Harden Environmental Services Ltd.
4622 Nassagaweya-Puslinch Townline Road
Moffat, Ontario, L0P 1J0
Phone: (519) 826-0099 Fax: (519) 826-9099

Groundwater Studies
Geochemistry
Phase I / II
Regional Flow Studies
Contaminant Investigations
OMB Hearings
Water Quality Sampling
Monitoring
Groundwater Protection Studies
Groundwater Modeling
Groundwater Mapping
Permits to Take Water
Environmental Compliance Approvals

Our File: 0004

August 9, 2023

Township of Puslinch
7404 Wellington Road 34
Guelph, ON, N1H 6H9

Attention: Mr. Glenn Schwendinger
CAO

Dear Glenn;

Re: Mill Creek Aggregates Pit –Review of 2022 Monitoring Data
Part Lot 24, Concession 1, and
Part Lots 21, 22, 23, and 24, Concession 2

Background

This 188.4-hectare property is owned by the University of Guelph and operated by Dufferin Aggregates. Extraction at the Mill Creek Aggregates Pit (“the Site”) commenced in 1995 and there are presently four large open water bodies where aggregate was extracted below the water table. The Site is adjacent to Provincially Significant Wetlands and Mill Creek flows along the northern and western extents of the property. Mill Creek is a cold-water fishery with healthy brook and brown trout populations. Brown trout spawn in the creek in sections of Mill Creek along the Site. Groundwater discharges into Mill Creek from the site providing both water temperature and water quantity conditions favourable for spawning conditions. Groundwater and surface water monitoring are conditions of the aggregate license and there are specific water level thresholds designed to ensure that groundwater quantity and quality to Mill Creek is not significantly affected.

We are pleased to provide a review of the 2022 monitoring data and their relationship to threshold levels. We have reviewed the following documents.

Mill Creek Aggregates Pit Hydrogeology, Appendix B of the Coordinated Monitoring Report, WSP March 29, 2023

Mill Creek Aggregates Pit Surface Water, Appendix A of the

Coordinated Monitoring Report, WSP March 29, 2023

Mill Creek Aggregates Pit Fisheries, Appendix C of the Coordinated Monitoring Report, WSP March 29, 2023

Extractive Activity 2022

In 2022 the extractive activity that occurred was above water table and below water table extraction in Phase 2,5 and 6 (see attached figure) as well as in Silt Pond 4. Aggregate processing also occurred which involves pumping water from Phase 1 through an aggregate sorting plant and discharge of effluent into Silt Pond 4 and in Phase 1to allow for settlement and containment of non-marketable fine-grained materials. This silt pond is located between the main Phase 1 pond and Mill Creek.

2022 Monitoring Report

Our comments on the 2022 report are as follows.

1) 2022 had 27% less precipitation than the 30-year average.

2) Flowing artesian conditions occurred throughout the year from the bedrock aquifer in the southwest corner of the site adjacent to Mill Creek. The monitoring location is TW16-78. The original farmhouse well is also monitored for bedrock water levels and historically low water levels in the bedrock aquifer were noted at this location.

3) In 2022, all groundwater levels measured at the monitors were within their maximum and minimum historical range. There is a trend toward lower water levels in groundwater monitors adjacent to Pond 3. The water levels in monitoring wells DP12, DP16, 92-27, 92-28, 92-29, 92-32 and 92-33 declined between 2014 and 2020. In 2021 and 2022 there was a stabilization of water levels in these monitors, despite the noted lack of groundwater recharge early in the year. We see this as a positive outcome and likely due to stabilized water levels in the Phase 3 Pond.

4) Wetland monitoring stations DP6, DP7 and DP8 are within historical range in 2022. This area of the site is influenced by water levels in Pond 3.

5) A review of the Mill Creek drive point monitors shows that there are significant changes in hydraulic gradients within Mill Creek occurring in 2022. These drive point monitors have been valuable in showing the potential for groundwater discharge to Mill Creek. In 2022 it is observed that historically significant downward gradients occurred in Mill Creek between the Hanlon Expressway off

ramp from Hwy 401 to Concession Road 7. The report states that the "sudden change in gradient is due to upgradient activities".

6) The temperature plots of groundwater and surface water (thermographs) do not indicate changing conditions compared to the previous five years. The development of open water bodies at the site has increased groundwater temperature immediately adjacent to the ponds and temperatures have increased in groundwater between Mill Creek and the ponds. The temperature does trend toward background groundwater temperatures as distance from the ponds increases. The coordinated report states that the cold-water fishery has not been affected by observed temperature changes.

7) Groundwater discharge volume to Mill Creek is within the historical range and in 2022 is similar to the long-term average.

8) There were threshold breaches between BH92-27-DP2 and OW5-84-DP5CR. These gradient pairs were chosen to determine if groundwater flow is being maintained to Mill Creek. It is our observation that groundwater flow between the site and Mill Creek around BH92-27 and OW5-84 depends on the water level in Pond 3. Since 2017 as the water level in Pond 3 has decreased, the hydraulic gradient between Pond 3 and Mill Creek also decreased resulting in the registered warning level breach and threshold breach. Figures G7, G9 and G11 show how the hydraulic gradients west of Pond 3 are hovering near their minimum allowable levels and on occasion fall below those levels.

Discussion

Aggregate extractive activities at this Site have had an impact on groundwater levels and temperature. The impact on groundwater levels occurs within tens of metres of the ponds as seen in groundwater monitors located close to Pond 3. As a result of changing operations at the site, the water levels in Pond 3 have stabilized.

The rate of groundwater discharge to Mill Creek remained within historical range.

Groundwater temperatures adjacent to the ponds reflect the seasonal temperature variation in the ponds. Whereas groundwater temperature is generally 8 to 12 ºC it is possible to find groundwater temperature ranges from 0 to 25 ºC adjacent to one of the pit ponds. Groundwater temperatures trend back to ambient groundwater temperatures with increasing distance from the pond. However, Mill Creek is located near enough to the ponds to have a small temperature change occur.

The vertical hydraulic gradient data available for several drive points show that groundwater discharges to Mill Creek south of Hwy 401, but at three locations north of Hwy 401 a reversal has occurred and the stream contributed to the groundwater system in 2022.

The following is a quote from the conclusions of the 2022 Fisheries Study. *The results from 2022 provide further evidence that aggregate extraction below the water table (beginning in 1995) has had no measurable impact on the level of Brown trout spawning activity. Therefore, Dufferin Aggregates continues to be in compliance with License Condition #23, which states there must be no "net loss of the productive capacity of fish habitat in Mill Creek or its tributaries."*

The threshold breaches in monitoring pairs BH92-29/DP1 and OW5-84/DP5CR are concerning insofar as the artificial water level in Phase 3 pond strongly influences the hydraulic gradient between these monitoring pairs. Temporary responses to storm events that trigger the observed breaches and Figures G7, G9 and G11 show that the hydraulic gradient is riding close to the threshold. These breaches did not occur with a higher Phase 3 Pond water level. Continued monitoring during active and post extraction phase will be necessary to confirm that water levels have stabilized at an elevation favourable for continued groundwater discharge to Mill Creek.

Recommendations

The lower Pond 3 water level is influencing groundwater flow to Mill Creek west of Pond 3. Groundwater flow is hovering around the minimum allowable. We recommend a review of Pond 3 levels and the factors that influence the Pond level in hopes of identifying methods to stabilize the Pond level with more favourable groundwater flow to Mill Creek in an important fishery area.

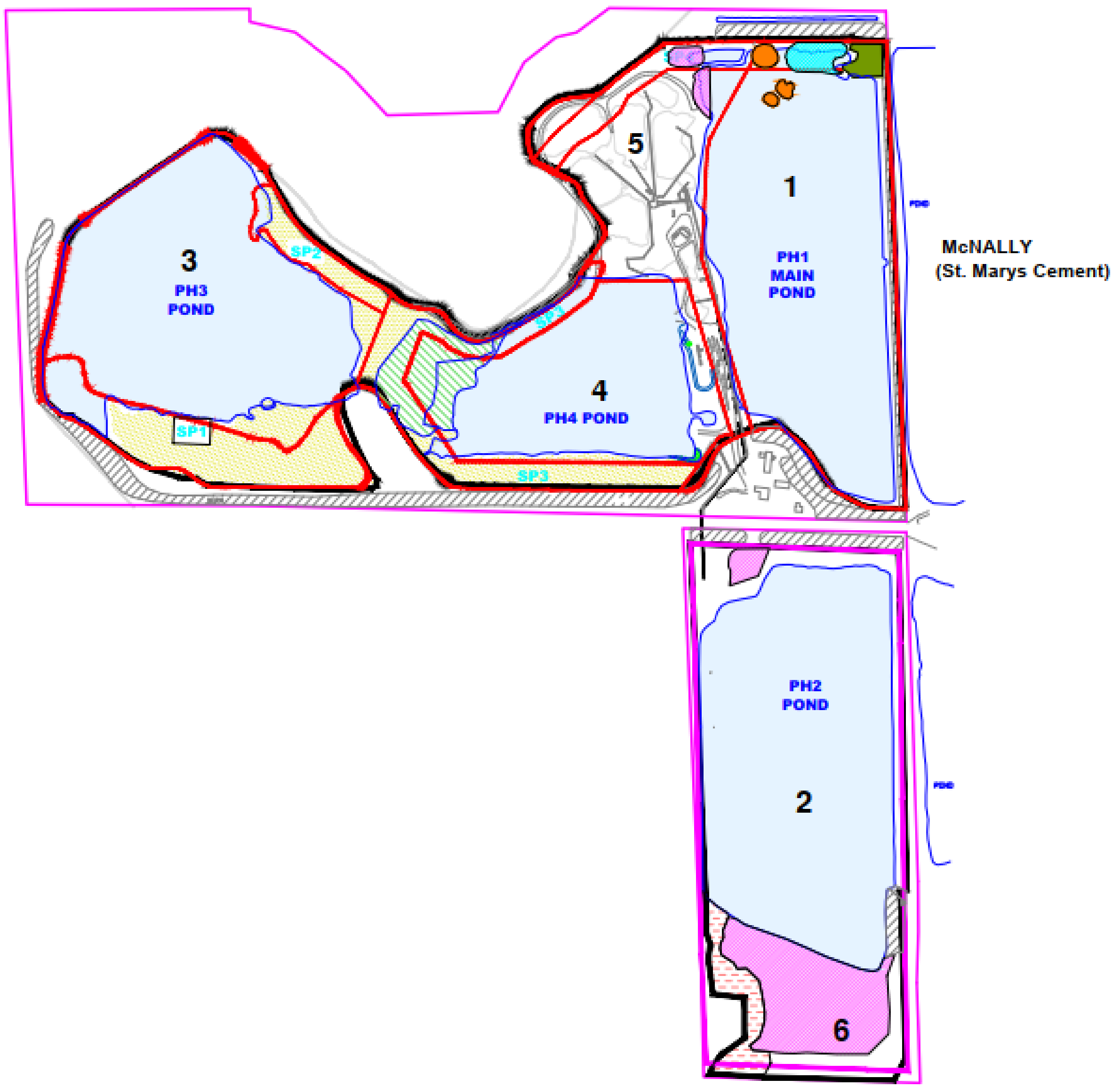
The Township in collaboration with the aggregate industry and other water users in the area should identify the root cause for the reversal of groundwater flow to Mill Creek as indicated by monitors DP18, DP19 and DP20 between Hwy 401 and Concession Road 7.

Sincerely,

Harden Environmental Services Ltd.

[redacted]

Stan Denhoed, P.Eng., M.Sc.
Senior Hydrogeologist



LEGEND

- BOUNDARY OF LICENSED PROPERTY
- LICENCED LIMIT OF EXTRACTION PER SITE PLANS
- BOUNDARY OF EXTRACTION AREA PER G.R.C.A. FILL PERMIT APPLICATION
- 3 PHASE DESIGNATION
- SP3 SILT POND DESIGNATION
- BERM
- INFILLED SILT POND
- PARTIALLY INFILLED SILT POND
- EXTRACTED AREA TO BE SLOPED
- 2022 DEPOSITION AREA
- 2020 DEPOSITION AREA
- 2022 EXTRACTED AREA
- 2021 DEPOSITION AREA

NOTES:

BASE MAPPING BY PLANNING INITIATIVES LTD., DATED AUGUST 1987, DRAWING NUMBERS 1A AND 1B OF 4.

POND BOUNDARIES BASED ON AERIAL PHOTOGRAPHY (DUFFERIN AGGREGATES, NOVEMBER 2020).

SITE PLAN SEQUENCING

2022 ANNUAL GROUNDWATER MONITORING REPORT
MILL CREEK AGGREGATES PIT
Township of Puslinch
for Dufferin Aggregates

SCALE: NOT TO SCALE
PROJECT: 111-52958-14 100
DATE: FEBRUARY 2023
REF. NO.: 111-52958-14 100 F3 2023

FIGURE 3

MILL CREEK AGGREGATES PIT

2022 COORDINATED MONITORING REPORT

DUFFERIN AGGREGATES, A DIVISION OF CRH CANADA GROUP INC.

PROJECT NO.: 111-52958-14
DATE: MARCH 30, 2023

WSP
SUITE 700
55 KING STREET
ST. CATHARINES, ON, CANADA L2R 3H5

T: +1 905 687-1771
F: +1 905 687-1773
WSP.COM

March 30, 2023

DUFFERIN AGGREGATES, A DIVISION OF CRH CANADA GROUP INC.
3300 Steeles Avenue West
4th Floor
Concord, ON L4K 5X6

Attention: Martin Bradley, Site Manager

Dear Sir:

Subject: Mill Creek Aggregates Pit, 2022 Coordinated Report

This report provides an overview of the operations and results of environmental monitoring programs for the period January 1 to December 31, 2022, for the University of Guelph Mill Creek pit, operated by Dufferin Aggregates, a division of CRH Canada Group Inc.. A discussion of compliance with the groundwater threshold values is also provided. Detailed monitoring data for hydrology, hydrogeology and fisheries are provided in separate Appendices.

This is the twenty eighth annual coordinated monitoring report for the Mill Creek program.

Data, text and figures have been integrated into this coordinated report from the following separate Technical Appendices which will be provided electronically:

- Appendix A - Surface Water
- Appendix B - Hydrogeology
- Appendix C - Fisheries

Kind regards,

[redacted]

Greg R. Siiskonen, P.Eng.
Director, Earth & Environment

WSP ref.: 111-52958-14

SUITE 700
55 KING STREET
ST. CATHARINES, ON, CANADA L2R 3H5

T: +1 905 687-1771
F: +1 905 687-1773
wsp.com

DISTRIBUTION LIST

ASSOCIATION / COMPANY NAME	PDF	NUMBER OF HARD COPIES
Dufferin Aggregates	✓	0
Ministry of Natural Resources & Forestry	✓	0
University of Guelph	✓	0
Fisheries and Oceans Canada	✓	0
Grand River Conservation Authority	✓	0
WSP Canada Inc.	✓	0
Township of Puslinch	✓	0

SIGNATURES

PREPARED BY

Leslie Keith, H.B. Sc.
Ecologist - Fisheries

[redacted]

Rebecca Warrack, P.Eng.
Project Engineer, Earth & Environment

REVIEWED BY

Kim LeBrun, H.B.Sc.
Senior Ecologist, Fisheries

[redacted]

Greg R. Siiskonen, P.Eng.
Director, Earth & Environment

WSP Canada Inc. ("WSP") prepared this report solely for the use of the intended recipient, DUFFERIN AGGREGATES, A DIVISION OF CRH CANADA GROUP INC., in accordance with the professional services agreement between the parties. In the event a contract has not been executed, the parties agree that the WSP General Terms for Consultant shall govern their business relationship which was provided to you prior to the preparation of this report.

The report is intended to be used in its entirety. No excerpts may be taken to be representative of the findings in the assessment.

The conclusions presented in this report are based on work performed by trained, professional and technical staff, in accordance with their reasonable interpretation of current and accepted engineering and scientific practices at the time the work was performed.

The content and opinions contained in the present report are based on the observations and/or information available to WSP at the time of preparation, using investigation techniques and engineering analysis methods consistent with those ordinarily exercised by WSP and other engineering/scientific practitioners working under similar conditions, and subject to the same time, financial and physical constraints applicable to this project.

WSP disclaims any obligation to update this report if, after the date of this report, any conditions appear to differ significantly from those presented in this report; however, WSP reserves the right to amend or supplement this report based on additional information, documentation or evidence.

WSP makes no other representations whatsoever concerning the legal significance of its findings.

The intended recipient is solely responsible for the disclosure of any information contained in this report. If a third party makes use of, relies on, or makes decisions in accordance with this report, said third party is solely responsible for such use, reliance or decisions. WSP does not accept responsibility for damages, if any, suffered by any third party as a result of decisions made or actions taken by said third party based on this report.

WSP has provided services to the intended recipient in accordance with the professional services agreement between the parties and in a manner consistent with that degree of care, skill and diligence normally provided by members of the same profession performing the same or comparable services in respect of projects of a similar nature in similar circumstances. It is understood and agreed by WSP and the recipient of this report that WSP provides no warranty, express or implied, of any kind. Without limiting the generality of the foregoing, it is agreed and understood by WSP and the recipient of this report that WSP makes no representation or warranty whatsoever as to the sufficiency of its scope of work for the purpose sought by the recipient of this report.

In preparing this report, WSP has relied in good faith on information provided by others, as noted in the report. WSP has reasonably assumed that the information provided is correct and WSP is not responsible for the accuracy or completeness of such information.

Benchmark and elevations used in this report are primarily to establish relative elevation differences between the specific testing and/or sampling locations and should not be used for other purposes, such as grading, excavating, construction, planning, development, etc.

Overall conditions can only be extrapolated to an undefined limited area around these testing and sampling locations. The conditions that WSP interprets to exist between testing and sampling points may differ from those that actually exist. The accuracy of any extrapolation and interpretation beyond the sampling locations will depend on natural conditions, the history of Site development and changes through construction and other activities. In addition, analysis has been carried out for the identified chemical and physical parameters only, and it should not be inferred that other chemical species or physical conditions are not present. WSP cannot warrant against undiscovered environmental liabilities or adverse impacts off-Site.]

The original of this digital file will be kept by WSP for a period of not less than 10 years. As the digital file transmitted to the intended recipient is no longer under the control of WSP, its integrity cannot be assured. As such, WSP does not guarantee any modifications made to this digital file subsequent to its transmission to the intended recipient.]

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

EXECUTIVE SUMMARY

SITE CONDITIONS AND OPERATIONS

- Extraction in 2022 occurred both above and below the water table in Phase 2, Phase 5 and Phase 6, as well as below the water table in Silt Pond 4 (SP4); and,
- Silt Pond (SP4)/Phase 1 and Phase 4 pond operated within the minimum/maximum water level thresholds.

CLIMATE

- Mean monthly air temperature in 2022 was 0.6°C higher than the 30-year average of 8.3°C;
- Total precipitation in 2022 was 682 mm, which is 27% lower than the 30-year average of 935 mm.
- It is important to note that 2022 was an appreciably dry year. The annual precipitation recorded in 2022 (682 mm) was similar to the annual precipitation recorded in 2012 (679 mm), which was the lowest annual precipitation recorded since 1998. As reported in the 2021 Surface Water Report, persistent dry conditions were previously observed from early 2020 through summer 2021, and were followed by wetter conditions in the fall of 2021.

HYDROLOGY

- There is no indication that aggregate extraction has affected stream flow in Mill Creek;
- The calculated minimum and maximum instantaneous flow rates at SWM2 were within the historical range observed since 2000;
- The 7-day low flow value at SWM2 (0.098 m^3/s) was observed in December and was slightly lower than the historical minimum 7-day low flow values recorded since 2000;
- Stream flow in Mill Creek responded to climatic conditions including precipitation events, periods of snow melt and periods of low precipitation; and,
- Considering the extensive history of surface water monitoring data demonstrating a lack of surface water flow impacts by the pit operations, consideration should be given to reducing the surface water monitoring program.

GROUNDWATER

- The head difference at the OW5-84 to DP5CR pair exceeded the Action Threshold Value on one occasion in 2022. The exceedance is attributed to a more rapid groundwater level increase at DP5CR due to precipitation in the days prior to the measurement, which temporarily reduced the head difference at the well pair;
- Water levels in the Phase 1 to Phase 4 ponds did not exceed their respective low-water level threshold values in 2022 and are reflective of precipitation;
- The estimated groundwater contribution from the Mill Creek Aggregates Pit property located north of Township Road 2 was similar in 2022 compared to the historic average;
- In 2022, vertical gradients observed at the creek drive points located south of Highway 401 were consistent with historical results;
- The calculated net water surplus for 2022 was 129 mm, which is 175 mm (58%) lower than the 30-year average surplus of 304 mm;
- Groundwater temperatures at the monitoring stations closest to the Phase 1 and 3 Ponds were influenced by water temperatures in the ponds, which is not unexpected; however, groundwater temperatures rapidly moderate away from the ponds and do not impact water temperatures in Mill Creek;

- Groundwater patterns at the Mill Creek site have been influenced by climatic conditions and the presence of beaver dams in recent years. Beaver dams that were located within Mill Creek both on the Site and immediately downstream of the Site were removed in September 2021;
- Groundwater quality has generally remained consistent over the years. Some Ontario Drinking Water Quality Standards were exceeded due to natural conditions in the area, which is consistent with previous findings; and,
- No changes to the groundwater monitoring program are recommended for 2023.

MILL CREEK WATER QUALITY AND TEMPERATURE

- Surface water quality has remained stable over the past decade. In recent years, however, there have been signs of increasing conductivity and chloride levels which are unrelated to pit activities, and may be attributed to road salting activities;
- The maximum stream temperatures in 2022 were 23.9°C at SWM1 on August 7th and 22.8°C at SWM2 on June 22nd; which are within historical ranges and below historical highs and,
- During the spring, summer and fall months, stream temperatures continue to decrease across the University property due to a combination of input from two coldwater tributaries, groundwater input, and shading which continue to enhance the coldwater fish habitat attributes of the stream.

FISHERIES

- The upper tolerable temperature for Brown trout (26.8°C) was not exceeded at any of the monitoring stations during the summer of 2022;
- The upper tolerable temperature for brook trout (23.9°C) was not exceeded at any of the monitoring stations during the summer of 2022;
- Brown trout spawning activity in 2022 was lower than 2021 and recent years in both the University and Hanlon reaches;
- The number of redds in the University section was 11 in 2022 compared with 41 in 2021;
- In the Hanlon section, the redd count was 15 in 2022 compared with 39 in 2021;
- Spawning activity was lower in 2022 due to beaver dam activity upstream of the western boundary and increased sedimentation within the reaches during the survey program; and,
- The redd count in both stream sections in the past several years was lower than in the preceding decade but similar to results for the period 1996-2006.
- The estimated Brown trout population adjacent to the aggregate operation remained within historic ranges;
- Trout numbers and biomass continue to be higher in the University reach compared with the Hanlon reach due to better habitat conditions.

GENERAL CONCLUSION AND RECOMMENDATIONS

- The available monitoring data do not indicate that the Mill Creek aggregate operation negatively impacted the local environment in 2022.

TABLE OF CONTENTS

TABLES

FIGURES

APPENDICES

1 INTRODUCTION

1.1 THE SITE

The Mill Creek Property is owned by the University of Guelph and encompasses approximately 185.5 ha, situated on Part Lot 24 Concession 1 and Part Lots 21-24 Concession 2, Township of Puslinch, in the County of Wellington (Figure 1). The land consists of active pit areas, areas that have been rehabilitated or are in the process of being reclaimed, ponds, and abutting wetlands that are part of the provincially significant Mill Creek Wetland Complex.

The northwest corner of the property is traversed by Mill Creek and by two tributaries, Galt Creek and Pond Creek. These waters support a naturally sustaining brown trout (*Salmo trutta*) and brook trout *(Salvelinus fontinalis)* population. The aggregate extraction operation is designed to limit the impacts on both Mill Creek and its tributaries, and the wetland area adjacent to the creek.

The aggregate extraction is operated by Dufferin Aggregates, a division of CRH Canada Group Inc. Extraction is occurring above and below the water table and will eventually create a number of small lakes. The operation is licensed to extract aggregate from 122.1 ha of the property.

1.2 MONITORING REQUIREMENTS

Approval for aggregate extraction on this property followed an Ontario Municipal Board Hearing in 1988 and 1989, with a decision in 1990. The Ministry of Natural Resources and Forestry (MNRF) issued a licence to the University of Guelph under the Aggregate Resources Act in September 1991. The licence (#5738) has 42 conditions.

The original monitoring programs and specific licence conditions were included in the Coordinated Report on Monitoring Programs (Planning Initiatives 1993). The monitoring program was revised in 2006 as part of the Pre-Phase 3 application (C. Wren & Associates Inc. and Jagger Hims Ltd. 2006). That program was followed up to 2012 when additional program changes were recommended and implemented beginning in 2013 (see Coordinated Monitoring report for 2013 and 2014 for description of changes).

Licence conditions 19 to 23, and 25 required the development of approved monitoring plans before extraction could proceed. This included: surface water (including Mill Creek and its tributaries), groundwater, fisheries and ecology of the wetland (vegetation). The vegetation monitoring plan was approved in 1992 and the others in December 1993. Licence conditions 19 - 25 are provided in Table 1-1. Threshold values for groundwater were first developed in 2001 and are periodically updated or revised as discussed in detail in Section 3 of this report.

Table 1-1 Conditions of License

CONDITIONS OF LICENCE	RELATED DISCIPLINE (1993 DOCUMENT)
19. The licensee shall, prior to the start of excavation operations, provide the District Manager, Ministry of Natural Resources, with a comprehensive groundwater monitoring report which shall include a description of monitoring equipment, monitoring locations, methods of data collection and recording, action, thresholds, calculations to be carried out (e.g. base flow calculations), frequency of data collection, a proposed reporting schedule, and any other details required by the District Manager. The reporting schedule shall include the requirement to provide a comprehensive interim monitoring report for review and District Manager approval prior to commencement of excavation in each phase of the pit operation. The licensee shall maintain the monitoring programs described above, throughout the operating life of the extraction and during the site rehabilitation period and beyond, until such time that the Ministry of Natural Resources agrees to the termination of, or reduction in, the monitoring program.	Hydrogeology – refer to Appendix B, Groundwater Monitoring Program – Jagger Hims Limited (November, 1993)
20. The licensee shall, prior to the start of excavation operations, provide the District Manager, Ministry of Natural Resources, with a detailed wetland habitat monitoring report which will outline a program designed to measure ecological changes in those parts of the Mill Creek wetland adjacent to extraction operations carried out under this licence. The reporting schedule shall include the requirement to provide a comprehensive interim monitoring report for review and District Manager approval prior to commencement of excavation in each phase of the pit operation.	Terrestrial Ecology – refer to Appendix D, Habitat Monitoring Manual, Paul F.J. Eagles Planning Ltd. (November, 1992)
21. (a) The licensee shall, prior to the start of excavation operations, provide the District Manager, Ministry of Natural Resources, with a comprehensive hydrological and biological monitoring report for Mill Creek and its tributaries, and this report shall include a description of monitoring equipment, monitoring locations, methods of data collection and reporting, action thresholds, a proposed reporting schedule, and any other details required by the District Manager. The reporting schedule shall include the requirement to provide a comprehensive interim monitoring report for review and District Manager approval prior to commencement of excavation in each phase of the pit operation.	Surface Water and Fisheries – refer to Appendices A and C, Surface Water Monitoring Program and Fish Habitat Monitoring Program. M.M. Dillon Limited and ESG International Inc. respectively (November, 1993).
(b) The licensee shall provide the District Manager, Ministry of Natural Resources, with a detailed surface water drainage plan which will describe the existing surface water in and surrounding the site and the proposed water diversion, storage, and drainage facilities on the site, and points of discharge to surface waters.	Refer to Drainage Plan prepared by Planning Initiatives Ltd. in conjunction with M.M. Dillon. (November, 1992)
(c) The monitoring report described in this licence condition shall include a description of those tests and analytical methods to be used to determine whether there is or is likely to be either a net gain or a net loss in fish habitat as a consequence of pit operations.	Fisheries, Surface Water and Groundwater – refer to Appendix C, Fish Habitat Monitoring Program. (November, 1993)
22. The licensee shall, prior to the start of excavation operations obtain the written approval of the District Manager, Ministry of Natural Resources, for the reports required under licence condition nos. 19, 20, and 21 and, upon approval of the reports, the licensee shall carry out the monitoring programs as described in the monitoring reports.	
23. Pit operations shall not result in a net loss of the productive capacity of fish habitat in Mill Creek or its tributaries.	Fisheries, Surface Water and Groundwater - refer to Appendix C, Fish Habitat Monitoring Program. (November, 1993).
25. Prior to the start of excavation operations, the licensee shall provide, to the satisfaction of the District Manager, Ministry of Natural Resources, a contingency plan that will describe the actions proposed to be taken by the licensee to ensure compliance to condition of 23 of this licence.	Fisheries, Surface Water and Groundwater – refer to Section 5.0 of original program.

1.3 PROGRAM CONTACT NAMES

The names and addresses of the primary contact people involved with the Mill Creek monitoring program are provided in the following table:

Table 1-2 List of Personnel

<table>
<tr><th></th><th>NAMES</th><th>ROLE</th></tr>
<tr><td>Licence Holder</td><td>Ms. Sonya Donovan, Director Real Estate
University of Guelph
25 University Avenue, Guelph, Ontario
Phone: (519) 767-5051 Fax: (519) 763-4974</td><td>Licence Holder</td></tr>
<tr><td>Aggregate Operator</td><td>Mr. Martin Bradley
Dufferin Aggregates
2300 Steeles Avenue West, 4th Floor
Concord Ontario L4K 5X6
Phone: (905) 761-7500 Fax: (905) 761-7505</td><td>Project Coordination</td></tr>
<tr><td>Surface Water Monitoring Program</td><td rowspan="4">Mr. Greg Siiskonen, P.Eng.
WSP Canada Inc.
55 King Street, Suite 700 | St. Catharines, ON L2R 3H5
Phone: (289) 267-0821

Ms. Kim LeBrun, H.B.Sc.
WSP Canada Inc.
582 Lancaster Street West | Kitchener, ON N2K 1M3
Phone: (519) 904-1767</td><td>Surface Water
(Technical Appendix A)</td></tr>
<tr><td>Groundwater Monitoring Program</td><td>Hydrogeology
(Technical Appendix B)</td></tr>
<tr><td>Fisheries Monitoring Program</td><td>Fisheries
(Technical Appendix C)</td></tr>
<tr><td>Coordinated Report</td><td>Preparation of Annual Coordinated Report</td></tr>
<tr><td>Terrestrial Monitoring</td><td>Dr. Paul F.J. Eagles
Paul F.J. Eagles Planning Ltd.
37 Hughson Street, Branchton, Ontario N0B 1L0
Phone: (519) 740-1590 or (519) 885-1211 ex.2716
Fax: (519) 746-6776</td><td>Terrestrial Biology Investigations</td></tr>
</table>

1.4 COORDINATED MONITORING REPORT

The first coordinated monitoring report filed for the Mill Creek Property was submitted March 31, 1995 (ESP *et al.* 1995). That report included background information and monitoring data collected in 1994. The purpose of the Coordinated Report is to summarize and integrate monitoring data collected for the previous year from the three different, but inter-related, disciplines: hydrology, hydrogeology and fisheries. This year represents the twenty-eighth Coordinated report and summarizes the monitoring data collected in 2022. Details of individual monitoring programs are included in the separate Technical Appendices to this report.

The current monitoring program includes an annual report for each monitoring component, except for terrestrial vegetation monitoring which is filed prior to the start of each new phase of extraction. The Pre-Phase Two Biological Monitoring Report was submitted to the MNRF in February of 2002 (Eagles Planning 2002). The Pre-Phase Three Environmental Monitoring Report was submitted to the MNRF in January 2006 (C. Wren & Associates Inc. and Jagger Hims Limited, 2006). Both reports were approved by the MNRF. In March 2002, Fisheries and Oceans Canada (DFO) released a report that reviewed the fisheries, hydrology and hydrogeology data collected to date for the Mill Creek Property and the Reid Heritage Pit (Blackport and Portt 2002). In addition to the data analysis and review, that report also evaluated the adequacy of the monitoring programs, and an assessment of impacts of the two gravel pits on the local water table, surface flow and the fisheries of Mill Creek. That report supported our conclusions that there had been no "sustained or significant changes in brown trout abundance" since aggregate extraction began at the University of Guelph property.

In mid-2004, the MNRF, supported by the aggregate operators, the Grand River Conservation Authority (GRCA) and the Township of Puslinch, initiated a cumulative impact assessment of the Mill Creek aggregate extraction area by Golder Associates Ltd. The first (of two) reports was finalized in November 2005. A draft of the second report was issued in November 2006 though it is our understanding that this report was never finalized. Both external peer reviews agreed that the Mill Creek Aggregates Pit operation had no discernible effect on the fisheries or water flow of Mill Creek.

The specific objectives of this report are as follows:

1. Summarize 2022 data collected on hydrogeology and surface water hydrology, and integrate them with fisheries biology data;
2. Compare 2022 groundwater levels with action thresholds to evaluate compliance;
3. Review monitoring results and make recommendations to revise the monitoring program if necessary; and
4. Review monitoring results and determine if mitigation or other actions are required.

1.5 WATERSHED ACTIVITIES

1.5.1 MILL CREEK EXTRACTION OPERATIONS

The Mill Creek Pit is surrounded by other aggregate operations (Figure 1). Significant aggregate extraction has occurred within the properties immediately to the north, east, and west of this site, and until 2007 at the property to the north of Highway 401. The design of the Mill Creek Aggregates pit and the associated monitoring program were developed and approved prior to other operations north and east of the site being approved and beginning extraction.

PIT OPERATION

Figure 1 shows the site details based on the most current (2019) approved extraction areas. In 2022, extraction occurred both above and below the water table in Phase 2, Phase 5 and Phase 6, as well as below the water table in Silt Pond 4 (SP4).

SILT PONDS

As part of routine operations, water is taken from the on-site pond in Phase 1 and used for aggregate washing (Figure 1). The wash water is directed to silt pond SP4/Phase 1 pond for settlement of the suspended silt.

The taking of water for washing aggregates, dust control, and water movement on-site is approved by Amended PTTW #5557-B93NZ5, issued on February 7, 2019 (which replaced the previously approved PTTW #8520-A48LDY through a renewal application). A Copy of the current approved PTTW is included in Appendix F of the separate Hydrogeology Technical Report.

1.5.2 OTHER EXTRACTION OPERATIONS

Other aggregate operators within the Mill Creek watershed near the Dufferin Aggregates Mill Creek pit include:

- CBM (St. Marys) Main Pit (Upstream);
- CBM McNally Pit (Upstream);
- CBM (formerly Puslinch Quality Aggregates) Mast Pit;
- Lafarge McMillan Pit;
- CBM McMillan Pit (no extraction since 2007, depleted);
- CBM Lanci Pit, and
- CBM Hohle Pit.

1.5.3 OTHER ACTIVITIES IN MILL CREEK

The Friends of Mill Creek (FOMC) was established in the fall of 1997 and is a working group with the primary objective of habitat rehabilitation in Mill Creek. The FOMC established a Stewardship Ranger program in 2003 which hires summer students to carry out the stream rehabilitation under the supervision of a trained fisheries biologist. The program is administered by the GRCA. The Mill Creek Stewardship Rangers were not permitted to work in this study area in 2019 due to concerns regarding the spill of Jet Fuel or between 2020 and 2022 due to COVID-19 safety measures in place.

Trout productivity and carrying capacity remains lower in the Hanlon reach compared with the University reach (also see Section 5.0) and Dufferin Aggregates and their biologists have previously recommended that fish habitat restoration again be undertaken within the Hanlon reach. In 2018, MTO expropriated a portion of the study area to secure a new Morrison By-pass route for Highway 6, therefore any potential habitat restoration plans will need to conform to MTO's construction plans for the by-pass.

Occasionally, beaver dam activity occurs within the study area. Beaver dams are a concern as they interrupt water flow and water levels, and likely also interfere with Brown trout spawning activity (migration). The Mill Creek Rangers removed a beaver dam from the study area in 2015, and in 2018 Dufferin retained trappers to remove beavers (at least five) from the adjacent lands. The Mill Creek Rangers were scheduled to remove another three beaver dams in 2019 but works were postponed due to the jet fuel spill and COVID-19 concerns. The Mill Creek Rangers were inactive between 2020 and 2022 as well due to the COVID-19 pandemic. Dufferin retained trappers to remove beavers from Mill Creek, and arranged for the Trout Unlimited stewardship crew, under the supervision of the GRCA, to demolish dams present within and immediately downstream of the site in September 2021.

2 SURFACE WATER HYDROLOGY

2.1 METHODS

Surface water hydrology is monitored to assess potential impacts of aggregate extraction on Mill Creek and involves the collection of water level, stream discharge, water temperatures and climatic data. Most of the surface water flow in Mill Creek within the Study Area originates upstream of the site. However, within the Study Area, additional water contributions include: a) groundwater discharge, b) local surface runoff and c) input from two tributaries (Galt Creek, Pond Creek).

Station SWM1 is located where Mill Creek flows onto the University Property and SWM2 is located where Mill Creek flows off the University Property (Figure 2). Stations SWM3 and SWM4 are in Pond Creek and Galt Creek, respectively. A summary of the 2022 monitoring methods is as follows.

- Water levels were logged hourly at stations SWM1 and SWM2, using model 3001 Solinst Leveloggers;
- Stream discharge was measured manually at stations SWM1 and SWM2 monthly, if wading conditions were safe to do so;
- Water temperatures were logged hourly at stations SWM1, SWM2, SWM3 and SWM4 using model 3001 Solinst Leveloggers;
- Air temperature and atmospheric pressure were logged hourly at Air Temperature Station 1 and Air Temperature Station 2 using Solinst Barologgers;
- Climate data (air temperature and precipitation) were obtained from the Grand River Conservation Authority (GRCA) Climate Station at Shade's Mills Conservation Area in Cambridge, Ontario (located in the lower Mill Creek watershed, approximately 10 km southwest of the Mill Creek property).

Atmospheric pressure data were used to correct the data from the in-stream loggers for changes in atmospheric pressure. All on-site data loggers were pre-programmed to record data 'on the hour', at the same time.

To estimate a stream discharge at each station, water levels (m) were converted to flow (m^3/sec) using rating curves. The equation of the best fitting stage-discharge curve at SWM1 and SWM2 was used to convert water level data (m above logger) into stream discharge rates (m^3/s).

Greater details on monitoring methods and rating curves development are provided in Technical Appendix A (Surface Water).

2.2 SURFACE HYDROLOGY RESULTS

2.2.1 CLIMATE DATA

AIR TEMPERATURE

Figure 2-1 shows the monthly average air temperatures observed in 2022 compared to the 30-year average. The mean monthly air temperature in 2022 was 8.9ºC, which is 0.6ºC higher than the 30-year average.

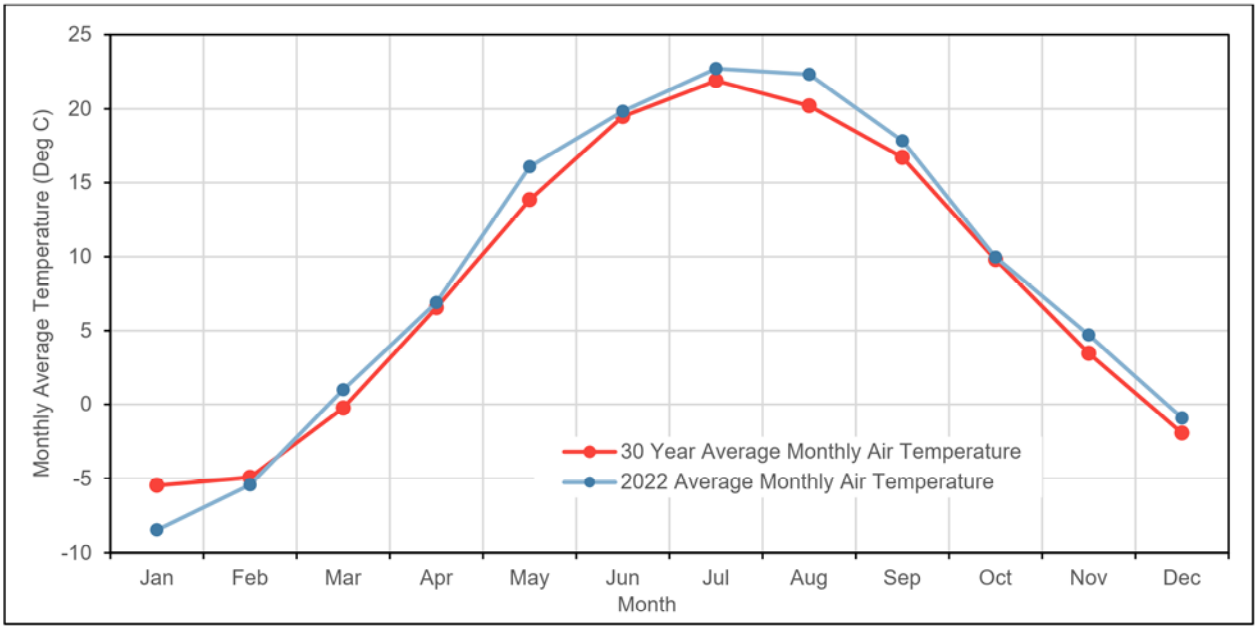


Figure 2-1 2022 GRCA Shade's Mills Mean Monthly Air Temperatures Compared to 30-year Normal Temperatures

PRECIPITATION

Monthly precipitation for 2022 is illustrated in Figure 2-2 along with the 30-year average. In 2022, total monthly precipitation was appreciably lower than the 30-year average for the month in eight months of the year. Total precipitation in 2022 was 682 mm, which is 27% lower than the 30-year average of 935 mm.

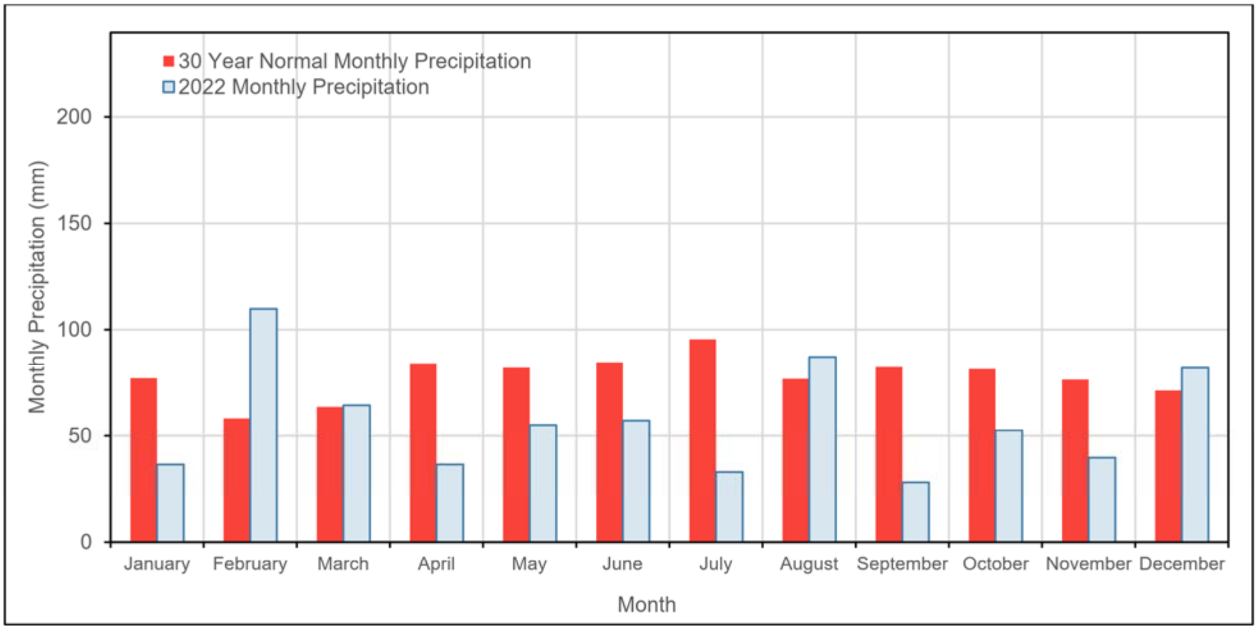


Figure 2-2 Total 2022 Monthly Precipitation (mm) at GRCA Shade's Mills Climate Station Compared to the 30-year Average

2.2.2 ANNUAL STREAM FLOW TRENDS

Detailed stream flow data are presented in Technical Appendix A and summarized below. Calculated flows at station SWM1 and SWM2 are presented in Figure 2-3 and Figure 2-4, respectively.

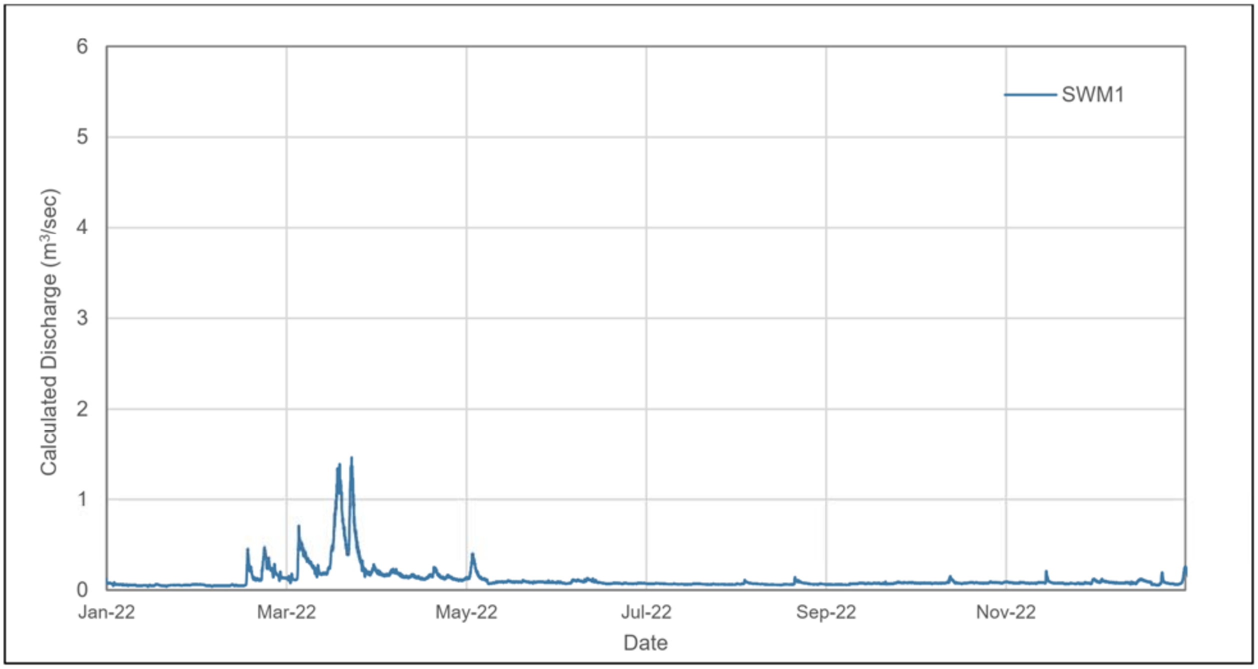


Figure 2-3 2022 Mill Creek Hourly Discharge at Surface Water Monitoring Station SWM1

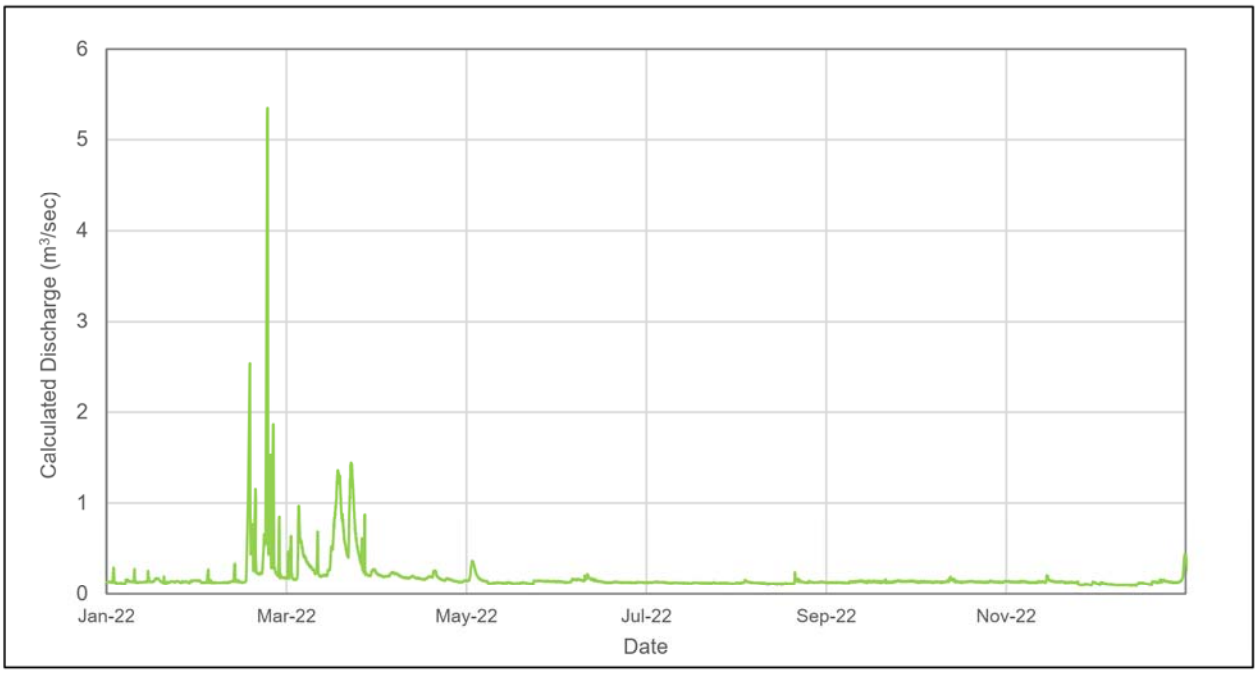


Figure 2-4 2022 Mill Creek Hourly Discharge at Surface Water Monitoring Station SWM2

RELATIONSHIP BETWEEN PRECIPITATION AND STREAM FLOW

Precipitation events recorded at the GRCA's Shade's Mills climate station are compared with calculated average daily stream discharge at SWM1 and SWM2 in Figure 2-5 and Figure 2-6, respectively. The plot of precipitation data with the flow data shows a strong correlation, as increased flows were often observed shortly after precipitation events. In the drier months, rainfall events did not always result in increases in discharge, which is likely attributed to higher soil infiltration and vegetative cover.

The maximum daily average flow at SWM1 in 2022 occurred on March 20, after 16 mm of precipitation occurred between March 16 and 20 and air temperatures rose above 0°C, which likely resulted in snow melt. The maximum daily average flow at SWM2 in 2022 occurred on February 22, which followed 63 mm of precipitation that fell between February 17 and 20 and air temperatures which rose above 0°C on February 22, which likely resulted in snow melt. The maximum average daily flow rates measured at SWM1 and SMW2 (1.26 and 2.64 m^3/s, respectively) are interpreted to be overestimated due to the lower accuracy of the rating curve formula at higher flows. These maximum values should, therefore, be interpreted with caution.

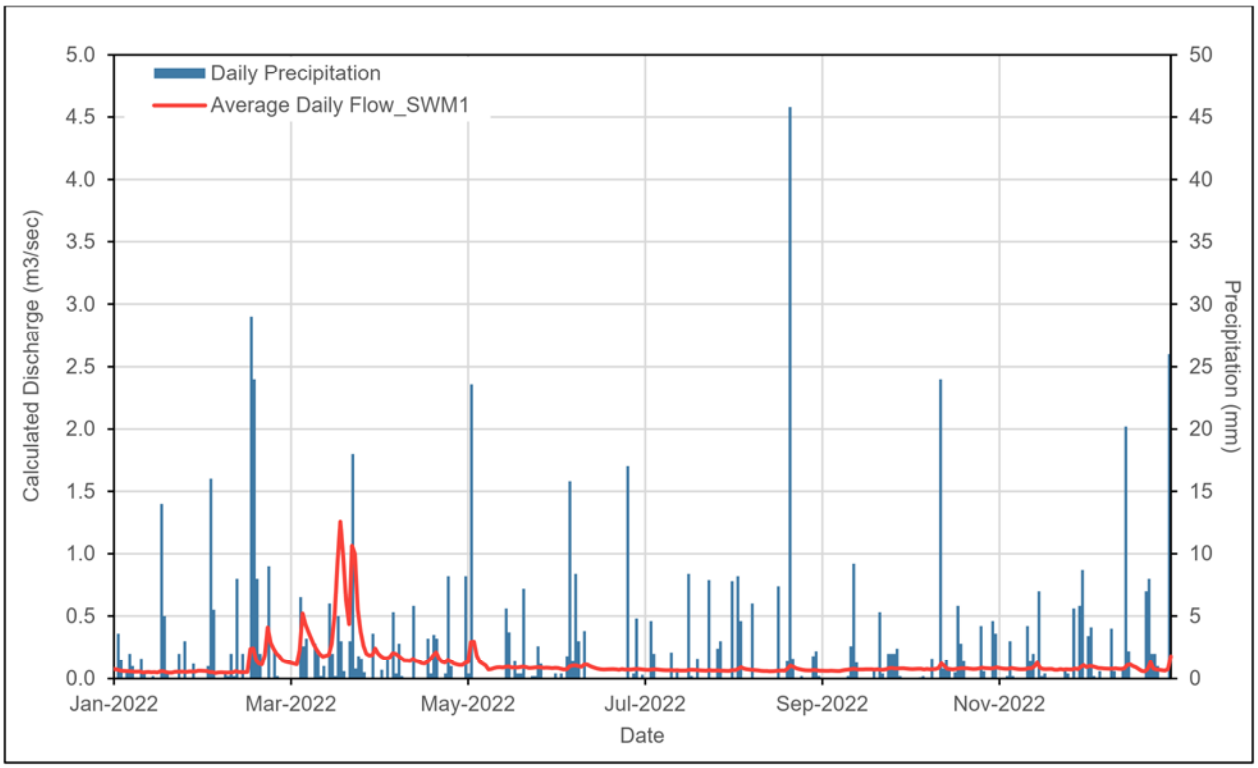


Figure 2-5 Daily Average Flow in 2022 at SWM1 Compared to Precipitation Events

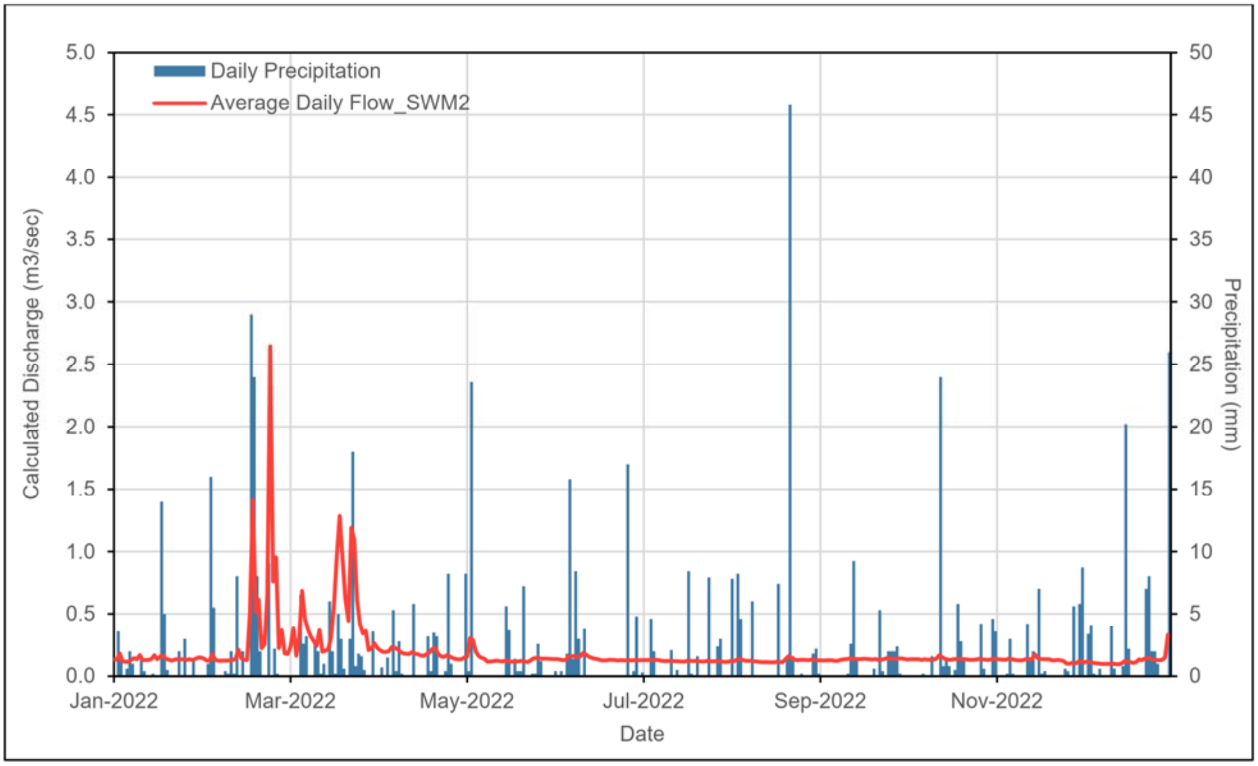


Figure 2-6 Daily Average Flow in 2022 at SWM2 Compared to Precipitation Events

MAXIMUM AND MINIMUM FLOWS

The minimum and maximum instantaneous flows recorded at stations SWM1 and SWM2, as well as corresponding dates when these flow events occurred, are provided in Table 2-1.

Table 2-1 2022 Minimum and Maximum Instantaneous Discharge Flows at Station SWM1 and SWM2

	SWM1		SWM2	
	Discharge (m^3/s)	Date	Discharge (m^3/s)	Date
Minimum Stream Discharge	0.038	14-Jan	0.090	15-Dec
Maximum Stream Discharge	1.46	24-Mar	5.35	24-Feb

Minimum and maximum instantaneous flows since 2000 are shown in Figure 2-7 and Figure 2-8 respectively, for stations SWM1 and SWM2.

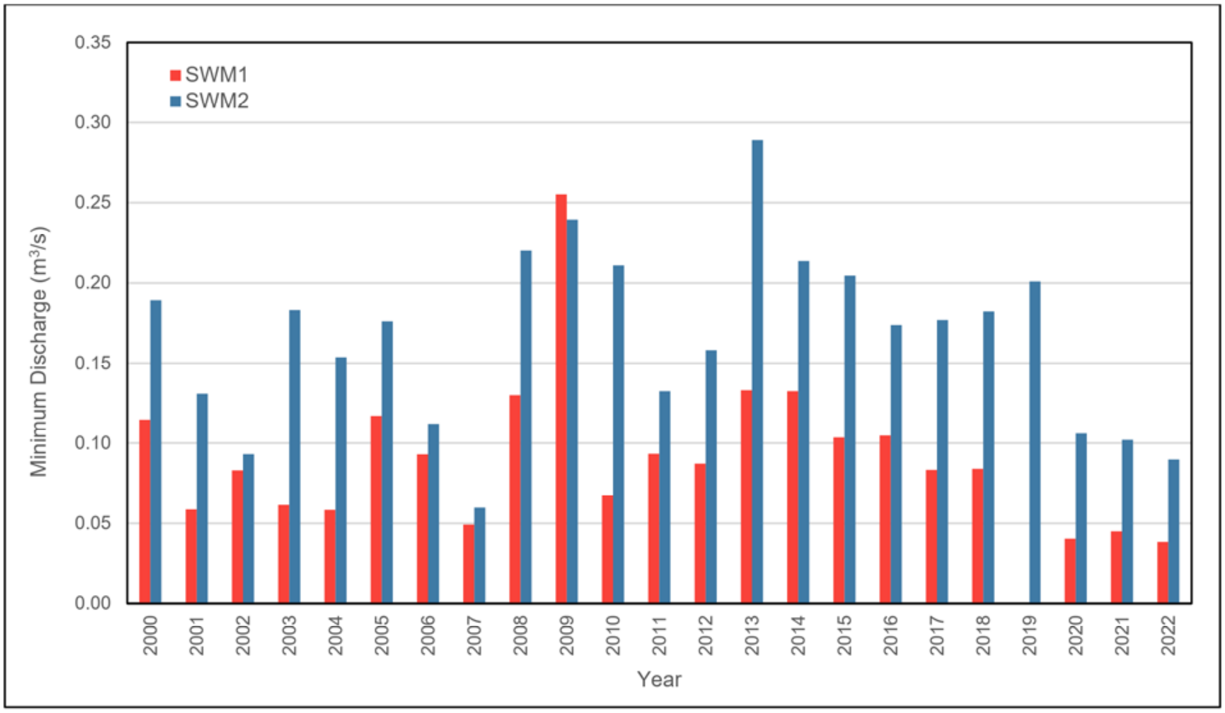


Figure 2-7 Instantaneous Minimum Stream Discharges at SWM1 and SWM2, 2000 through 2022

The 2022 minimum instantaneous stream discharge values at SWM1 and SWM2 are similar to the 2020 and 2021 minimum instantaneous stream discharge values. The 2022 minimum instantaneous stream discharge value at SWM1 is marginally lower than the historical range of values from SWM1, while the 2022 minimum instantaneous stream discharge value at SMW2 is within the historical range of values at SWM2, but the second lowest value recorded since 2000. The 2022 maximum instantaneous stream discharge values are within the historical range of values recorded since 2000.

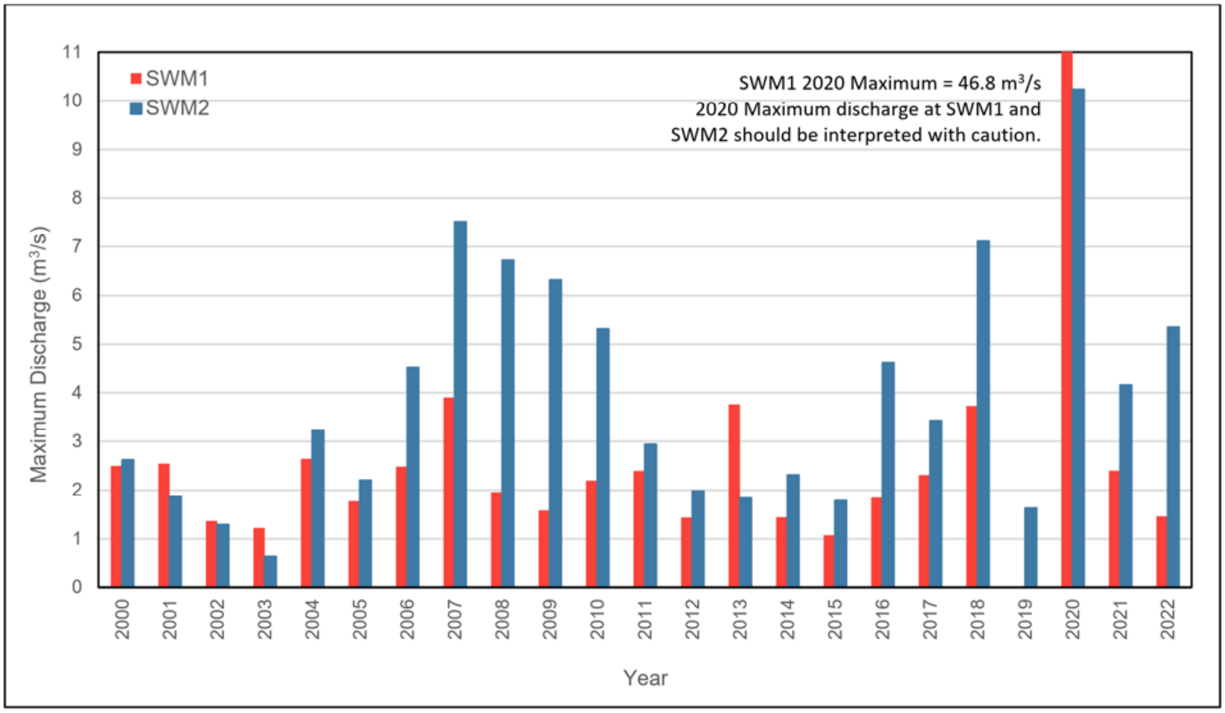


Figure 2-8 Instantaneous Maximum Stream Discharge at SWM1 and SWM2, 2000 through 2022

Estimates of peak flows may be less accurate than low flow estimates since the higher flow rates are well above manual measurements used for the rating curves. It is not safe for field staff to attempt manual flow measurements during periods of peak runoff.

2.2.3 HISTORICAL STREAM FLOW TRENDS

The 7-day low flow is a standard hydrological value which represents the average flow rate of the 7-day period of lowest flow for each year. The 7-day low flow at SWM2 is used to compare low flows over time for the Site. In 2022, the 7-day low flow at SWM2 was 0.098 m^3/s, which occurred from December 8 to 14. As discussed in Section 2.2.1 of this report, notably dry climatic conditions were observed during the months of April through July and September through November 2022, prior to the 7-day low flow at SWM2. In the absence of rainfall and runoff, the 7-day low flow likely represents baseflow conditions.

The 2022 7-day low flow at SWM2 is slightly lower than the 7-day low flow value from 2021 and 2007 and is the lowest value recorded since 2000. The average of the SWM2 7-day low flow values from 2000 to 2021 is 0.212 m3/s. The 2022 7-day low flow of 0.098 m3/s is considerably lower than the historic average. The lower 7-day low flow values recorded in 2020 and 2021 were attributed to the lower-than-normal amount of precipitation received in 2020 and the first five months of 2021. The low 7-day low flow value recorded in 2022 is attributed to the appreciably dry climatic conditions observed in 2022 and likely also reflects a cumulative impact from dry conditions in 2020 and 2021.

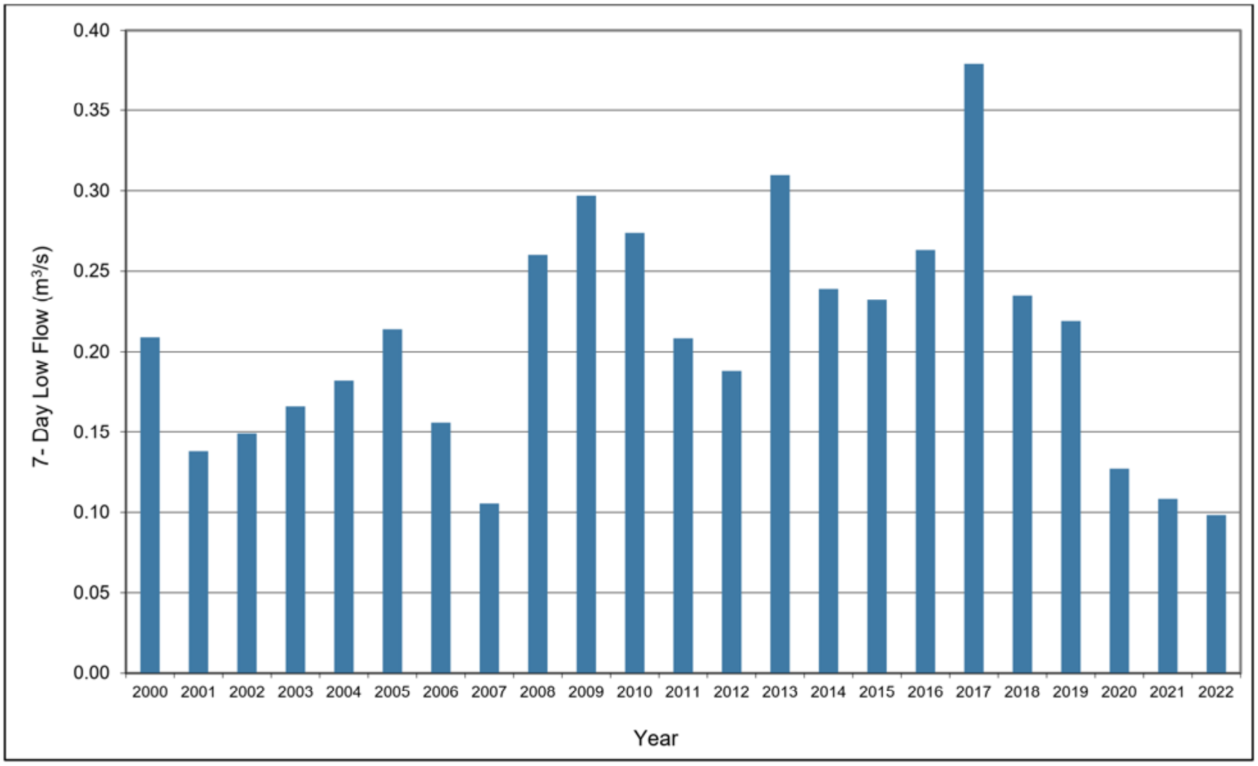


Figure 2-9 Seven Day Annual Low Flow Values at SWM2, 2000 through 2022

The daily average stream flow at SWM2 in summer months (June 21 to September 22 inclusive) is illustrated in Figure 2-10 to further examine if there have been any changes in stream flow over time. The flow data are presented as log transformed, in a box and whisker plot (boxplot). Boxplots are useful when comparing two or more datasets and allow for the visualization of flow data between years. The data were log transformed because variability in flow is high and the data are not normally distribution. With a log transfer, the data have a greater normal distribution and therefore, flow rate differences are more readily observed.

For the box & whisker plot, data within the box represents 50% of the summer daily average flows and data outside the box represent those daily average flows in the upper and lower quartiles (maximum and minimum calculated flows). The horizontal line within the box represents the median flow for the summer months.

In 2022, the boxplot indicates that the daily average flow was often closer to the minimum flow recorded for the year. Figure 2-10 also shows that a long-term fluctuating trend in daily average summer flows has occurred in Mill Creek since 2003, rather than an increasing or decreasing trend.

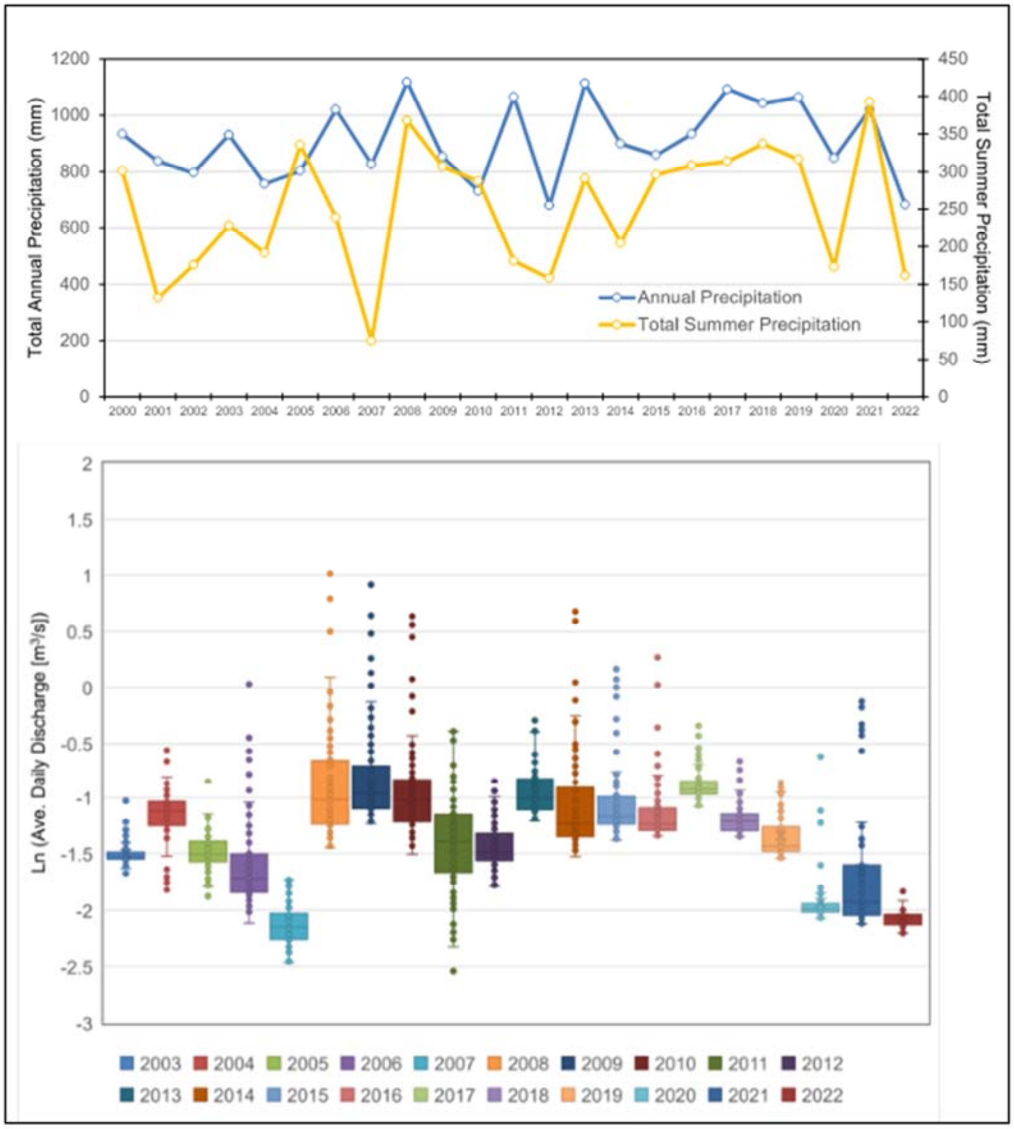


Figure 2-10 Boxplot of Mean Daily Average Summer (June-September) Stream Flows at SWM2, 2000 to 2022

2.3 SURFACE HYDROLOGY SUMMARY

The mean air temperature in 2022 was marginally higher than the 30-year average. Total precipitation in 2022 was 682 mm, which is 27% lower than the 30-year average of 935 mm. Appreciably dry conditions were observed in each month of 2022, except for February, March, August and December.

Overall, changes in discharge in Mill Creek were related to precipitation or snow melt periods. The maximum instantaneous flow calculated at SWM2 in 2022 was within the historic range. A long-term fluctuating stream flow trend is observed, rather than an increasing or decreasing trend, based on the historical summer flow data collected from the Site.

The 2022 7-day low flow at SWM2 is slightly lower than the 7-day low flow value from 2021 and 2007 and is the lowest value recorded since 2000 (Figure 2-10). The average of the SWM2 7-day low flow values from 2000 to 2021 is 0.212 m^3/s. The 2022 7-day low flow of 0.098 m^3/s is considerably lower than the historic average.

Based on the available data, there is no indication that aggregate extraction, or the resulting ponds, are affecting stream flow in Mill Creek on the University of Guelph property.

3 HYDROGEOLOGY

Groundwater monitoring has been conducted at the Mill Creek Property since late-1986. The principal objectives of the 2022 Annual Monitoring Program were as follows.

— To comply with the pertinent terms of the 2022 groundwater monitoring program;
— To provide an assessment of the effects of on-site aggregate extraction activities on the local groundwater and surface water setting;
— To determine and assess any changes in the groundwater quality;
— To document results in an annual monitoring report as part of a coordinated report; and
— To recommend any changes to the monitoring program for implementation in 2023.

Detailed results of the groundwater monitoring program are provided in Technical Appendix B (Hydrogeology).

3.1 METHODS

The methods and results of the hydrogeology program have been separated into a) Routine or historical procedures, and b) Groundwater thresholds, which were introduced in 2001. These are described in detail in Technical Appendix B.

The MNRF requires that Dufferin Aggregates submits a monthly summary checklist report, which is to be issued within 10 business days of the last day of the preceding month. The summary includes groundwater level data corresponding to threshold monitoring pairs, threshold values, and pond levels. Below-water table extraction (wet tonnes extracted/day), water pumped from the Phase 1 pond, water pumped from the Phase 4 pond, and monthly precipitation totals are also reported in the summary report. In the event that a threshold value/level is exceeded for any period, this would be included in the summary with appropriate comments attached. The monthly reports are included with the correspondence (Sub Appendix F) in Technical Appendix B.

3.1.1 ROUTINE MONITORING

At the request of the MNRF, a new monitor, designated BH14, was installed in June 2015 between monitor 92-12 and Mill Creek. A data logger was installed in BH14 to record automatic groundwater level and temperature data. The purpose of monitor BH14 is to detect any groundwater temperature changes caused by extraction activities in Phase 5 which commenced in 2019. It is noted that it is not anticipated that extraction activities in Phase 5 will impact the water temperature in Mill Creek.

There are various types of groundwater monitoring stations established on, and adjacent to, the property. Monitor types are described below and summarized in Table 3-1, Locations of the groundwater monitoring stations are shown in Figure 3.

Table 3-1 Groundwater Monitor Groupings at the Mill Creek Property

BEDROCK	SAND AND GRAVEL		WETLAND	CREEK
TW16-78	Boreholes	Multi-level	Drive points	Drive Points
Well 4794	1*	92-13	DP6	DP1
	1-R	92-14*	DP7	DP2
	2*	92-15*	DP8	DP3
	2-R	92-28	DP9	DP4*
	3	92-29	DP10	DP4R
	4	92-32	DP11	DP5A*
	5	92-33	DP12	DP5B*
	6		DP16	DP5C*
	7-I*			DP5CR
	7-II*	Observation and Test Wells		DP17*
	11			DP17R
	12*	TW16-79		DP18
	13	OW1-84		DP19
	14	OW2-84		DP20
	CBM1*	OW4-84	DP113	DP21
	CBM2*	OW5-84		DP22
	CBM3*	OW16A-78		
	92-1*			
	92-1R			
	92-5			
	92-8			
	92-12			
	92-26			
	92-27			

* indicates monitor was decommissioned/removed/replaced and is no longer included in monitoring program

1 Drilled stratigraphic boreholes within, or adjacent to, the property. These are instrumented with standpipes to measure the elevation of the water table in the shallow soil sequence.

Monitors (manual):

- Borehole Monitors at BH1/1R, BH2-R, BH3 to BH6, BH11, BH13, BH14
- the OW (observation well) and TW (test well) monitors adjacent to Mill Creek near the southwest corner of the site
- monitors that were installed at selected locations in the 1992 resource boreholes across the property (92-series of stations)

Frequency:

- monthly
- more frequently at BH13, OW5-84, 92-12, 92-27, and 92-29, which are included in a threshold pair

2 Shallow water table drive point monitors

Monitors (manual):

- DP6 to DP12 and DP16 in the wetland areas (Mill Creek Property)
- DP113 north of Highway 401 (Reid Heritage Property)

Frequency:

- monthly
- more frequently at DP6, which is included in a threshold pair

3 In-stream drive point monitors.

Monitors (manual):

- In-stream drive point monitors DP1 to DP4/4R, DP5CR, and DP17R to DP22. Measurements at the Mill Creek drive point monitors included groundwater levels and temperatures, and surface water levels and temperatures. In addition, surface water levels are monitored at stations SW1 and SW2, both of which are located in Mill Creek.

Frequency:

- Monthly,
- More frequently at DP1, DP2, DP3, DP5CR, DP17R, DP21, which are included in a threshold pair.

4 Multi-level nests equipped with data loggers. These monitors have combination water level pressure transducers and temperature probes (installed in Nov. 2006).

Monitors:

- 92-28, 92-29, and 92-32 – west side of property adjacent to Mill Creek – installed in November 2006 as part of extraction monitoring in Phase 3.
- 92-27 (a data logger was installed in December 2011 for the purpose of collecting groundwater level and temperature data from the shallow part of the aquifer) - west side of property adjacent to Mill Creek.
- 92-33 (a data logger was installed in March 2012 for the purpose of collecting groundwater level and temperature data from the shallow part of the aquifer. The previous permanent, non-removable multi-level pressure transducer and thermistor instrumentation malfunctioned at monitor nest 92-33 in 2010. A second shallow data logger was installed at 92-33 in October 2017 at a depth similar to the previous (i.e. pre-2012) shallow data logger.) – west side of property adjacent to Mill Creek.
- 92-12 (a data logger was installed in June 2012 for the purpose of collecting groundwater level and temperature data from the shallow part of the aquifer) – centre of property adjacent to Phase 4 operations
- 92-13 (a data logger was installed in May 2013 for the purpose of collecting groundwater level and temperature data from the shallow part of the aquifer) – east side of property adjacent to Phase 1.
- BH4, DP7, DP8, DP9 and DP16 – centre of property adjacent to Phase 4 operations. These are single level data logger installations.
- A data logger was installed in BH14, located between Monitor 92-12 and Mill Creek, in June 2015.

Frequency:

- Readings of water level (pressure) and temperature were recorded by data loggers once per day. The data were downloaded monthly for review.

5 Water Wells

- As in previous years, and although not part of the 1993 "official" monitoring program, water wells located on the property, and a well supplying a local resident in the vicinity of the property, were monitored monthly. Water level monitoring began in the summer of 1994 at select locations.

6 Pond Staff Gauges

- Surveyed staff gauges were maintained in the Phase 1 pond, Phase 2 pond, Phase 3 pond, and Phase 4 pond. Starting in 2013, a new staff gauge was installed at the east end of the silt pond SP3 northerly extension, which represents water levels in both silt pond SP3 and the Phase 4 pond, since they are hydraulically connected. Measurements of pond water levels were completed daily during the ice-free period through 2022. Pond temperatures were measured monthly during the ice-free period.

The results of the routine groundwater monitoring program are summarized in Section 3.2 in the following order.

- Bedrock Aquifer (Section 3.2.1)
- Sand and Gravel Aquifer (Section 3.2.2)
- Wetland Monitors (Section 3.2.3)
- Mill Creek Drive Points (Section 3.2.4)

3.1.2 THRESHOLD MONITORING

On June 27, 2001, and following detailed negotiations with MNRF and other regulatory agencies, Dufferin Aggregates issued a document entitled Mill Creek Aggregates Interim Groundwater Threshold and Action Response Plan. Interim thresholds and early warning values were set at six locations across the site, and each location includes a pair of groundwater monitors (Figure 4). The thresholds are based on maintaining positive seasonal hydraulic head differences on the water table between the monitor pairs, such that a hydraulic gradient will continue to exist from the site toward Mill Creek.

The thresholds and early warning values were Id to ensure that the quantity of groundwater that discharges to Mill Creek does not decline below a minimum level, and they are based on seasonal historic low water level data. A summary of thresholds for groundwater monitoring pairs and the on-site ponds is provided in Table 3-2. The monitoring program and development of threshold monitoring pairs has undergone refinement, with MNRF approval, since 2001.

Table 3-2 Summary of Thresholds for Groundwater Monitoring Pairs and the On-Site Ponds

MONITOR PAIR/LOCATION	THRESHOLD VALUES	EARLY WARNING
(11) (1) BH13 to $DP21_{in}$ – East of Hanlon Interchange to Creek	Spring: 0.11 m head difference (305.60mASL) Summer: 0.10 m head difference (305.49mASL) Fall: 0.09 m head difference (305.58mASL) Winter: 0.11 m head difference (305.66mASL)	0.13 m head difference 0.12 m head difference 0.11 m head difference 0.13 m head difference
(2) BH92-12 to $DP17R_{in}$ – East of Hanlon interchange to Creek	Spring: 0.14m head difference (305.17mASL) Summer: 0.06 head difference (305.17mASL) Fall: 0.04 m head difference (305.17mASL) Winter: 0.07 m head difference (305.17mASL)	0.19 m head difference 0.12 m head difference 0.09 m head difference 0.13 m head difference
(3) $DP6_{in}$ to $DP3_{in}$ – South of Hanlon Interchange to Creek	Spring: 0.73 m head difference (304.54mASL) Summer: 0.58 m head difference (304.54mASL) Fall: 0.55 m head difference (304.54mASL) Winter: 0.57 m head difference (304.54mASL)	0.84 m head difference 0.76 m head difference 0.73 m head difference 0.69 m head difference
(4) BH92-29 to $DP1_{in}$ - Northwest corner of site; west of approved Phase 3 extraction area	Spring: 0.17 m head difference (303.97mASL) Summer: 0.23 m head difference (303.91mASL) Fall: 0.19 m head difference (303.96mASL) Winter: 0.29 m head difference (303.88mASL)	0.22 m head difference 0.28 m head difference 0.24 m head difference 0.34 m head difference
(5) BH92-27 to $DP2_{in}$ -West of approved Phase 3 extraction area	Spring: 0.34 m head difference (303.69 mASL) Summer: 0.32 m head difference (303.50 mASL) Fall: 0.34 m head difference (303.55 mASL) Winter: 0.43 m head difference (303.65 mASL)	0.39 m head difference 0.37 m head difference 0.39 m head difference 0.48 m head difference
(6) OW5-84 to $DP5C_{in}$ – Southwest corner of site downgradient from SP1 to Creek	Spring: 0.30 m head difference (302.86) *Revised: 0.18 m head difference (302.86)** Summer: 0.25 m head difference (302.79) *Revised: 0.15 m head difference (302.79)** Fall: 0.25 m head difference (302.84) *Revised: 0.15 m head difference (302.84)** Winter: 0.30 m head difference (302.88) *Revised: 0.20 m head difference (302.88)**	0.34 m head difference *0.21 m head difference** 0.28 m head difference *0.18 m head difference** 0.28 m head difference *0.18 m head difference** 0.34 m head difference *0.23 m head difference**
(7) Phase 1 Pond	305.5 mASL – All seasons	305.75 mASL – All seasons
(8) Phase 2 Pond	305.0 mASL – All seasons	305.30 mASL – All seasons
(9) Phase 3 Pond	303.85 mASL – All seasons	304.10 mASL – All seasons
(10) Phase 4 Pond	304.50 mASL – All seasons	305.10 mASL – All seasons
(11) Silt Pond SP3	Maximum: 307.1 mASL Minimum: 304.85 mASL	Maximum: 306.85 mASL Minimum: 305.10 mASL

Thresholds and action response plan came into effect on June 30, 2001.
Values in brackets refer to minimum water level elevations at monitors DP21, DP17R, DP1, DP2, DP3, DP5C/CR.
Seasons are as follows: WINTER = Jan. to Mar. inclusive, SPRING = Apr. to Jun. inclusive
SUMMER = Jul. to Sep. inclusive, FALL = Oct. to Dec. inclusive

** indicates revised thresholds approved on June 30, 2022*

3.2 RESULTS OF GROUNDWATER MONITORING

3.2.1 BEDROCK AQUIFER

As noted in Table 3-1, there are two water wells on the property that were developed within the bedrock aquifer: TW16-78 and North Farmhouse Well 4794. Water level data for these wells are provided in Technical Appendix B.

The water levels (as far as could be monitored) recorded in the bedrock aquifer wells exhibited normal seasonal trends that reflected prevailing climatic conditions and were not affected by pit operations.

3.2.2 SAND AND GRAVEL AQUIFER

The following section describes both groundwater levels and temperature.

GROUNDWATER LEVELS

The monitors that are screened in the sand and gravel aquifer are noted in Table 3-1.

Compared to 2021, water levels in the representative monitors were, on average, 0.03 m lower (92-32) to 0.02 m higher (1-I) in 2022. The average water levels remained similar from 2021 to 2022 due to the higher levels observed in spring 2022 being offset by the lower levels observed in the fall of 2022. In 2022, average water levels at the individual monitors ranged from approximately 0.1 m above ground surface to 8.5 m below ground surface across the site, and fluctuations ranged from 0.3 m to 0.7 m during 2022. In 2022, the maximum and minimum water levels at the monitors were within their historical ranges, with two exceptions. In September 2022, the water level at BH14 was 0.01 m lower than the historic range of levels recorded since monitoring began in 2015 and in November 2022, the water level at 92-12 was 0.01 m lower than the historic range of levels recorded since monitoring began in 2001.

The interpreted low water table configuration illustrated in Figure 5 indicates that groundwater continues to move from east to west across the northern property. The water table contours south of Highway 401 tend to "bend back" toward the creek, indicating that the creek receives groundwater discharge from the subject property along the reach south of Highway 401. Typically, water table contours bend back further (i.e., more strongly) under high flow water table conditions, indicating an increased component of groundwater flow northwestward toward the creek near the Hanlon interchange and to the west.

GROUNDWATER TEMPERATURE

Shallow groundwater monitoring immediately downgradient of the pit ponds show the influence of the ponds on groundwater temperatures and that temperatures quickly dissipate within a short distance from the ponds. For example, at the west side of the site, shallow groundwater temperatures at Monitor 92-29 have increased while the shallow groundwater temperatures at Monitor 92-28, located between Monitor 92-29 and Mill Creek, have remained relatively stable (Figures 3-1 and 3-2).

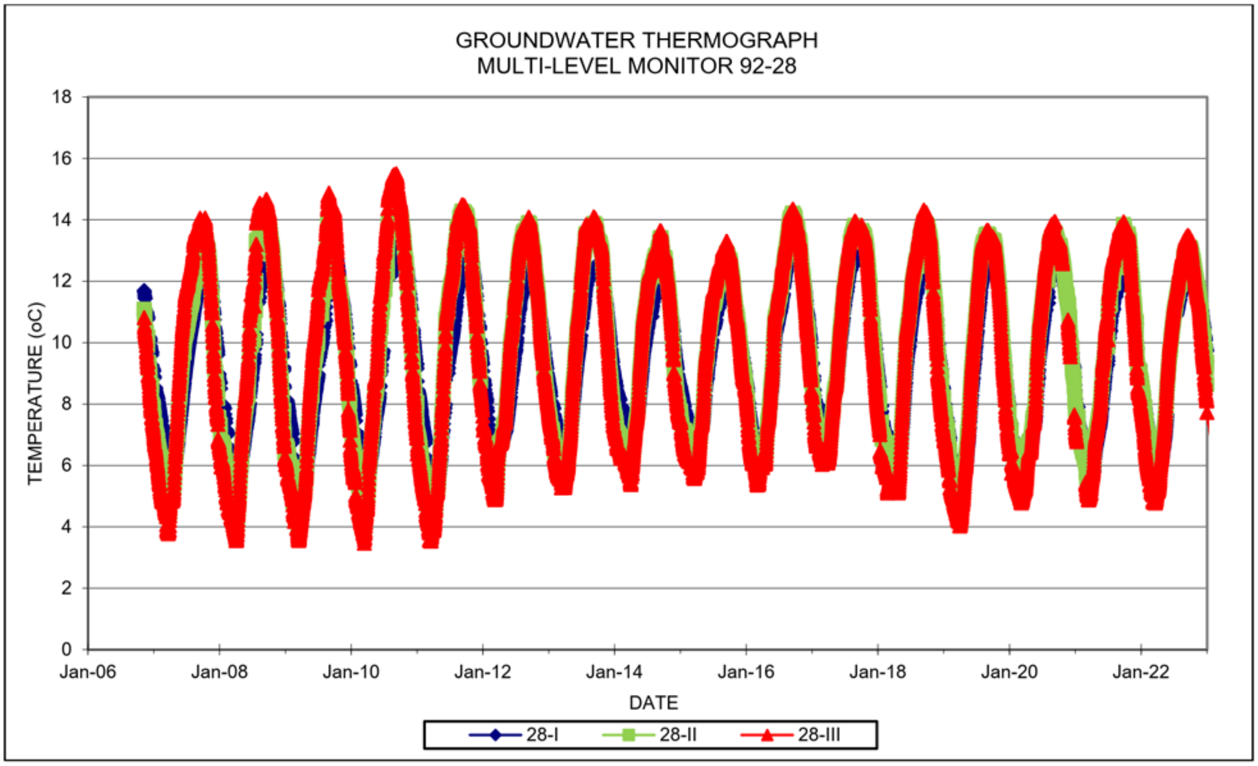


Figure 3-1 Groundwater Thermograph of Multi-level Monitor 92-28

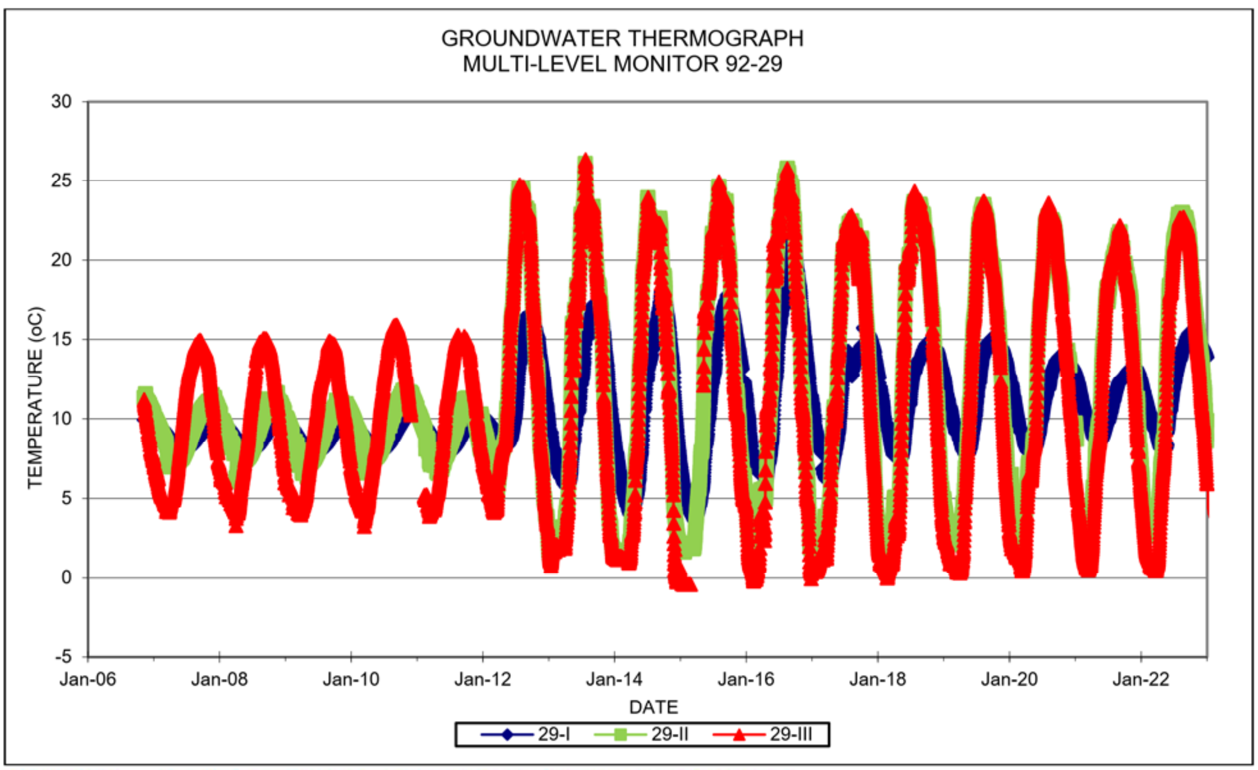


Figure 3-2 Groundwater Thermograph of Multi-level Monitor 92-29

Further downgradient of 92-29 is DP1, located in Mill Creek. 92-29 and DP1 represent a monitoring pair for Threshold pair monitoring (see Section 3.2.5). The thermograph for DP1 (Figure 3-3) suggests that development of the Phase 3 pond in 2012 has not influenced groundwater temperatures in Mill Creek to any notable degree.

Monitor 92-27 is also adjacent to the Phase 3 pond, and with DP2 represents a threshold monitoring pair. This threshold pair exhibits a similar groundwater temperature relationship as the 92-29 to DP1 threshold pair. Similar to DP1, the thermograph for DP2 (Figure 3-4) suggests that development of the Phase 3 pond in 2012 has not influenced groundwater temperatures in Mill Creek to any notable degree. However, there does appear to be a subtle almost 2°C increase in groundwater temperature at DP1 and DP2 that began prior to operational activities in this area and may be a regional phenomenon, as suggested by a similar subtle increasing trend observed at upstream drive point DP20 (Figure 3-5).

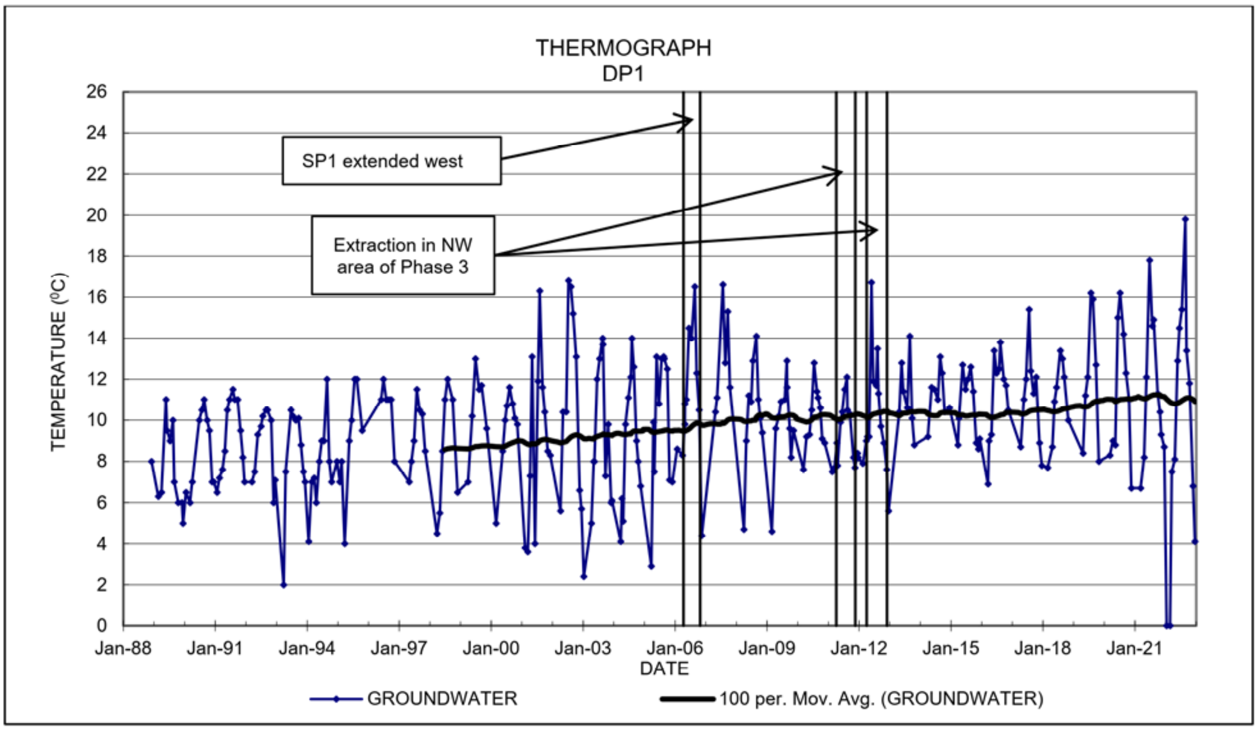


Figure 3-3 Groundwater Thermograph of Drive Point DP1

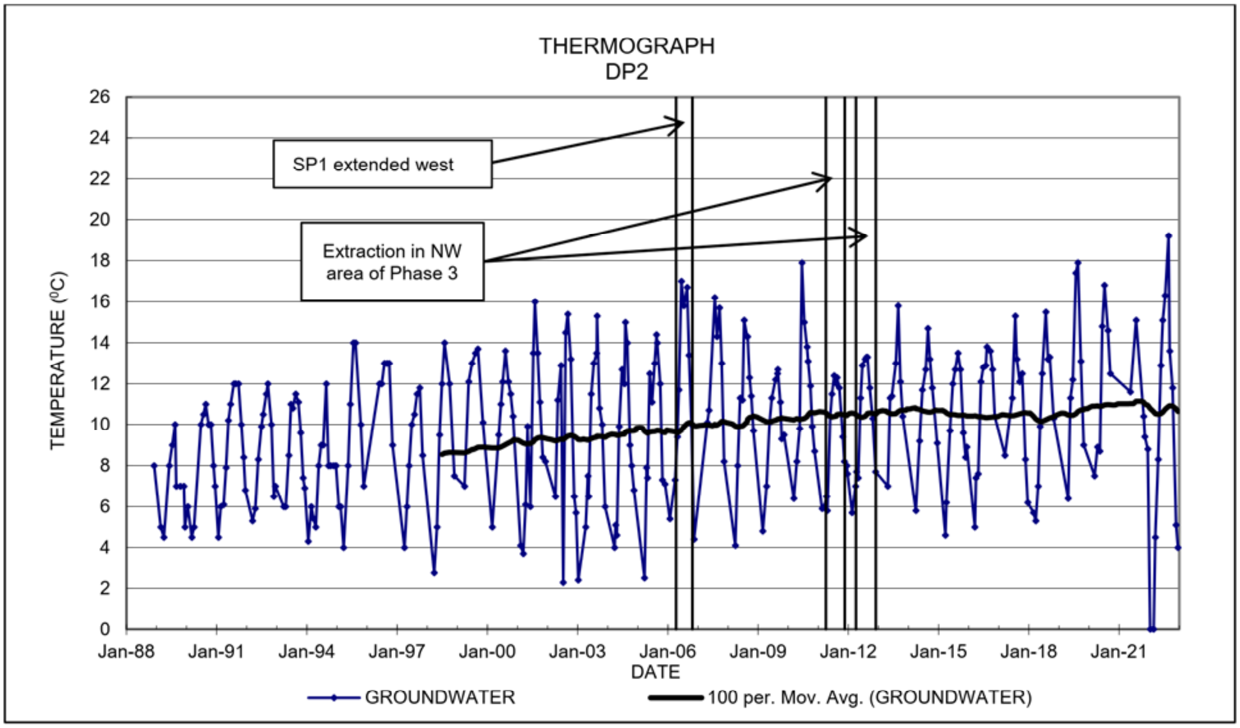


Figure 3-4 Groundwater Thermograph of Drive Point DP2

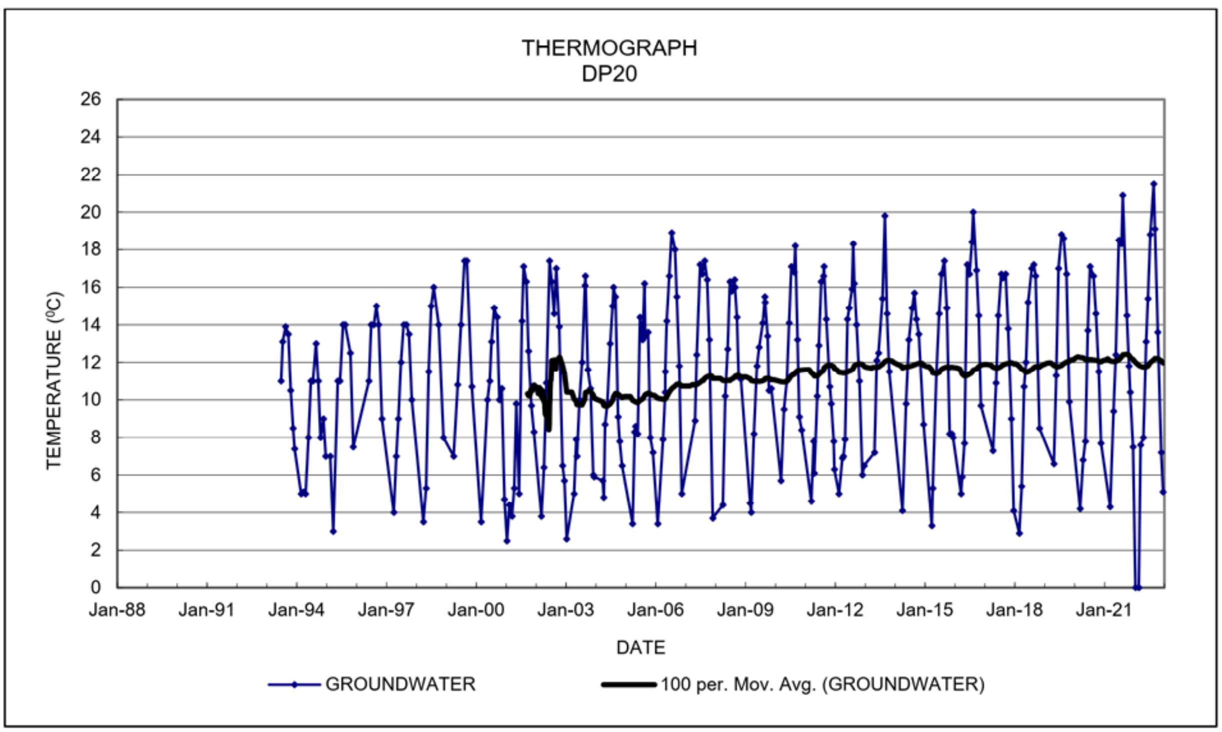


Figure 3-5 Groundwater Thermograph of Drive Point DP20.

3.2.3 WETLAND WATER LEVELS

The drive point monitors that are located in the wetland are noted in Table 3-1. Monitors DP6 to DP12 are located in the large wetland area in the north-central part of the property. DP15 was located in a wetland pocket in the northwestern part of the property and was removed due to extraction after August 2011, and DP16 is located in the wetland along the western side of the property. A groundwater hydrograph of three representative drive points in the wetland is presented in Figure 3-6. As shown in the hydrograph, of the three representative drive points, the groundwater elevation at DP7 is typically highest, and the lowest elevations occur at DP11. This is expected, as DP7 is located furthest from Mill Creek and DP11 is closest, and groundwater flow is toward Mill Creek at the site. Hydrographs for all wetland drive points are provided in Technical Appendix B.

Monitoring of wetland drive points on the Reid Heritage property adjacent to Mill Creek north of Highway 401 commenced in August 2000, and those monitors were incorporated into the routine monitoring program. Each of these drive points have now been removed except for DP113, located immediately north of Hwy 401.

Historically, the groundwater levels within the wetland remained reasonably close to ground surface throughout the year. The water levels are nearest to ground surface, and in some instances above ground surface, mostly during the spring melt. The groundwater levels then show a progressive decline to their maximum depth below ground surface during the summer to early fall months. The fluctuations between the spring high water levels to the summer low water levels usually range from 0.1 m to 1.0 m, depending on the location.

The groundwater level recorded within the wetland areas in 2022 averaged about 0.12 m below the historical average, and about 0.06 m below the 2021 average for the site. The lower levels compared to 2021 are attributed to the lower water surplus that occurred at the site in 2022 compared to historic results. The decrease in water levels within the wetland areas generally is less than the decrease experienced at other locations across the site. This is primarily due to the proximity of the wetland areas to Mill Creek, which acts as a buffer, or hinge point, for the water table that reduces the magnitude of seasonal variations. The wetland groundwater levels recorded in 2022 were within the historical maximum and minimum groundwater levels. An aggregate extraction influence is not apparent.

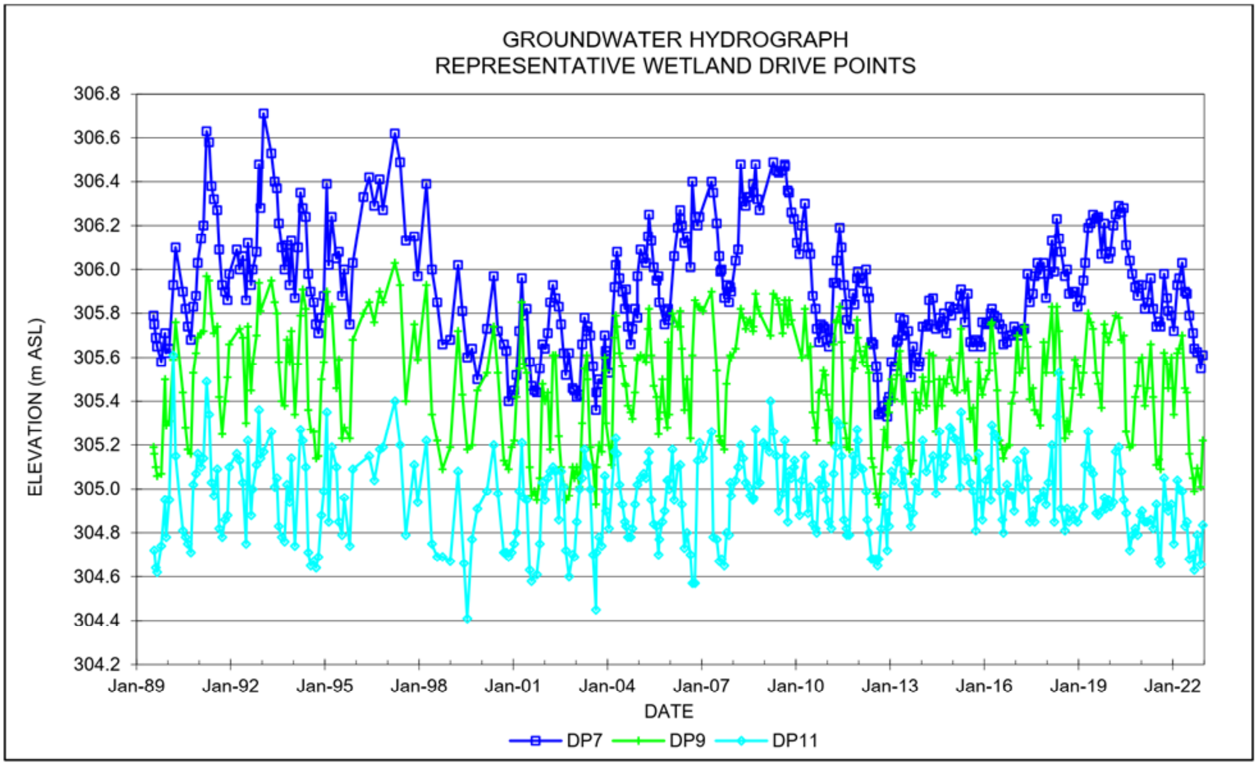


Figure 3-6 Groundwater Hydrograph of Three Representative Drive Points in the Wetland

3.2.4 MILL CREEK DRIVE POINTS

GROUNDWATER LEVEL

The drive point monitors in the creek bed are listed in Table 3-1 with their locations shown on Figure 3. Detailed data for hydraulic head and groundwater flux for the in-stream drive points are provided in Technical Appendix B.

The yearly average vertical hydraulic gradients for the in-stream drive points from 2021 to 2005, are shown in Table 3-3 as well as the annual historic average from the start of data collection (1988 to 1993) to 2005.

Table 3-3 Average Vertical Hydraulic Gradient

DRIVE POINT	2022	2021	2020	2019	2018	2017	2016	2015	2014	2013
DP5A/B/C/CR	0.68	0.66	0.55	0.52*	0.54	0.47	0.18	0.21	0.28	0.18
DP2	0.24	0.25	0.24	0.25	0.26	0.25	0.33	0.34	0.29	0.33
DP1	0.28	0.23	0.20	0.25	0.27	0.25	0.33	0.33	0.37	0.37
DP3	0.06	0.06	0.05	0.04	0.07	0.04	0.06	0.05	0.05	0.05
DP17/R	0.04	0.04	0.06	0.05	0.07	0.06	0.04	0.05	0.03	0.03
DP22	0.04	0.04	0.06	0.07	0.07	0.08	0.05	0.05	0.08	0.05
DP4/R	0.03	0.02	0.06	0.13	0.13	0.16	0.10	0.14	0.17	0.11
DP21	0.08	0.07	0.12	0.08	0.06	0.11	0.03	0.06	0.08	0.07
DP20	-0.07	0.08	0.11	0.13	0.08	0.14	0.10	0.12	0.12	0.14
DP19	-0.20	0.03	0.06	0.05	0.02	0.01	-0.03	-0.01	0.06	0.03
DP18	-0.09	0.15	0.10	0.10	0.06	0.12	0.08	0.11	0.09	0.10

DRIVE POINT	2012	2011	2010	2009	2008	2007	2006	2005	HISTORIC AVERAGE (UP TO 2005)
DP5A/B/C/CR	0.40	0.19	0.18	0.12	0.12	0.09	0.09	0.11	0.09
DP2	0.32	0.30	0.30	0.24	0.22	0.22	0.21	0.14	0.17
DP1	0.30	0.31	0.27	0.21	0.22	0.19	0.21	0.23	0.22
DP3	0.06	0.06	0.07	0.06	0.06	0.06	0.06	0.05	0.04
DP17/R	0.03	0.04	0.06	0.05	0.06	0.04	0.04	0.04	0.02
DP22	0.04	0.06	0.06	0.09	0.09	0.06	0.07	0.06	0.03
DP4/R	0.08	0.12	0.15	0.22	0.20	0.12	0.12	0.09	0.04
DP21	0.05	0.09	0.10	0.14	0.16	0.11	0.11	0.08	0.06
DP20	0.08	0.10	0.11	0.19	0.15	0.14	0.14	0.12	0.00
DP19	0.00	0.04	0.04	0.12	0.09	0.04	0.05	0.07	-0.06
DP18	0.07	0.08	0.07	0.13	0.12	0.06	0.07	0.08	0.03

NOTES:

1) (-) = downward vertical gradient
2) Because of several drive point replacements due to vandalism, DP5 data from 2012 onward are interpreted with caution.
3) * Due to the presence of a beaver dam downstream of DP5CR, DP5CR data for 2019 are interpreted with caution.

The hydrographs for the drive point monitors show the seasonal changes in elevation of the groundwater at each monitor, together with the surface water elevation data for the creek. Hydraulic gradients for select drive points (DP2, DP3, DP17, DP19 and DP21) are shown in Figures 3-7 to 3-11. The following patterns and trends were observed in 2022:

- Based on the average condition through 2022, upward gradients between the groundwater and the creek occurred from where Mill Creek crosses highway 401 (DP21) downstream to DP5CR. Groundwater discharge continues to provide base flow to these reaches of Mill Creek. As shown in the preceding table, the magnitude of the average vertical hydraulic gradient is variable from DP21 downstream to DP5A/B/C/CR, with the strongest upward gradients being observed at DP1, DP2, and DP5A/B/C/CR, and the weakest upward gradients in the creek between DP4/R, DP22 and DP17/R. Between 1998 and 2005, downward vertical gradients persisted in the reach north of Highway 401, from DP18 down to about DP20, for much of each year. From 2005 to June 2022, the vertical gradients at these drive points remained upward, with the exception of neutral and downward vertical gradient conditions on average over the course of the year at DP19 in 2012 and in 2015 and 2016, respectively (varied between downward and upward gradient conditions). Beginning in July 2022, strong upward gradients were consistently observed within the reach north of Highway 401, which is caused by a notable decrease in groundwater level recorded at the drive point locations. The cause of the sudden change in gradient is not apparent; however, it is interpreted to be related to upgradient activities. In 2022, the average vertical hydraulic gradients were higher than the 2021 values at DP1, DP4/R, DP5CR and DP21; equal to the 2021 values at DP3, DP17/R and DP22; and lower than the 2021 values at the remaining in-stream drive points. The difference between the 2022 average and the 2021 average at the locations north of Highway 401 was -0.24 m, -0.23 m and -0.15 m at DP18, DP19 and DP20, respectively. The difference between the 2022 average and the 2021 average at the remaining locations ranged between -0.01 at DP2 and 0.05 at DP1. The 2022 average vertical hydraulic gradients at the creek drive points were generally higher than the pre-2005 averages, with the exceptions of the locations north of Highway 401. This overall increase in hydraulic gradients likely reflects a buffering effect due to the presence of the Phase 1, Phase 3, and Phase 4 ponds, and translates into a proportional increase in the groundwater discharge to Mill Creek. This is discussed in further detail later in this section.
- Generally, the seasonal fluctuation of the surface water elevation in Mill Creek at the drive point monitors was similar to the variation of the groundwater elevation in 2022. Historically, greater seasonal groundwater fluctuations have been observed compared to surface water fluctuations.

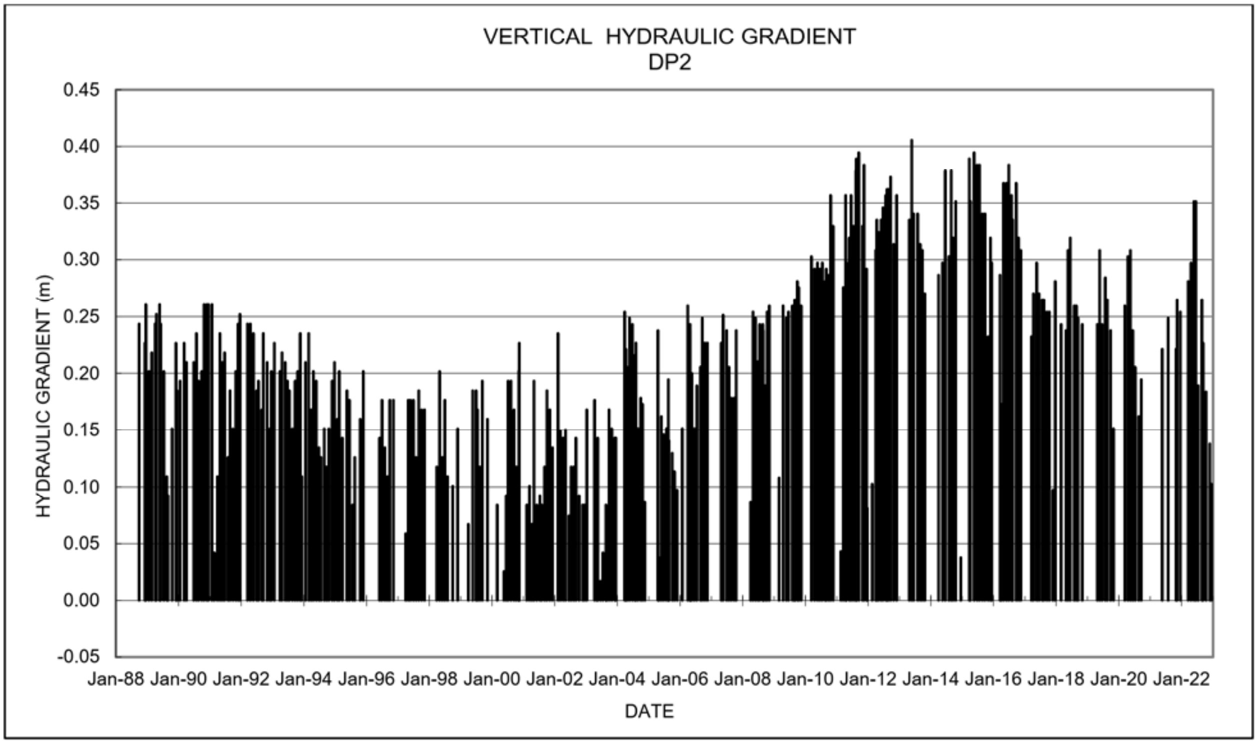


Figure 3-7 Hydraulic Gradient at Stream Drive Point Station DP2

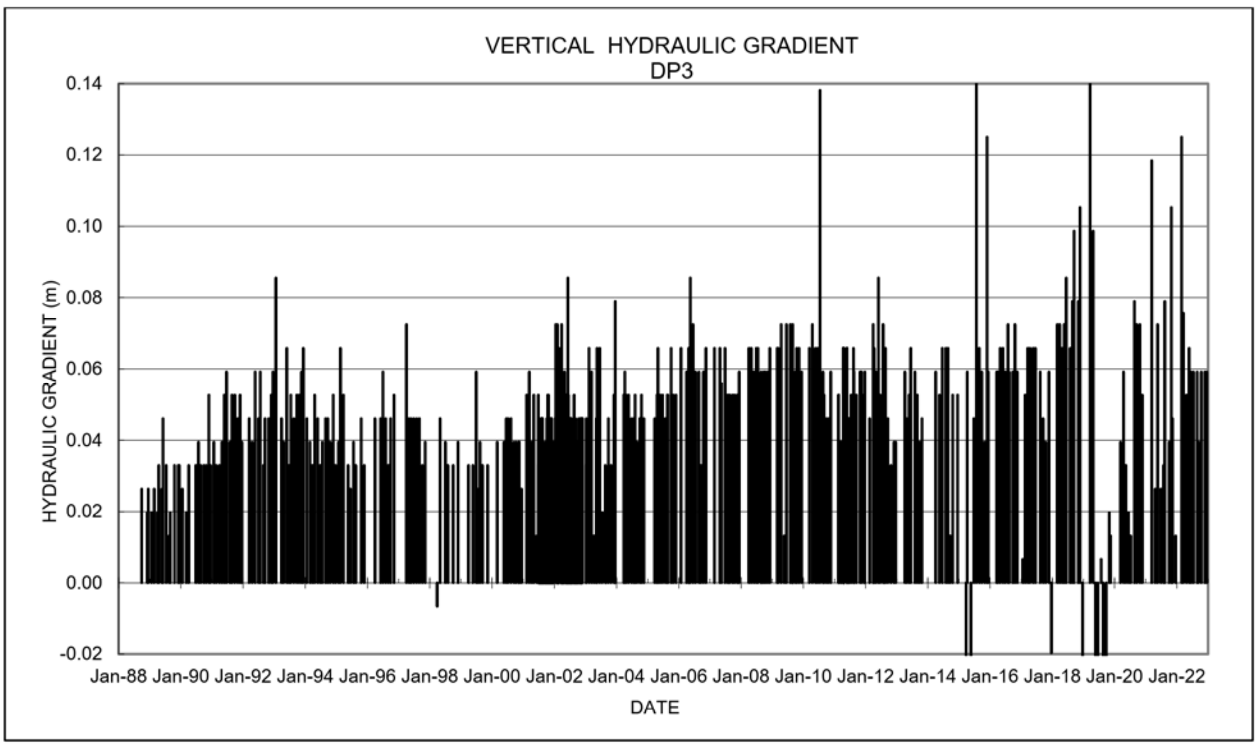


Figure 3-8 Hydraulic Gradient at Stream Drive Point Station DP3

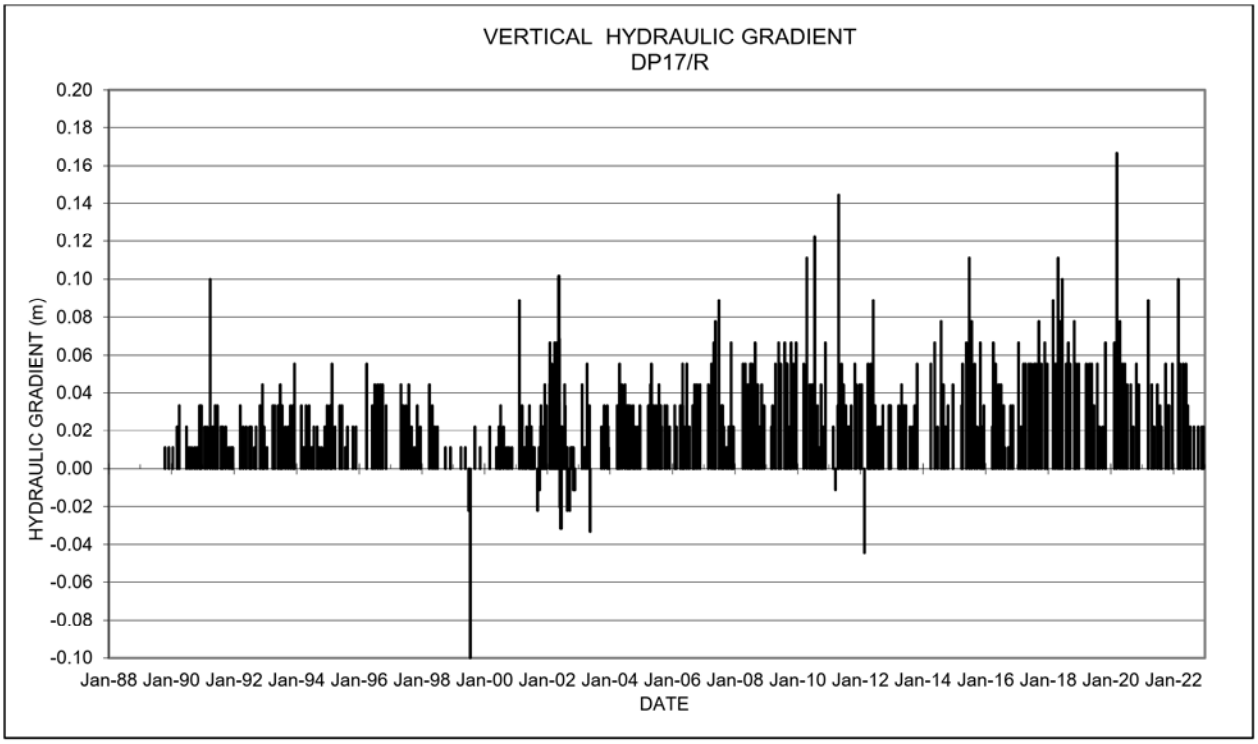


Figure 3-9 Hydraulic Gradient at Stream Drive Point Station DP17/R

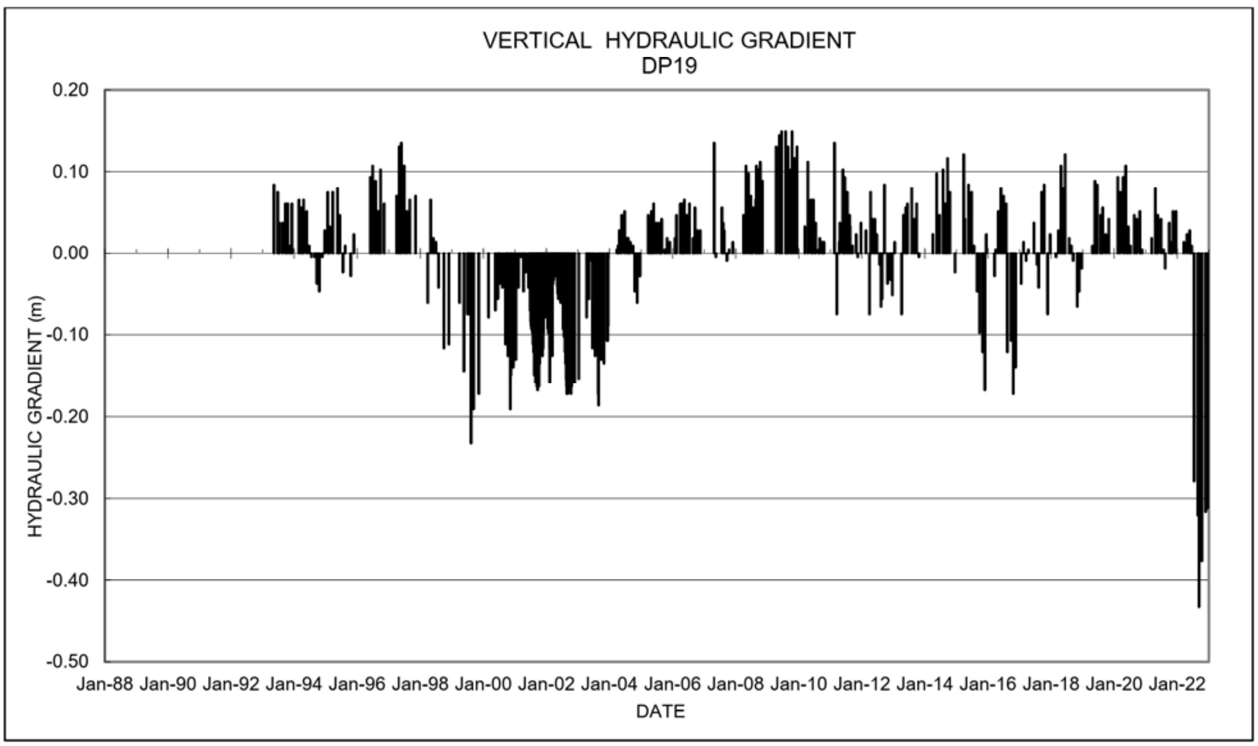


Figure 3-10 Hydraulic Gradient at Stream Drive Point Station DP19

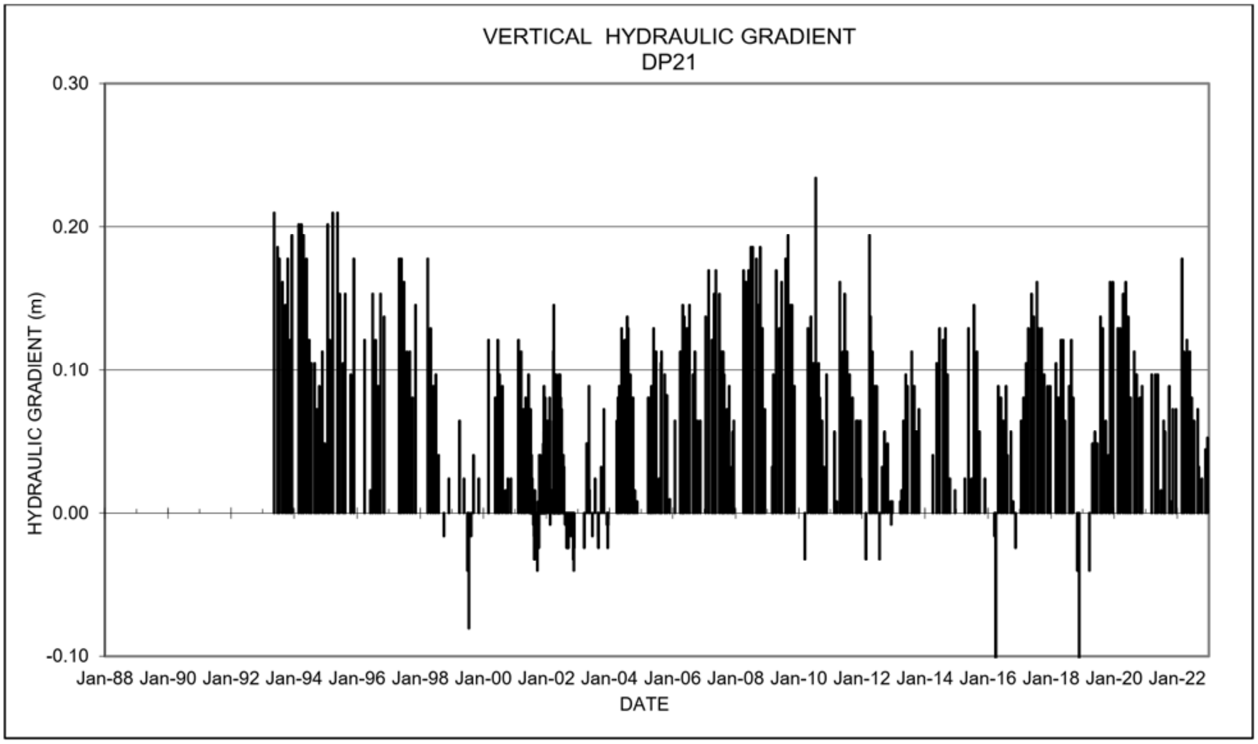


Figure 3-11 Hydraulic Gradient at Stream Drive Point Station DP21

GROUNDWATER TEMPERATURE FOR IN-STREAM DRIVE POINTS

An example of a thermograph from one in-stream drive point (DP2) is provided in Figure 3-12. This figure illustrates the relationship between surface water and groundwater temperatures. The water temperatures at the Mill Creek drive points show the following general seasonal patterns:

— A wide seasonal variation in the surface water temperatures, which are low in the winter and high in the summer. In 2022, the surface water temperature ranged from 0.0°C to 21.3°C, which was within the historical range. Note, surface water temperatures cited in this discussion are from manual measurements taken at same time as manual groundwater measurements and as such differ slightly from the automated surface water temperatures discussed in Section 4.3;

— Whereas there is a somewhat smaller seasonal variation in groundwater temperatures recorded (historically between 2°C and 21°C when all drive point monitors are considered), this is still considered to be a wide seasonal variation for typical groundwater. It is noted, however, that thermal transfer from the creek surface water will affect the shallow groundwater temperatures at the drive points. In addition, the amount of monitor development that is completed before a groundwater temperature reading is taken can affect the value. The groundwater temperature in 2022 ranged from 2.5°C to 21.5°C.

— Along Mill Creek downstream of Highway 401 in 2022, vertical gradients were generally upward, and groundwater discharge provided a cooling influence on creek temperatures during the warm summer months, and a warming influence during the cold winter months.

— The temperature patterns for 2022 shown on the thermographs are generally consistent with historic patterns. At the Mill Creek drive points, average 2022 groundwater temperatures were higher than the historical averages. The surface water temperatures downstream of Highway 401 were lower in 2022 compared to the historical averages, while surface water temperatures upstream of Highway 401 were equal to, or higher in 2022 compared to the historical averages. Compared to the historical averages (start of monitoring to 2021), the 2022 groundwater temperature averages differed by between 0.5°C and 1.6°C, and the surface water temperature averages differed by between -1.4°C and 0.7°C.

Thermographs for all creek drive points are included in Technical Appendix B.

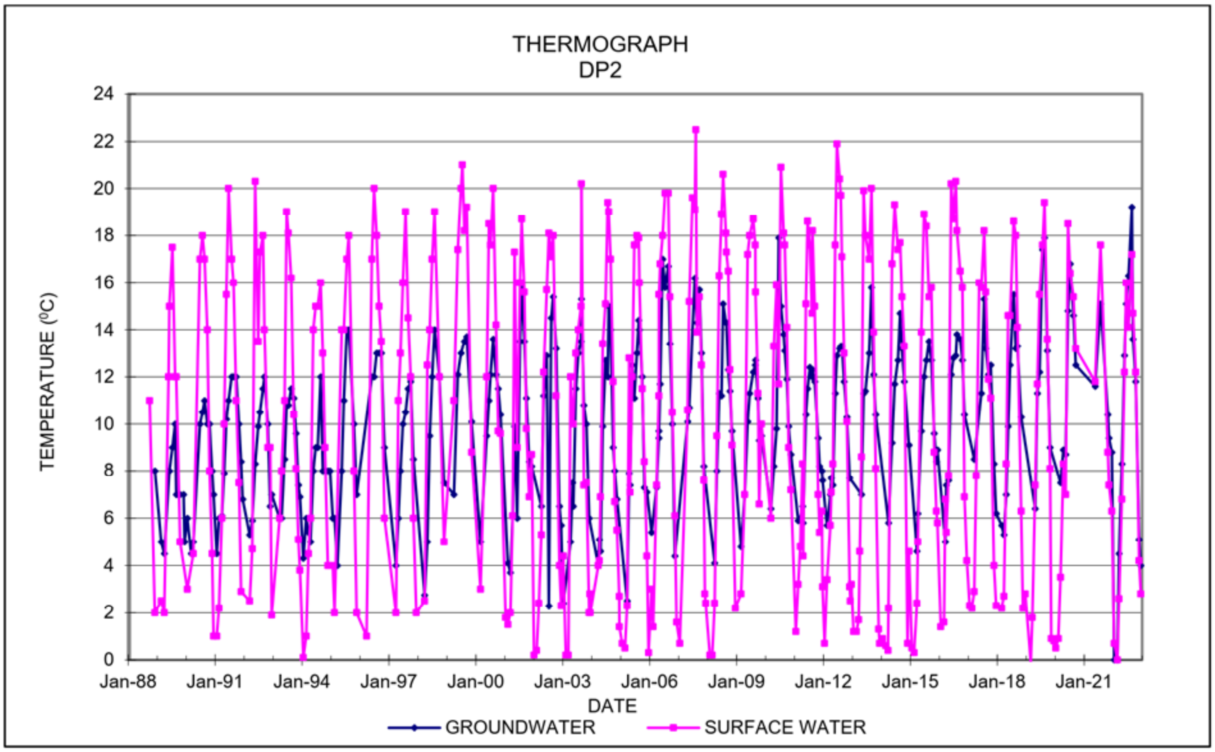


Figure 3-12 Thermograph for DP2

3.2.5 COMPLIANCE WITH INTERIM THRESHOLD VALUES

The early warning and interim threshold values, which came into effect on June 30, 2001, are based on maintaining positive seasonal hydraulic head gradients across the water table between specific monitor pairs, such that a positive hydraulic gradient continues to exist from the site toward Mill Creek. In other words, the groundwater levels should be lower at locations closer to Mill Creek.

Maximum and minimum elevations with associated early warning values are defined for each pond. The interim threshold and early warning values generally are based on a review of historic pre-extraction low water level data (where available) and are defined seasonally; pond threshold water level values do not change seasonally. Where necessary, threshold pairs have been modified over time to reflect extraction conditions and the removal of individual monitor locations.

It is noted that the groundwater levels in the in-stream drive points typically respond more rapidly to precipitation and snowmelt events than the deeper groundwater monitors. As such, occasionally, early warning and threshold value exceedances can occur due to these natural events.

A summary of the head differences for the monitor pair locations and pond elevations are illustrated in the following Figures 3-13 to 3-22. Where available, historical data are shown in the figures for comparison purposes. The six monitor pairs and the six ponds are briefly described below.

Overall, groundwater conditions remained within threshold limits in 2022, with the exceptions of an exceedance at the OW5-84 to DP5C/CR pair, as further discussed below.

BH92-29 to DP1 (Figure 3-13)

This monitor pair replaced the BH92-30 to BH92-28 threshold pair in May 2012, as BH92-30 was removed during extraction activities in April 2012. This pair is located in the northwest corner of the site, south of the confluence between the Pond Creek tributary and Mill Creek. DP1 is an in-creek drive point located in Mill Creek near the western property boundary. There were no exceedances of the threshold values or the early warning values at this pair in 2022.

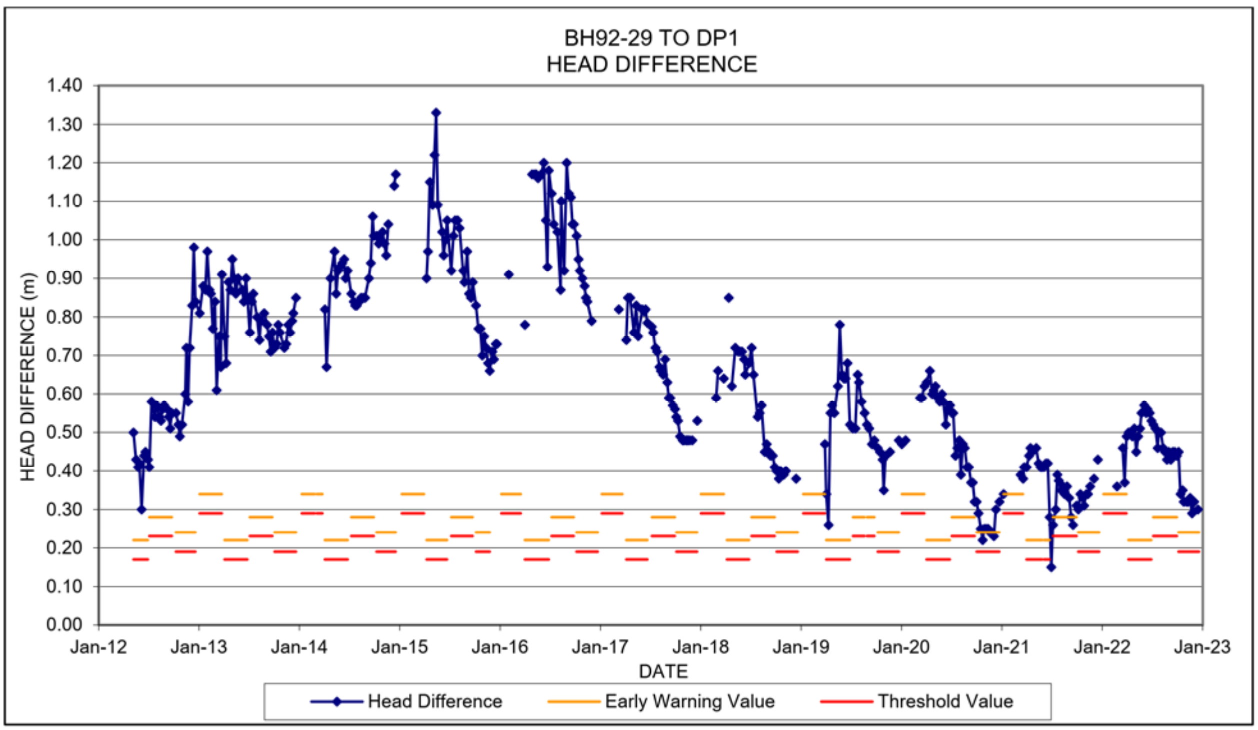


Figure 3-13 Hydraulic Head Difference for Monitoring Pair BH92-29/DP1; May 2012 to December 2022

BH92-27 to DP2 (Figure 3-14)

DP2 is an in-creek drive point located in Mill Creek at the western property boundary. There were no exceedances of the threshold values at this pair in 2022; however, the early warning value was exceeded on four occasions. Early warning value exceedances were observed on February 2, October 21, October 25 and November 4, 2022. Several weekly measurements before and after the February 2 event could not be measured at DP2 due to frozen conditions. As such, the February 2 exceedance was likely caused by a lag in groundwater level response following snowmelt conditions. Early warning threshold exceedance have occurred at this well pair during the fall in 2019, 2020, 2021 and 2022. The early warning value exceedances are generally attributed to the lag in groundwater level response following an increase in precipitation that typically occurs in the fall. In 2022, a total of 51 mm of precipitation was recorded between October 13 and November 1.

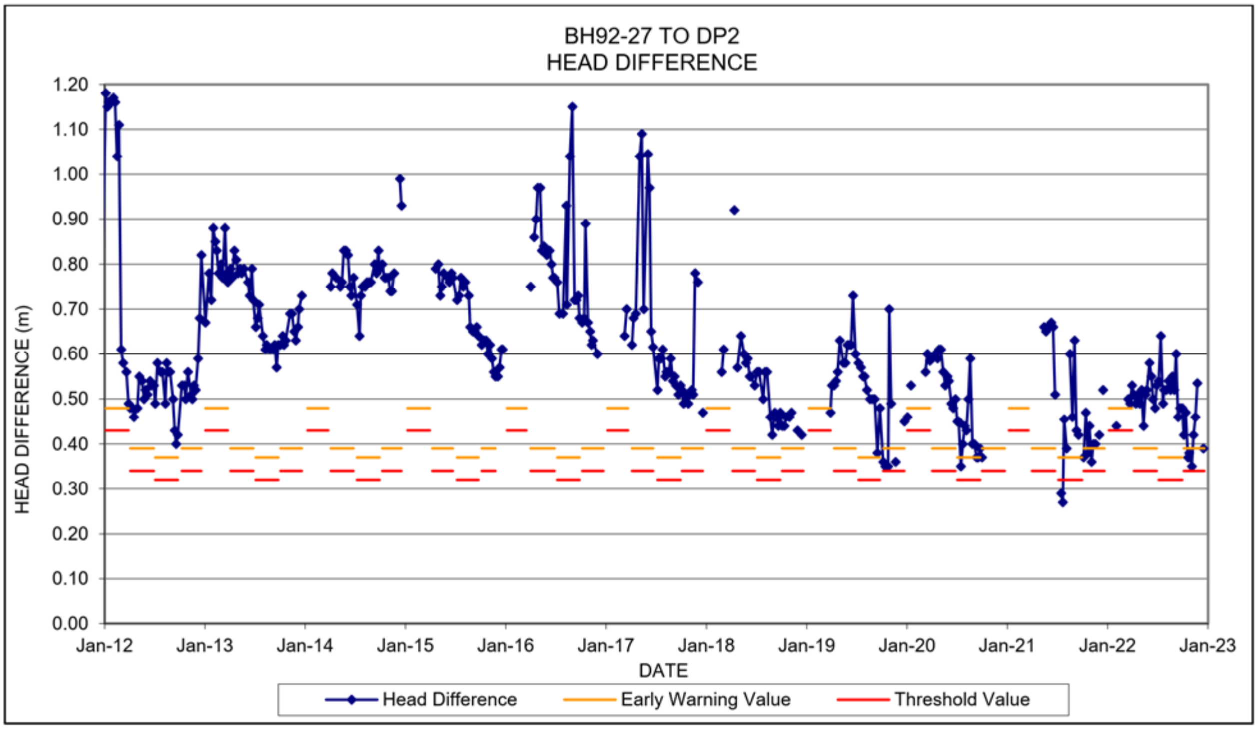


Figure 3-14 Hydraulic Head Difference for Monitoring Pair BH92-27/DP2; December 2011 to December 2022.

OW5-84 to DP5C/CR (Figure 3-15)

This pair of monitors is located in the southwest corner of the site, adjacent to Mill Creek. OW5-84 is a groundwater monitor screened to about full depth in the aquifer, and is situated just inside the property line. The location of DP5 has been modified several times due to vandalism and access issues. DP5A was an in-creek drive point situated in Mill Creek just north of the bridge at Township Road 2. DP5B replaced DP5A in this threshold pair in December 2011 when DP5A became inaccessible due to landowner permission being withdrawn. DP5B, located south of the bridge, was vandalized in July 2012, and replaced with DP5C, which was installed slightly upstream from DP5B, but still south of the bridge. New (preliminary) threshold values were implemented for the OW5-84 to DP5C pair in September 2012. Based on hydraulic conductivity testing, it is interpreted that DP5C was installed in lower-conductivity soil that is not reflective of the sand/gravel aquifer in which DP5A and DP5B were developed. This condition would result in groundwater levels that do not respond to climatic conditions as quickly as nearby drive points screened in more representative soils with higher hydraulic conductivities.

DP5C was vandalised in Spring 2017 and replaced with DP5CR, which was installed at the location of DP5C. The early warning and threshold values were not exceeded at DP5C prior to the vandalism. Frequent exceedances of the early warning and threshold values at the OW5-84 to DP5CR pair occurred between the DP5CR installation in 2017 and 2021, which were considered to be “false” exceedances that were the result of the observed hydrogeological variability at this location in Mill Creek. Revised early warning and threshold values were developed by WSP in 2021 and were submitted to by Dufferin Aggregates to the MNRF in early 2022. The MNRF provided written approval to implement the revised early warning and threshold values in mid-2022. As such, the revised values are now used to assess compliance.

The head difference at the OW5-84 to DP5CR pair exceeded the revised early warning value on four occasions in 2022 (March 17, September 15, September 22 and September 30) and exceeded the revised threshold value on one occasion (September 30, 2022). Based on a review of the 2022 daily climate data, melting conditions were present on March 17. As such, the lower head difference measured on March 17 is attributed to the lag in groundwater level response to snowmelt conditions. The head difference increased by 0.11 m between March 17 and 24. In September 2022, rainfall events ranging from 5 to 15 mm occurred in the days prior to each of the September 15, 22 and 30 monitoring events. It is interpreted that a more rapid groundwater level increase occurred at DP5CR following the precipitation events than at OW5-84, which temporarily reduced the head difference at this well pair. The head difference returned to a value greater than the early warning and threshold values in October 2022.

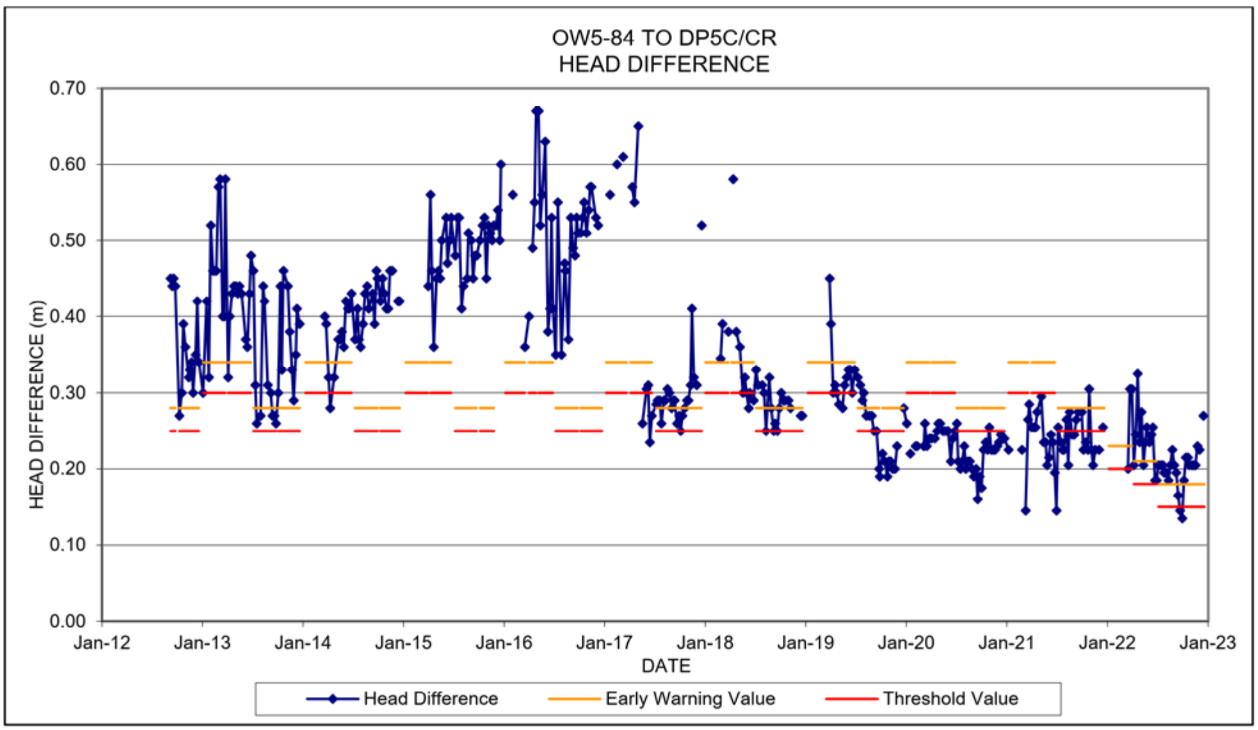


Figure 3-15 Hydraulic Head Difference for Monitoring Pair OW5-84/DP5C/CR; September 2012 to December 2022

BH92-12 to DP17/R (Figure 3-16)

BH92-12 was established in 2001 just outside the licensed area of extraction, west of Phase 5 (extraction began in the northeast corner of Phase 5 at the end of 2019). Monitor DP17 is an in-creek drive point located at the Hanlon interchange, upstream from DP3. The threshold values have not been exceeded since its implementation on June 30, 2001. The early warning and threshold values were not exceeded at this pair in 2022.

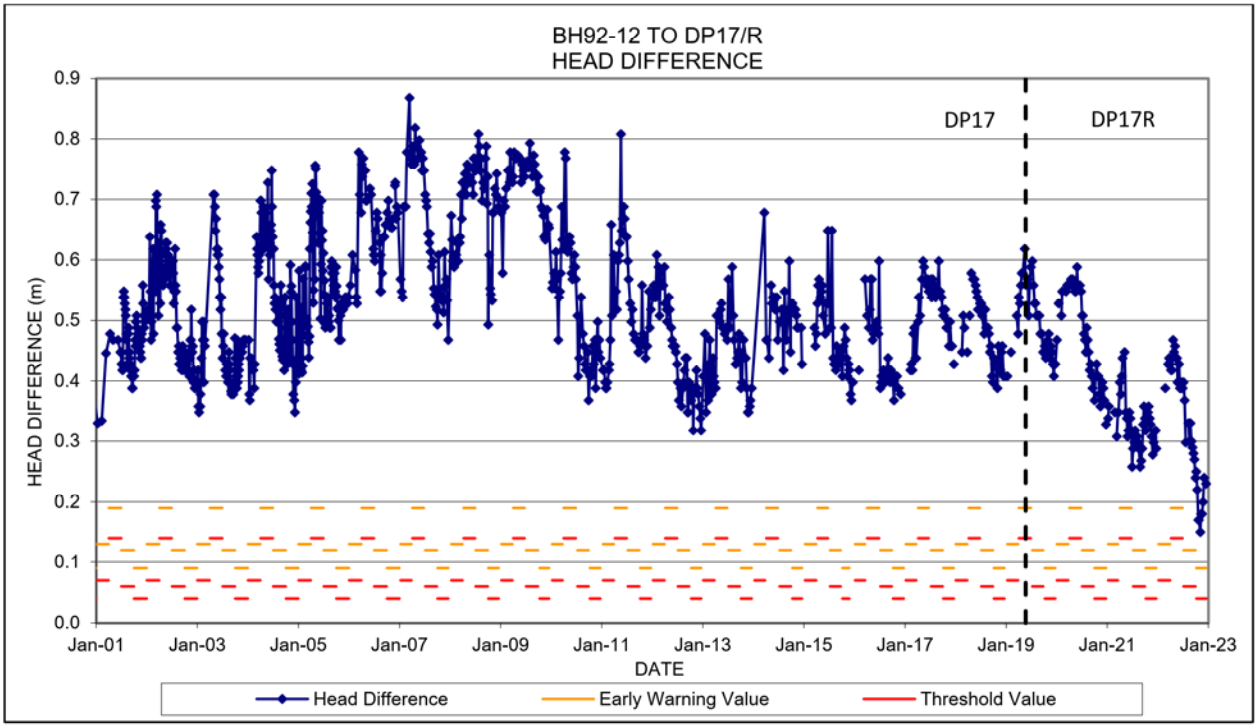


Figure 3-16 Hydraulic Head Difference for Monitoring Pair BH92-12/DP17/R; July 2000 to December 2022

DP6 to DP3 (Figure 3-17)

DP6 is located at the eastern limit of the central wetland area, adjacent to Phase 5, and DP3 is an in-creek drive point monitor located directly south of the Hanlon interchange. There were no exceedances of the threshold values or the early warning values at this pair in 2022.

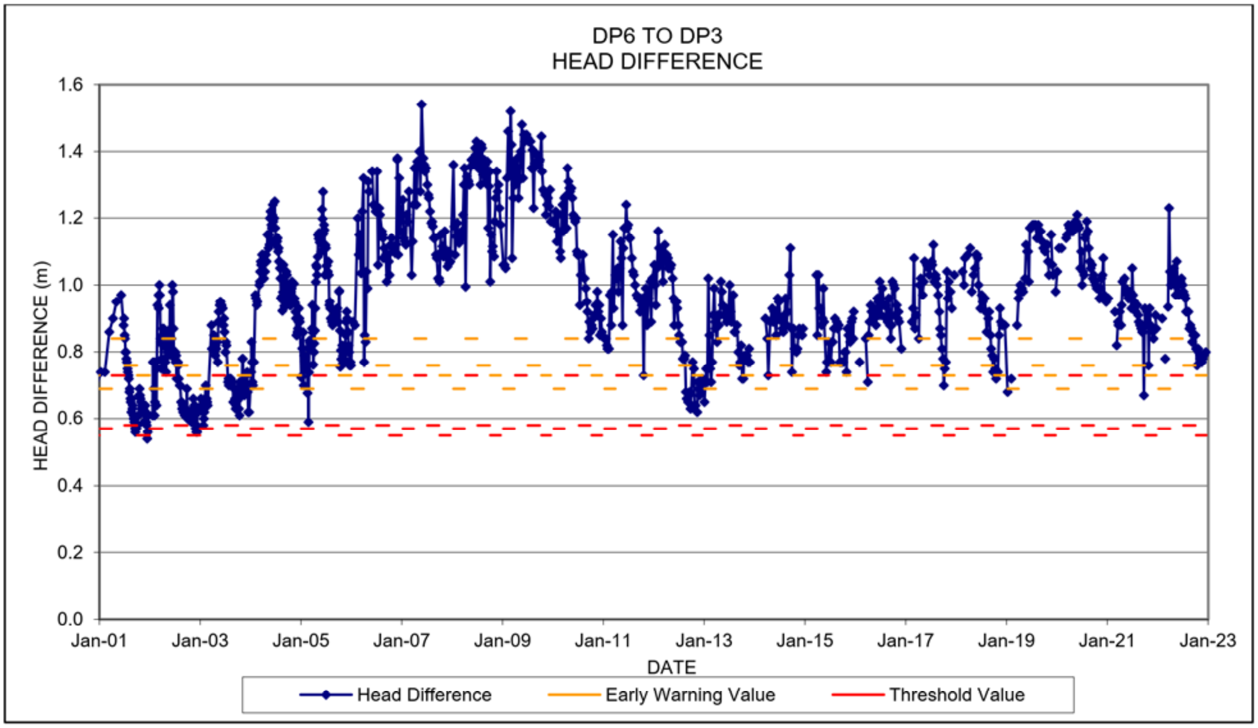


Figure 3-17 Hydraulic Head Difference for Monitoring Pair DP6/DP3; July 2000 to December 2022

BH13 to DP21 (Figure 3-18)

BH13 is located adjacent to the northern boundary of the property (north of Phase 5) and to the east of DP21. DP21 is an in-creek drive point monitor located immediately downstream of the property line, south of Highway 401. There were no exceedances of the threshold values or the early warning values at this pair in 2022.

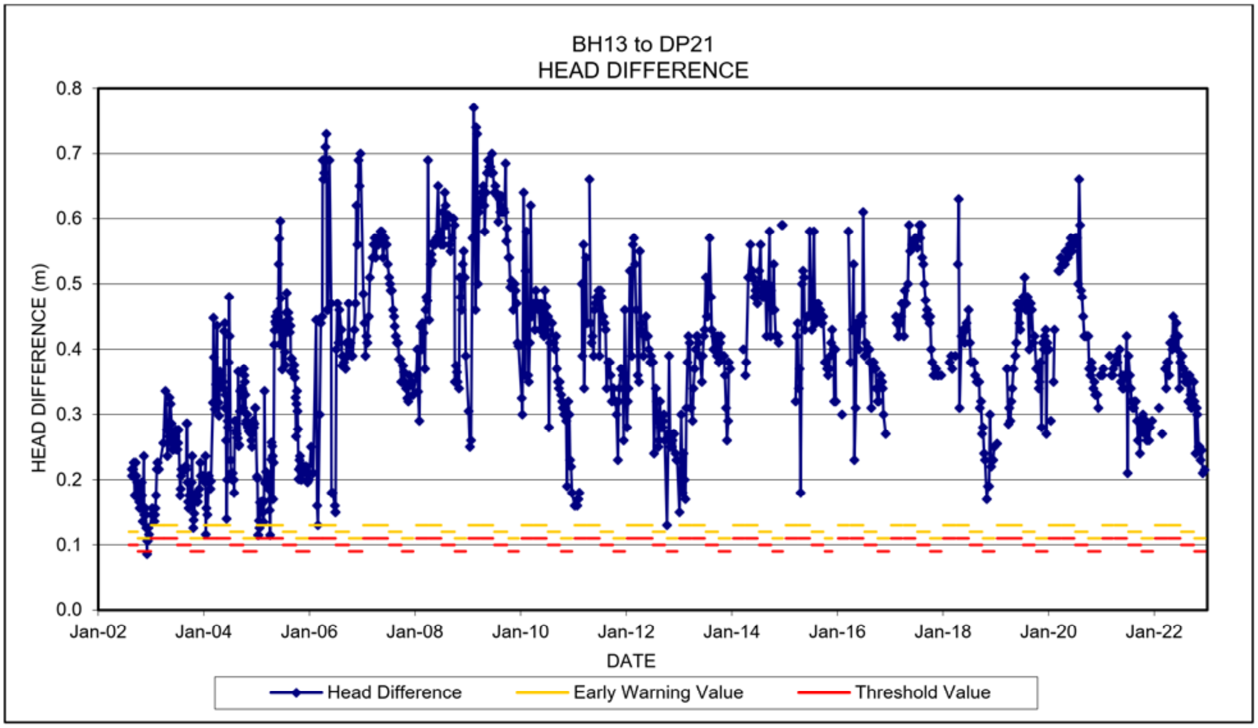


Figure 3-18 Hydraulic Head Difference for Monitoring Pair BH13/DP21; August 2002 to December 2022

On-Site Ponds (Figure 3-19)

The early warning and threshold values established for the Phase 1, 2, 3 and 4 ponds were not exceeded in 2022. The pond water levels typically decreased in 2020, 2021 and 2022, which reflects the lower precipitation amounts observed during that period. In 2022, the pond levels remained within their respective historic range.

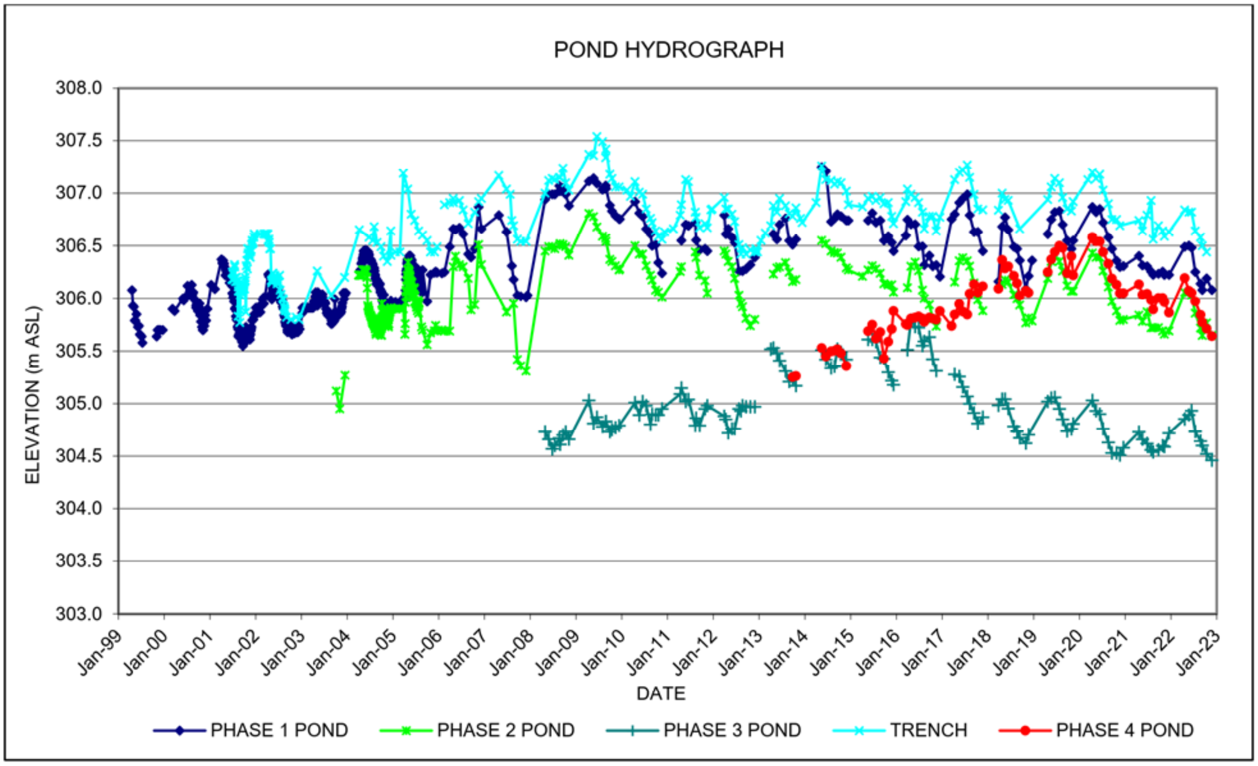


Figure 3-19 Pond Hydrograph; January 1999 to December 2022

3.3 GROUNDWATER CONTRIBUTION

Seasonal variation in stream flow is a reflection of normal long-term climatic seasonal variation, as well as specific climatic events.

During low flow periods, and in the absence of rainfall, stream flow is sustained by groundwater discharge to the creek. The groundwater discharge component of stream flow is termed base flow. Since base flow is derived from the groundwater flow system, which shows subdued seasonal changes compared to surface waters, the magnitude of the seasonal variation under base flow conditions will be less than that of the surface runoff component. In addition, since the temperature of groundwater, and particularly the deeper groundwater, does not fluctuate seasonally to anywhere near the same degree as does the surface water, the temperature of the groundwater discharge to the creek remains relatively more consistent.

Thus, groundwater discharge to the creek provides two important functions:

1. It provides base flow to maintain stream flow during low flow periods, and
2. It provides a cooling effect on the creek temperatures during the warm summer season, and a warming effect during the cold winter season.

Groundwater influx to Mill Creek is estimated at each drive point location for different flow conditions and the measurement interpolated for the stream sections between drive points. These calculations are presented in Technical Appendix B. The results of these calculations are summarized below in Table 3-4.

Table 3-4 Groundwater Influx (L/s) from the Mill Creek Aggregates Pit Property

	HISTORIC RANGE (1989-1999)	HISTORIC AVERAGE (1989-1999)	2022	2021	2020	2019	2018	2017	2016
Summer Low Flow Conditions (May to October)	15 - 24 L/s	18.9 L/s	22.5 L/s (Sept)	27.7 L/s (May)	23.8 L/s (July)	23.1 L/s (Aug)	26.9 L/s (July)	28.2 L/s (Sept)	27.8 L/s (Aug)
Winter Low Flow Conditions (November to April)	18 - 28 L/s	22.2 L/s	23.4 L/s (Nov)	26.1 L/s (Nov)	25.3 L/s (Mar)	29.2 L/s (Apr)	26.0 L/s (Feb)	19.8 L/s (Dec)	26.2 L/s (Nov)
Average		22.8 L/s	26.4 L/s	25.9 L/s	25.2 L/s	23.7 L/s *	28.9 L/s	27.3 L/s	27.5 L/s

* Data are interpreted with caution due to reduced flux values in the fall of 2019 due to beaver dam downstream of DP5CR

	2015	2014	2013	2012	2011	2010	2009	2008	2007
Summer Low Flow Conditions (May to October)	29.2 L/s (Sept)	33.9 L/s (Aug)	24.1 L/s (Oct)	27.2 L/s (Aug)	33.0 L/s (July)	30.6 L/s (Aug)	26.4 L/s (Sept)	29.5 L/s (June)	22.1 L/s (Sept)
Winter Low Flow Conditions (November to April)	26.3 L/s (Dec)	25.2 L/s (Dec)	28.5 L/s (Apr)	21.6 L/s (Nov)	26.7 L/s (Mar)	35.1 L/s (Nov)	32.5 L/s (Nov)	31.7 L/s (Mar)	Not Available
Average	29.0 L/s	30.3 L/s	28.3 L/s	25.6 L/s	34.6 L/s	35.7 L/s	33.0 L/s	31.5 L/s	26.9 L/s

	2006	2005	2004	2003	2002	2001	2000
Summer Low Flow Conditions (May to October)	24.7 L/s (Aug)	22.0 L/s (Oct)	23.8 L/s (Sept)	12.5 L/s (Aug)	16.1 L/s (Sept)	17.0 L/s (Aug)	21.7 L/s (May)
Winter Low Flow Conditions (November to April)	25.2 L/s (Jan)	23.6 L/s (Nov)	22.1 L/s (Nov)	22.1 L/s (Apr)	24.5 L/s (Nov)	22.4 L/s (Apr)	26.5 L/s (Nov)
Average	27.6 L/s	26.7 L/s	27.3 L/s	19.9 L/s	22.6 L/s	24.1 L/s	25.5 L/s

The summer low flow groundwater influx values have fluctuated from 2004 to 2022. The calculated 2022 summer low flow groundwater influx (22.5 L/s) was about 19% higher than the historical average yearly summer low flow influx (18.9 L/s), which is based on the average of the yearly summer low flow data for each drive point for the period 1989 to 1999. The winter low flow groundwater influx values increased from 2003 to 2010, decreased to 2012, and fluctuated from 2013 to 2022. The calculated 2022 winter low flow groundwater influx (23.4 L/s) was about 5% higher than the historical average yearly winter low flow influx (22.2 L/s), which is based on the average of the yearly winter low flow data for each drive point for the period 1989 to 1999.

The 2022 annual average influx (26.4 L/s) was about 16% higher than the pre-1999 historic long-term average influx (22.8 L/s). The higher values of groundwater discharge from 2004 to 2022 compared to the pre-1999 historic average are attributed to the consistently higher water level in the Phase 1 pond since 2004, and in the Phase 3 and Phase 4 ponds in recent years, and the resulting higher groundwater levels across the site. The overall average groundwater influx to Mill Creek in 2022 was similar to the average historic conditions. An impact from aggregate operations at the Site on groundwater influx to the creek is not apparent.

3.4 THERMAL BUDGET

The thermal effects on Mill Creek temperatures from the two tributaries, as well as the groundwater discharge component, are relatively significant during much of the year, based on the observed temperature differences between SWM1 (upstream) and SWM2 (downstream). Generally, during the summer low flow, those three sources of input water provide a cooling effect on Mill Creek. It is noted that canopy cover along some reaches also provides a cooling effect in Mill Creek during the summer months.

In 2022, the largest summer temperature difference between SWM1 and SWM2 (using average daily temperatures from data loggers) during routine monitoring events was noted on August 25, 2022. The mean temperature of the water entering the Mill Creek Aggregates Pit property at Highway 401 (SWM1) on August 25 was measured at 19.9°C. The mean water temperature in the creek leaving the property at SWM2 on August 25 was 17.7°C, which is 2.2°C lower than at SWM1. On August 25, the mean water temperature of Galt Creek (SWM4) and Pond Creek (SWM3) was 13.4°C and 12.5°C, respectively, which is strongly indicative of groundwater discharge into those tributaries.

The relative cooling effect of the two tributaries and groundwater on Mill Creek during the summer months was estimated during the period 2005 to 2012. Approximately 33% to 66% of the total temperature differential was attributed to the two tributaries, whereas approximately 34% to 67% was attributed to the combined groundwater discharge from both sides of Mill Creek. After 2012 stream flow monitoring in the two tributaries ceased so it is no longer possible to calculate the relative cooling effect of the tributaries compared with groundwater. However, there is no reason to believe that current conditions would differ substantially from the ranges of effect established during the period 2005-2012.

3.5 SUMMARY OF GROUNDWATER CONDITIONS

Monitoring results adjacent to the pond in Phase 1 indicate changes to the pond levels and local groundwater levels resulting from seasonal climatic variation, the pumping of water from the pond for aggregate processing, and the recirculation discharge of clean water back into the Phase 1 pond.

The water table in the wetland areas adjacent to Mill Creek continues to be at or near ground surface during the spring melt high groundwater conditions, with seasonal decreases in the order of 0.5 m over the course of the year.

In 2020, 2021 and 2022, groundwater levels in several monitors were lower compared to those recorded in 2019. Given the precipitation patterns described herein, these lower groundwater levels experienced across the central and eastern areas of the site are not unexpected. The groundwater levels were generally similar in 2022 compared to historical averages, although there were some exceptions.

In 2022, vertical gradients observed at the creek drive points south of Highway 401 were consistent with historical results.

The multi-level monitors within the sand and gravel aquifer continued to exhibit the general pattern of upward to neutral gradients, which is consistent with historic trends. Several observations of downward gradients also occurred in 2022, which is also consistent with historic trends. The groundwater temperatures at the multi-level monitors showed a pattern similar to historic trends, with the shallow water temperatures exhibiting the greatest, and the deep temperatures showing the least, seasonal fluctuations. The multi-level monitor temperatures also show a time lag response pattern between the shallow, intermediate and deep profiles, which also is consistent with historic patterns.

Overall, the average groundwater temperatures at the Mill Creek drive points upstream of the Site (DP18, DP19 and DP20) have been approximately 12°C over the long term. The temperature recorded at the drive point locations on the Site are typically cooler than observed upstream of the Site, and the temperature at the farthest downstream drive point DP5A/B/C/CR has remained similar to, or cooler than, upstream conditions. As such, the data indicate that groundwater temperatures at the Mill Creek drive points have not been measurably affected by pit operations.

Shallow groundwater monitoring immediately downgradient of the pit ponds show the influence of the ponds on groundwater temperatures, but these temperatures quickly dissipate with distance from the ponds.

An exceedance of the Action Threshold Values established for the monitoring pairs located adjacent to Mill Creek occurred on one occasion in 2022. The exceedance is not attributed to extraction activities at the Site, as discussed in Section 3.12, but is related to a lag in groundwater level response following precipitation events.

Phase 1, 2, 3 and 4 pond water levels typically decreased in 2020, 2021 and 2022, which reflects the lower precipitation amounts observed during that period. In 2022, the pond levels remained within their respective historic range and did not exceed their respective low-water level threshold values.

4 WATER QUALITY AND STREAM WATER TEMPERATURE

4.1 SURFACE WATER QUALITY

4.1.1 SURFACE WATER QUALITY METHODS

For this report, water samples were collected by WSP on November 18, 2022 at the four surface water sampling stations (SWM1, SWM2, SWM3, and SWM4). A blind duplicate sample was collected at SWM1 and submitted to the laboratory as SWM5. Station locations are shown on Figure 1. Water samples were submitted to Bureau Veritas in Mississauga and analyzed for the following parameters:

- pH, conductivity, hardness
- total alkalinity
- nitrate, nitrite, ammonia
- total phosphorus, orthophosphate
- total organic carbon
- suspended solids
- chloride
- fecal coliform bacteria, Total coliforms and *Escherichia coliforms* (E. coli)
- biological oxygen demand, chemical oxygen demand

In addition to the field duplicate, the lab conducts its own internal QA/QC program which includes routine duplicate analysis, spiked matrix samples, spiked blanks, and method blank samples.

Water quality results for the period from 1993-2021 are found in **Sub-Appendix A** of Technical Appendix C. Historical surface water quality data (pre-1993) are available in ESP *et al*. (1995). Groundwater chemistry is analyzed as part of the groundwater monitoring program (Technical Appendix B).

4.1.2 SURFACE WATER QUALITY RESULTS

The water quality monitoring program provides a snapshot of existing water quality conditions. Data for 2022 are provided in Table 2. The entirety of the data from 1993 to 2021 for water chemistry is provided in **Sub-Appendix A** of this report. Overall, the results indicate that water quality is similar within the Study Area, but the data do suggest possible influences from road salt and agricultural practices.

In 2022, the fecal coliform count ranged from less than 10 to 120 CFU/100 mL with results exceeding the Provincial Water Quality Objective (PWQO) of 100 CFU/100 mL at SWM1. These numbers have increased from the 2020 range of 10-30 CFU/mL but are comparable to 2021 with 97 CFU/100mL reported at SWM1, indicating an increase in contamination specifically at the Highway 401 sampling location.

For nitrate, there is no PWQO for the protection of freshwater biota, as it is relatively non-toxic to fish. There is a federal (Environment Canada) water quality guideline for nitrate of 12 mg/L and the Ontario Drinking Water Standard for nitrate is 10 mg/L. The concentrations of most of the water quality parameters are similar between the upstream (SWM1) and downstream (SWM2) limits of the Mill Creek Property and follow concentration trends from previous years. The presence of nitrate in the two tributaries can be attributed to agricultural runoff in the watershed. In 2022, the highest nitrate level was observed at SWM3 (Pond Creek) with a value of 5.02 mg/L, which was similar to recent years (4.68 mg/L and 4.35 mg/L in 2020 and 2021, respectively) and is lower than both he federal and provincial drinking water guidelines. For the first time since 2017, nitrite was detected at SWM3 (0.013 mg/L) in 2022 at slightly above the detection limit but still well below the federal guideline of 0.1 mg/L.

Total phosphorus was below detection limits (0.020 mg/L) at all sample locations in 2022 and remain below PWQO limits (0.030 mg/L for streams). Phosphorus levels in Mill Creek have varied historically from less than the analytical detection limits to exceeding the PWQO in different years.

The Canadian water quality guidelines for chloride for the protection of freshwater life are 640 mg/L (short term exposure of < 96 hrs) and 120 mg/L for long term or indefinite exposure (CCME, 2012). Chloride and conductivity were higher in Galt Creek (SWM4) relative to the other three stations (Table 2) which is consistent with previous years. The recent results show chloride concentrations in Mill Creek ranged from 31 mg/L at SWM3 to 110 mg/L at SWM4. Therefore, salt concentrations measured in Mill Creek are below levels expected to impact fisheries. The basic water chemistry of Mill Creek appears relatively unchanged over the past 30+ years, however, chloride and conductivity levels in Mill Creek appear to have gradually increased during the past 22 years (Figure 2). Prior to 1999, chloride levels in Mill Creek were consistently below 40 mg/L but are now routinely above 50 mg/L, with some recent values above 100 mg/L. Sampling has been conducted in November and December in recent years. It is likely that road salt has already been applied by this time and these changes are likely due to the influence of road salts applied within the watershed and entering the water system. Therefore, stream chloride and conductivity values could be influenced by seasonal conditions and time of sampling.

Conductivity values in Mill Creek are relatively high (typically greater than 650 mS/cm) for a surface stream indicating the high proportion of groundwater in the system. The higher conductivity in Galt Creek (SWM4) further emphasizes the strong groundwater influence on this small tributary.

Table 4-1 Mill Creek Water Quality November 18, 2022

	SWM1 Hwy 401	SMW2 (Boundary)	SWM3 Pond Creek	SMW4 Galt Creek	PWQO[1]	RDL[2]
All units are mg/L, unless otherwise indicated.						
pH (units)	8.35	8.41	8.27	8.28	**6.5-8.5**	**N/A**
Conductivity (mS/cm)	0.72	0.81	0.70	0.95	-	**0.001**
Hardness (mg/L as $CaCO_3$)	320	320	340	360	-	**1.0**
Alkalinity (Total mg/L as Ca CO_3)	270	270	290	280	-	**1.0**
Chloride	58	83	31	110	-	**1.0**
Nitrate (mg/L)	0.41	1.63	5.02	4.72	**See[3]**	**0.10**
Nitrite (mg/L)	<0.010/ND	<0.010/ND	<0.010/ND	<0.010/ND	**<0.1[4]**	**0.010**
Total Ammonia-N	<0.050	<0.050	<0.050	<0.050	**1.20**	**0.050**
Orthophosphate	<0.010/ND	<0.010/ND	<0.010/ND	<0.010/ND	-	**0.010**
Total Phosphorus	<0.020/ND	<0.020/ND	<0.020/ND	<0.020/ND	**0.030**	**0.020**
Total Organic Carbon	3.0	2.6	1.6	1.7	-	**0.40**
Total BOD	<2/ND	<2/ND	<2/ND	<2/ND	-	**2**
Total Chemical Oxygen Demand	8.0	6.0	<4.0	<4.0	-	**4.0**
Total Suspended Solids	<10/ND	<10/ND	<10/ND	<10/ND	-	**10**
Fecal Coliforms (CFU/100mL)	120	30	<10	30	**100**	**10**
Total Coliforms (CFU/100mL)	-*	-*	-*	-*	-	**N/A**
Escherichia coli	120	30	<10	30	-	**10**

[1] PWQO = Provincial Water Quality Guideline for the Protection of Aquatic Life (- denotes no guideline)
[2] RDL = Reportable Detection Limit
[3] concentrations that stimulate prolific weed growth should be avoided
[4] federal guideline (CCREM)
* total coliform data was not completed due to lab error

N/A = Not Applicable ND = Not Detected

4.2 GROUNDWATER QUALITY

4.2.1 GROUNDWATER QUALITY METHODS

Chemical analyses of groundwater and surface water were completed in March and November 2022 for samples collected from BH1-R, 92-32-III, and 92-8, and the Phase 1 pond. Samples were tested in the field for temperature, pH, and conductivity and then submitted to Bureau Veritas Laboratories for chemical analysis. Water samples were analyzed for major cations and anions, alkalinity, conductivity, pH, hardness, and oil and grease.

4.2.2 GROUNDWATER QUALITY RESULTS

The 2022 chemical results are generally similar to historic values, with some exceptions. Based on the 2022 chemical data, which are provided in Technical Appendix B, the following observations are made.

- Groundwater quality generally complies with the Ontario Drinking Water Quality Standards (ODWQS) for the parameters tested, except as outlined below.
  - BH1-R – hardness (March and November)
  - 92-8 – hardness (March and November) and manganese (March and November)
  - 92-32-III – hardness (March and November) and manganese (March and November)

  Hardness and manganese are not considered to be health-related parameters. The standard for hardness is a guideline, which is established for parameters that need to be controlled to ensure efficient treatment of water supplies. The standard for manganese is an aesthetic objective, which is established for parameters that may impair the taste, odour, or colour of water. Hardness and manganese exceedances were observed historically at the property, both before and after extraction commenced. The elevated concentrations of hardness and manganese are attributed to natural conditions at the site.
- Over the short term, in 2022 the parameter concentrations were generally similar to the 2021 concentrations. The 2022 results from replacement well BH1-R were similar to the historical results from the original well (BH1).
- The concentrations of most parameters have been fluctuating slightly or have been relatively consistent over the long-term. Exceptions are (a) conductivity values (laboratory) and sodium and chloride concentrations at BH1/BH1-R (located at the eastern, upgradient, boundary of the property) and BH92-8, which have exhibited an overall increasing trend since the mid-1990s, and (b) sodium and chloride concentrations at Monitor BH8-I/92-32-III, which increased sharply in 2009, but have been stable or decreased in recent years. It is noted, however, that the following historically high concentrations were detected in 2022.
  - BH1/1-R: chloride (190 mg/L) and conductivity (laboratory) (990 µS/cm) (each in November)
  - 92-8: sodium (82 mg/L) and chloride (160 mg/L) (each in November)
  - Phase 1 pond: sodium (91 mg/L), potassium (3.6 mg/L), magnesium (38 mg/L), chloride (170 mg/L), conductivity (laboratory) (950 µS/cm) and total oil and grease (2.6 mg/L) (each in November)

The increasing sodium, chloride and conductivity concentrations may reflect road salting activities along Highway 401 and/or along the Township roads. As these increasing trends are observed at locations both upgradient and downgradient of the property, they are not attributed to operations at the Mill Creek Pit.

— Trace concentrations of total oil and grease (0.7 mg/L – 1.5 mg/L) were detected at each of the three groundwater wells during at least one of the sampling events in 2022. Similar detections have occurred historically.

— Historically, and in 2022, with increasing distance downgradient across the site (from Monitor BH1/1-R/92-5 to 92-8 to BH8/92-32-III), detected parameter concentrations generally tend to either increase or fluctuate. Exceptions include sodium, potassium and chloride, which decreased across the site in 2022.

— Parameter concentrations in the Phase 1 pond are generally similar to values detected at Monitor BH1/1-R/92-5. The surface water quality complies with the Provincial Water Quality Objectives for the parameters tested in 2022, with the exception of zinc in November. Similar zinc exceedances have occurred historically.

— A concentration of total oil and grease (2.6 mg/L) was detected at the Phase 1 pond in November 2022, which was the highest concentration reported to date at that location. A verification sample was collected in December 2022, along with a blind duplicate sample, to confirm the oil and grease detection. Oil and grease was not detected in the December 2022 original or duplicate sample, and, therefore, the November 2022 result should be interpreted with caution. Occasional detections of oil and grease (up to 1.6 mg/L) have previously been reported at the Phase 1 pond.

4.3 SURFACE WATER TEMPERATURE

4.3.1 METHODS

Water temperatures in Mill Creek were measured with a thermistor within leveloggers installed at SWM1, SWM2, SWM3 and SWM4. Specifically, the loggers are in a 5 cm diameter steel pipe embedded into the stream bed approximately 1 m. Leveloggers rest on a bolt in the pipe and are at the substrate and water interface. Leveloggers were programmed to record water temperature every hour, continuously throughout the year. Temperature data were downloaded concurrently with water level data once per month.

4.3.2 RESULTS

Water temperatures in the main channel of Mill Creek (SWM1 and SWM2) for the summer of 2022 are shown in Figure 4-1 along with critical trout temperatures. The maximum recommended tolerable temperature for Brown trout is considered to be 26.8°C (Raleigh et al, 1986).

The maximum summer water temperature in Mill Creek in 2022 was 23.9°C at SWM1 on August 7 at 17:00 hours (Figure 4-1). The highest water temperature ever recorded in the Study Area was 27.9°C in 2002. Water temperatures relative to air temperatures are discussed in further detail in Technical Appendix A. The main branch of Mill Creek within the study area did not exceed the upper tolerable temperature for Brown trout (26.8°C) in 2022. The maximum temperature which Brook trout can tolerate is 24°C (Raleigh 1982) and this was also not exceeded in 2022 (Figure 4-1).

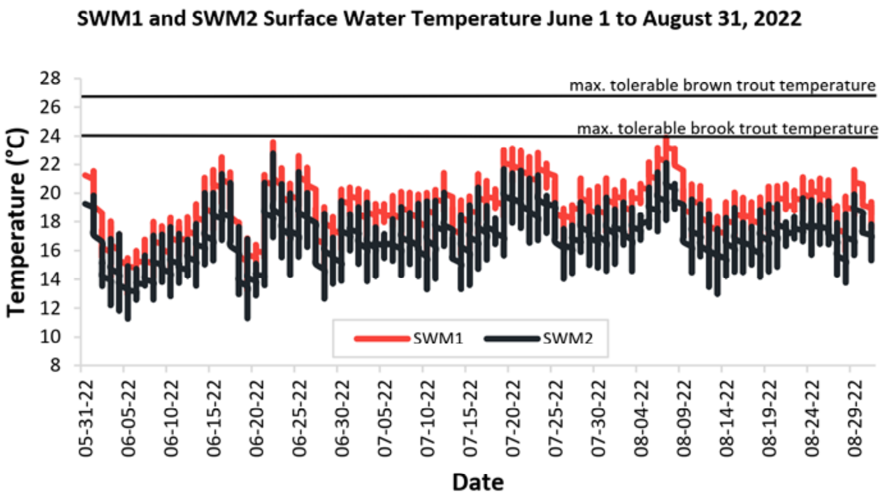


Figure 4-1 Thermographs from SWM1 and SWM2, for June 1 to August 31, 2022

Stream water temperatures have traditionally been cooler at the downstream SWM2 station compared with SWM1 and this trend continued in 2022. When the maximum water temperature occurred at SWM1 (23.9°C: August 7, 17:00), the temperature at SWM2 was 1.9°C lower (Figure 4-2). The maximum summer temperature at SWM2 in 2022 was 22.8°C, on June 22nd, at 17:00. The greatest temperature difference between SWM1 and SWM2 during the summer of 2022 occurred on July 23rd at 13:00 when SWM2 was 3.2°C cooler than SWM1.

Surface water temperatures are cooler at SWM2 than SWM1 due to groundwater input, inflow of the two coldwater tributaries, and good shade from riparian vegetation within the University of Guelph reach down to Concession Road 2. The maximum summer temperatures in the two small tributaries were only 16.7°C (SWM3) and 14.8 °C (SWM4). Thus, through the conveyance from the coldwater tributaries, this reach of Mill Creek continues to protect and enhance the coldwater attributes of the stream and provides good habitat for Brown trout.

The continuous temperature recorders also illustrate the effect of diurnal solar warming on Mill Creek as the water temperatures gradually rise during the day and cool off at night. At SWM1 the temperature fluctuation was 1.8°C between August 7th and August 8th, following the maximum temperature. At SWM2 the temperature fluctuation was 7.2°C. At SWM3 and SWM4, the temperature fluctuation was 5.7°C and 1.3°C, respectively (Figure 4-3), again supporting the conclusion that the temperatures at SWM3 and SWM 4 are controlled by groundwater inputs.

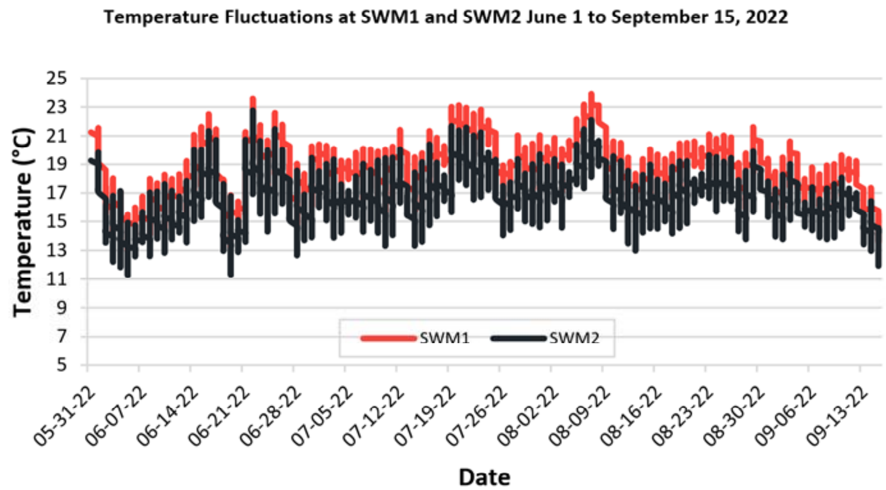


Figure 4-2 Diurnal Temperature Fluctuations from June 1 to September 15, 2022 at SWM1 and SWM2

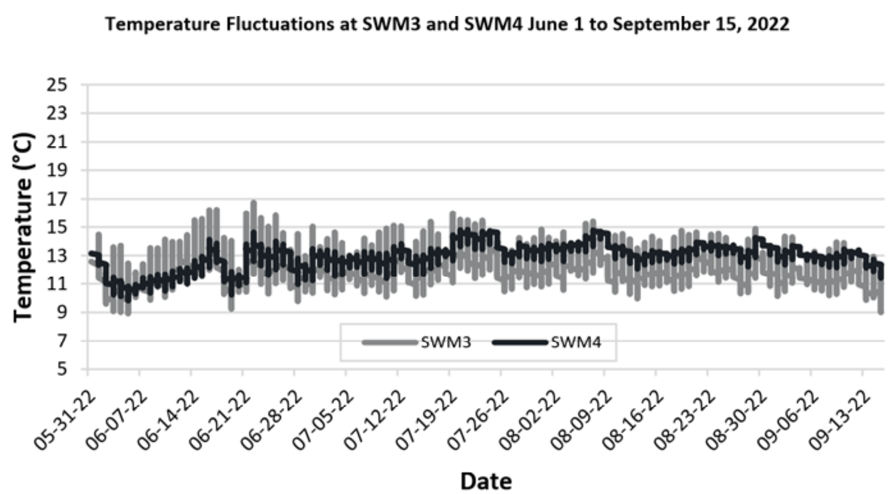


Figure 4-3 Diurnal Temperature Fluctuations from June 1 to September 15, 2022 at SWM3 and SWM4

The maximum surface water temperatures recorded at all four monitoring locations within Mill Creek since 1983 are illustrated in Figures 4-4 and 4-5, respectively. Surface water data were collected manually prior to 1997 and true maximum temperatures may not be represented by the dataset, since data were not recorded on a continual basis (sampling events were selected according to weather conditions). In addition, temperatures were typically recorded manually between noon and 15:00, but maximum temperatures can now be observed after 16:00. Therefore, while water temperatures appear higher since 1998, maximum temperatures prior to 1997 may actually have been greater than those presented in Figures 4-4 and 4-5.

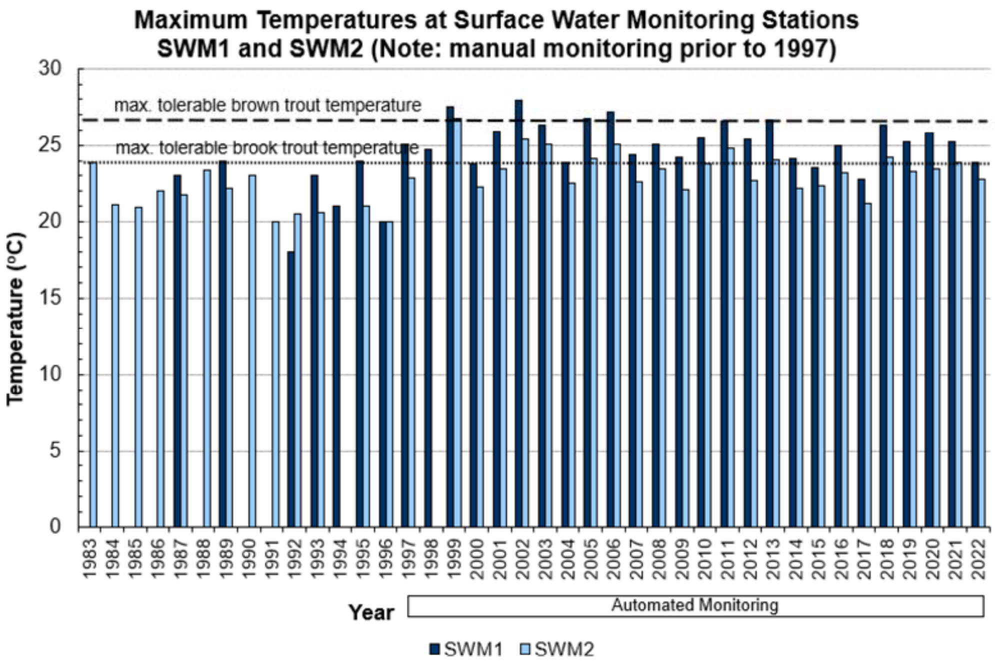


Figure 4-4 Historical Maximum Mid-Summer Water Temperatures in Mill Creek (1983 to 2022) at SWM1 and SWM2

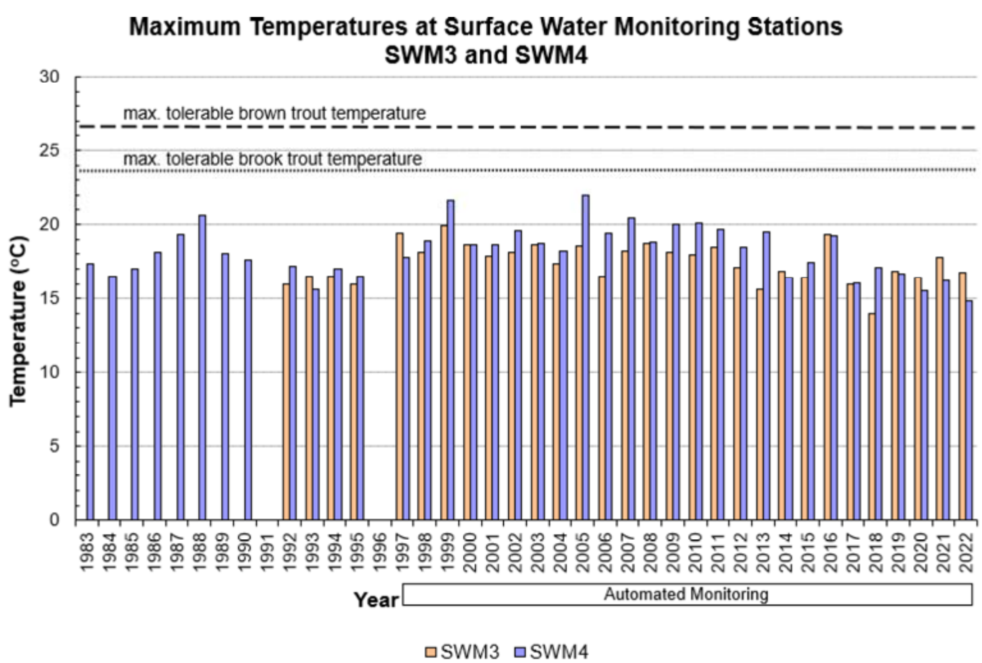


Figure 4-5 Historical Maximum Mid-Summer Water Temperatures in Mill Creek (1983 to 2022) for SWM3 and SWM4

5 FISHERIES

5.1 METHODS

Monitoring conducted and reported in 2022 as part of the fisheries monitoring program includes:

- Mark-Recapture Population surveys for Brown trout; and
- Brown trout spawning (redd) surveys.

5.1.1 TROUT POPULATION SURVEYS

In 2022 the electrofishing field survey was conducted on September 6th and 8th, and October 4th for the Mark Run, and September 14th and 15th and October 13th for the Recapture Run.

The basic survey approach has not changed since the studies began, although the equipment used has changed. In all cases, the basic method is a single pass electrofishing assessment without blocking of the stream at either end for each of the mark and recapture runs, and for each reach surveyed. This method is considered appropriate to estimate trout populations in Southern Ontario streams (Jones and Stockwell 1995). Mark and recapture runs were generally separated by a one-week period. A minimum of 6 people were involved in all surveys and the time to conduct the mark run has been approximately 5-6 hours for each reach and the recapture run has been approximately 4-5 hours per each. The shorter time for the recapture run is due to the quicker processing time for fish (only counting clipped versus unclipped fish).

A description of electrofishing effort, weather, conditions, and conductivity is provided in **Technical Appendix C**.

5.1.2 REDD SURVEYS

The annual Mill Creek Brown trout spawning (redd) survey was undertaken on November 18 and 19, 2022. The location of each redd was identified by experienced fisheries biologists who are familiar with the Study Area, and classified as confirmed, probable, or a scrape. A confirmed redd is a disturbance in the substrate and a fish visually observed in the general vicinity; a probable redd has substrate disturbance but no fish visually observed; and a scrape is a less defined or small clearing of disturbed substrate with no fish visually observed. Since we only complete a one-day spawning survey, scrapes can give some more indication of additional redds that may form later on in the spawning period. In 2022, a large beaver dam was noted upstream of the west property boundary and sampling was completed over 2 days due to sediment impeding the visual identification of spawning activity. This period of sedimentation may have also impacted the results WSP reported for 2022, as the sediment may have forced Brown Trout to retreat to lower reaches where spawning may have taken place unobserved. All redds and scrapes were recorded on spawning field sheets, with clusters identified with a GPS point, and compared to historical data.

Redd surveys are not conducted at the Bond Tract Station due to absence of suitable spawning habitat.

5.2 RESULTS

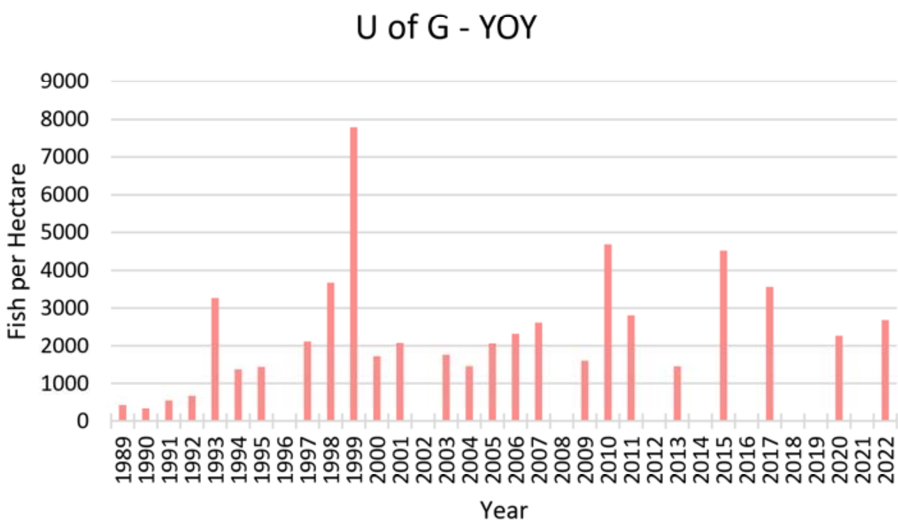
5.2.1 TROUT POPULATION SURVEYS

Brown trout population data for young of the year (YOY) and adult (age 1+ and older) fish from 1989 to 2020 are summarized in Figure 5.1 to 5.2 for the University of Guelph and Hanlon By-pass reaches. For the purposes of this report, all fish aged 1+ or greater are considered adults. Fish surveys were not conducted in 1996, 2002, 2008, 2012, 2014, 2016, 2018, 2019, or 2021.

University of Guelph Reach

During the initial mark run, a total of 331 Brown trout (163 adult, 168 YOY) were captured and marked (fin-clipped) within the University of Guelph reach. During the recapture run, a total of 423 Brown trout were captured (177 adults, 246 YOY). Of these, 108 were recaptured fish (69 adult, 39 YOY) providing a moderate percentage (25.5%) of recaptured fish. The relative proportion of adult (42%-49%) and YOY (51%-58%) remained similar between the mark and recapture events which provides further confidence in the numbers. The data gathered from the mark and recapture surveys were then used to estimate trout population numbers which are expressed as the number of fish per hectare (Figure 5-1). Expressing the population estimates as number of fish per ha takes into account the different lengths of the study reaches to provide numbers that are more directly comparable.

The estimated number of YOY trout is higher than some recent years at 2687 fish/hectare but within the historical range observed. The number of adults per hectare in 2022, 1095 fish/hectare, is higher than all years observed (Figure 5-1). Although the population estimates are higher, the fluctuation in estimated size is expected and within historic observations for cyclical patterns in population numbers.



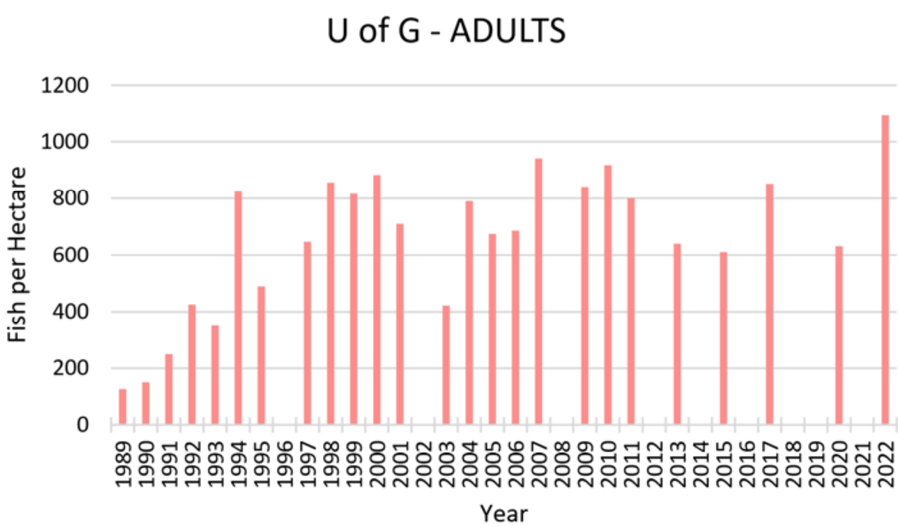


Figure 5-1 Brown Trout Population Estimates - University of Guelph Station

Hanlon By-Pass Reach

A total of 151 Brown trout were captured during the mark run comprised of 69 adults and 82 YOY. During the recapture run, 125 Brown trout were captured (65 adults, 60 YOY), of which 31 were recaptured (24 adult, 7 YOY). The combined recapture rate in this reach was moderate at 24.8%.

The estimated number of YOY, 1020 fish/hectare, is the highest number since 2013 and within the historical range observed. The estimate for adults, 305 fish/hectare is also similar to recent years (Figure 5-2). Although the YOY population estimates are higher than recent years, the fluctuation in estimated size is expected and within historic observations of population fluctuations.

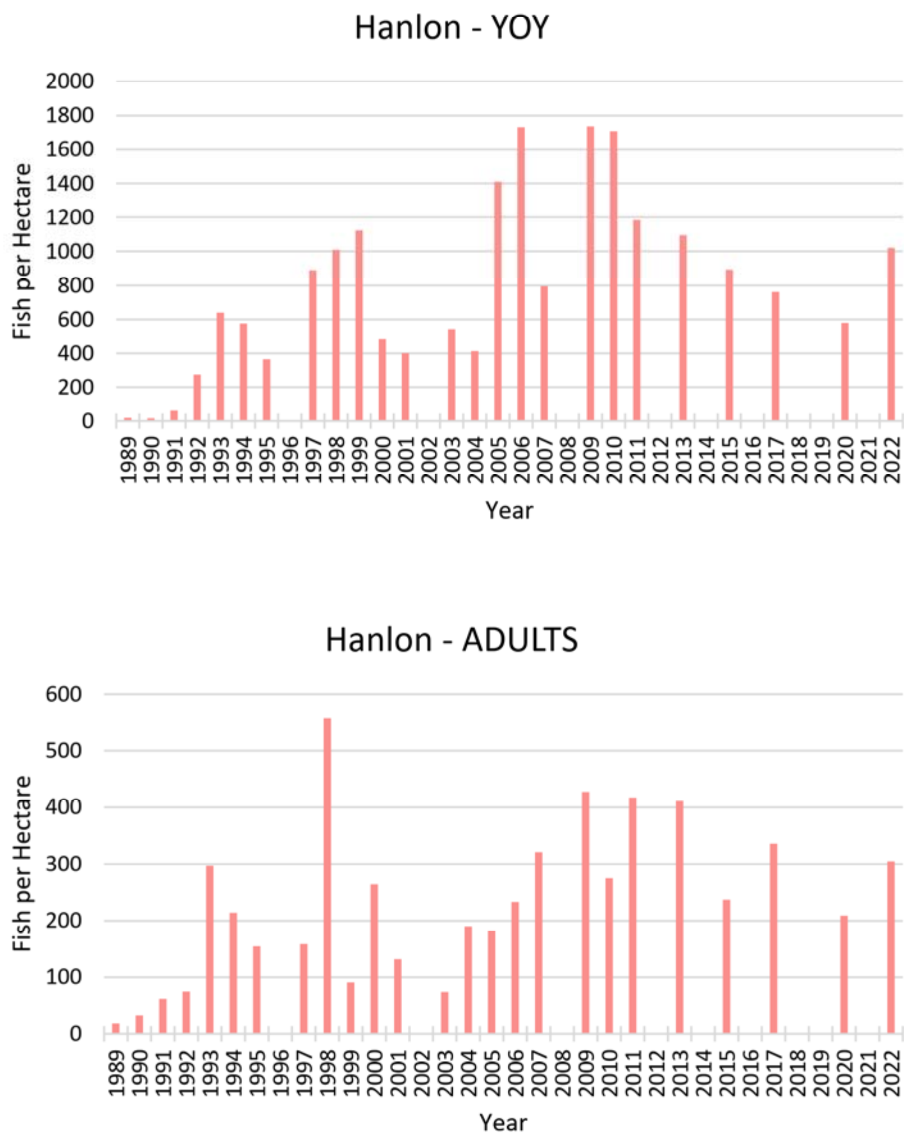


Figure 5-2 Brown Trout Population Estimates - Hanlon By-Pass Station

Bond Tract Reach

In 2022, 10 YOY were captured and marked during the mark run and 4 YOY were captured during the recapture run, none of which were recaptures. Therefore, a conservative estimate of the population is 78 YOY per hectare (Figure 5-3), which is slightly lower than recent years but skewed downward by the relatively low number of YOY fish caught this year. This year 71 adult brown trout were captured on the mark run and a total of 55 adults were caught on the recapture run. Of these 55 adults, 28 were recaptured fish representing a recapture rate of 50.9%. The estimated number of adult trout per hectare is 300 fish/ha which is similar to previous years. Note that the recapture rate of Brown trout in 2009 was very low (only 5.6%) which skewed the population estimate upward despite the fact that the actual number of fish caught was relatively low (Figure 5-3).

The Bond Tract continues to provide a poor reference site for the University and Hanlon reaches due to the different nature of the habitat. The Bond Tract is much deeper and contains little or no spawning and nursery habitat like the other stream reaches. In addition, it is very likely that the Bond Tract is heavily fished by local anglers which could remove a significant proportion of the adult trout. The reach is much larger/wider and deeper then the other two reaches which may also contribute to fish being missed/escaping during electrofishing.

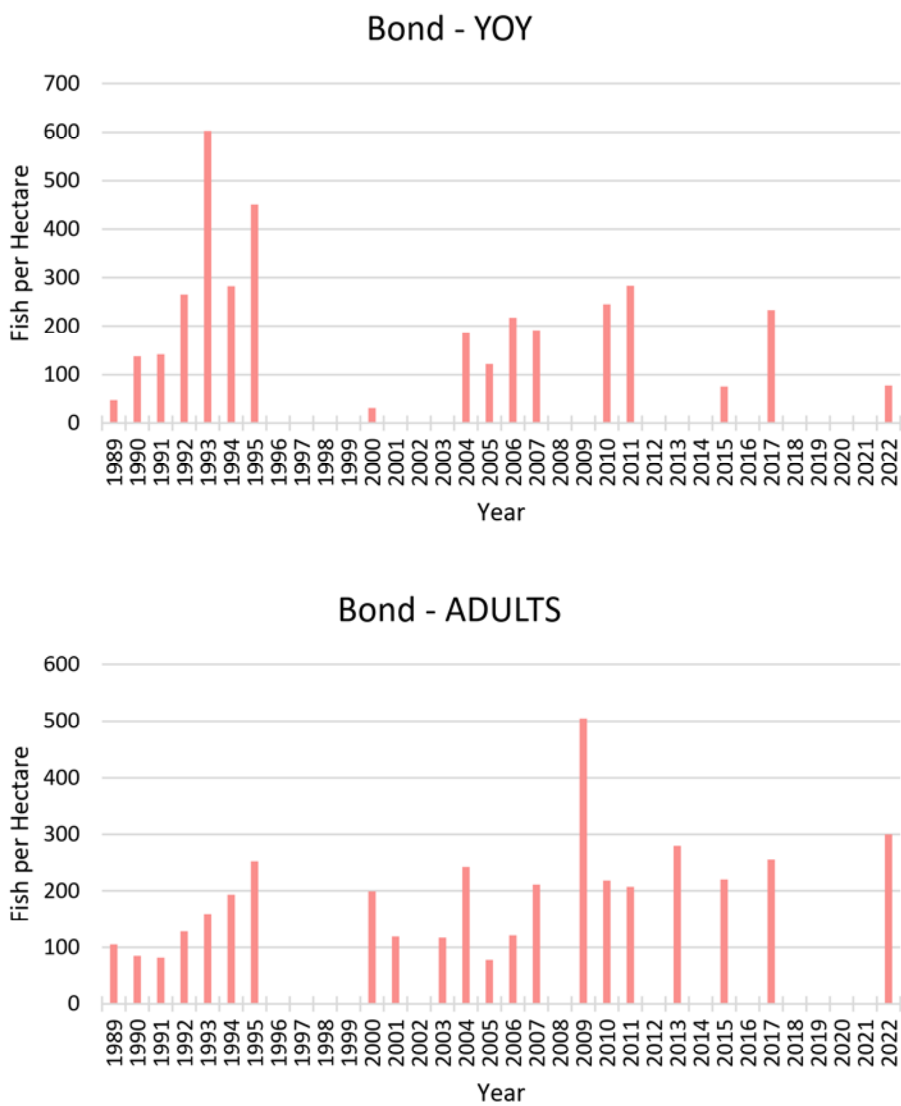


Figure 5-3 Brown Trout Population Estimates - Bond Tract Station

5.2.2 PRE VERSUS POST-EXTRACTION BROWN TROUT POPULATION ESTIMATES

The number of YOY and adult Brown trout are higher throughout the study area since extraction began compared to pre-operational (before 1995) population estimates. A statistical analysis of Brown trout populations in the University of Guelph and Hanlon reaches was performed to compare population size prior to extraction below the water table to the population after extraction. Both YOY and adult (age 1+) populations in each reach were considered. The available database was divided into pre-operational (1989-1994) and post-operational (1995-2022) periods. Although topsoil stripping began in 1993, extraction below the water table began in spring of 1995. Therefore, 1995 was considered as the starting timeframe for evaluation of potential effects of extraction below the water table on fisheries' resources in the area.

A one-tailed t-test (assuming unequal variance) was performed to determine if there has been a significant change in Brown trout population size since 1995. The test calculates whether the pre-operational period population estimates are greater than or less than the post-operational period. The test calculates a probability value (P value) or percent probability of incorrectly concluding a statistical significance. For this analysis, a confidence level of 5% was used, therefore any P value less than 0.05 indicates a significant difference between the two periods.

Adult and YOY populations were significantly ($P<0.05$) greater in the University of Guelph reach during post-operational years (Table 5-1). The average number of adult fish (age 1+) increased from approximately 354 per hectare during the pre-operational period to 753 per hectare during the post-operational period. The average number of YOY also increased significantly during post-operational period (2771 per hectare) compared with the pre-operational numbers (1104 per hectare) (Table 5-1).

Similarly, the number of YOY in the Hanlon By-pass increased significantly ($P<0.05$) from an average of 264 individuals per hectare to 955 individuals per hectare (Table 5). Adult populations also increased significantly ($P<0.05$) between periods in this reach with 116 and 262 individuals, pre and post-extraction, respectively.

This analysis indicates there has been no decrease, and in fact, the Brown trout population has generally increased since commencement of aggregate extraction below the water table.

Table 5-1 Statistical Comparison of Brown Trout Population Size in Mill Creek Before and After Aggregate Extraction

Statistic	Pre-Operational Mean (SE)	Post-Operational Mean (SE)	P Value
University of Guelph			
YOY per ha	1104.0 (457.2)	2770.6 (358.5)	0.0072
Age 1+ per ha	354.0 (104.7)	752.6 (37.5)	0.0053
Hanlon By-Pass			
YOY per ha	264.3 (115.7)	955.0 (103.3)	0.0003
Age 1+ per ha	116.3 (46.0)	261.9 (29.2)	0.0121
SE = Standard Error *Significantly greater during post-operational period at the 0.5 level			

5.2.3 OTHER SPECIES

Since 1998 the number of other fish species caught in the study area has been recorded as this provides an indication of general habitat quality and could represent possible competition with the trout. During the 2022 survey, 10 non-trout species were observed in the University reach, and 12 non-trout species were captured in the Hanlon reach. This is consistent with previous years. In 2022, no Brook trout were captured in the University, the Hanlon or the Bond Tract reaches.

5.2.4 REDD SURVEYS

The redd spawning survey indicated a total of 3 confirmed redds, 24 probable redds, and 8 scrapes within the Mill Creek project limits. The 2022 survey indicates that the number of Brown trout redds was similar in the University and Hanlon sections of the creek. This differs from previous years as the numbers in the University reach are generally higher than in the Hanlon reach due to the availability of suitable habitat. In 2022, a large beaver dam was noted upstream of the west property boundary and sampling was completed over 2 days due to sediment impeding the visual identification of spawning activity. This period of sedimentation may have also impacted the results WSP reported for 2022, as the sediment may have forced Brown Trout to retreat to lower reaches where spawning may have taken place unobserved.

The number of redds in the University section was 11 in 2022 compared with 41 in 2021 (Figure 5-4). The University section also had a total of 6 scrapes, which can be indicative of a potential for more redds in the reach (completed redds post field investigations). The redd count was lower than in the preceding year but similar to results for the period from 2018 when other beaver dams were present. The highest number of redds recorded to date in this reach was 194 in 2010.

In the Hanlon section, the redd count was 15 in 2022 compared with 39 in 2021 (Figure 5-5). The Hanlon redd numbers were similar to those observed from 1995 to 2005. There was also a total of 2 scrapes identified within the Hanlon section, which again can be indicative of a potential for more redds in the reach (completed redds post field investigations). The highest number of redds recorded to date in this reach was 107 in 2016 which was also the first time that the number of redds in the Hanlon reach exceeded the number of redds in the University reach.

As previously discussed, a scrape is a less defined or small clearing of disturbed substrate with no fish visually observed. They could be indicators of redds being created but were then abandoned either due to fish being startled off, or the fish uncovered less then desirable spawning conditions in the substrate. 2020 was the first year in which scrapes had been recorded in the University and Hanlon sections, therefore it is unclear whether this is comparable to previous years; however, as more scrape data are recorded, trends may become evident. The number of scrapes in the University section was 6 in 2022 compared to 23 in 2021 and 18 in 2020. The number of scrapes in the Hanlon section in 2022 was 2, with 35 and 43 in 2021 and 2020, respectively.

The very low numbers of Brown trout redds observed in the fall of 2018 were largely attributed to the presence of beaver dams in the study reaches of Mill Creek. The beaver dams were physically placed over top of prime spawning habitat, and also altered water flow patterns, resulting in silt deposition and scouring of good spawning habitat. It is also possible that the presence of the beaver dams masked redds that had been created under the branches and woody debris and were, therefore, not visible to the biologists. These beaver dams were destroyed by natural occurrences and were not impacting flows during the 2020 field investigations; however, a new beaver dam was identified during the 2020 redd surveys approximately 20 m upstream of the west property boundary, which was impacting flows. This beaver dam was removed/destroyed prior to the 2021 redd surveys and has since been re-built prior to the 2022 redd surveys.

Additionally, excess sediment was noted in the creek during the 2022 redd survey so it was conducted over two days to facilitate visibility of spawning activity by biologists.

The spill of jet fuel into Mill Creek occurred on January 13, 2019, after the fall spawning period in 2018, therefore, it would not have interfered with spawning activity or redd counts for 2018. Redd surveys are not conducted at the Bond Tract Station due to absence of suitable spawning habitat.

Redd survey dates and results are summarized in **Sub-Appendix B**.

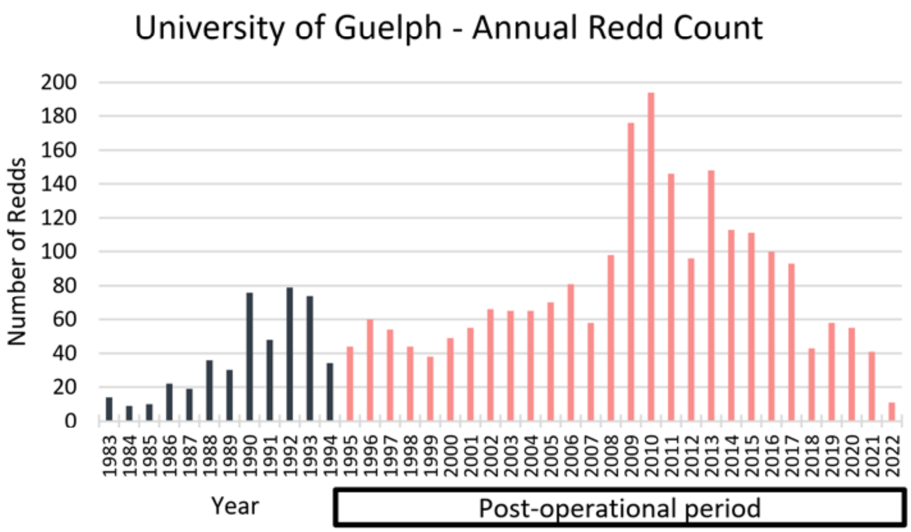


Figure 5-4 Annual Brown Trout Redd Counts in the University of Guelph Station

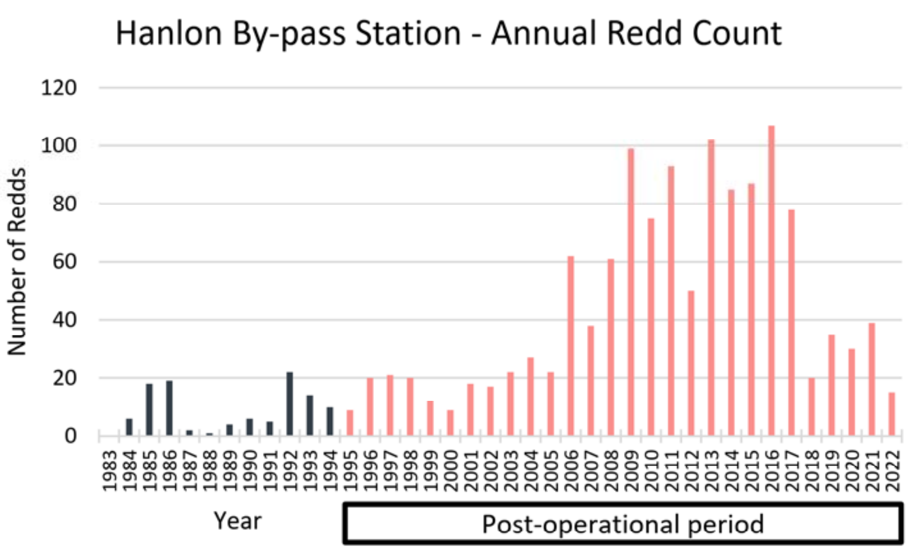


Figure 5-5 Annual Brown Trout Redd Counts in the Hanlon By-Pass Station

5.3 SUMMARY OF FISHERIES MONITORING

The fisheries monitoring program again demonstrates that the Brown trout population remained healthy in the study area in 2022. The 2022 estimated adult Brown trout population for the reaches is comparable to historical populations, which exhibit a cyclical growth pattern.

The data indicate that aggregate extraction below the water table (beginning in 1995) has had no measurable impact on the Brown trout population. Significant natural fluctuations in population and spawning activity occurred for the period 1983-1994 prior to extraction and were, therefore, unrelated to aggregate extraction (see Technical Appendix C).

Spawning activity, as indicated by the observed number of redds, was lower in both the University and Hanlon reaches in 2022 than in the preceding decade. The lower redd numbers are likely attributed to beaver activity and increased sedimentation which makes the survey difficult and has physically altered areas where high redd concentrations have been observed in past years.

The results from 2022 provide further evidence that aggregate extraction below the water table (beginning in 1995) has had no measurable negative impact on the level of Brown trout spawning activity. Therefore, Dufferin Aggregates continues to be in compliance with Licence Condition #23, which states there must be no “net loss of the productive capacity of fish habitat in Mill Creek or its tributaries.”

6 SUMMARY

SITE CONDITIONS AND OPERATIONS

- Extraction in 2022 occurred both above and below the water table in Phase 2, Phase 5 and Phase 6, as well as below the water table in Silt Pond 4 (SP4); and
- Silt Pond (SP4)/Phase 1 and Phase 4 pond operated within the minimum/maximum water level thresholds.

CLIMATE

- Mean monthly air temperature in 2022 was 0.6ºC higher than the 30-year average of 8.3ºC;
- Total precipitation in 2022 was 682 mm, which is 27% lower than the 30-year average of 935 mm.
- It is important to note that 2022 was an appreciably dry year. The annual precipitation recorded in 2022 (682 mm) was similar to the annual precipitation recorded in 2012 (679 mm), which was the lowest annual precipitation recorded since 1998. As reported in the 2021 Surface Water Report, persistent dry conditions were previously observed from early 2020 through summer 2021, and were followed by wetter conditions in the fall of 2021.

HYDROLOGY

- There is no indication that aggregate extraction has affected stream flow in Mill Creek;
- The calculated minimum and maximum instantaneous flow rates at SWM2 were within the historical range observed since 2000;
- The 7-day low flow value at SWM2 (0.098 m^3/s) was observed in December and was slightly lower than the historical minimum 7-day low flow values recorded since 2000;
- Stream flow in Mill Creek responded to climatic conditions including precipitation events, periods of snow melt and periods of low precipitation; and,
- Considering the extensive history of surface water monitoring data demonstrating a lack of surface water flow impacts by the pit operations, consideration should be given to reducing the surface water monitoring program.

GROUNDWATER

- The head difference at the OW5-84 to DP5CR pair exceeded the Action Threshold Value on one occasion in 2022. The exceedance is attributed to a more rapid groundwater level increase at DP5CR due to precipitation in the days prior to the measurement, which temporarily reduced the head difference at the well pair;
- Water levels in the Phase 1 to Phase 4 ponds did not exceed their respective low-water level threshold values in 2022 and are reflective of precipitation;
- The estimated groundwater contribution from the Mill Creek Aggregates Pit property located north of Township Road 2 was similar in 2022 compared to the historic average;
- In 2022, vertical gradients observed at the creek drive points located south of Highway 401 were consistent with historical results;
- The calculated net water surplus for 2022 was 129 mm, which is 175 mm (58%) lower than the 30-year average surplus of 304 mm;
- Groundwater temperatures at the monitoring stations closest to the Phase 1 and 3 Ponds were influenced by water temperatures in the ponds, which is not unexpected; however, groundwater temperatures rapidly moderate away from the ponds and do not impact water temperatures in Mill Creek;

- Groundwater patterns at the Mill Creek site have been influenced by climatic conditions and the presence of beaver dams in recent years. Groundwater quality has generally remained consistent over the years. Some Ontario Drinking Water Quality Standards were exceeded due to natural conditions in the area, which is consistent with previous findings; and,
- No changes to the groundwater monitoring program are recommended for 2023.

MILL CREEK WATER QUALITY AND TEMPERATURE

- Surface water quality has remained relatively stable over the past decade. In recent years there have been signs of increasing conductivity and chloride levels which is not related to pit activities, and may be attributed to road salting activities;
- The maximum stream temperatures in 2022 were 23.9°C at SWM1 on August 7th and 22.8°C at SWM2 on June 22nd; which are within historical ranges and below historical highs;
- The upper tolerable temperature for Brown trout (26.8°C) was not exceeded at any of the monitoring stations during the summer of 2022;
- The upper tolerable temperature for brook trout (23.9°C) was not exceeded at any of the monitoring stations during the summer of 2022; and,
- During the spring, summer and fall months, stream temperatures continue to decrease across the University property due to a combination of input from two coldwater tributaries, groundwater input, and shading which continue to enhance the coldwater fish habitat attributes of the stream.

FISHERIES

- Brown trout spawning activity in 2022 was lower in both the University and Hanlon reaches;
  - The number of redds in the University section was 11 in 2022 compared with 41 in 2021;
  - In the Hanlon section, the redd count was 15 in 2022 compared with 39 in 2021;
- The redd count in both stream sections in the past four years was lower than in the preceding decade but similar to results for the period 1996-2006;
  - The lower redd numbers observed in the past three years are attributed to beaver activity and increased sedimentation which has directly impacted spawning habitat, as well as interfering with stream access and the ability of biologists to survey the stream and observe redds;
- The estimated Brown trout population adjacent to the aggregate operation remained within historic ranges post extraction;
- Trout numbers and biomass continue to be higher in the University reach compared with the Hanlon reach due to better habitat conditions overall;
- Beaver activity is changing the creek and the riparian corridor. A beaver dam at the lower end of the University reach was noted during the 2022 redd survey and should be removed in summer of 2023, if possible; and,
- Additional stream restoration work in the vicinity of the lower Hanlon reach should be considered to improve the in-stream habitat in this area.

GENERAL CONCLUSION AND RECOMMENDATIONS

- The available monitoring data do not indicate that the Mill Creek aggregate operation negatively impacted the local environment in 2022.

7 THRESHOLD AND REQUIRED ACTIONS

7.1 THRESHOLDS

The action thresholds for the threshold pairs/locations, as proposed in the Monitoring Program, are presented in Table 3-2.

7.2 ACTION RESPONSE FOR GROUNDWATER THRESHOLD PAIRS

EARLY WARNING VALUE EXCEEDANCE

Included in Table 3-2 is a summary of the early warning head difference values at each threshold pair. In the event of an exceedance of an early warning value, the following internal response protocol would be followed.

— Verify the water level data at the subject monitor pair within two days.
— If the head difference is confirmed to be less than the early warning value, the monitoring frequency will be increased to twice per week in the general vicinity of the monitoring pair.
— Concurrent with the intensified monitoring frequency, the extraction and processing operations will be reviewed with Dufferin Aggregates to determine if there is an obvious cause for the decline in head difference between the monitors. If such a cause is identified, it will be rectified as quickly as possible.
— Monitoring will continue at the intensified frequency to establish a trend in the water levels, and to determine the cause of the problem (e.g., low stream flow upstream of the threshold pair, high rate of extraction, interruption of pumping cycle, abnormally dry season, etc.), and the degree of impact likely to ensue from an exceedance of the threshold. Groundwater discharge gradient conditions at the drive point monitors will be reviewed as part of the assessment.

In the event that the trend in the water levels indicates that the threshold value could be exceeded, Dufferin Aggregates will prepare and, if necessary, implement mitigation measures to prevent an exceedance of the threshold. Potential mitigation measures include the following.

— Relocation of extraction operations to another phase.
— Recharge injection wells or trench.
— Groundwater barrier wall (silt pond extensions).
— Pumping water from one of the on-site ponds to flood a particular area.
— Suspend extraction activities.
— Develop a groundwater source in the bedrock aquifer.

– Divert a portion of the peak flows from Mill Creek into the on-site pond(s) to raise water levels. This approach is to be reviewed with agency staff to determine if it is feasible/appropriate.

Some mitigation measures will require approval by MNRF by way of an amendment to the site plans.

MNRF will be contacted prior to the implementation of any additional mitigation measures. The initial results of the mitigation will be documented and submitted to MNRF within one month of implementation. Any additional actions that may be required will be agreed to with MNRF at that time.

GROUNDWATER THRESHOLD EXCEEDANCE

In the event that mitigation measures are not successful while extraction is occurring, and a threshold is exceeded for more than seven consecutive days, then below water table extraction will cease at that location and not begin again until that threshold shows recovery for seven consecutive days. Dufferin Aggregates will notify MNRF immediately if a threshold has been exceeded for more than seven consecutive days.

7.3 POND LEVEL THRESHOLDS

Low-water level threshold values and early warning values have been established for the Phase 1, Phase 2, Phase 3, and Phase 4 ponds, as well as silt pond SP3, to ensure that water levels do not become so low that groundwater discharge to Mill Creek would be affected. The threshold values and early warning values are presented in Table 3-2.

8 MONITORING PROGRAMS AND RECOMMENDATIONS

SURFACE WATER MONITORING

- Considering the extensive history of surface water monitoring data demonstrating a lack of surface water flow impacts by the pit operations, consideration should be given to reducing the surface water monitoring program.

GROUNDWATER MONITORING

- Groundwater monitoring will continue at the established stations.

FISHERIES MONITORING

- Surface water quality data will continue to be collected every year, in the fall, as in past years, with the next sampling period planned for fall 2023;
- The Brown trout population estimate continues to take place every other year following MNRF direction. Therefore, the next population survey is planned for fall of 2024, including the Bond Tract; and,
- The annual redd survey will continue to be conducted every year, with the next planned for the fall of 2023.

9 REFERENCES

Blackport, B. and Portt, C. 2002. Mill and MacCrimmon Creek Review of Flow Requirements for Fish Habitat. Draft Report Prepared for the Department of Fisheries and Oceans.

C. Wren & Associates Inc. and Jagger Hims Ltd. 2006. Pre-Phase 3 Coordinated Monitoring Programs for Mill Creek Aggregates, Township of Puslinch. Prepared for Dufferin Aggregates Ltd. January 2006.

Eagles Planning Ltd. 2011. Pre-Phase Four Compliance Report Biological Monitoring Activities on the Mill Creek Aggregates Site Puslinch, Ontario. Prepared for Dufferin Aggregates Ltd.

Eagles Planning Ltd. 2005. Pre-Phase Three Compliance Report Biological Monitoring Activities on the Mill Creek Aggregates Site Puslinch, Ontario. Prepared for Dufferin Aggregates Ltd.

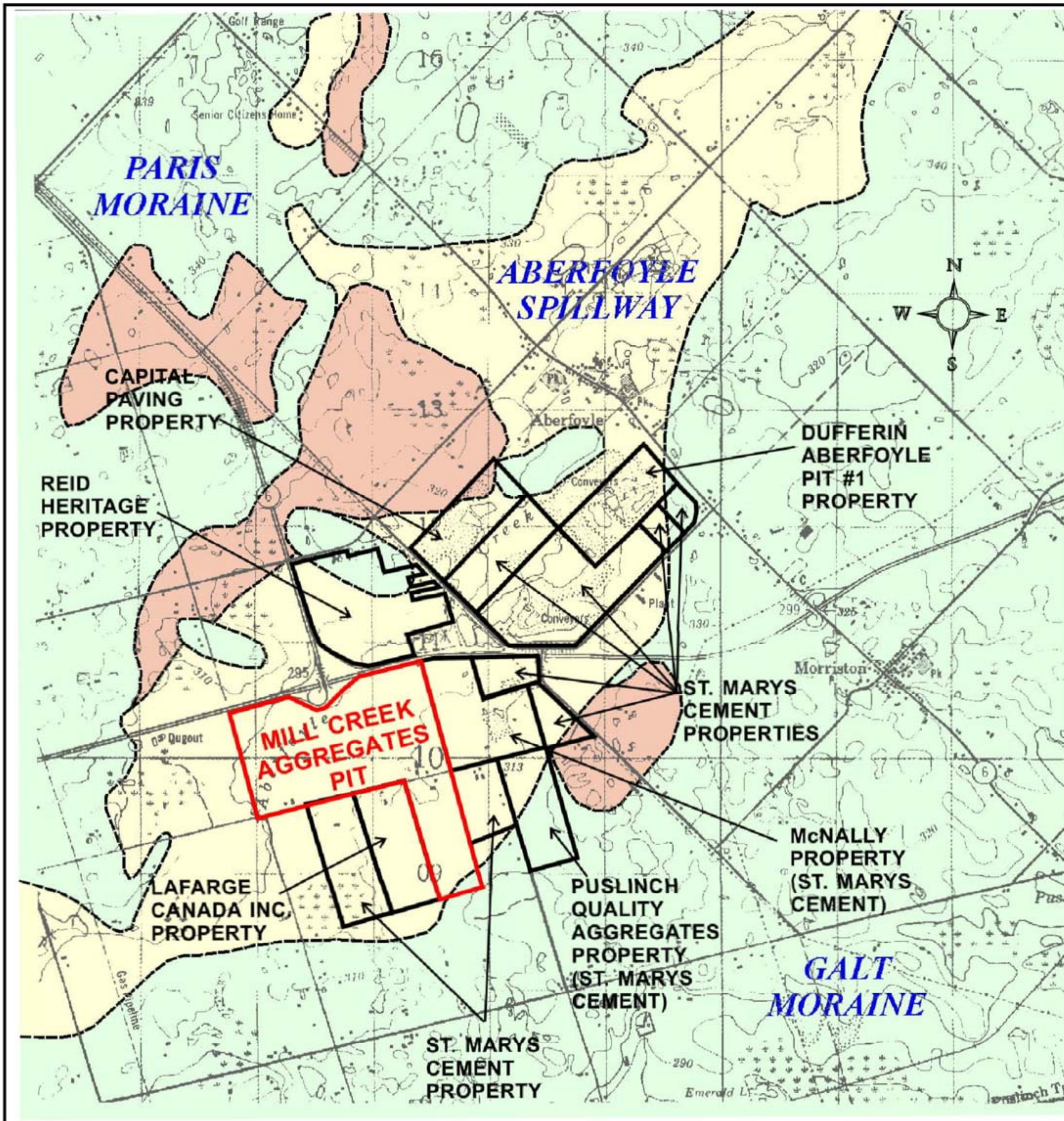
Eagles Planning Ltd. 2002. Pre-Phase Two Biological Monitoring Report for the Mill Creek Aggregates Site. Prepared for Dufferin Aggregates Ltd.

Planning Initiatives, 1993. Co-ordinated Report on Monitoring Programs for Mill Creek Aggregates. November, 1993.

Raleigh, R.F. 1982. Habitat Suitability Index Models: Brook Trout, U.S. Dept. Int., Fish and Wildlife Service. FWS/OBS-82/10.24. 42 pp.

Raleigh, R.F., LAD. Zuckerman and P.C. Nelson. 1986. Habitat Suitability Index Model and Instream Flow Suitability Curves: Brown Trout. Biological Report 82(10.124) of the U.S. Department of the Interior, Fish and Wildlife Service (National Ecology Center)

FIGURES



Legend

SANDY SILT TILL

ICE-CONTACT STRATIFIED DRIFT SAND, SILT, GRAVEL

OUTWASH SAND AND GRAVEL

SOURCE:
GENERALIZED AFTER KARROW, 1987.

500 0 1000 metres

LOCATION AND PHYSICAL SETTING

2022 COORDINATED MONITORING REPORT
MILL CREEK AGGREGATES PIT
Township Of Puslinch
for Dufferin Aggregates

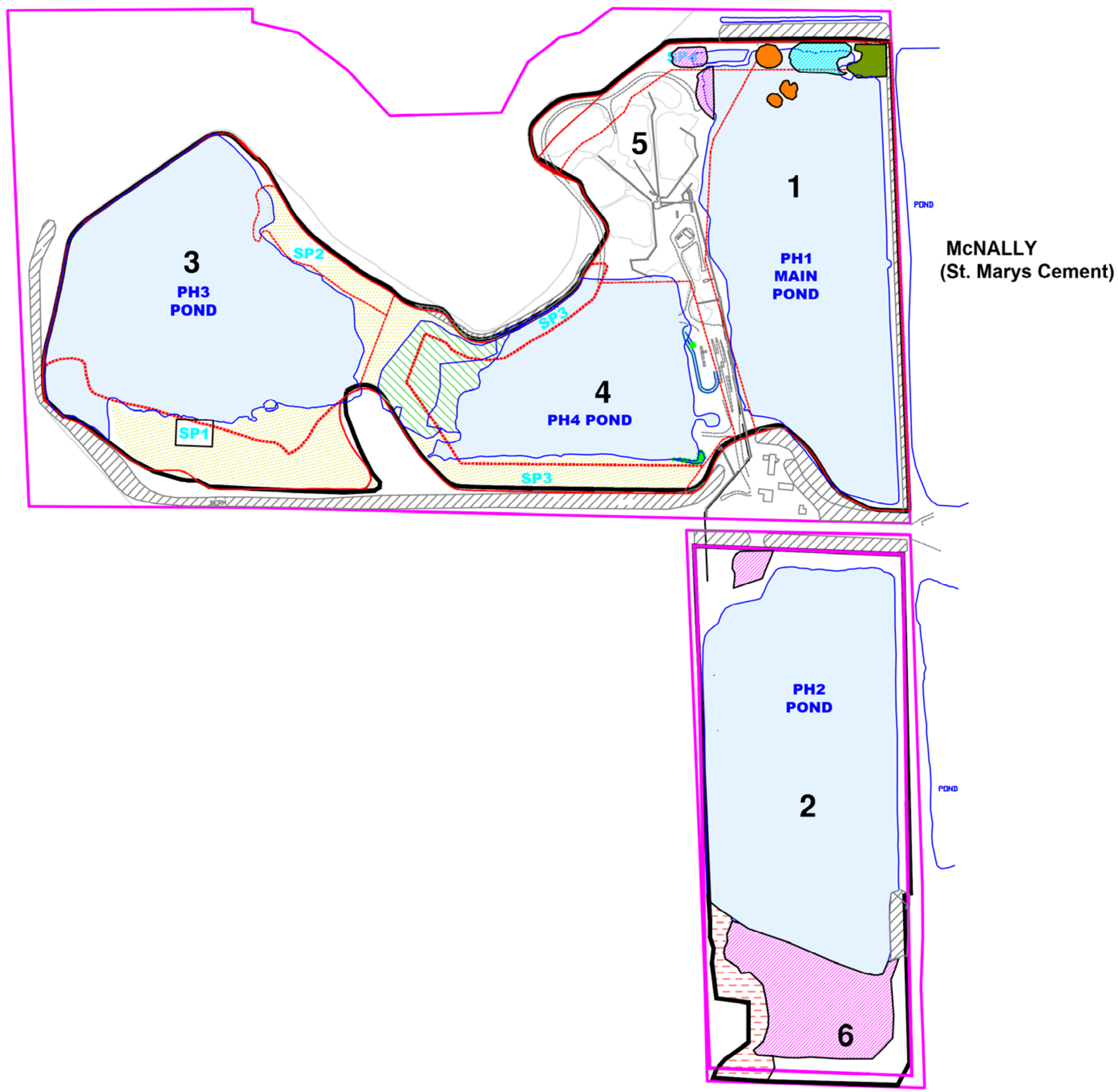
Dufferin Aggregates A CRH COMPANY

DATE: MARCH 2023	SCALE: 1:50000
PROJECT: 111-52958-14 100	REF. NO.: 111-52958-14 100 F1 2023

wsp

FIGURE 1

\\CORP.PBWAN.NET\CA\ENV_GIS\PROJECTS\CRC CAD\ON\2023_PROJECTS\111-52958-14 MILL CREEK PIT 2022 AMR\4 MODELS AND DRAWINGS\41 XX\04 WIP\01 CAD\COORDINATED MONITORING REPORT\111-52958-14-100 F1 2023.DWG



LEGEND

BOUNDARY OF LICENSED PROPERTY

LICENCED LIMIT OF EXTRACTION PER SITE PLANS

BOUNDARY OF EXTRACTION AREA PER G.R.C.A. FILL PERMIT APPLICATION

3 PHASE DESIGNATION

SP3 SILT POND DESIGNATION

BERM

INFILLED SILT POND

PARTIALLY INFILLED SILT POND

EXTRACTED AREA TO BE SLOPED

2022 DEPOSITION AREA

2020 DEPOSITION AREA

2022 EXTRACTED AREA

2021 DEPOSITION AREA

NOTES:

BASE MAPPING BY PLANNING INITIATIVES LTD., DATED AUGUST 1987, DRAWING NUMBERS 1A AND 1B OF 4.

POND BOUNDARIES BASED ON AERIAL PHOTOGRAPHY (DUFFERIN AGGREGATES, NOVEMBER 2020).

SITE PLAN SEQUENCING

2022 COORDINATED MONITORING REPORT
MILL CREEK AGGREGATES PIT
Township of Puslinch
for Dufferin Aggregates

SCALE: NOT TO SCALE
PROJECT: 111-52958-14 100
DATE: MARCH 2023
REF. NO.: 111-52958-14 100 F2 2023

FIGURE 2

\\CORP.PBWAN.NET\CA\ENV_GIS\PROJECTS\ICRC CAD\ON\2023_PROJECTS\111-52958-14 MILL CREEK PIT 2022 AMR\4 MODELS AND DRAWINGS\41 XX\04 WIP\01 CAD\COORDINATED MONITORING REPORT\111-52958-14-100 F3 2023.DWG

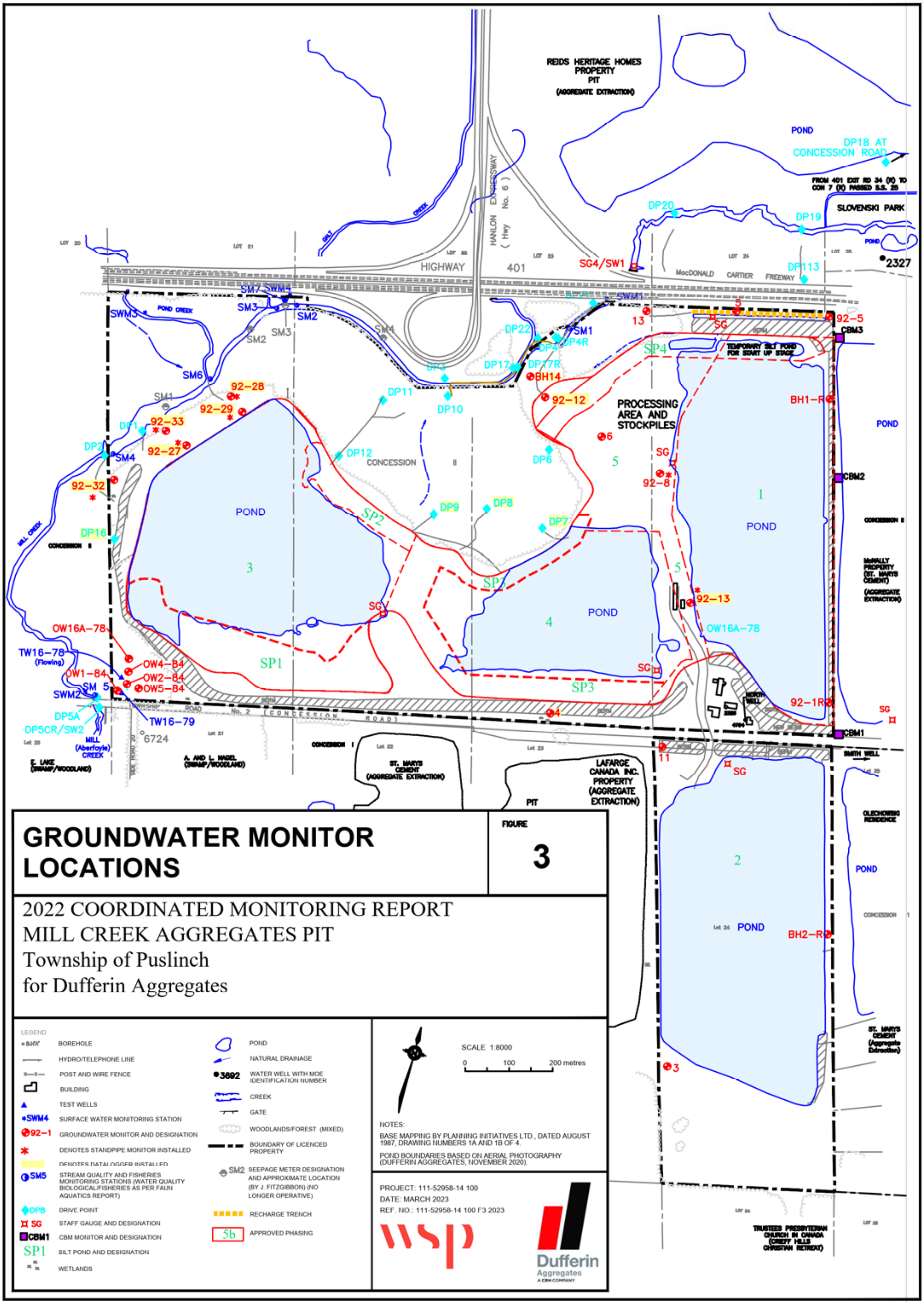


FIGURE 3

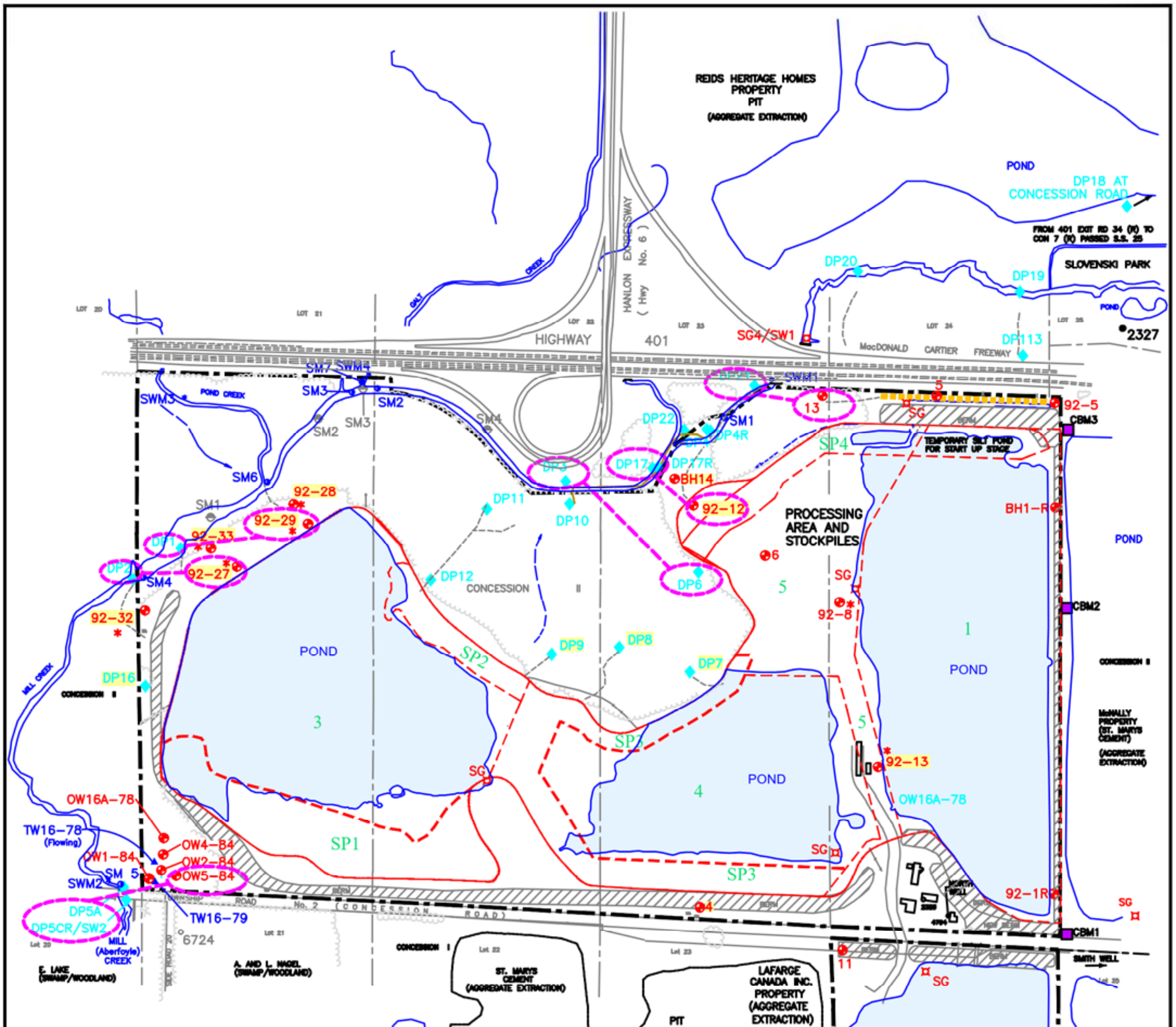
GROUNDWATER MONITOR LOCATIONS

2022 COORDINATED MONITORING REPORT
MILL CREEK AGGREGATES PIT
Township of Puslinch
for Dufferin Aggregates

NOTES:
BASE MAPPING BY PLANNING INITIATIVES LTD., DATED AUGUST 1987, DRAWING NUMBERS 1A AND 1B OF 4.
POND BOUNDARIES BASED ON AERIAL PHOTOGRAPHY (DUFFERIN AGGREGATES, NOVEMBER 2020).

PROJECT: 111-52958-14 100
DATE: MARCH 2023
REF. NO.: 111-52958-14 100 F3 2023

wsp
Dufferin Aggregates
A CRH COMPANY



LOCATION OF GROUNDWATER THRESHOLD MONITORING PAIRS

FIGURE **4**

2022 COORDINATED MONITORING REPORT
MILL CREEK AGGREGATES PIT
Township Of Puslinch
for Dufferin Aggregates

LEGEND

- GROUNDWATER THRESHOLD PAIRS
- BOREHOLE
- HYDRO/TELEPHONE LINE
- POST AND WIRE FENCE
- BUILDING
- TEST WELLS
- SWM4 SURFACE WATER MONITORING STATION
- 92-1 GROUNDWATER MONITOR AND DESIGNATION
- DENOTES STANDPIPE MONITOR INSTALLED
- DENOTES DATALOGGER INSTALLED
- SM5 STREAM QUALITY AND FISHERIES MONITORING STATIONS (WATER QUALITY BIOLOGICAL/FISHERIES AS PER FAUN AQUATICS REPORT)
- DP8 DRIVE POINT
- SG STAFF GAUGE AND DESIGNATION
- CBM1 CBM MONITOR AND DESIGNATION
- SP1 SILT POND AND DESIGNATION
- WETLANDS
- POND
- NATURAL DRAINAGE
- 3692 WATER WELL WITH MOE IDENTIFICATION NUMBER
- CREEK
- GATE
- WOODLANDS/FOREST (MIXED)
- BOUNDARY OF LICENCED PROPERTY
- SM2 SEEPAGE METER DESIGNATION AND APPROXIMATE LOCATION (BY J. FITZGIBBON) (NO LONGER OPERATIVE)
- RECHARGE TRENCH
- 5b APPROVED PHASING

SCALE 1:8000

0 100 200 metres

NOTES:

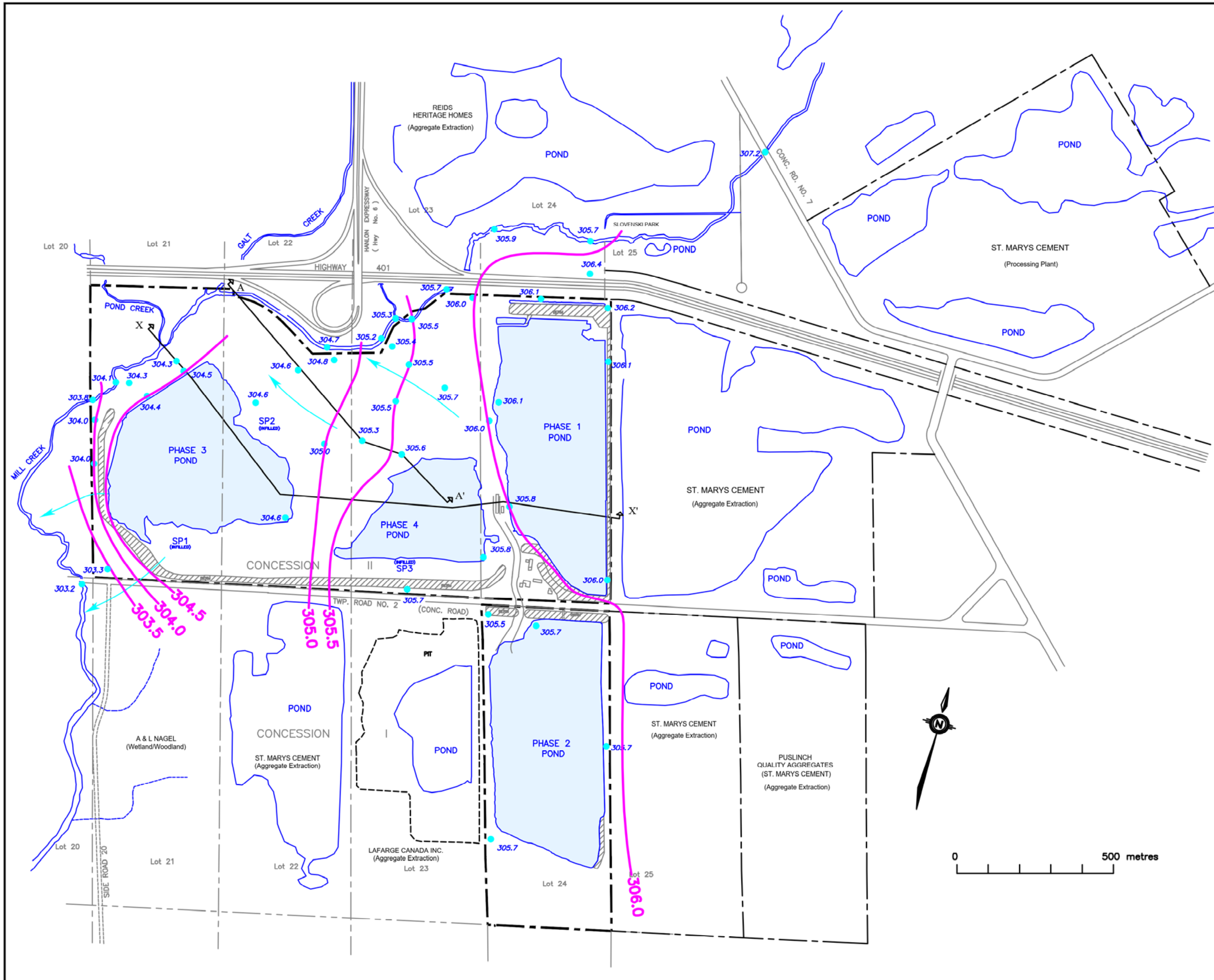
BASE MAPPING BY PLANNING INITIATIVES LTD., DATED AUGUST 1987, DRAWING NUMBERS 1A AND 1B OF 4.

POND BOUNDARIES BASED ON AERIAL PHOTOGRAPHY (DUFFERIN AGGREGATES, NOVEMBER 2020).

PROJECT: 111-52958-14 100
DATE: MARCH 2023
REF. NO.: 111-52958-14 100 F4 2023

wsp

Dufferin Aggregates
A CRH COMPANY



LEGEND

BOUNDARY OF LICENCED PROPERTY

305.7 WATER TABLE ELEVATION (mASL) SEPTEMBER 8, 2022

306.0 INTERPRETED WATER TABLE CONTOUR (mASL)

INFERRED DIRECTION OF GROUNDWATER FLOW

A GEOLOGIC CROSS SECTION LOCATION

2022 'LOW FLOW' WATER TABLE CONFIGURATION (SEPTEMBER)

2022 COORDINATED MONITORING REPORT
MILL CREEK AGGREGATES PIT
Township of Puslinch
for Dufferin Aggregates

DATE: MARCH 2023	SCALE: 1:12500
PROJECT: 111-52958-14 100	FILE NO.: 111-52958-14 100 F5 2023

FIGURE 5

\\CORP.PBWAN.NET\CA\ENV_GIS\PROJECTS\ICRC CAD\ON\2023_PROJECTS\111-52958-14 MILL CREEK PIT 2022 AMR\4 MODELS AND DRAWINGS\41 XX\04 WIP\01 CAD\COORDINATED MONITORING REPORT\111-52958-14-100 F5 2023.DWG