,380 to $394,200 of direct disposal fees each year. It is noted that exceedances of the sewer-use by-law by certain parameters maybe incur additionally charges, if even allowed. Should the impacted groundwater exceed the requirement for TKN for instance, it has a discharge premium fee of $5.25 per kg.

At present it is unclear what type of pre-treatment could be required but a capital cost for engineering and design would be required. No MECP approvals of on-Site pre-treatment would be required.

There are significant unknowns regarding the development of this contingency and Golder generally doesn't operate leachate collection systems but assists with troubleshooting, maintenance and compliance. Depending on off-Site leachate-impacted groundwater treatment fees and leachate-impacted groundwater volume, Golder would anticipate that annual operational costs for maintenance, some type pre-treatment, staffing, monitoring, transport and off-Site treatment could range from several hundred thousand dollars a year up to a million dollars a year.

4.3 Early Closure of the Site

This contingency would consider the early closure of the Site. No additional waste would be accepted for landfilling at the Site, and closure would include the installation of either a permeable (soil) or low permeability (compacted clay, geosynthetic clay liner (GCL) or geomembrane) final cover over the landfill. Early site closure would require the preparation of a Closure Plan as required by Condition 29 in the ECA.

Using either a permeable or a low permeability cover, the total volume of leachate generated that could impact groundwater downgradient of the Site over time would be reduced by the application of the cover. Ceasing landfilling operations provides less waste and hence less contaminant mass that can generate leachate from the landfill over time. A permeable cover will allow precipitation to infiltrate into the existing waste; leachate will continue to be generated at a similar but slightly lower rate as it currently is. A low permeability cover will significantly reduce the amount of precipitation that infiltrates into the existing waste, thereby reducing the rate of leachate generation rate and the peak concentration in the groundwater produced, but extending the length of time that the groundwater is impacted. This is likely to mean that post-closure monitoring is required for a longer period of time. As part of this assessment, Golder estimated the contaminating lifespan of the Site with early closure and a permeable soil cover using the POLLUTE model to estimate landfill leachate source concentrations. The POLLUTE model results were calibrated to actual site measured data and input parameters of the model were amended to better match existing conditions. The POLLUTE data were compared to the RUPO to evaluate the site potential contaminating lifespan and was found to be 20 to 50 years (noting that there is a general lack of hydrogeological information, as discussed earlier in this Options Assessment, that limits the accuracy of the model). It could generally be stated that the contaminating lifespan of the Site should a low-permeability cover be installed would be longer.

It is important to note that compliant concentrations of parameters of concern in groundwater at the property boundary would likely be observed prior to the end of the contaminating lifespan, however post-closure monitoring will be required to the end of the contaminating lifespan (as is typical of the environmental monitoring requirements for landfill sites in Ontario) even after compliance concentrations at the property boundary are reached. Even if the early closure of the Site results in compliant concentrations of parameters of concern in groundwater at the property boundary before the contaminating lifespan is reached, it is still expected that early closure represents a long term solution to the groundwater compliance issues. This was discussed with the MECP during the call on August 27, 2020. The MECP noted that, as there are no current downgradient groundwater users, the risk is that the downgradient property be developed in the future and groundwater use pursued before the Site becomes compliant with Guideline B-7. It was generally acknowledged that this long-term solution may require further action in the future should downgradient groundwater use be proposed.

In order to pursue early site closure, preparation of a Closure Plan would be required as per Condition 29 of the ECA. Additional capital costs would include engineering costs for the design of the final cover system, and the cost to construct the final cover system. Generally speaking, both the engineering costs and the construction costs would be expected to be higher should a low-permeability final cover be the preferred option.

Implementation of a low-permeability final cover system would also require an amendment to the design and operations report and the ECA. Capital costs are estimated to range from $700,000 to $1,130,000.

The early closure of the Site would significantly decrease operational costs for the Site, which would then be limited to Town staff time to manage the asset, on-going environmental monitoring and reporting, likely continuing but slowly decreasing in its requirements until the end of the contaminating lifespan (estimated at 25 to 50 years), and some maintenance of the final cover system. With early closure, there will be no further revenue generated from the Site.

Early closure of the Site should be expected to incur costs to otherwise manage the waste generated by the Town. The Site presently has about 24 more years of capacity for landfilling waste. The Town would be required to find an alternate means to manage the waste that would have otherwise been landfilled. This could include hauling the waste to a private or a neighbouring municipality's waste management facility (transfer station or landfill). Potential costs associated would include:

- hauling fees for transport of waste
- tipping fees at the destination site
- re-negotiation of the current arrangement for waste collection and hauling (if a private contract)
- consideration of age of fleet of waste collection vehicles utilized by the Town (owned by the Town or contracted) due to increased hauling distance
- establishment of a transfer station to reduce hauling distance (requiring additional capital costs and environmental approval)

4.4 Comparison Matrix

Table 2 provides a comparison of purchasing downgradient groundwater rights, purge wells for leachate-impacted groundwater collection and off-Site treatment at the Town's Water Pollution Control Centre and early site closure. The comparison matrix considers the expected time frame for implementation and site compliance, the likelihood of achieving site compliance, MECP approvability, probable capital costs, operation and maintenance considerations and costs, and other considerations.

Table 2: Comparison Matrix

Contingency Option	Expected Timeframe	Likelihood of Achieving Site Compliance	Approvability	Probable Capital Costs	Operation and Maintenance Costs	Other Considerations
Option 1: Extend the Contaminant Attenuation Zone via Groundwater Easement	Process to acquire rights could take 2 to 5 years. Will immediately achieve groundwater compliance if groundwater easement purchased. Expected timeframe would be similar for pursuing a legal agreement with the downgradient property owner giving the Town first right of refusal to purchase the land/groundwater rights.	Immediate resolution of groundwater compliance issues if groundwater rights purchased through elimination of potential for downgradient groundwater users. Site compliance would transition to assessing surface water quality within the Ottawa River. Pursuing a legal agreement with the downgradient property owner for first right of refusal to purchase the land/groundwater rights controls the compliance issues potentially to the satisfaction of the MECP.	Approvability of a groundwater easement purchase is relatively simple. Will require an administrative ECA amendment. A legal agreement giving the Town first right of refusal to purchase the land/groundwater rights would require a detailed proposal to the MECP which includes the legal instruments to be used to obtain these rights so that they could review the legality of the option and provide a definite response	Cost to purchase groundwater rights, including legal fees: is presently unknown. If the Town pursues a legal agreement with the owner giving the Town first right of refusal to purchase the land/groundwater rights, these costs would not be incurred immediately but could possibly be expected in the near to long term. Some sort of compensation to secure this agreement is expected and it could be a capital or annual cost. Legal fees would be incurred twice. Cost to conduct an investigation (i.e., drilling, sampling and testing) of groundwater quality to support decision to purchase groundwater easement.	Minimal annual costs for a groundwater easement purchase. Will require some administrative effort and negligible impact to monitoring costs. Pursuit of a legal agreement with the downgradient property owner giving the Town first right of refusal to purchase the land/groundwater rights may be more complicated at the onset and involve ongoing discussion with the downgradient property owner likely including a capital or annual cost.	Acquiring downgradient groundwater rights on waterfront property could be contentious within the communities of Arnprior and McNab/Braeside. Possibility the Town could become responsible for historical groundwater contamination from activities un-related to the landfill. Reduction in annual groundwater monitoring program may be possible as Site would transition to surface water-based site compliance in the Ottawa River. Some additional surface water monitoring likely to be required. While pursuit of a legal agreement with the downgradient property owner giving the Town first right of refusal to purchase the land/groundwater rights delays the capital costs associated with this option, it should only be considered a delay to that capital expenditure at this time.
Option 2: Pump and Treat Leachate-Impacted Groundwater with Treatment at the Water Pollution Control Centre	Process to design, permit and construct system will take 2-3 years. Will take 2-10 years to possibly achieve groundwater Site compliance; the MECP indicated that achieving compliance is not immediately urgent provided that the downgradient groundwater remains unused.	Volume of water required to be treated may be too high to be feasible for the Water Pollution Control Centre and will use up capacity otherwise available for Town growth. Continual optimization of system would be required to achieve and maintain compliance. Fractured bedrock groundwater flow and/or desire to not collect water from the Ottawa River may make this option technically unfeasible such that compliance certainty is reduced. Re-direction of groundwater south toward purge well system could result in off-site groundwater contamination impacting compliance at the property boundary.	Will require technical ECA amendment. Technical information to support the ECA amendment would include hydrogeological studies and purge well system design. May require a Municipal Class EA including supporting technical information and system design details detailing the selection of treatment at the Water Pollution Control Centre. May require a Permit to Take Water.	ECA amendment, including hydrogeological studies and purge well system design: $130K - $250K Install purge wells: $200K - $450K Pre-treatment system engineering design and construction: cost not developed Possible purchase of tanker trucks: cost not developed Municipal Class EA and Permit to Take Water: cost not developed Two phase power assumed to be available at the Site: cost not included	Depending on off-Site leachate treatment fees and leachate-impacted groundwater volume, the annual operational costs for maintenance, some type of pre-treatment, staffing, monitoring, transport and off-Site treatment for the duration of the Site operation (24 years) and for the contaminating lifespan of the landfill (a minimum of 20 to 50 years post closure) in 2020 dollars: $100K -$1,000K	Re-direction of groundwater south toward purge well system could result in off-site groundwater contamination un-related to the landfill being extracted for treatment (quality unknown). If use of the groundwater on the downgradient property is pursued by the current or a future owner before this system improves groundwater quality to meet compliance requirements, the Town may be required to quickly implement option 1.

Contingency Option	Expected Timeframe	Likelihood of Achieving Site Compliance	Approvability	Probable Capital Costs	Operation and Maintenance Costs	Other Considerations
Option 3: Early Closure of the Site	Process to design, permit and construct system will take 2-3 years. Compliance concentrations would not be reached at the property boundary potentially for decades; the MECP indicated that achieving compliance is not immediately urgent provided that the downgradient groundwater remains unused.	A long-term solution that will alleviate compliance concerns over the very long term (decades).	Relatively simple. Early site closure would require the preparation of a Closure Plan as required by Condition 29 in the ECA. Implementation of a low-permeability final cover system would require an amendment to the design and operations report and the ECA.	Engineering services for preparation of the Closure Plan and design of the final cover: $100K - $130K (more for a low-permeability cover) Construction costs for the final cover system: $600K - $1,000K (more for a low-permeability cover)	Minimal. Will require some administrative effort and ongoing monitoring costs to end of contaminating lifespan (20 to 50 years, longer for a low permeability cover). Some maintenance of final cover system may also be required. Operational costs associated with the Site will decrease significantly if not entirely upon closure and capping. The Town would need to find an alternate means of managing the waste generated by the Town that is received at the Site.	The Town would lose in any revenue stream associated with landfill. If use of the groundwater on the downgradient property is pursued by the current or a future owner before this system improves groundwater quality to meet compliance requirements, the Town may be required to quickly implement option 1. Potential additional costs associated with changes to requirements for hauling waste or establishment of a transfer station.

5.0 DISCUSSION

Based on the above comparison matrix, a list of the advantages and disadvantages for pursuing each option are listed below in Table 3.

Table 3: Advantages and Disadvantages of Contingency Options

Contingency Option	Advantages	Disadvantages
Extend the Contaminant Attenuation Zone via Groundwater Easement	■ Groundwater easement immediately resolves groundwater Site compliance ■ Possible reduction in annual groundwater monitoring program as Site would transition to surface water compliance ■ Simple MECP approval process (slightly more complex if pursuing a legal agreement with the downgradient property owner giving the Town first right of refusal to purchase the land/groundwater rights)	■ Expensive up-front costs (immediate or in future) ■ Permanently restricting groundwater use on waterfront property ■ Possibility this is a political and/or contentious undertaking from public's perspective ■ Possibility of acquiring responsibility for historic contamination on downgradient property (currently unknown) ■ No change to groundwater quality
Pump and Treat Leachate-impacted Groundwater with Treatment at the Water Pollution Control Centre	■ Potentially lower initial costs compared to purchase of groundwater rights ■ Positive impact on groundwater quality ■ Legally, development opportunities requiring groundwater utilization may be available on the downgradient privately owned property (depending on existing groundwater quality and impacts from other historic activity)	■ Achieving groundwater compliance is not guaranteed (may have to resort to extending the CAZ in the longer term) ■ Expensive long-term costs, ongoing operation, maintenance and monitoring of the system for contaminating lifespan of the landfill (i.e., after closure of the landfill) ■ More sophisticated landfill staffing will be required to operate and maintain the purge wells and any pre-treatment system ■ Will require more complex MECP approvals; possibly a Municipal Class EA, ECA amendment and possibly a Permit to Take Water. ■ Possibility of extracting/treating off-site groundwater contaminated by activities other than the landfill. ■ May have to resort to extending the CAZ in the longer term if the use of downgradient groundwater is pursued prior to achieving compliance at the site boundary

Contingency Option	Advantages	Disadvantages
Early Closure of the Site	■ Potentially lower initial costs compared to purchase of groundwater rights. ■ Effectively eliminates costs associated with landfill operation (work for Town staff and ongoing environmental monitoring still required). ■ Positive impact on groundwater over the long term (alleviates compliance issues within decades). ■ Legally, development opportunities requiring groundwater utilization may be available on the downgradient privately owned property (depending on existing groundwater quality and impacts from other historic activity). ■ Approval framework is relatively simple.	■ Environmental monitoring required for 25 to 50 years (to end of contaminating lifespan). ■ The Town would need to find an alternate means of managing the waste generated by the Town that is received at the Site (could be costly). ■ The Town would lose in any revenue stream associated with landfill. ■ May have to resort to extending the CAZ in the longer term if the use of downgradient groundwater is pursued prior to achieving compliance at the site boundary.

6.0 LIMITATIONS

Golder Associates Ltd. has relied in good faith on all information provided and does not accept responsibility for any deficiency, misstatements or inaccuracies contained in the memorandum as a result of omissions, misinterpretation, or fraudulent acts of the persons contacted or errors or omissions in the reviewed documentation.

The services performed, as described in this memorandum, were conducted in a manner consistent with that level of care and skill normally exercised by other members of the engineering and science professions currently practicing under similar conditions, subject to the time limits and financial and physical constraints applicable to the services.

Any use which a third party makes of this memorandum, or any reliance on, or decisions to be made based on it, are the responsibilities of such third parties. Golder Associates Ltd. accepts no responsibility for damages, if any, suffered by any third party as a result of decisions made or actions based on this memorandum.

The findings and conclusions of this memorandum are valid only as of the date of this memorandum. If new information is discovered in future work, including excavations, borings, or other studies, Golder Associates Ltd. should be requested to re-evaluate the conclusions of this letter and to provide amendments as required.

7.0 CLOSURE

Should you have any questions regarding this memorandum, please contact the undersigned.

Golder Associates Ltd.

Andria Caletti, P.Eng.
Environmental Engineer

Trish Edmond, M.E.Sc., P.Eng.
Geoenvironmental Engineer/ Principal

ETB/ALC/PLE/sg
https://golderassociates.sharepoint.com/sites/119264/project files/5 technical work/options assessment/03_december 2020 revision - mecp/19134510-tm-rev0-options assessment - dec2020.docx

Attachments: Figure 1 – Site Plan

OTTAWA RIVER

TEMBEC

ATTENUATION ZONE

COUNTY ROAD No 3 - USBORNE STREET

TEMBEC
PART 4 PLAN 49R-12219

SW-19

TEMBEC

BR-11

SW-20

BR-7S, BR-7D
TBM #7

CAZ
AREA A

BR-8S, BR-8D

BR-6S, BR-6D
TBM #6

BR-12

BR-5S, BR-5D
TBM #8

BM #805168

SW-12

BR-9S, BR-9D

CAZ
AREA B

BR08-3S, BR08-3D

TEMBEC
REMAINDER PART 1 PLAN 49R-12219

BR-18S, BR-18D

REGISTERED PLAN No. 26

SW-18

300m±

BOAT LAUNCH

SW-17

SW-16

BR-10

SW-21

SW-22

BR08-1S, BR08-1D

SW-4

BR-08-2S, BR08-2D

CANADIAN PACIFIC RAILWAY

SW-11

WETLAND

SW-23

SW-2

SW-3

SW-5

SW-6

TBM #1

TBM #2

TBM #3

OV-2

FENCE LINE

30 m BUFFER

BR-1S, BR-1D

OV-9

CAZ
AREA D

OV-10

2019 SURVEY LIMITS

BR-2

ROAD ALLOWANCE BETWEEN LOTS 10 AND 11

REGISTERED PLAN No. 44

CAZ
AREA C

ATTENUATION ZONE

30 m BUFFER

LICENSED LANDFILL

FILL AREA

OV-8

OV-5

BR-3
TBM #5

30m BUFFER ZONE

30 m BUFFER

LICENSED FILL AREA BOUNDARY

TBM #4

OV-4

BR-4

OV-13

BR-13S, BR-13D

SW-26

SW-10

		AREA (HECTARES)	
		SUBTOTAL	TOTAL
CONTAMINANT ATTENUATION ZONE (CAZ)	AREA A	8.9	30.8
	AREA B	12.8	
	AREA C	3.4	
	AREA D	5.7	
LANDFILLING SITE	BUFFER AREA	3.4	9.6
	FILL AREA	6.2	
TOTAL AREA			40.4

0 100 200
1:4,000 METRES

LEGEND

- BR-1 BEDROCK MONITORING STATION
- SW-6 SURFACE WATER MONITORING STATION
- OV-7 OVERBURDEN MONITORING STATION
- TBM #6 TEMPORARY BENCHMARK
- TOPOGRAPHICAL CONTOURS (2013, 2014, 2015, 2016, 2017, 2018 AND 2019 COMBINED SURVEYS)

REFERENCE(S)

1. BASE PLAN SUPPLIED IN DIGITAL FORMAT BY J.L. RICHARDS
2. TOPOGRAPHICAL CONTOURS BEYOND THE EXTENT OF THE 2014 TO 2019 SURVEYS SUPPLIED IN DIGITAL FORMAT BY JP2G CONSULTANTS INC.
3. PROJECTION: TRANSVERSE MERCATOR, DATUM: NAD 83, COORDINATE SYSTEM: UTM ZONE 18, VERTICAL DATUM: CGVD28

CLIENT
CORPORATION OF THE TOWN OF ARNPRIOR

PROJECT
TOWN OF ARNPRIOR OPTIONS ASSESSMENT, ARNPRIOR WASTE DISPOSAL SITE

CONSULTANT
GOLDER

YYYY-MM-DD	2020-05-29
PREPARED	ABD
DESIGN	ETB
REVIEW	ALC
APPROVED	PLE

TITLE
SITE PLAN

PROJECT No.	CONTROL	Rev.	FIGURE
19134510	0001	0	1

IF THIS MEASUREMENT DOES NOT MATCH WHAT IS SHOWN, THE SHEET SIZE HAS BEEN MODIFIED FROM: ANSI B

0 25 mm

Path: \\golder.gds\complexdata\ottawa\Active\Spatial_IM\Township_McNabBraeside\Arnprior_Waste_Disposal\99_PROJ\19134510_OptionsAssessment\40_PROD\0001_Waste\ | File Name: 19134510-0001-CO-0001.dwg

8.0 REFERENCES

Cooper, H.H., Jr., and Jacob, C.R., 1946. A generalized graphical method for evaluation formation constants and summarizing well field history. *Transactions, American Geophysical Union*, Vol. 27, No. 4.

Ministry of the Environment and Energy, 1994. Guideline B-7: Incorporation of the Reasonable Use Concept into MOEE Groundwater Management: MOEE Program Development Branch: Ontario Ministry of the Environment and Energy, April 1994, 8 p.

Ottawa River Regulation Planning Board (ORRPB), 2020. Monthly and Annual Mean Water Levels in Metres From 1950 (Chats Lake). http://ottawariver.ca/information/historical-water-level-streamflow-summary/chats-lake-at-arnprior/

Town of Arnprior, By-law No. 6227-13, Sewer Use By-Law.

From:	Ponalo, Thandeka (MECP)
To:	rpaquette@arnprior.ca; John Steckly; Deanna Nicholson; Caletti, Andria
Cc:	Worth, Adam (MECP); Hart, Tracy (MECP); Edmond, Trish
Subject:	Arnprior Waste Disposal Site SW and GW TSS Memos
Date:	May 19, 2021 5:18:33 PM
Attachments:	ftg-tp-2020 AMR and GW Compliance Plan- Arnprior WDS.pdf flf-tp-2020 AMR and GW Contingency.pdf

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EXTERNAL EMAIL

Good afternoon,

The surface water and groundwater unit of the Ministry's Technical Support Section (TSS) has completed a review of the following reports,

- "2020 Site Development, Operations and Environmental Monitoring Report, Arnprior Waste Disposal Site, Township of McNab/Braeside, Ontario", prepared by Golder Associates Ltd. (Golder) and dated March 2021 with Project No. 19131181 (3000); and
- "Arnprior Waste Disposal – Groundwater Compliance Contingency Plan", submitted to District Manager of MECP on December 3, 2020 by Golder Associates Ltd. (Golder).

The reports listed above propose a variation on the option to purchase the downgradient property to groundwater easement, specifically, the Town proposes that a legal agreement be drawn with the current property owner of the downgradient land giving the Town first right of refusal to purchase the groundwater rights. This agreement could be considered as an alternative to immediately purchasing the downgradient rights. As outlined in the attached Ministry TSS memos, the Ministry agrees that obtaining a right of first refusal to purchase the groundwater right may comply with the requirements in the RUG given that there are currently no groundwater users downgradient from the Site. However, we will require a detailed proposal which includes the legal instruments to be used to obtain these rights so that the Ministry could review the legality of the option and provide a definite response.

The Ministry is available for a meeting to discuss the Recommendations and Conclusions in the memorandums, and any questions you may have. In addition, it was also my understanding that the Town has some questions about land use planning, the operation of the waste disposal site and redevelopment of contaminated lands. I am happy to schedule a meeting with our Ministry to discuss these matters.

If you have any questions, I can be reached at 613-858-0695 or Thandeka.Ponalo@Ontario.ca.

Thank you,

Thandeka Ponalo
Senior Environmental Officer
Ontario Ministry of the Environment, Conservation and Parks
Ottawa District Office

2430 Don Reid Drive
Ottawa ON K1H 1E1
Tel: 613-521-858-0695 | Fax: 613-521-5437
Spills Action Centre (SAC): 1-800-268-6060
Thandeka.Ponalo@ontario.ca | www.ene.gov.on.ca

We want to hear from you. How was my service? You can provide feedback at 1-888-745-8888 or ontario.ca/inspectionfeedback

Ministry of the Environment, Conservation and Parks
Eastern Region
1259 Gardiners Road, Unit 3
Kingston ON K7P 3J6
Phone: 613.549.4000
or 1.800.267.0974

Ministère de l'Environnement, de la Protection de la nature et des Parcs
Région de l'Est
1259, rue Gardiners, unité 3
Kingston (Ontario) K7P 3J6
Tél: 613 549-4000
ou 1 800 267-0974

Ontario

M E M O R A N D U M

April 16, 2021

TO: Thandeka Ponalo
Senior Environmental Officer
Ottawa District Office
Eastern Region

FROM: Thomas Guo
Hydrogeologist
Technical Support Section
Eastern Region

RE: 2020 Site Development, Operations and Environmental Monitoring Report and Groundwater Compliance Plan
Arnprior Waste Disposal Site
Part of Lots 9, 10, 11, Concession 13
Township of McNab/Braeside
County of Renfrew

Environmental Compliance Approval (ECA): A412603

I have reviewed the following the documents:

- "2020 Site Development, Operations and Environmental Monitoring Report, Arnprior Waste Disposal Site, Township of McNab/Braeside, Ontario", prepared by Golder Associates Ltd. (Golder) and dated March 2021 with Project No. 19131181 (3000); and
- "Arnprior Waste Disposal – Groundwater Compliance Contingency Plan", submitted to District Manager of MECP on December 3, 2020 by Golder Associates Ltd. (Golder).

The first report was provided on behalf of the Town of Arnprior to document the monitoring results at the site in 2020. The second one was attached a technical memorandum prepared by Golder and dated December 3, 2020 with subject of "Options Assessment for the Town of Arnprior Disposal Site Compliance Issue".

I offer the following comments for your consideration.

Summary

- Reasonable Use Guideline B-7 (RUG) applies to operating waste disposal sites and sites closed post 1986. The landfill site is an active site; thus, the RUG applies to this site;
- Exceedances of the RUG were detected at monitoring wells BR-5D/5S, BR-6D/6S, BR-7S/7D, BR-10, and BR-12 along the northern property boundary. As

such, the site is not in compliance with the RUG along the northern property boundary;

- Golder presented “Options Assessment for the Town of Arnprior Disposal Site Compliance Issue” to the Town and the Town has decided to investigate Option1 – Extend the CAZ via Groundwater Easement as the preferred contingency option to bring the site back into compliance with respect to groundwater;
- The Town and Golder also proposed a variation on the option to purchase the downgradient property to groundwater easement, specifically if a legal agreement with the current property owner of the downgradient land giving the Town first right of refusal to purchase the groundwater rights could be considered as an alternative to immediately purchasing the downgradient rights;
- This Ministry has informed the Town that obtaining a right of first refusal to purchase the groundwater right may comply with the requirements in the RUG given that there are currently on groundwater users downgradient from the Site. However, this Ministry will require a detailed proposal which includes the legal instruments to be used to obtain these rights so that this Ministry could review the legality of the option and provide a definite response; and
- Golder recommends that groundwater monitoring and sampling continue at a frequency of twice per year (spring and fall) with the current parameters list (Table 5). The reporting frequency is to be annual; and
- Golder also recommended that an additional overburden and bedrock monitoring wells be installed in the vicinity of OV-9, near the southern corner of CAZ (contaminant attenuation zone) Area B or the eastern corner of CAZ Area D to discern groundwater flow direction and possible landfill leachate impacts at the southern property boundary. I concur with these recommendations.

Environmental Compliance Approval (ECA)

The Arnprior Waste Disposal Site (WDS) operates under ECA No. A412603 as a domestic, commercial and non-hazardous solid industrial waste and dewatered sewage sludge disposal site. The landfill is located on Part of Lots 9, 10, 11, Concession 13, Geographic Township of McNab. The approved waste disposal area is approximately 9.6 ha within a total approved site area of 40.44 ha. There are no engineering systems in place to control generated leachate and therefore the site operates as a naturally attenuating landfill.

The ECA was originally issued on October 26, 1999, which was amended by Notice on June 20, 2003; April 28, 2008; August 18, 2017; and October 12, 2018. The 2018 amendment was a minor change regarding an updated date for submission of the trigger mechanism. The March 2020 revision of the ECA was initiated by changes to the requirement to submit an updated mechanism.

Golder indicates that Contaminant Attenuation Zone (CAZ) lands located north and northeast of the landfill are covered with wood waste fill and the property was used for lumber industry related activities.

The landfill has been in operation since about 1970 and as of July 1, 2011, the site operations were subcontracted to Tomlinson Environmental Service Inc., Ottawa, Ontario.

Geology

Golder reports that the geology of the site comprises the following:

Overburden

- Major overburden deposits in the area are alluvial sand and glacial sand and/or gravel;
- The alluvial sand has a maximum thickness of 5.5 m at monitoring location OV-5;
- The glacial material occurs at surface or below the alluvial material and has a maximum thickness of 7 metres;
- Overburden thickness varies from less than 1 m to approximately 24 m in the southeastern portion of the site; and
- Overburden located within the CAZ northeast of the rail line ranges from 0.5 to 1.8 m in thickness and consists of topsoil, sawdust fill and/or sand and gravel fill.

Bedrock

- The region is transected by several faults which generally trend in a northwesterly to southeasterly direction;
- A fault is reported to the southwest of the site with the landfill situated on the up-thrown side;
- Paleozoic bedrock geology at the site consists of Gull River Formation, Rockliffe Formation and Oxford-March formation;
- The Rockliffe Formation occurs as outcrops or near surface bedrock in the site area and adjacent properties;
- Test holes primarily encountered limestone bedrock. Bedrock monitors BR-5, BR-6 and BR-7, located north and east of the site, are drilled through the limestone of March-Oxford formation; and
- The base of the Rockliffe formation is believed to be shale encountered in the upper portion of bedrock well BR-6; and
- Limestone and/or shale are encountered in monitors BR08-1 and BR08-3 to depths of 12.14 and 15.85 m, respectively. Monitor BR08-2 consists of approximately 0.76 m of sand and gravel fill underlain by sandstone, followed by layers of limestone, siltstone and shale.

Hydrogeology

The consultant determined the physical hydrogeological characteristics to be:

- Downward vertical gradients (recharging condition) are observed in multi-level bedrock monitors BR-1D/1S, BR-5D/5S, BR-8D/8S, BR-9D/9S and BR-13D/13S, and BR-18D/18S was downward or recharging-level wells BR-6D/6S and BR-7S/7D are located north of the licensed landfill area and in proximity of the Ottawa River and are likely discharging to the river;
- The vertical gradient between the overburden monitor OV-13 and bedrock monitor BR- 13S indicates downward groundwater flow;

- The horizontal hydraulic gradient in overburden from borehole OV-13 to borehole OV-7 was estimated to be 0.014 in both May and October 2020;
- The horizontal hydraulic gradient in the shallow bedrock from monitoring well BR-13S to BR-19S was estimated to be 0.01 in both May and October 2020;
- The horizontal groundwater flow within the overburden unit is interpreted towards the north and east; and
- The horizontal groundwater flow direction within the shallow bedrock unit is interpreted to be north, northeastern and east towards the Ottawa River.

Groundwater Monitoring

The 2020 groundwater monitoring program was the same as the 2019 groundwater monitoring program with the exception of the inclusion of monitoring well BR-18Da and BR-18S.

The groundwater levels in the monitors included in the sampling sessions were measured on May 5, 2020 and October 27, 2020. The spring groundwater monitoring session was conducted on May 5-7 and 27, 2020. The fall groundwater monitoring session was conducted on October 27-29, 2020.

Background Groundwater quality

Prior to 2001, background groundwater conditions were represented by monitor OV-5 for the overburden and several nearby bedrock residential wells. In 2001, monitoring wells OV-13, BR-13S and BR-13D were installed to provide a more suitable background source of water quality at the site.

Overburden Background Quality

Groundwater quality at overburden background monitoring well OV-13 is historically variable with higher leachate indicator parameter concentrations in the spring than in the fall. Water quality from this monitor is characterized by elevated concentrations of manganese and total dissolved solids (TDS) occasionally exceeding Ontario Drinking Water Quality Standards (ODWQS); slightly elevated concentrations of chloride (typically in spring); and low or non-detect concentrations of boron. Iron has historically exceeded the ODWQS twice. Elevated chloride and TDS concentrations are interpreted by road salting activities.

Bedrock Groundwater Quality

Bedrock background quality has been monitored at monitors BR-13S and BR-13D which are characterized by elevated concentrations of TDS and chloride. TDS frequently exceeds the ODWQS and iron and manganese have occasionally exceeded the ODWQS. Groundwater quality within the bedrock is reported to be more mineralized than the overburden.

Leachate

Leachate quality from the waste mound has been characterized at monitoring well OV-7. During May and November 2020, the groundwater quality in this monitor met the ODWQS with the exceptions of dissolved organic carbon (DOC), iron, manganese, sodium and TDS. Golder states that generally parameter concentrations at this location are staying constant or decreasing slightly.

The following parameters have been identified as site-specific leachate indicator parameters (LIPs): alkalinity, ammonia, barium, boron, chloride, iron, hardness, potassium, manganese, sodium, DOC, TDS, and dissolved reactive phosphorous.

Downgradient Water Quality

Golder provides the following interpretations, based on analysis of water quality using the Piper trilinear diagrams:

- Monitoring wells OV-7, BR-1D and BR-1S have been impacted by landfill leachate;
- Monitoring wells BR-5D, BR-5S, BR-6D, BR-6S, BR-8D, BR-8S, BR-9D, BR-9S, BR-12, BR08-1D, BR08-1S, BR08-2D and BR08-2S have been possibly impacted by landfill and wood waste deposited on the CAZ. Golder states that groundwater monitors BR-5D/5S, BR-6D/6S and BR-12 may also be influenced by road salting;
- Monitoring wells BR-7D, BR-7S, BR-10, and BR-11 are interpreted to be impacted by road salt, wood waste, or other industrial activities on CAZ lands, but not by landfill leachate;
- Groundwater monitors BR08-3D and BR08-3S are interpreted to be potentially impacted by landfill leachate, as well as wood waste or other industrial activities in the CAZ lands; and
- Monitoring wells OV-9, OV-10 and BR-3 are interpreted not to be impacted by landfill leachate or wood waste. However, several LIPs have been elevated recent years at monitoring wells OV-10 and BR-3.

VOC Concentrations

Monitoring wells OV-7 and BR-1S, which are located within the northern boundary of the landfill, were sampled for VOCs in June 2019. All VOC parameters were below ODWQS except the following:

- Benzene above ODWQS at OV-7 and BR-1S; and
- 1,4-Dichlorobenzene and chlorobenzene above ODWQS at OV-7.

Golder reports that the analytical results are historically consistent at these locations. The next VOC sampling event is scheduled in the spring of 2024.

Installation of Monitoring Wells BR-18D and BR-18S

In order to help discern the difference between landfill impacts and historical impacts that could be contributing to groundwater quality at the site boundary, monitoring wells BR-18D and BR-18S were installed in the southeast portion of CAZ Area B in October 2018.

Groundwater level measurements, sampling and analytical testing of the groundwater were undertaken from the new wells on October 29, 2018, November 24, 2018, December 15, 2018, January 1, 2019, and January 27, 2019.

Based on an analysis of the data from the above sampling sessions, the new interpreted groundwater flow direction establishes that BR-18 is downgradient of the landfill, and therefore not suitable for use as a background monitor. Therefore, the approach to establish BR-18 as background monitor for assessing compliance was abandoned by the Town.

Groundwater Surface Water Interaction

An on-site wetland is located to the north of the waste disposal area. There is a potential for groundwater to impact on-site surface water.

Guideline B-7

Reasonable Use Guideline B-7 (RUG) applies to operating waste disposal sites and sites closed post 1986. Golder provides the RUG assessment for leachate indicator parameters and compares the RUG limits to the downgradient groundwater quality at bedrock monitors BR-5D, BR-5S, BR-6D, BR-6S, BR-7D, BR-7S, BR-10, BR-11 and BR-12; and overburden monitor OV-10.

The following exceedances of RUG limits and/or trigger levels (75 % of RUG limits) were observed at these monitors:

- OV-10 – alkalinity, iron, manganese and TDS;
- BR-5D – alkalinity, barium, iron, manganese;
- BR-5S – alkalinity;
- BR-6D – alkalinity, iron, manganese, sodium, and TDS;
- BR-6S – alkalinity, manganese, and TDS;
- BR-7D – alkalinity, sodium, and TDS;
- BR-7S – alkalinity, manganese and TDS;
- BR-10 – alkalinity, iron, manganese, and TDS; and
- BR-12 – alkalinity, iron, manganese, DOC.

The Town is taking action to address the non-compliance issue.

Groundwater Compliance Contingency Plan

On December 3, 2020, Golder, on behalf of the Town, submitted a letter with subject of “Arnprior Disposal Site – Groundwater Compliance Contingency Plan” to address the non-compliance issue for the site. This letter is attached a memorandum entitled “Options Assessment for the Town of Arnprior Disposal Site Compliance Issue”.

The options assessment presents and compares possible contingency options that the Town could consider to address the groundwater compliance issue. Following a review of the options assessment, the Town’s municipal council resolved that the Town would further investigate Option1 – Extend the CAZ via Groundwater Easement as the preferred contingency option to bring the site back into compliance with respect to groundwater.

On August 27, 2020, the Town and Golder discussed with this Ministry about a variation on the option to purchase the downgradient property to groundwater easement, specifically if a legal agreement with the current property owner of the downgradient land giving the Town first right of refusal to purchase the groundwater rights could be considered as an alternative to immediately purchasing the downgradient rights.

On October 6, 2020, Sr. Environmental Officer Thandeka Ponalo sent an email to Golder and the Town indicating that a review of this variation on the contingency option

concluded that obtaining a right of first refusal to purchase the groundwater right may comply with the requirements in the RUG given that there are currently on groundwater users downgradient from the Site. Ms. Ponalo also noted that before this were to be approved, this Ministry will require a detailed proposal which includes the legal instruments to be used to obtain these rights so that this Ministry could review the legality of the option and provide a definite response.

Groundwater Monitoring Program

Golder recommends that groundwater monitoring and sampling continue at a frequency of twice per year (spring and fall) with the current parameters list (Table 5). The reporting frequency is to be annual.

Golder also recommended that an additional overburden and bedrock monitoring wells be installed in the vicinity of OV-9, near the southern corner of CAZ Area B or the eastern corner of CAZ Area D to discern groundwater flow direction and possible landfill leachate impacts at the southern property boundary.

I concur with these recommendations.

Thomas Guo, M. Eng, P. Geo.
TG/

ec: Victor Castro, Water Resources Supervisor

cc: Lauren Forrester, Surface Water Specialist
File No. GW RE MC 01 02 C13 (Arnprior WDS -A412603)
TG/ECHO # 1-120406787

Ministry of the Environment, Conservation and Parks
Eastern Region
1259 Gardiners Road, Unit 3
Kingston ON K7P 3J6
Phone: 613.549.4000
or 1.800.267.0974

Ministère de l'Environnement, de la Protection de la nature et des Parcs
Région de l'Est
1259, rue Gardiners, unité 3
Kingston (Ontario) K7P 3J6
Tél: 613 549-4000
ou 1 800 267-0974

Ontario

M E M O R A N D U M

April 23, 2021

TO: Thandeka Ponalo
Senior Environmental Officer
Ottawa District Office
Eastern Region

FROM: Lauren Forrester
Surface Water Specialist
Technical Support Section
Eastern Region

RE: 2020 Annual Monitoring Report and Groundwater Contingency Plan
Arnprior WDS
Part lots 9, 10 and 11, Concession 13
Geographic Township of NcNab/Braeside, Renfrew County
ECA No. A412603

As requested, I have reviewed the pertinent sections of the report titled "2020 Site Development, Operations and Environmental Report, Arnprior Waste Disposal Site, Township of McNab/Braeside, Ontario", prepared by Golder Associates (Golder) and dated March 2021 and "Arnprior Waste Disposal Site – Groundwater Compliance Contingency Plan", dated December 3, 2020 and prepared by Golder. For the purpose of this review, I have also consulted the memorandum prepared by Groundwater reviewer Thomas Guo, dated April 16, 2021.

I offer the following comments with respect to surface water matters.

Background

The site is operated under ECA No. A412603 and functions as a naturally attenuating site. The WDS has been in operation since about 1970. The approval has been amended several times in recent years; mostly recently to update the Site's trigger mechanism. The landfill site currently consists of a 9.6 ha licensed fill area (which includes 30 metre buffer) within a 40.44 hectare Site. Approximately 10,741 cubic metres of waste and cover were placed at the site in 2020. Remaining landfill life was estimated by the consultant as 23 years.

Contaminant Attenuation Zone (CAZ) has historically been to the north and northeast (between a CP Rail Line and Usborne Street) (CAZ Areas A, B and C). It has been reported that property is covered with wood waste fill and the property was used for lumber industry related activities. Berms related to the CP Rail line are of unknown quality. An additional CAZ Area (CAZ Area D) is located to the southwest.

Surface Water Regime

The site is drained by two separate drainage areas, both of which ultimately drain to the Ottawa River. The northern watershed drains most of the landfill area, including CAZ areas A and C, by way of a small intermittent stream through a series of perennial ponds on both sides of the CP railroad tracks and a wetland area north and east of the CPR tracks. Monitoring stations SW-2, SW-21, and SW-22 area intended to capture water quality conditions within CAZ Area A, ponds and wetlands downstream of the landfill area. SW-1 is located just downstream of CAZ Area A.

The southern watershed approaches the southern boundary of the landfill property and is drained by and unnamed ephemeral stream that becomes intermittent downgradient of the bedrock ledge. The southern watershed is captured by monitoring locations SW-10 (background), SW-11, and SW-12.

The Ottawa River is monitored at three locations: SW-26 (Background), Braeside Beach (SW-18) (downgradient of the landfill), and at the outfall from the northern drainage area (SW-19).

Groundwater generally flows to the north, northeast, towards the Ottawa River.

Site specific LIP for surface water include alkalinity, unionized ammonia, barium, boron, chloride, iron, hardness, potassium, manganese, sodium, total dissolved solids (TDS), dissolved organic carbon (DOC), and total phosphorus.

Trigger concentrations for surface water are as follows: Alkalinity (280 mg/L), unionized ammonia (0.02 mg/L), boron (1.5 mg/L), chloride (120 / 640 mg/L), iron (0.74 mg/L), and total phosphorus (0.19 mg/L). CWQG are used for boron and chloride. I support this continued approach.

Results and Discussion

Surface water monitoring was undertaken in May, August and October of 2020. Golder reports that there were no deviations from the prescribed monitoring program, although excessive flows, insufficient flows for measurement or dry conditions were encountered at SW2, SW10 (except May), SW18, SW21, SW22, SW23, and SW26 in 2020.

<u>Northern Drainage Area</u>

All sampling stations within and on the periphery of the wetland (SW1, SW2, SW21, SW22, SW23) had parameters in excess of PWQO, attributable to the landfill, industrial activities (railway / lumber industry), and/or natural wetland conditions.

Water quality at SW-1 and SW-2 was similar, with PWQO non-compliances related to dissolved oxygen, boron, iron and cobalt (SW-2 only). Unionized ammonia also exceeded the PWQO in the spring. With the exception of iron, these are generally minor. Though slightly elevated, neither boron nor chloride exceeded CWQG. Iron was most elevated at SW2 in the spring at 2.2 mg/L.

Water quality at SW-21 and SW-22 was similar and characterized by high hardness and alkalinity, low dissolved oxygen, slightly elevated chloride, boron and iron, and low

unionized ammonia. Concentrations of parameters are generally only slightly outside of PWQO. SW-23 (in the northern-most extent of CAZ Area A), water quality is notably less impacted (lower alkalinity, hardness, chloride).

Golder notes that the previously observed decreasing trend in dissolved oxygen throughout the northern drainage area now appears to be stabilizing or improving.

Generally speaking, water quality within the northern drainage area likely reflects impact from the Site (landfill leachate, industrial activities, wood waste, or some combination thereof). At some monitoring locations, TSS and low flow conditions may contribute to the seasonal trends observed. Significant impacts are not likely at this time.

Southern Drainage Area

Golder concludes that, water quality in the south drainage area is generally consistent and does not suggest impacts from the landfill. This includes SW-10, used to characterize background. This location is frequently dry and the potential for road-related impacts has been noted previously.

Previously identified increasing trends in sodium and chloride in downgradient stations in this area have reportedly stabilized since 2015 (but may again be slightly increasing at SW-11). These observations are likely related to road salting.

Ottawa River

Water quality within the Ottawa River is found to be distinctly different from the on-site ephemeral/intermittent streams, ponds and wetlands characteristic of the Site. Golder concludes that SW-18 and 19 (within or in close proximity to the Ottawa River) are not impacted by landfill leachate, despite concentrations of some parameters in excess of PWQO on some dates in 2020 (i.e. Al, Fe, boron, and unionized ammonia).

As in previous years, concentrations of many leachate indicators at SW-19 are similar to those at SW-1 and SW-2 (determined to be impacted by the Site). While negative impacts are unlikely at this time, leachate cannot be ruled out as influence at SW-19. Trends should continue to be monitored carefully.

Although minor changes are evident at SW-18 (offshore, downgradient of CAZ Area A and up-gradient of the outfall from the northern drainage area), the relative contribution from the landfill cannot be distinguished from other possible sources (i.e. road impacts, upstream Ottawa River). Water quality is generally representative of the Ottawa River.

Trigger and Contingency Assessment

Surface water triggers are established based on PWQO and 75th percentile from background (represented by SW-10), with consideration for CWQG, as described in Section 4.3 of the 2013 Site Development Operations and Environmental Monitoring Report. This includes criteria for review of results exceeding trigger concentrations and for the implementation of Contingency Measures. The response to results exceeding triggers is determined on a case by case basis rather than following a specified number of trigger exceedances.

At both SW-1 and SW-2 (in the North Drainage area), alkalinity consistently exceeds the site-specific trigger concentration in 2020. Although alkalinity appears to be relatively stable over time, this does not appear to be discussed within the report. Boron also exceeded the PWQO trigger in the spring at both SW-1 and SW-2; however, this exceedance was marginal and well below the CWQG. Iron and unionized ammonia exceeded the respective triggers at SW-2 in the spring only. Golder interprets these exceedances to have been within the historical range for these locations and, as such, not representative of site impacts. While I do not agree that site impacts do not contribute, it is unlikely the sole explanation for these results. The parameters exceeding trigger concentrations are unlikely to result in significant impacts to the receiver at this time.

The consultant concludes that the site has not resulted in persistent increases in the concentrations of site-specific trigger parameters. With the exception of iron and alkalinity, this is reasonable. Iron has exceeded the site-specific trigger at SW-2 on several occasions in recent years (including two consecutive monitoring dates Nov 2019 and May 2020). The next annual monitoring report should include an evaluation of the cause of elevated iron concentration in that area and, if justified, recommendations for possible mitigation measures to be undertaken. To support that evaluation, I also recommend that surface water samples be analyzed for both total and dissolved iron, consistent with the approach put forward by the British Columbia Ministry of the Environment and endorsed by the Ontario MECP Standards Development Branch.

Groundwater Compliance Contingency Plan

Because of limitations in the ability to enact the contingency measures set out in the 2013 Site Development, Operations and Environmental Monitoring Report (Jp2g, 2014), the recently amended ECA requires that contingency measures be established to address groundwater compliance issues at the northern site boundary. The Town's preferred contingency option is outlined in the letter dated December 3, 2020, prepared by Golder.

The *Arnprior Waste Disposal Site – Groundwater Compliance Contingency Plan* includes an Options Assessment for resolving groundwater issues. It is my understanding that the Town has resolved to investigate an extension of the CAZ via groundwater easement to achieve groundwater compliance. I defer to the groundwater reviewer for comment on matters relating to groundwater. It is notable that potential groundwater-surface water interactions have been identified in the northern drainage area, with potential for discharge of shallow groundwater to the ephemeral ponds and wetlands within it. Surface water trends should be monitored carefully moving forward to confirm that leachate impacts to surface (via discharge of contaminated groundwater) remain stable / are not intensified.

Conclusions

Based on current monitoring data, the effect of current and historical site activities on surface water is generally minor. While site-related impacts are identified at several locations in the north drainage area, guideline and/or trigger exceedances are generally not expected to be resulting in significant impacts to surface water or downstream

receivers at this time. Ongoing monitoring and careful evaluation of trends is justified. As described above, the next annual report should include further evaluation of iron impacts in the vicinity of SW-2.

If you have any questions about these comments, I would be happy to discuss them with you.

Lauren Forrester, M.Sc.
LF

ec: James Mahoney, Technical Support Section Manager
Victor Castro, Water Resources Unit Supervisor
Thomas Guo, Regional Hydrogeologist
Emily Tieu, Ottawa District Supervisor

c: File SW RE MB 03 06 C13 - Arnprior WDS, Township of McNab-Braeside
File 13 01 07 02 OT – Ottawa River
LF/ECHO 1-20402692

From:	Edmond, Trish
To:	thandeka.ponalo@ontario.ca; emily.tieu@ontario.ca; kyle.stephenson@ontario.ca; thomas.guo@ontario.ca; paul.mcculloch@ontario.ca; rpaquette@arnprior.ca; John Steckly; Ryan Francis; EBlanchard@blg.com
Cc:	Caletti, Andria
Subject:	Arnprior Waste Disposal Site Progress Update November 3 Meeting Summary
Date:	November 18, 2021 1:24:43 PM
Attachments:	20394265-Meeting Summary -3Nov2021.pdf image001.png image002.png

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Good afternoon,

Please find attached a summary of our call held on November 3regarding the Arnprior Waste Disposal Site. If there are any errors or omissions please let us know by November 25 so an updated summary can be prepared.

Thank you,

Trish

Trish Edmond
Principal, Geoenvironmental Engineer

Golder Associates Ltd.
1931 Robertson Road, Ottawa, Ontario, Canada, K2H 5B7
T: +1 613 592 9600 | **D:** +1 613 592-9600 x3246 | **C:** +1 613 799-1960 | **golder.com**
LinkedIn | Instagram | Facebook | Twitter

Work Safe, Home Safe

GOLDER
MEMBER OF WSP

MEETING SUMMARY

Arnprior Waste Disposal Site Groundwater Compliance

November 3, 2021
1:00 pm

Attendees:	Town of Arnprior	Ryan Francis Robin Paquette John Steckly
	Borden Ladner Gervais LLP	Emma Blanchard
	Ministry of the Environment, Conservation and Parks	Thomas Guo Paul McCulloch Thandeka Ponalo Kyle Stephenson Emily Tieu
	Golder Associates Ltd.	Andria Caletti Trish Edmond

Agenda Items

The following is a summary of the call between the Town of Arnprior (Town), the Town's legal counsel Borden Ladner Gervais LLP (BLG), the Ministry of the Environment, Conservation and Parks (MECP) and Golder Associates Ltd. (Golder) on November 3, 2021 at 1 pm to discuss progress on resolving groundwater compliance concerns at the Arnprior Waste Disposal Site (the Site, or AWDS).

On behalf of the Town, BLG provided the following update on contact with legal counsel for Rayonnier, the owner of the property downgradient of groundwater flow from the Site:

- Rayonnier has stated that it is their current policy not to dispose of lands where historic industrial activity has taken place, in particular for the purpose of future residential development. BLG explained that Rayonnier has indicated that this is their broad corporate policy to mitigate risk on old sites. Legal counsel for Rayonnier was surprised to learn about the development proposal for these lands (i.e., that caused a change to the McNab/Braeside Official Plan in 2018). Rayonnier has offered to sign a letter confirming that they have no plans to sell this property, in particular for the purpose of residential development.
- BLG explained that, while Rayonnier are willing thus far to cooperate, they are generally not interested in this issue. It is BLG's impression that Rayonnier is keen to convey that development of these lands is not part of their corporate strategy in the hopes that this will resolve the issue as they have little interest in speaking to the Town on the matter and it is hard to get their attention.
- BLG has had some preliminary discussions with Rayonnier about other alternatives such as a restrictive covenant or a groundwater easement, but Rayonnier has conveyed that they are hopeful that this letter would be sufficient.

Golder provided a summary of the current status of groundwater compliance at the AWDS that is the reason for these discussions with Rayonnier. The Groundwater Compliance Options Assessment submitted to the MECP in 2020 suggested that a "first right of refusal" type of agreement in the event of sale of the property be sought between the downgradient property owner and the Town in lieu of a groundwater easement to extend the CAZ, since there are no existing groundwater users on the downgradient lands. The MECP provided a response in May 2021 indicating that such an option could be acceptable, but that further detail of the legal mechanism would be required in order to evaluate the proposal. It was acknowledged by Golder and the Town that this possible option is unconventional, but the Town's actions are limited by the intention of the downgradient property owner, and that Town staff are also accountable to Town Council to confirm the course of action.

The MECP's legal representative (Paul McCulloch) stated that the letter proposed by Rayonnier is not an acceptable option; the MECP would be looking for a solution that would involve a registration on title for the lands. The MECP would also like to ensure that Rayonnier is aware that it is in their best interest to do this with respect to contamination from the landfill on the property. It was agreed that the letter would not be pursued further.

The option for the Town to acquire just the groundwater rights to the property was discussed. The Town/BLG/Golder expressed that the site is very large, and not all of it is downgradient of the landfill. Further, historic activity on the site may have caused contamination unrelated to the landfill that the Town does not want to take on the liability of. It was agreed that acquisition of groundwater rights would require testing to delineate the impacts from the landfill and impacts from other potential historic contamination. It was agreed that, as there are currently no groundwater users on the downgradient property, the delineation of landfill impacts to groundwater is not urgent. It was suggested by the MECP that the registration on title to be explored could consider requiring delineation prior to the use of groundwater on the site by the current or future owner.

Action: BLG will provide a list for review by the MECP of possible legal options that would involve registration on title of the property to restrict groundwater use. MECP to review and identify which options would be acceptable before BLG / the Town engage further with Rayonnier on the matter. It was agreed that this is the preferred option so as not to spend time on an option with Rayonnier that is unacceptable to the MECP.

Action: Regarding the comments on the Options Assessment received in May 2021, Thandeka will confirm with the Director the interpretation that, since more information and concurrence with the downgradient property owner are required to determine the nature of the legal instrument to resolve groundwater compliance issues, the Town is not required to fulfill the requirement of Condition 28.2 of ECA No. A412603 at this time.

From:	Ponalo, Thandeka (MECP)
To:	rpaquette@arnprior.ca; John Steckly; Ryan Francis
Cc:	Edmond, Trish; Caletti, Andria; Hart, Tracy (MECP); Tieu, Emily (MECP)
Subject:	Condition 28.1 and 28.2 of ECA Number A412603
Date:	November 18, 2021 4:02:35 PM

EXTERNAL EMAIL

Good afternoon,

The Ministry has reviewed Conditions 28.1 and 28.2 of ECA Number A412603 and can confirm that the six month deadline required by Condition 28.2 has not been triggered. The contingency measures have been provided but final comments have not been provided. As soon as the Town is in receipt of final comments on the contingency measures, the Town should ensure that an amendment of the ECA is submitted to the Director.

Thank you,

Thandeka Ponalo
Senior Environmental Officer
Ontario Ministry of the Environment, Conservation and Parks
Ottawa District Office
2430 Don Reid Drive
Ottawa ON K1H 1E1
Tel: 613-858-0695 | Fax: 613-521-5437
Spills Action Centre (SAC): 1-800-268-6060
Thandeka.Ponalo@ontario.ca | www.ene.gov.on.ca

wsp.com