APPENDIX C – COMPREHENSIVE WATER QUALITY MONITORING PROGRAM – 2022

COMPREHENSIVE WATER QUALITY MONITORING—WESTCHESTER QUARRY

Suspended Sediment and Conductivity Monitoring of Streams Adjacent to the Chapman Brothers Westchester Quarry, 2327 Westchester Road Rose, Nova Scotia

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Executive Summary

Chapman Bros. Construction Ltd. has operated its Westchester Road quarry since 2014 under an Industrial Approval for operations of a quarry less than 4 ha. In November, 2021, the company registered an Environmental Assessment for the expansion of the quarry to 40.36 ha. Following review by NSECC, a request for additional information on water resources and fish habitat was issued. One component of the requirement was for a Comprehensive Water Quality Monitoring Program (CWQMP) to be carried out to determine if the Quarry was impacting a watercourse located adjacent. The program was carried out from May to September 2022 and monitored suspended sediment and conductivity levels, as well as other standard water quality parameters in the watercourse and in two other watercourses in the general vicinity, which served as controls.

The Quarry was determined to not be affecting levels of Total Suspended Solids (TSS) in the nearby watercourse. An elevated level of TSS observed in the watercourse in 2017 was likely due to contamination by dust due to the proximity of the sampling location to Westchester Road, not due to Quarry operations. A partially blocked culvert on the watercourse under the access road, and the resulting ponding of water upstream, and adjacent to the road, currently provide a measure of sedimentation and filtration to protect the lower watercourse from sediment in surface water runoff from the road. Presence of the access road itself and associated airborne dust entering the watershed and seepage of stream flow through the road bed, are the likely sources of elevated conductivities observed in the watercourse downstream of the site. Elevated conductivities are caused by elevated dissolved solids levels and are not harmful to freshwater aquatic life at the levels observed.

No changes to the existing Quarry access road which crosses the subject watercourse are required. The addition of a berm on the southeast side to separate the road from the upstream watercourse edge would prevent surface water from the road from entering the watercourse, and may lead to a reduction in conductivity levels in the water further downstream in the watercourse.

1. Introduction

Chapman Bros. Construction Ltd. has operated its Westchester Road quarry since 2014 under an Industrial Approval for operations of a quarry less than 4 ha. In November, 2021, the company registered an Environmental Assessment for the expansion of the quarry to 40.36 ha. Following review by NSECC, a request for additional information on water resources and fish habitat was issued. The information provided in this report forms the results of a Comprehensive Water Quality Monitoring Program conducted from May to September 2022 as a response to the Minister's Request; and supports a Surface Water Resources Assessment of the quarry conducted in parallel. The study was requested by the Minister of the Nova Scotia Department of Environment and Climate Change (NSECC) following the review of the Environmental Assessment Registration Document for a proposed expansion of the quarry under the Nova Scotia *Environment Act*.

2. Scope and Objective,

2.1 Scope

This Comprehensive Water Quality Monitoring Program (CWQMP) was conducted to provide information to support a Surface Water Resources Assessment for the Chapman Brothers Construction Ltd. Westchester Quarry.

The Minister's request for additional information dated January 18, 2022 indicated the following with respect to the CWQMP:

> *3) A comprehensive water quality monitoring program in clear flow conditions (not turbid flow caused by a recent precipitation event) and associated assessment in the second unnamed watercourse immediately east to the existing quarry site to understand whether the significant elevations of TSS, conductivity and specific conductivity in this watercourse are associated with existing quarry activities. If so, provide appropriate mitigation measures to be planned and incorporated into the surface water management with the development plan of the proposed expansion. If the elevated turbidity is determined to be unrelated to the existing quarry, provide specific mitigation measures to be included to prevent further impacts to the water quality in this watercourse as a result of the proposed expansion.*

This CWQMP specifically is intended to provide information on Total Suspended Solids (TSS) and Conductivity (including Specific Conductivity) in the unnamed watercourse (Watercourse 1, Figure 1), to determine whether elevated levels in one sample observed during a baseline survey in 2017 are typical and associated with existing quarry activities. In addition, the program included measurements of standard water quality parameters including pH which is another water characteristic is useful in evaluating impacts of industrial activities on surface waters. The monitoring program was required to take place under "clear flow conditions (not turbid flow caused by a recent precipitation event)" as outlined in a letter dated January 18, 2022 from the Minister of NSECC (the Honourable Tim Halman) to Chapman Bros. Construction Ltd (see above).

2.2 Objective

The objective of this CWQMP is to provide data on TSS and Conductivity under clear flow conditions in an unnamed watercourse east of the quarry (Watercourse 1, Figure 1) for a period of time during active operations at the Westchester Quarry, to allow an assessment as to whether abnormal levels of those parameters occur, and whether they can be attributed to the Quarry. Samples and measurements from two nearby streams, and from Watercourse 1 upstream of any quarry influence have been used as 'controls' to establish background conditions.

3. Background

3.1 General

After the review of the Biophysical Environmental Assessment report which was part of the Environmental Assessment Registration submission, NSECC highlighted an elevated level of Total Suspended Solids (TSS)

and Conductivity / Specific Conductivity[1] in a sample taken downstream of the Quarry in the baseline study in September 2017. The level of TSS (46 mg/L) and Specific Conductivity (137 uS/cm) were above the range of 1.5 to 9.0 for TSS and 44.8 to 67 µS/cm for specific conductivity, measured in other watercourses in the general vicinity; and the level of TSS was above the 25 mg/L guideline for levels above background to indicate possible impacts of industrial activities on water quality.

The present document describes the Comprehensive Water Quality Monitoring Program, results, and discussion. The unnamed watercourse (Watercourse 1), adjacent to the quarry, as well as two watercourses in the general vicinity which serve as controls (i.e. in locations not likely to be influenced by the Quarry) are shown in Figure 1.

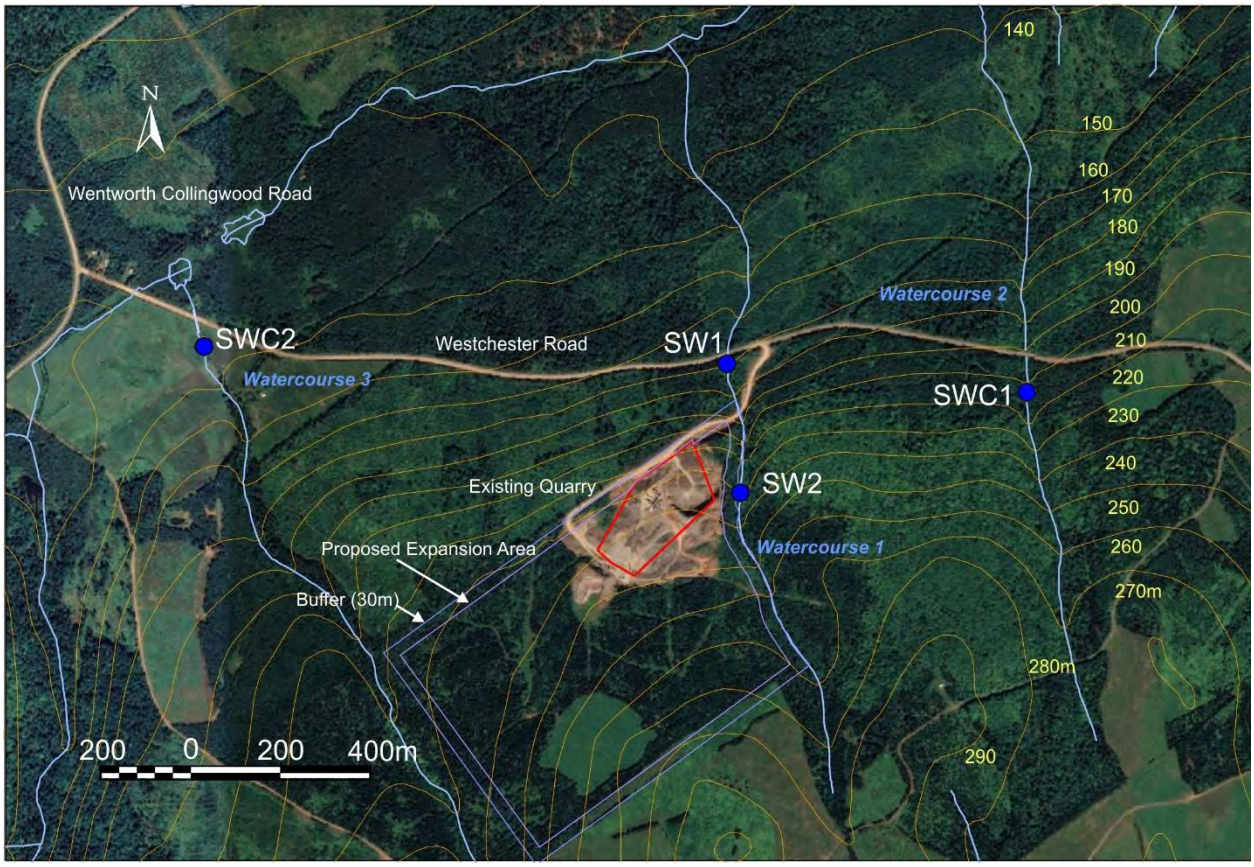

Figure 1. Location of Site Features and proposed sampling locations, Chapman Bros. Construction Ltd., Westchester Quarry. .

3.2 Chapman Brothers Quarry and Drainage Features

The Westchester Quarry is an aggregate quarry which produces crushed stone for various construction needs, particularly highway construction. Operations are monitored for impacts on the aquatic environment through an Industrial Approval for a quarry less than 4.0 ha. Access to the quarry is along a road ("access road") connecting it with the Westchester Road (Figure 1). The watercourse which is the object of the study ("Watercourse 1" on Figure 1) flows north beside, and east of, the Westchester Quarry.

[1] Conductivity depends both on electrical properties of the water and on water temperature. Specific Conductivity is the conductivity adjusted to a standard temperature, in this case 25° C., to allow measurements at different sites and times during the year to more readily be compared.

It originates in a headwater area adjacent to blueberry fields. After passing the Quarry, it flows under the quarry access road in a subsurface flow where an existing culvert is partially blocked. A small pool/pond is located immediately upstream of the access road (Photo 9) upstream of the partially blocked culvert. The Quarry floor is largely level or slightly sloping to the northwest. Precipitation entering the quarry leaves the site primarily through percolation into fractures in the bedrock to enter the water table; however excess runoff is channeled off site to the northwest[2]. The access road leaves the level floor of the quarry on the northeast side and has a downhill slope towards and past Watercourse 1, eventually reaching Westchester Road.

3.3 Site Hydrology

Three small headwater streams originate in the general vicinity of the Quarry (Watercourses 1 to 3, Figure 1). None of the streams are large enough to be mapped on 1:50,000 mapping of the area. One of the watercourses—Watercourse 3, Figure 1—originates on the western edge of the study area, flowing north towards Westchester Road, which it crosses. A second watercourse (Watercourse 1) follows a steeply-incised valley immediately east of the existing quarry, flowing north into a tributary of West Branch Wallace River; and a third stream (Watercourse 2, Figure 1), also flowing northeast, drains an area east of the study area along Westchester Road.

4. Water Quality Monitoring Plan

4.1 Purpose of Monitoring

Activities in and around water may release fine sediments from erosion of surfaces or through disturbance of soil. High levels of suspended sediments and deposition of fine sediments artificially generated is detrimental to biological organisms living in streams which are adapted to conditions that are typically free of sediments. In particular, spawning areas of high value fish species such as salmonids, including Atlantic Salmon, can be negatively impacted by suspended sediments; salmonids are known to occur in both the Wallace River and River Philip watersheds, and the Quarry is within their catchment areas. For these reasons, activities in the project must be managed to minimize release of suspended sediments. Total Suspended Solids (TSS) is an appropriate monitoring parameter for suspended sediments. Conductivity (and Specific Conductivity, which is Conductivity standardized to a temperature of 25 °C) is another monitoring parameter which measures the influence of industrial activity, as it reflects concentrations of dissolved solids and can indicate relative contributions of groundwater to flow as well as the presence of artificial inputs, such as sewage outfalls, or natural inputs through springs, on surface waters. pH or the relative acidity or alkalinity of water in turn is a water quality parameter which may be impacted by industrial activities and is useful to measure in association with other parameters to determine industrial impacts on water quality.

4.3 Water Quality Criteria

The water quality targets based on the CCME Freshwater Aquatic Life Guidelines are:

Total Suspended Sediments: Under clear flow conditions, the CCME freshwater aquatic life guideline is a maximum increase of 25 mg/L from background levels for any short-term exposure (e.g., 24-h period).

[2] A full description of the drainage patterns is presented in the Water Resources Assessment produce by W.G. Shaw and Associates, in an accompanying Appendix.

The guideline for longer term exposures (e.g., inputs lasting between 24 h and 30 d) is a maximum average increase of 5 mg/L from background levels

Conductivity: There is no guideline for the effects of conductivity or total dissolved solids of which conductivity is an indicator, in terms of maintenance of freshwater aquatic life. In a watercourse, conductivity will vary throughout the year, in particular due to relative contributions of surface runoff generated by precipitation and groundwater. Conductivity levels will increase in a stream throughout the year as the flow, due to precipitation and surface water runoff, declines and the proportion of groundwater increases. As an example of conductivities expected to occur naturally, levels of conductivity in one study ranged from 21 to 118 us/cm in distilled water, and in spring water from 39 to 586 us/cm (Saleh et al. 2008).

pH: is a significant water quality parameter for aquatic organisms including salmonids. pH is influenced by rainfall (acid rain) and organic acids from the breakdown of organic material, which gives a tea-colour to the water. The acceptable range for pH is 6.5 to 9, according to CCME Guidelines for the Protection of Freshwater Aquatic Life.

5. Methods

Field Monitoring Program Monitoring Locations

Water sampling was conducted under 'clear water' conditions as requested by NSECC, when flows were considered normal and not influenced by recent rain events. Sampling was conducted on May 4 and 20, June 16, July 13, and September 12, 2022, during which period the Westchester Quarry was operating. Sampling locations are shown in Figure 1. Water samples and an *in situ* measurement of temperature, dissolved oxygen, dissolved oxygen (%), conductivity, and specific conductivity were taken upstream of Westchester Road in Watercourse 1 and in each of two nearby streams (Watercourses 2 and 3), the latter which served as controls to illustrate typical conditions in the area. Sampling in Watercourse 1 included a sample 165 m upstream of the quarry access road; and on September 12, a pool/pond located on Watercourse 1 immediately adjacent to and upstream of the access road. The upstream point on Watercourse 1 was the furthest location upstream which the survey team felt would support flow throughout the monitoring period.

Sampling Methods

Each permanent sampling point (see Figure 1), was chosen and marked with flagging tape on a tree (Photos 1 to 8). The sampling points chosen were sites where an adequate water sample could be taken without disturbance. Water measurements were made with a YSI Model 85 hand-held, dissolved oxygen, temperature, and conductivity probe; and water samples for laboratory analysis of Total Suspended Solids (TSS) and pH were taken at each site. Field notes were taken on field data sheets documenting measurements, the number and type of samples, water depth, the strength of stream flow (low, moderate and high), and turbidity (clear, slightly turbid (suspended material partially obscures the stream bed), moderately turbid (the streambed can barely be seen), and highly turbid (the streambed cannot be seen)).

Laboratory Quality Assurance

Water samples for TSS and pH were analyzed at Envirosphere Consultants Limited's accredited laboratory[3]. The YSI hand-held field meter was calibrated for dissolved oxygen in the field prior to each use; and periodically for conductivity against a certified reference standard (1,413 µS/cm @ 25 °C.).

6. Results

Dissolved Oxygen

Overall, levels of all parameters reflected normal ranges for flowing upper-watershed streams in Nova Scotia (Table 1). Dissolved Oxygen was measured at all water sampling locations (Table 1, Figure 5). Dissolved Oxygen was at or above the CCME Freshwater Aquatic Life (FAL) Guideline of 6.5 (coldwater fish) except at two locations—the upstream site (SW2) on Watercourse 1 in September (4.6 mg/L) and Watercourse 2 (SWC1) in July (6.34 mg/L). A level of 4.4 mg/L was observed in the pool which occurs on Watercourse 1 immediately upstream of the access road. Low levels of dissolved oxygen are attributable to low flows immediately upstream of the sampling location, as both are flowing water environments albeit at low flow, and oxygen concentration is dependent on flows to mix the water and expose it to air. A spring can cause locally low oxygen levels; however they are usually accompanied by a lower temperature, and temperatures at both the sites were not depressed. A relatively high dissolved oxygen level was observed at the downstream location on Watercourse 1 (SW1) in September (7.6 mg/L) when levels were comparable to those in Watercourses 2 and 3 (7.0 and 6.5 mg/L respectively).

Relative Levels of Total Suspended Solids, pH and Specific Conductivity

Water Quality measurements and sample results are presented in Tables 1 and 2. Overall, levels of all parameters reflected normal ranges. The sampling location on Watercourse 1 at the pool and downstream of the quarry access road (SW1) showed elevated levels of Specific Conductivity and pH compared with the Watercourse 1 upstream site (SW2), and the two control streams (SWC1 and SWC2) (Table 1, Figures 1 and 2). Total Suspended Solids (TSS), however, was variable at SW1 and consistent with the measurements at the other sites (Table 1, Figure 3).

Specific Conductivity at SW1 on Watercourse 1 was highest of all sites and the differences with the other locations were statistically significant (Kruskal Wallace (KW) One-Way Analysis of Variance, n=5)[4], with SW1 greater than SW2 ($p<0.01$); SW1 greater than SWC1 ($p<0.01$); and SW1 greater than SWC2, $p<0.05$). Specific Conductivity at the upstream site on Watercourse 1 (SW2) was in turn significantly higher than Watercourse 3 (SWC2) (KW One-Way Analysis of Variance, n=5, $p<0.05$), but was not significantly different from that observed in Watercourse 2 (SWC1).

Specific Conductivity at all sites except SWC2 on Watercourse 3 showed a gradual increase with season, presumably reflecting decreased flows and lower influence of precipitation and surface water influences later in the year.

The highest Specific Conductivity recorded at SW1 in September 2022 (187.2 µS/cm) was comparable to if not slightly higher than the level reported in the Biophysical Assessment for the Environmental Assessment (Envirosphere Consultants Limited 2018), measured in September 2017, which was 137

[3] Canadian Association for Laboratory Accreditation (CALA), Registration Number 3464.
[4] The KW Statistical Test compares the average value over all sampling occasions (Sokal and Rohlf 1981). Comparisons were conducted using Systat 5.0 software (Systat Software Inc. 1990).

µS/cm (Table 2), and which was one of the factors which triggered the need for the current study. Specific Conductivity in the pool located in Watercourse 1 immediately upstream of the quarry access road at 168.4 µS/cm in September 2022 (Table 1), but specific conductivity at the further upstream site (SW2) was lower (60.7 µS/cm)(Table 1).

Total Suspended Solids None of the water sampling sites showed particularly elevated concentrations of Total Suspended Solids (TSS), with 10 mg/L being the highest in Watercourse 1 (SW1) and 6 mg/L on Watercourse 2 (SWC2). The highest TSS measured in the present study was 18 mg/L, observed in the pool on Watercourse 1 upstream of the access road (Table 1) but was not accompanied at the time by an elevated level of TSS in the sampling location (SW1) further downstream. All levels of TSS observed were below the level of 46 mg/L measured at in Watercourse 1 immediately above Westchester Road in 2017 which in part resulted in the request for additional information which triggered this study.

pH as an indicator of water quality was monitored in parallel to TSS and Specific Conductivity. pH at SW1 was highest of all sites and the differences from the other sites were statistically significant (KW One-Way Analysis of Variance, n=5)(SW1 greater than SW2, $p<0.05$); SW1 greater than SWC1, $p<0.01$); and SW1 greater than SWC2, $p<0.05$). pH at the upstream site on Watercourse 1 (SW2) and sampling locations in the other watercourses were similar (i.e. not statistically significantly different). All sites showed a general gradual increase in pH through the year. The pH of 7.6 observed in the pool on Watercourse 1 in September 2022 (immediately upstream of the quarry access road) was comparable to the pH of 7.8 observed further downstream at SW1.

Comparison 2017 – 2022

Measurements of Total Suspended Solids (TSS), pH and Specific Conductivity at the study locations in 2022 were comparable to those made at the same or nearby sites[5] in 2017 (Table 2). None of the TSS levels measured in the study as a whole approached the 46 mg/L observed at SW1 in 2017; the site in 2017 was immediately adjacent to the road and flow was negligible, and high levels of dust from the Westchester Road were reported at the time, and the elevated level of TSS may have caused by contamination by dust. The highest levels of TSS observed at any of the sites in 2022 was 10 mg/L (Table 1).

Specific Conductivity was approximately 37% higher at the SW1 site (Watercourse 1) in 2022 than in 2017 but was higher in 2017 at all other locations including upstream sites adjacent to the quarry (Table 2). pH levels were similar in 2022 compared to 2017, except that pH was higher at 7.8 at the SW1 site on Watercourse 1 compared to the 7.1 reported in 2017 (Table 2).

[5] All sampling locations near Westchester Road in 2022 were located further upstream than in 2017, to eliminate possible impacts of dust and other sediments arising from the road and road ditches.

Table 1. Water quality measurements in watercourses in the vicinity of the Westchester Quarry Rose, Nova Scotia, May to July 2022. Site Locations are shown in Figure 1

Site	Location Description	Geographic Coordinates (UTM Zone 20)		Temperature (°C)	Dissolved Oxygen (mg/L)	DO Saturation (%)	Conductivity (µs/cm)	Conductivity (Specific, 25 °C) (µs/cm)	TSS (mg/L)	pH
		Northing	Easting							
MAY 4, 2022										
SW1	Watercourse 1, 30 m upstream of Westchester Rd	5049051	441662	6.6	12.13	99.0	41.1	63.4	0.5	7.2
SW2	Watercourse 1, 165 m upstream of access road	5048795	441714	6.1	10.62	85.6	20.9	32.8	1.5	6.9
SWC1	Watercourse 2, 50 m upstream of Westchester Rd.	5049034	442342	6.1	10.62	85.3	15.2	23.8	<0.5	6.9
SWC2	Watercourse 3, 30 m upstream of Westchester Rd.	5049142	440501	6.3	11.17	95.2	15.6	24.3	<0.5	6.9
MAY 20, 2022										
SW1	Watercourse 1, 30 m upstream of Westchester Rd	5049057	441661	10.0	11.15	98.8	52.6	73.7	0.5	7.3
SW2	Watercourse 1, 165 m upstream of access road	5048831	441705	11.7	11.07	102.0	28.4	38.0	1.0	7.1
SWC1	Watercourse 2, 50 m upstream of Westchester Rd.	5049030	442343	11.2	11.10	101.4	21.5	29.1	<0.5	7.0
SWC2	Watercourse 3, 30 m upstream of Westchester Rd.	5049141	440503	10.7	11.72	106.0	21.4	29.3	0.5	6.9
JUNE 16, 2022										
SW1	Watercourse 1, 30 m upstream of Westchester Rd	5049051	441667	12.5	8.34	78.3	109.1	143.1	0.5	7.6
SW2	Watercourse 1, 165 m upstream of access road	5048824	441714	13.9	7.76	75.3	37.8	48.1	<0.5	7.2
SWC1	Watercourse 2, 50 m upstream of Westchester Rd.	5049027	442353	13.1	8.05	76.6	25.4	32.9	3.5	7.1
SWC2	Watercourse 3, 30 m upstream of Westchester Rd.	5049142	440504	14.9	8.44	83.7	18.1	22.4	0.5	7.1
JULY 13, 2022										
SW1	Watercourse 1, 30 m upstream of Westchester Rd	5049052	441671	15.7	9.15	92.1	112.3	137.4	10.0	7.6
SW2	Watercourse 1, 165 m upstream of access road	5048828	441711	17.6	7.45	78.9	44.7	52.3	6.0	7.2
SWC1	Watercourse 2, 50 m upstream of Westchester Rd.	5049033	442354	17.0	6.34	67.5	30.2	35.8	2.5	7.1
SWC2	Watercourse 3, 30 m upstream of Westchester Rd.	5049147	440526	16.7	10.3	101.6	27.6	33.1	0.5	7.1

Site	Location Description	Geographic Coordinates (UTM Zone 20)		Temperature (°C)	Dissolved Oxygen (mg/L)	DO Saturation	Conductivity (µs/cm)	Conductivity (Specific, 25 °C) (µs/cm)	TSS (mg/L)	pH
		Northing	Easting							
SEPTEMBER 12, 2022										
SW1	Watercourse 1, 30 m upstream of Westchester Rd	5049052	441671	14.9	7.6	75.7	150.9	187.2	1.0	7.8
SW2	Watercourse 1, 165 m upstream of access road	5048828	441711	14.4	4.6	46.0	48.4	60.7	0.5	7.2
Pool	Watercourse 1, upstream beside access road	5048956	441720	14.1	4.4	42.5	131.6	168.4	18.0	7.6
SWC1	Watercourse 2, 50 m upstream of Westchester Rd.	5049033	442354	15.5	7.0	69.7	34.8	42.5	6.0	7.0
SWC2	Watercourse 3, 30 m upstream of Westchester Rd.	5049147	440526	14.7	6.5	63.0	20.8	26.0	0.5	7.3

Table 2. Annual averages of measurements of TSS, pH and Specific Conductivity taken from May to September 2022 (n=5) at sampling locations in current study.

Parameter	Watercourse 1 (Downstream of Quarry) (SW1)		Watercourse 1 (Upstream of Quarry) (SW2)		Watercourse 2 (SWC1)		Watercourse 3 (SWC2)	
	Annual Mean	S.D.	Annual Mean	S.D.	Annual Mean	S.D	Annual Mean	S.D.
TSS (mg/L)	2.50	4.20	0.75	0.50	2.50	2.42	0.45	0.11
pH	7.50	0.24	7.12	0.13	7.02	0.08	7.06	0.17
Specific Conductivity (µS/cm @ 25 °C)	120.96	0.24	46.38	11.16	32.82	7.03	27.02	4.24

Table 3. Comparison of measurements of TSS, pH and Specific Conductivity taken in September 2017 and September 2022 at sampling locations used in current study.

Parameter	Watercourse 1 (Downstream of Quarry)		Watercourse 1 (Upstream of Quarry)		Watercourse 2		Watercourse 3	
	2017 (WS-4)	2022 (SW1)	2017 (WS-6)	2022 (US-1)*	2017 (WS-7)	2022 (SWC1)	2017 (WS-3)	2022 (SWC2)
TSS (mg/L)	4.6	10.0	9.0	2.5 (0.5)	1.5	6.0	2.5	0.5
pH	7.1	7.6	7.0	7.1 (7.2)	7.0	7.0	7.4	7.3
Specific Conductivity (µS/cm @ 25 °C)	137	187.2	67.0	56.9 (60.7)	53.6	42.5	44.8	26.0
* US-1 is the location sampled in the accompanying fish and fish habitat survey, which corresponds to WS-6 in 2017 (Appendix 3 in the Registration Document). The values for SW2 (adjacent to the quarry in Watercourse 1) on same date are bracketed.								

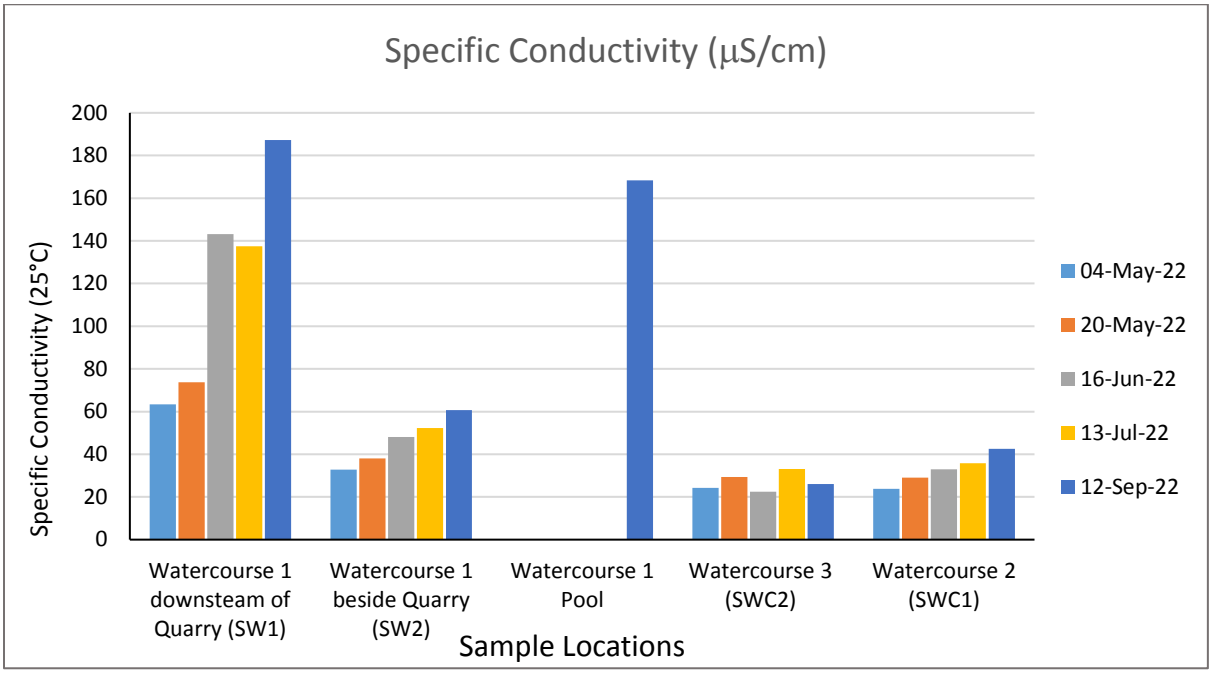

Figure 2. Specific Conductivity (uS/cm) in watercourses sampled in the vicinity of the Westchester Quarry, May to September 2022. Sampling locations are shown in Figure 1.

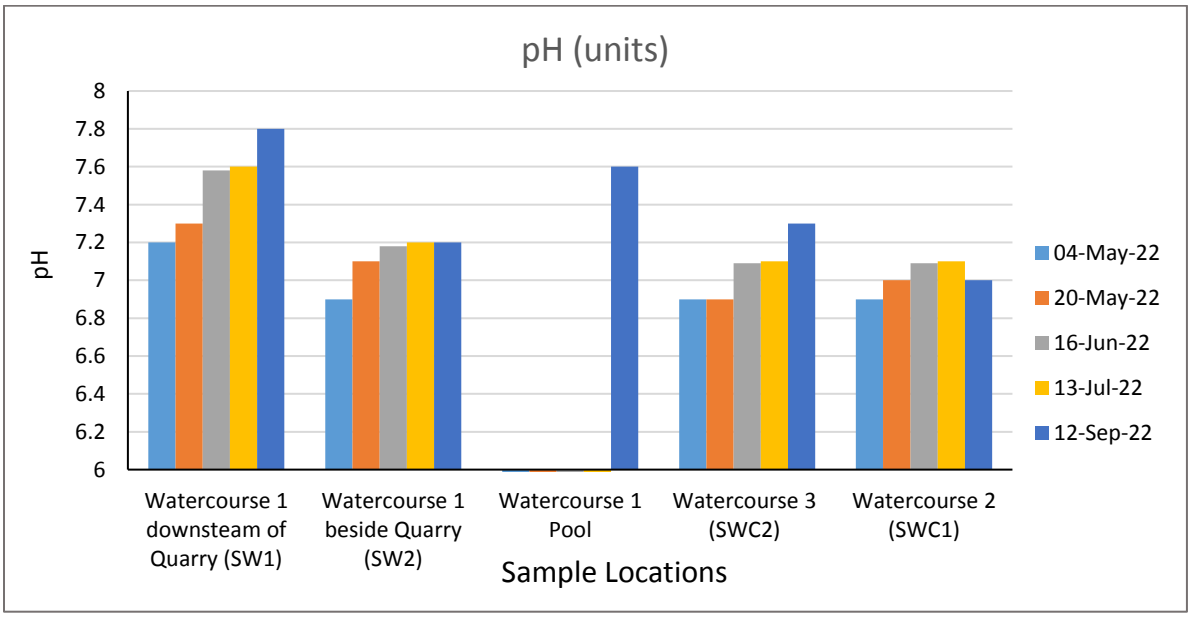

Figure 3. pH in watercourses sampled in the vicinity of the Westchester Quarry, May to September 2022. Sampling locations are shown in Figure 1.

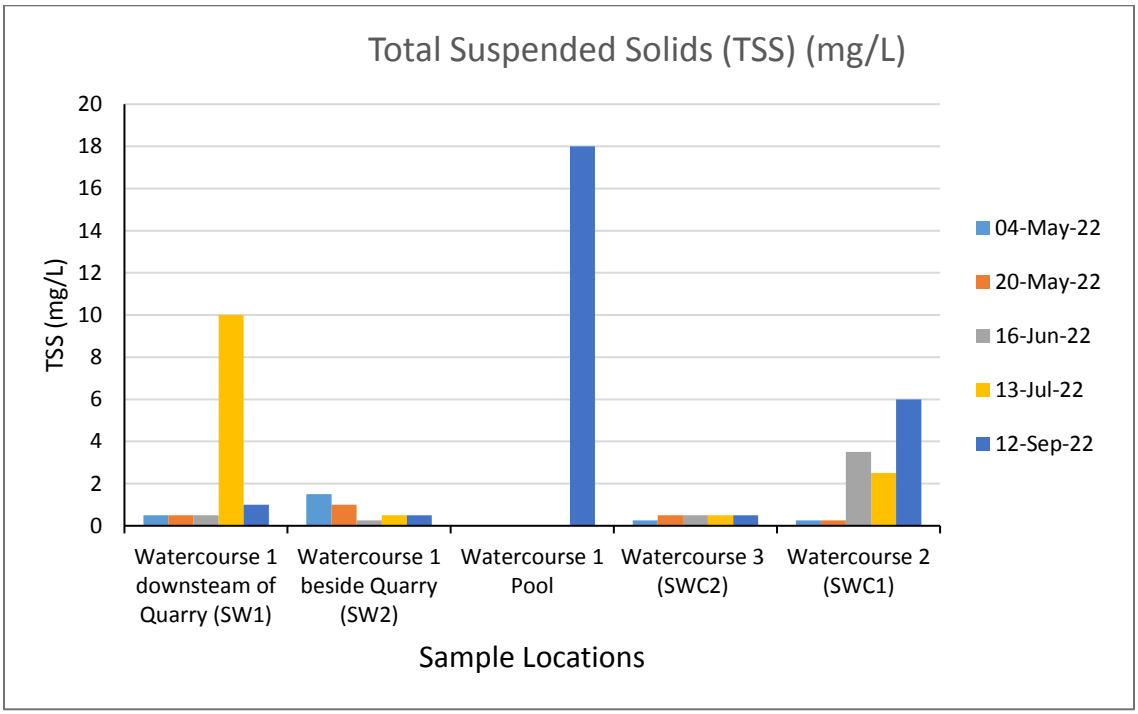

Figure 4. Total Suspended Solids (TSS) (mg/L) in watercourses sampled in the vicinity of the Westchester Quarry, May to September 2022. Sampling locations are shown in Figure 1.

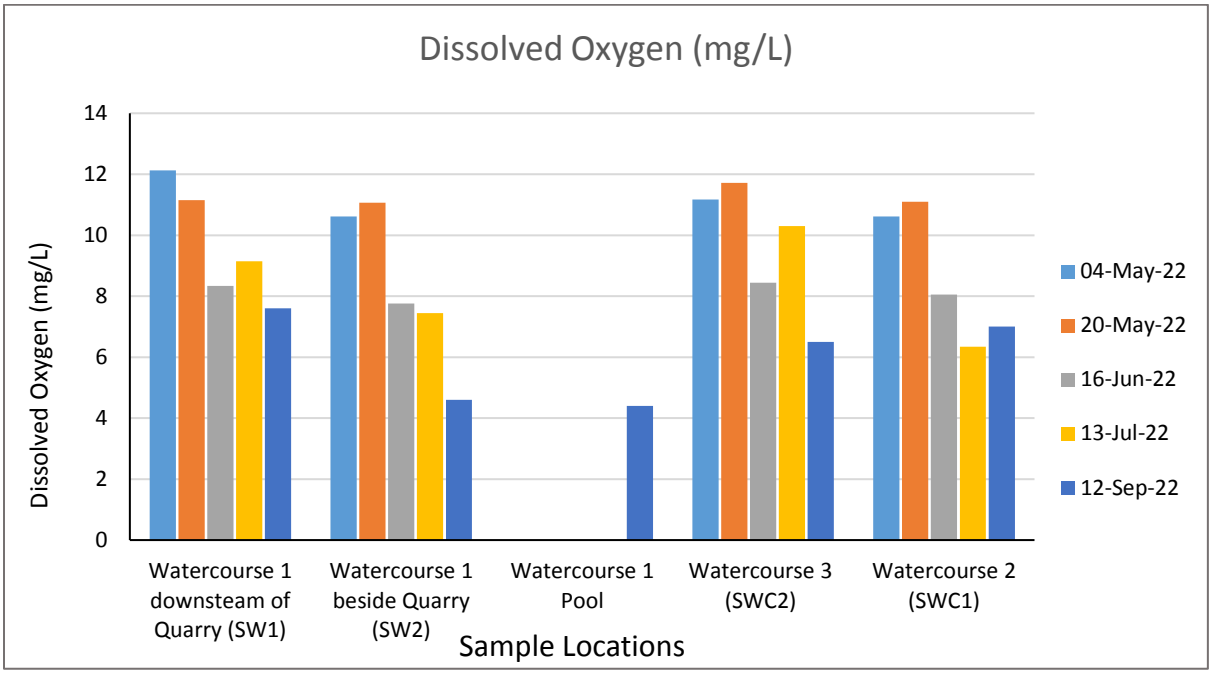

Figure 5. Dissolved Oxygen (mg/L) in watercourses sampled in the vicinity of the Westchester Quarry, May to September 2022. Sampling locations are shown in Figure 1.

7. Discussion

Three watercourses were chosen for monitoring. They were not expected to be identical in properties to be monitored (i.e. TSS, Specific Conductivity and pH), but to be a reasonable representation of conditions in the area. In general water properties proved to be relatively similar. Elevated measures of both pH and Specific Conductivity in Watercourse 1 occur in the stream section downstream of the quarry access road (Site SW1), a pattern similar to that observed in 2017. This correlation with the upstream presence of the access road, including an upstream pool/pond and a blocked culvert under the access road, suggests that these structures are causing the changes observed below it. Condition of the partially blocked culvert and associated disturbed drainage, including the presence of the pool/pond, haven't changed since 2017, when they were noted in connection with the blocked fish passage (Envirosphere Consultants Limited 2018). In the current situation, the pool is acting as a sedimentation pond on Watercourse 1 and the diversion of flow around the blocked culvert and under the road as a filter; in the September sampling, although the pond showed a moderate level of TSS (18 mg/L) and was observed to be slightly turbid, a negligible level of TSS was observed at the downstream site (SW1) and the water was noted to be clear.

Presence of the access road itself may be contributing to the elevated conductivity / specific conductivity. Use of the road leads to the generation of dust which can settle nearby; the road bed is slightly permeable and water percolating through it is exposed to minerals which can potentially dissolve; precipitation running off the outer road slopes can introduce fine particulates into the watershed below; the damaged and partially blocked culvert, assists in retaining (slowing the movement of) water, allowing potential for greater dissolution of solids, which would limit the occurrence of high concentrations of TSS in downstream areas.

Further, the access road between the level platform of the quarry and Watercourse 1 is short and wide and would not generate excessive flows during precipitation or melt events. There is little opportunity for excessive surface water to flow down the road and into the valley of Watercourse 1.

Most likely the elevated suspended sediment level observed in Watercourse 1 in 2017 was an outlier. The water was not noted to be turbid at the time, but high levels of dust were described as occurring at the site at the time due to the presence of Westchester Road; therefore the sample possibly was contaminated by dust.

Although elevated levels of specific conductivity and pH are observed in Watercourse 1 downstream of the Quarry access road (SW1), compared with other sampling sites, levels are not likely to be harmful to freshwater aquatic life; higher conductivities reflect higher levels of dissolved solids which likely are occurring, and which also lead to greater buffering capacity, which likely has led to the increased pH. A wide range of conductivities are typical in Nova Scotia waters. Lakes monitored in 1980-1991 in the vicinity of Halifax-Dartmouth had conductivities ranging from 30 to 700 µS/cm (Keizer et al. 1993). Margaree River, Cape Breton, conductivities ranged from 31 to 301 µS/cm from June 2002 to December 2008; and St. Mary's River, Guysborough County, from 23 to 41 µS/cm in 2007 to 2008 (Nova Scotia 2022).

The upper section of Watercourse 1, located immediately east of the Westchester Quarry—represented by SW2—showed slightly elevated Specific Conductivity compared with Watercourse 3. Although the difference is not large, it likely represents different natural conditions and not an influence of the quarry. Watercourse 1 has a larger catchment upstream of the sampling location and a 30 m forested buffer, and no direct influences of the quarry were noted.

In Watercourse 1 (which is nearest the Westchester Quarry on the east side) upstream of the quarry access road and pond/pool, water quality in terms of the chosen measures—TSS, pH and Specific Conductivity—did not change between 2017 and 2022 when measured in September, which is generally the low flow period of the year. During that time the quarry grew from less than 1 ha to occupying nearly its full 4.0 ha approved area, and therefore the quarry is inferred not to have impacted the water quality there over that time period.

8. Conclusions and Recommendations

Monitoring under clear water conditions in the watercourse immediately east of and adjacent to the Westchester Quarry of the two water quality parameters of concern highlighted in the Minister's Information request—Total Suspended Solids (TSS) and Conductivity / Specific Conductivity— showed that there was no impact of the Quarry on TSS, but there was a slight increase in conductivity, suggested to be due to the presence of the road and to a blocked culvert on Watercourse 1 and possible influence of the presence of the access road itself, and the resulting influence through dust and other influences on dissolved concentrations downstream of the road.

TSS, pH and Specific Conductivity in Watercourse 1 upstream of the access road—did not change between 2017 and 2022 when measured in September, which is generally the low flow period of the year. During that time the quarry grew from less than 1 ha to occupying nearly its full 4.0 ha approved area, and therefore the quarry is inferred not to have impacted the water quality there over that time period.

An elevated TSS level measured in a sample taken on the unnamed watercourse in 2017 and which was one of the factors triggering the Minister's information request, is determined to be due to the proximity of the sampling site to the Westchester Road and ditches, and suspected contamination from road dust.

An elevated conductivity / specific conductivity measured at the same location downstream of the Quarry in 2017 and which was also noted in the Minister's Information Request, however, is consistent with observations of slightly elevated values in 2022. Although the elevated conductivities may be a natural property of the watercourse, it is suggested that the presence of the road and dust, as well as the blocked culvert under the access road, and an associated adjacent pool/pond on the unnamed watercourse—both of which are exposed to downslope surface water drainage from the road—is creating conditions leading to elevated downstream conductivities.

The elevation in conductivity / specific conductivity is not harmful to aquatic life. A concurrent elevation in pH observed in the unnamed watercourse downstream of the Quarry, is also not harmful to aquatic life.

Although a mitigation approach for Total Suspended Solids is not required, an appropriate mitigation which would reduce specific conductivities would be to construct a berm on the road edge in the vicinity of the watercourse crossing, to prevent surface water runoff, as well as dust from the access road, from entering the watercourse.

9. References

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Photos

Photo 1. Watercourse 1 (Site SW1) downstream of the Westchester Quarry, May 4, 2022.

Photo 2. Substrate in Watercourse 1 (Site SW1) downstream of the Westchester Quarry, May 4, 2022.

Photo 3. Watercourse 1 (Site SW2) 165 m upstream of the Westchester Quarry access road, May 4, 2022.

Photo 4. Watercourse 1 (Site SW2) 165 m upstream of the Westchester Quarry access road, May 4, 2022. Downstream view. Access road visible in extreme background.

Photo 5. Watercourse 2 (Site SWC1) upstream of Westchester Road, May 4, 2022.

Photo 6. Watercourse 2 (Site SWC1) downstream and showing culvert under Westchester Road, May 4, 2022.

Photo 7. Watercourse 3 (Site SWC2) upstream of Westchester Road, May 4, 2022.

Photo 8. Watercourse 3 (Site SWC2) upstream of Westchester Road, showing substrate, May 4, 2022.

Photo 9. Pool/Pond in Watercourse 1 upstream of access road, showing encroachment by road, October 30, 2021. Photo is taken from the road surface looking upstream.

APPENDIX D – FISH AND FISH HABITAT STUDY - 2022

FISH AND FISH HABITAT ASSESSMENT WESTCHESTER QUARRY EXPANSION 2327 WESTCHESTER ROAD, ROSE, CUMBERLAND COUNTY, NOVA SCOTIA

NOVEMBER 2022

Submitted to:

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Submitted by:

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EXECUTIVE SUMMARY

Chapman Brothers Construction Ltd. (Chapman Brothers) is proposing to expand their existing Westchester Quarry at 2327 Westchester Road adjacent to the Wentworth-Collingwood Road near the community of Rose, in Cumberland County, Nova Scotia. Nova Scotia Department of Environment and Climate Change (NS ECC) has requested further information on fish and fish habitat in two unnamed, intermittent watercourses, located north/northeast of the study site, to supplement information provided in a previously submitted Registration Document regarding the expansion. An assessment for fish and fish habitat, including water quality characterization of the target watercourses, in lower and upper reaches of each stream (above and below Westchester Road, respectively) was conducted. Electro-fishing was also conducted, to document the presence/absence of fish, as well as type of fish species, if present. Surveys were carried out on July 13 and September 12, 2022.

The survey found acceptable fish habitat and presence of fish in waters surveyed. A single fish species, brook trout (*Salvelinus fontinalis*) was found only below Westchester Road, in lower reaches of both streams. Small numbers of juveniles and occasionally larger individuals were found overall. Unidentified frogs and a snake were observed and various amphibians of all life stages are expected to occur.

Water quality and stream conditions were generally acceptable for fish and for the maintenance of fish and other aquatic life according the Canadian Council of Ministers of the Environment (CCME) Freshwater Aquatic Life (FAL) guidelines for the parameters measured. Water levels were low during both survey days and flows were low to moderate. Waters had neutral to above neutral pH, low to high dissolved oxygen, low Total Suspended Solids (TSS), and low to moderate conductivity. Moderate conductivity values may be due to influence from the existing quarry access road; the level is not harmful to fish and other biological life. Chemical constituents measured were acceptable with the exception of aluminum, iron and manganese at various sites, according to the Canadian Drinking Water Quality Guidelines (CDWQG). Iron, aluminium and lead values at some sites on unnamed stream 1 also exceeded long-term concentration values according to the CCME Water Quality Guidelines of the Protection of Aquatic Life (Table 4). Low total phosphorus levels at all sites reflect ultra-oligotrophic conditions (e.g., low primary productivity) in the streams.

The quality of fish habitat in terms of streambed composition; accessibility by fish (i.e., absence of barriers to fish passage); and key water quality parameters was suitable for fish in lower reaches of the watercourses. The upper reaches of both streams (above Westchester Road) provide suitable habitat both direct and indirect but are not accessible to fish such as salmonids, throughout the year as a result of hanging culverts and other fish passage barriers.

INTRODUCTION

Chapman Brothers Construction Ltd. (Chapman Brothers) is proposing to expand their existing Westchester Quarry in the vicinity of the community of Rose, Cumberland County, Nova Scotia. A Registration Document for the proposed Westchester Quarry expansion was completed and submitted to Nova Scotia Department of Environment and Climate Change (NS ECC) in 2021. NS ECC concluded that additional information was required to supplement the Environmental Assessment; one requirement was to provide further information on fish and fish habitat in two unnamed, intermittent watercourses, located north/northeast of the study site.

Envirosphere Consultants Ltd. of Windsor, Nova Scotia, a consulting company which specializes in environmental surveys and analysis, in particular biological studies of aquatic environments—was asked to carry out the required fish and fish habitat assessment, including water quality characterization of the target watercourses. The assessment is to determine:

- Habitat characteristics and quality including substrate composition, types of flows (i.e., groundwater seepage), types of stream habitat, and relative amount (i.e., length of stream, depth, area, etc.);
- Suitability for fish, and if suitable, which species are present;
- Fish species concerns (e.g., possible presence of aquatic species at risk, including Atlantic Salmon);
- Water quality in terms of suitability for freshwater aquatic life, including measurements of temperature, dissolved oxygen, pH, suspended sediments, conductivity, metals and nutrients[1];
- Mitigation measures to reduce the risk of potential impacts, if fish and fish habitat is identified at the site.

The results of the assessment are summarized below, including mitigation measures that will adequately reduce the risk of impacts from quarry operations on these environments.

BACKGROUND

The previous baseline survey for the Environmental Assessment in 2017 determined that two unnamed streams (unnamed stream 1 and unnamed stream 2 (Figure 1) did not have fish in the vicinity of the quarry, through a partial walkover and limited water sampling, in particular because of a hanging culvert under the quarry access road unnamed stream 1) and hanging culverts under Westchester Road. This conclusion was questioned in the review of the environmental assessment for expansion of the quarry and Chapman Brothers was requested to conduct a more detailed fish survey following Department of Fisheries and Oceans (DFO) specifications to verify it.

In particular, the target streams and area of concern were considered important since the streams are in the upper watershed of the Wallace River, Colchester County near the watershed divide between the Wallace River and River Philip watersheds, both of which drain north to Northumberland Strait and the Gulf of St. Lawrence. The Wallace River in the area is known to support Atlantic Salmon, as well as Blacknose Dace (S3). No fish were observed in the upper reaches of the two unnamed, intermittent watercourses upstream of Westchester Road north/northeast of the existing Westchester Quarry site during the 2017 site survey.

STUDY AREA

The study area for the project encompasses the unnamed intermittent stream (unnamed stream 1) located immediately adjacent to the east of the existing Chapman Brothers Construction Limited Westchester Quarry (Westchester Quarry), and another unnamed stream (unnamed stream 2), further to the east (Figure 1). The Westchester Quarry in Cumberland County is located at 2327 Westchester Road adjacent to the Wentworth-Collingwood Road near the community of Rose, at approximately UTM Zone 20, NAD83, Easting 441571 and Northing 5048554, PID 25090887.

[1] Samples taken will be analyzed by a CALA accredited laboratory.

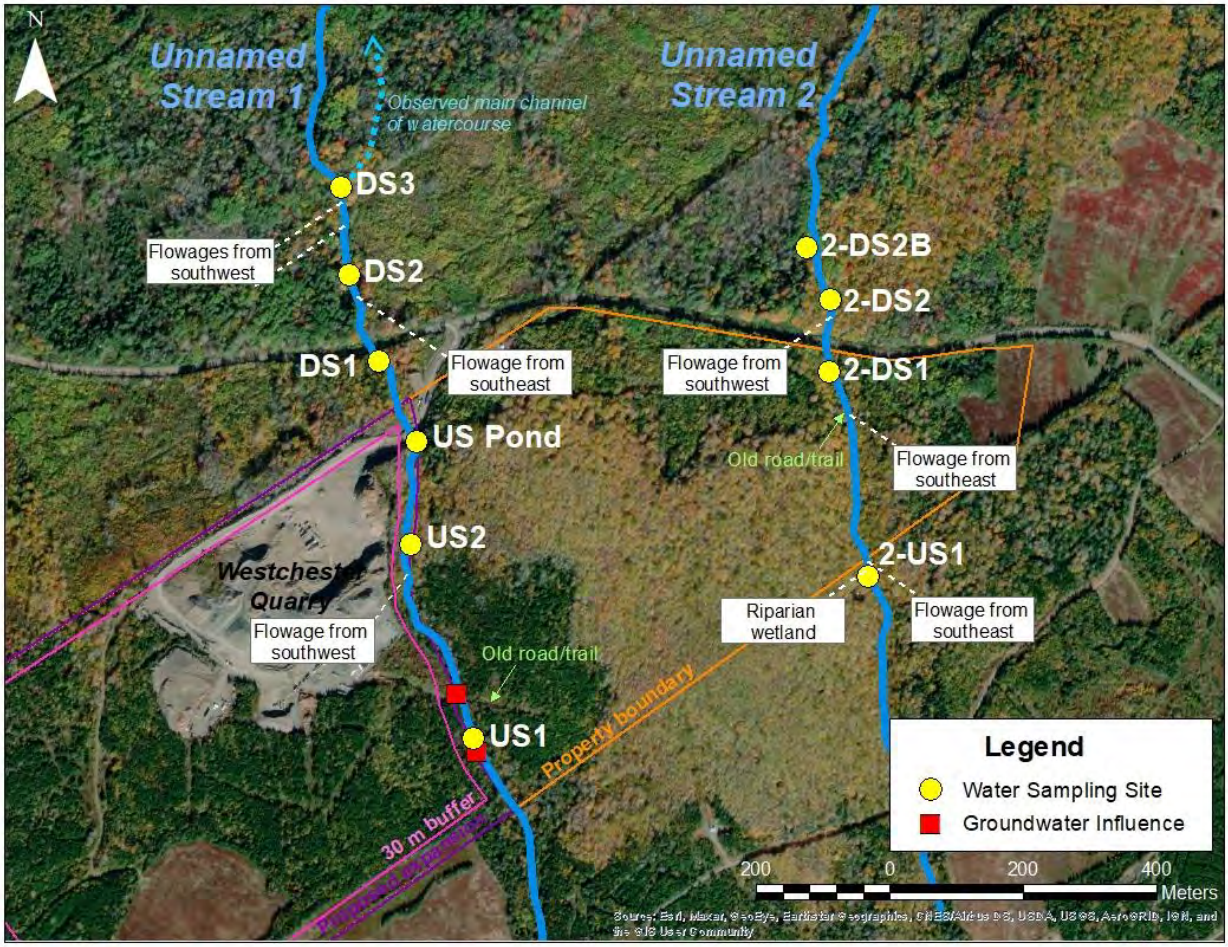

Figure 1. Project area and sampling sites, July 13 and September 12, 2022. Westchester Quarry and unnamed streams 1 and 2, Rose, Nova Scotia.

SURVEY APPROACH

Environmental biologist, Heather Levy (B.Sc. Bio & B.Sc (H) Env.Sc.) and Fish Habitat Professional Hayley Doyle (B.Sc. Env.Sc) of Envirosphere visited the site on July 13, 2022 and September 12, 2022 and performed a fish and fish habitat survey of the two selected unnamed watercourses. A breakdown of each survey component is given below. A study design was prepared and submitted to DFO (Sarah Macleod, Fish and Fish Habitat Protection Biologist) prior to conducting the survey.

Fish Habitat Survey

Two site visits (July and September, representing different seasons) were conducted to assess and document characteristics of each watercourse. The purpose of the surveys was to determine the quality of fish habitat in unnamed stream 1 and unnamed stream 2 (Figure 1) to determine conditions to allow a more complete assessment of potential impacts of the quarry on fish habitat and fish (if present) in the streams. There is presently a 30 m forested buffer zone between the quarry and unnamed stream 1. According to the study design, one survey was to be conducted when water levels were seasonally low [July was chosen]. Low flow conditions would provide information on changes in water chemistry and

contributions of groundwater seepages and springs, as well as identifying any potential refugia. The fish habitat survey included:

- A walkover of each watercourse during which habitat characteristics were assessed;
- Water quality measurements using field instruments and water samples including: temperature, dissolved oxygen, conductivity, suspended sediments, pH and chemical analysis of metals and nutrients;
- Documentation of habitat characteristics using a standard method[2], to allow objective estimates of habitat quality;
- One survey was to be conducted during a low flow period (July) to identify and record flows and groundwater seepages and areas of potential refugia;
- Location information recorded on a handheld GPS;
- Visual searches for fish and other vertebrates (e.g., amphibians, snakes and turtles) in areas appearing to have potential fish habitat; and
- Photographs of the stream and substrate taken at all locations showing upstream and downstream views.

Fish Survey

The presence, species composition, and abundance of fish on the two unnamed watercourses was assessed using an electro-fisher and included:

- Spot-checks along stretches of each watercourse, as suitable (Figure 2).
- Photographs taken of species captured during electrofishing surveys.
- A Smith-Root Model LR 20B backpack electro-fisher was used for surveys.
- Surveys were conducted under DFO Licence # SG-RHQ-22-057 (Gulf Region).

RESULTS AND DISCUSSION

Weather was sunny with partial cloud cover on both days (July 13 and September 12, 2022), and ideal for sampling and observations, except that high temperatures during the September survey curtailed some of the water sampling, due to safety concerns. Water levels were low in both watercourses on both days. Detailed site descriptions below for both unnamed stream 1 and unnamed stream 2 were recorded during the September 12, 2022 site survey. Fish habitat and fish species findings, including site descriptions for areas assessed for fish habitat and electro-fishing observations are presented below and in Table 1. Site locations with GPS coordinates are presented in Table 2 and secondary water quality measurements and water chemistry measurements are presented in Tables 3 and 4.

Fish Habitat Survey—Site Descriptions

Unnamed stream 1, located east of the existing quarry, flows down a steep slope with the steepest gradient (1:5) adjacent to the quarry extending to Westchester Road, and 1:7.5 in the headwaters. It flows through a partially blocked hanging culvert under the quarry access road (Figure 1). Below Westchester Road, the gradient levels out to approximately 1:9. Unnamed stream 2 further to the east flows down a

[2] Based on the Ohio Qualitative Habitat Evaluation Index (QHEI) (Ohio EPA 2006). Data forms were filled out in the field at each site and included parameters such as substrate composition, water quality, stream characteristics (i.e., wet width, bank width, depth) and riparian features.

gradient of 1:6 to 1:7 but crosses Westchester Road at a steeper gradient and levels out only after about 350 m below the Road. It has a low gradient of 1:10 at the extreme upper watershed.

Unnamed Stream 1

Unnamed stream 1 is an intermittent stream which follows a steeply incised valley immediately east of the existing quarry. It is a tributary of West Branch Wallace River in the Wallace River watershed. Site observations are summarized in Figure 1 and presented in detail below.

US1

Site US1 is a run located furthest upstream, on unnamed stream 1. The site is in an area surrounded by mixed wood forest consisting of spruce, balsam fir and yellow birch and is located upstream of an old road/trail running across the stream. Woody debris is present above and below the sampling site and in riparian areas; leaf litter, organic matter, and moss covered boulder and cobble were present on the streambed. Bottom substrate consisted of gravel, silty sand and occasional boulder and cobble. Channel stability was moderate and banks were covered in grasses, mosses, ferns, bedstraw and asters. The stream channel was about 25-50% shaded by a mixed canopy of coniferous/deciduous trees. Some bank erosion occurred at this site. Wet width was 0.75 m and mid-channel depth was 10 cm. Water temperature was 14.1 °C; dissolved oxygen was high at 8.9 mg/L; pH was 7.1; and TSS was 2.5 mg/L (Table 3). The water was clear and water levels were low; very little flow was present. Despite minimal flow at the time of sampling, oxygen levels were high and indicate potential mixing of ground water (spring water) and surface water. See Figure 1 for site location and Appendix A for site photos.

A short distance downstream of US1, an area upstream of an old road/trail crossing the stream, was flooded due to partial blockage of a culvert (Figure 2). Low flow and evidence of sedimentation was present immediately downstream of the road/trail. Further downstream was litter (tarps, plastics and geotextile fabrics in the stream), which caused additional unnatural blockage, leading to accumulation of fine sediment.

US2

Site US2 is a run immediately adjacent to the Westchester Quarry. The sampling site is the nearest to the quarry and in an area with steep embankments. Woody debris, and occasional leaf litter and organic matter were present on the streambed. Bottom substrate consisted of cobble and gravel with some silt, sand and boulder. Channel stability was moderate and banks were covered in grasses, mosses, sedges, evergreen wood fern (*Dryopteris intermedia*) and shrubs (hobble bush, *Viburnum lantanoides*). The stream channel was 50-75% shaded by a mixed canopy of coniferous/deciduous trees (birch and maple with occasional fir and spruce) and overhanging vegetation was nearly absent. Stream bank erosion was little (5-25%). Wet width was 0.75 m and mid-channel depth was 13 cm. Water temperature was 14.7 °C; dissolved oxygen was low at 3.7 mg/L; pH was 7.2; and TSS was 5.0 mg/L (Table 3). The water was clear, water levels were low and very little flow was present. See Figure 1 for site location and Appendix A for site photos.

US Pond

Site US Pond is a pool immediately above the quarry access road, although not created by the road. Flow exits the pool and flows through a partially blocked culvert under the access road; flow out of the pool was primarily subsurface at the time of the survey. The culvert is ‘hanging’ by 2+ m, and poses a barrier to fish passage at all times of year. The pool was approximately 5 m long by 4 m wide and approximately

60 cm deep at centre, with a mixed substrate of sand, gravel and silt; and the channel bed immediately upstream of the pool was dry. Water in the pool was slightly turbid, detritus and woody debris were present, and overhanging vegetation was nearly absent. Frogs, water striders, a fishing spider and a dragonfly also occupied the pool. The channel and riparian area were vegetated with goldenrod, aster, coltsfoot (*Tussilago farfara*), Christmas fern (*Polystichum acrostichoides*) and a moderate canopy cover consisting predominantly of maple, birch and spruce was present. Water temperature was 14.1 °C; dissolved oxygen was low/moderate at 4.4 mg/L; pH was 7.6; and TSS was 18.0 mg/L (Table 3). See Figure 1 for site location and Appendix A for site photos.

DS1

Site DS1[3] is a run located approximately 15 m upstream of Westchester Road culvert, below the quarry site. The site is surrounded by mixed wood forest consisting of balsam fir, maple, birch and beech. Woody debris and detritus is present instream and bottom substrate consists of cobble and boulder with gravel, bedrock and silty sand. Channel stability was moderate/high and banks were covered in evergreen wood fern and asters. The stream channel was >75% shaded by a mixed canopy of coniferous/deciduous trees. Some bank erosion reflecting periodically high flows occurred at this site. Wet width was 1-1.5 meters and mid-channel depth was 9 cm. Water temperature was 14.9 °C; dissolved oxygen was moderate at 7.6 mg/L; pH was 7.8; and TSS was 1.0 mg/L (Table 3). The water was clear, and water levels were low with moderate flow present. See Figure 1 for site location and Appendix A for site photos.

DS2

Site DS2 is a run/riffle located downstream of Westchester Road culvert. The site is surrounded by mixed wood forest consisting of balsam fir, spruce, maple, ash and birch. Woody debris and detritus is present instream and bottom substrate consisted of gravelly cobble with sand, silt and some boulder. Channel stability was moderate/high and banks were covered in buttercup, aster and sedges. The stream channel was 50-75% shaded by a mixed canopy of coniferous/deciduous trees. Moderate bank erosion occurred at this site (25-50%). Wet width was 1.3 m and mid-channel depth was 22 cm. Water temperature was 15.7 °C; dissolved oxygen was moderate at 5.8 mg/L; pH was 7.6; and TSS was 3.0 mg/L (Table 3). The water was clear, and levels were low with moderate flow present. See Figure 1 for site location and Appendix A for site photos.

DS3

Site DS3 is a run and the furthest sampling site on unnamed stream 1 downstream of the Westchester Quarry. The site is just below a junction with a smaller channel which was dry[4]. Woody debris and detritus is present instream and bottom substrate consisted of gravel and cobble with sand and silt. Channel stability was moderate/high and banks were covered in grasses, ferns, sedges, asters and tree seedlings. The stream channel was >75% shaded by a mixed canopy of coniferous/deciduous trees (balsam fir, maple and birch). Moderate bank erosion occurred at this site (25-50%). Wet width was 1.1 m and mid-channel depth was 11 cm. Water temperature was 15.7 °C; dissolved oxygen was moderate at 7.2 mg/L; pH was 7.6; and TSS was 0.5 mg/L (Table 3). The water was clear, and levels were low with slow flow present. See Figure 1 for site location and Appendix A for site photos.

[3] Also known as water quality sampling location SW1.
[4] Water was not present below the DS3 sampling site, at the time of the September survey.

Unnamed Stream 2

Unnamed stream 2 is an intermittent stream, flowing northeast, which drains an area east of the Westchester Quarry study area along Westchester Road.

2-US1

Site 2-US1 is a run/riffle located furthest upstream. The site is surrounded by mixed wood forest consisting of beech, maple, fir and birch. A camp building sits high on one of the stream embankments. Woody debris and detritus was present instream, and bottom substrate consisted of gravel with some cobble, silt and sand. Channel stability was moderate and banks were covered in grasses, maple seedlings, sedges, evergreen wood fern and buttercup. The stream channel was >75% shaded by a mixed canopy of coniferous/deciduous trees. Minimal bank erosion occurred at this site (5-25%). Wet width was 0.5-1.0 m and depth varied (4-11 cm). Water temperature was 13.9 °C; dissolved oxygen was high at 8.3 mg/L; pH was 7.0; and TSS was 4.0 mg/L (Table 3). The water was clear, levels were low and flow was moderate. See Figure 1 for site location and Appendix A for site photos.

2-DS1

Site 2-DS1[5] is a run/riffle located approximately 20 m upstream of Westchester Road culvert. The site surrounded by mixed wood forest consisting of balsam fir, birch and ash. Woody debris and detritus is present instream and bottom substrate consists of gravel and cobble with boulder, silt and sand. Channel stability was moderate and banks were covered in aster and buttercup. The stream channel was >75% shaded by a mixed canopy of coniferous/deciduous trees. Moderate bank erosion occurred at this site (25-50%). Wet width was 1 m and depth varied between 5-12 cm. Water temperature was 15.5 °C; dissolved oxygen was moderate at 7.0 mg/L; pH was 7.0; and TSS was 6.0 mg/L (Table 3). The water was clear, and levels were low with moderate flow present. See Figure 1 for site location and Appendix A for site photos.

2-DS2

Site 2-DS2 is a riffle located downstream of Westchester Road culvert (Figure 1). The site is surrounded by mixed wood forest consisting of balsam fir, beech, birch and maple. Woody debris and detritus is present instream and bottom substrate consists of gravelly cobble with boulder, silt and sand. Channel stability was moderate/high and banks were covered in maple seedlings, Christmas fern and hobblebush. The stream channel was >75% shaded by a mixed canopy of coniferous/deciduous trees. Moderate bank erosion occurred at this site (25-50%). Wet width was 1.5 m and mid-channel depth was 7 cm. Water temperature was 15.7 °C; dissolved oxygen was moderate at 7.7 mg/L; pH was 7.1; and TSS was 3.0 mg/L (Table 3). The water was clear, and levels were low with moderate flow present. See Figure 1 for site location and Appendix A for site photos.

2-DS2B

Site 2-DS2B is a run/riffle and the furthest sampling site downstream, along unnamed stream 2. The site is surrounded by a mixed forest consisting of balsam fir, beech, birch and maple. Woody debris and detritus is present instream and bottom substrate consists mainly of gravel with cobble, boulder, sand and silt. Channel stability was moderate/high and banks were covered in maple seedlings, Christmas fern, and evergreen wood fern. The stream channel was >75% shaded by a mixed canopy of

[5] Also known as water quality sampling location SWC1.

coniferous/deciduous trees. Moderate bank erosion occurred at this site (25-50%). Wet width was 0.9 m and mid-channel depth was 7 cm. Water temperature was 16.1 °C; dissolved oxygen was high at 8.7 mg/L; pH was 7.3; and TSS was 1.0 mg/L (Table 3). The water was clear, and levels were low with moderate flow present. See Figure 1 for site location and Appendix A for site photos.

Groundwater Seepages, Areas of Potential Refugia

Inputs to Unnamed Stream 1

At site US1, oxygen levels were high and temperatures were cool despite low flows at the time of September sampling indicating potential groundwater influence and mixing of ground water (spring water) and surface water. In the stream below the road/trail crossing [noted earlier as having caused flooding because of a partially blocked or damaged culvert which had restricted downstream flow], there was minimal water present in the stream and iron flocculant and a manganese sheen were observed on the stream bottom, indicating groundwater influence.

Between the old road/trail and site US2 and downstream of Westchester Road, there were flow channels leading to the stream and wet areas along stream embankments, which would indicate potential sources of water and nutrients to the stream during higher flow periods. See Figure 1 for locations and Appendix A for photos.

Inputs to Unnamed Stream 2

Flow channels leading to the stream and wet areas along stream embankments were observed in upper and lower reaches, which would provide sources of water and nutrients to the stream during higher flow periods. See Figure 1 for locations and Appendix A for photos.

Fish Survey

Fish Species

Electro-fishing was carried out along unnamed streams 1 and 2 (Figure 2) on both survey days. Both lower and upper reaches (below and above Westchester Road) were surveyed in July and upper reaches only in September[6]. Three (3) brook trout and four (4) unidentified fish (likely trout but they escaped before identification could be determined) were observed at sites below Westchester Road, along unnamed stream 1 (Table 1, Figure 2 and Figure 3). One (1) brook trout was caught below Westchester Road, along unnamed stream 2 (Figure 2) and others were periodically seen as well. No fish were caught in streams above Westchester Road, on either survey day. No species at risk (i.e., Atlantic Salmon) were observed during the surveys.

[6]Fish were documented in lower reaches but not in upper reaches in July and thus the September survey focused on upper reaches only.

Table 1. Summary of fish observations obtained by electrofishing and visual observation, as well as incidental observations of other species. July 13 and September 12, 2022. Unnamed streams 1 and 2 near Westchester Quarry, Rose, Nova Scotia.

Location	Method	Species	Approximate Size (cm)	Number of Individuals	Total
UNNAMED STREAM 1					
Section DS1 to US1 (above Westchester Road culvert)	Electrofishing	No fish observed or caught. Multiple fish barriers throughout this area.			
	Frogs in area and an unidentified snake.				
Section DS2 to DS3 (below Westchester Road culvert)	Electrofishing	Brook trout	8-10	3	7
		Unidentified species (escaped before identification could be determined)	--	4	
	Frogs throughout area.				
UNNAMED STREAM 2					
Section 2-DS1 to 2-US1 (above Westchester Road culvert)	Electrofishing	No fish observed or caught.			
Section 2-DS2 to 2-DS2B (below Westchester Road culvert)	Electrofishing	Brook trout	12-15	1	1
	Fish were observed swimming in this stretch.				

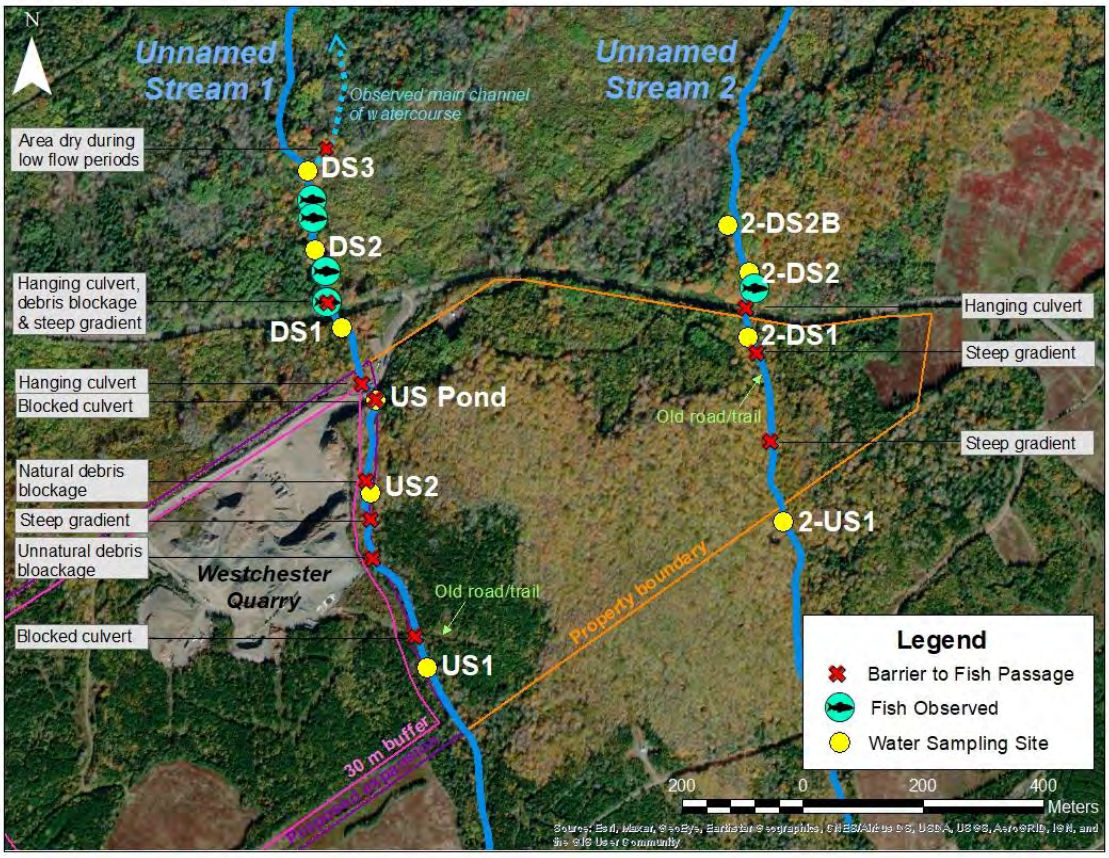

Figure 2. Electrofishing locations and fish passage barriers along unnamed streams 1 and 2, Rose, Nova Scotia. July 13 and September 12, 2022.

Figure 3. Brook trout netted below Westchester Road in unnamed stream 1, during the fish survey. July 13, 2022.

Barriers to Fish Passage

Along unnamed stream 1, numerous barriers to fish passage were observed (hanging culverts, steeply sloped rock waterfall, etc.) (Figures 2 and 4). In unnamed stream 2, a hanging culvert with a drop of 1.5 m was also present (Figure 5). Therefore, the upper reaches of both streams (above Westchester Road) were determined not accessible to fish due to the type and size of barriers present.

Figure 4. Fish barriers along unnamed stream 1. *Top left photo*, downstream end of culvert below Westchester Road, a hanging culvert 1+ m above the streambed. *Top right photo*, a steeply sloped rock waterfall in upper reaches of unnamed stream 1 (above Westchester Road). *Bottom left photo*, upstream end of the hanging culvert positioned under the Westchester quarry access road; it was partially blocked by sediment during both survey days. *Bottom right photo*, downstream end of the quarry access road culvert, which was 2+ m above the streambed. July 13, 2022.

Figure 5. Downstream end of culvert below Westchester Road; a hanging culvert along unnamed stream 2, situated approximately 1.5 m above the streambed creating a barrier to fish. July 13, 2022.

Water Quality

Water quality measures for all sites sampled on September 12, 2022 and incidental measurements at several sites sampled on July 13 are presented in Table 3. Metals and nutrient results from samples collected in September are presented in Table 4.

Temperature: Temperature is a key variable of suitable habitat for cold water fish species including salmonids. Water temperatures were warm during the surveys, ranging from 14.1 °C to 15.7 °C in

unnamed stream 1 and 13.9 °C to 17.0 °C in unnamed stream 2, and were acceptable for salmonids and other fish.

Dissolved Oxygen (DO): Dissolved oxygen enters streams from the surrounding air and as a product of photosynthesis of aquatic plants, and is used for respiration by aquatic life. Factors influencing dissolved oxygen levels include temperature, season, flow rate and volume, biological processes of aquatic life, as well as anthropogenic nutrient loading, sewage, and alteration of stream beds (e.g., damming).

Consistently high levels of dissolved oxygen are best for a healthy ecosystem. The CCME water quality guideline for dissolved oxygen for the protection of aquatic life in cold freshwater ecosystems, including fish species, is >9.5 mg/L for early life history stages and >6.5 mg/L for other life history stages (CCME 1999). Dissolved oxygen concentrations varied between sampling sites and survey date and at some sites below 6.5 mg/L. In unnamed stream 1, low values (3.7, 4.4, and 5.8 mg/L) were observed at US2, US Pond, and DS2 sites, respectively. In unnamed stream 2, low values of 6.3 and 5.9 were observed in July at sites 2-DS1 and 2-DS2; dissolved oxygen at these sites in September were above 6.5 mg/L (Table 3).

Conductivity: Conductivity is a measure of the amount of inorganic dissolved solids in the water and provides information on surrounding geology and other sources (e.g., groundwater versus surface water). Specific conductivity is the measure at a specified temperature (e.g., 25 °C). The conductivities of rivers in Nova Scotia generally range from 20-500 µs/cm (NSSA 2014). Conductivities are expected to be higher when conditions are drier, flow is lower and contributions from groundwater sources are greater. Conductivity is also influenced by sources of discharge and precipitation. Discharges to streams can change the conductivity depending on their makeup, and fluctuating conductivity levels over time can provide information of pollution impacts.

Overall, conductivities in unnamed streams 1 and 2 were all low to moderate with specific conductivity values (µS/cm @ 25 °C) highest in unnamed stream 1 ranging from 56.9-168.4 µS/cm and lower values in unnamed stream 2 ranging from 35.7-47.1 µS/cm (Table 3). Highest specific conductivity (168.4 µS/cm) in unnamed stream 1 was observed at site US Pond, immediately above the quarry access road. This level is not harmful to fish and other biological life and may be caused by the proximity of the access road (e.g., dust and sediments from the road which may reach the pond). Conductivity values gradually decreased downstream of this site. In contrast, specific conductivity values were low above the site US Pond and ranged from 56.9-63.8 µS/cm.

Total Suspended Solids (TSS): Total suspended solids is used as an indicator of erosion/sedimentation in a watercourse but can also be used to indicate the presence of biological growth and detritus, which affect water clarity. Rainfall can raise TSS levels as eroding sediment is carried into the water. Elevated TSS can raise water temperature, lower dissolved oxygen, reduce light penetration for aquatic plants, and suffocate aquatic fauna.

Flows were low and typical for the time of year, and TSS was generally low, ranging from 0.5-18.0 mg/L in unnamed stream 1 and 1.0-6.0 mg/L in unnamed stream 2. The highest value of 18.0 mg/L (site US Pond) can likely be attributed to resuspended fines and/or dust from traffic on the access road (Table 3).

pH: pH is a significant water quality parameter for aquatic organisms including salmonids. pH is influenced by rainfall (acid rain) and organic acids from the breakdown of organic material, which gives a tea-colour to the water.

pH at sampling sites in unnamed streams 1 and 2 were neutral (7.0-7.8) and were all within the acceptable range of 6.5 to 9, according to CCME guidelines for the protection of freshwater aquatic life (Table 3).

Chemical constituents measured were acceptable with the exception of aluminum, iron and manganese at various sites, according to the Canadian Drinking Water Quality Guidelines (CDWQG). Guidelines were exceeded for aluminium and manganese at sites US1 and US2 and for iron at site US2 on unnamed stream 1 (Table 4). Manganese at site US1 on unnamed stream 2 was also above the CDWQG's. Iron, aluminium and lead values at some sites on unnamed stream 1 also exceeded long-term concentration values according to the CCME Water Quality Guidelines of the Protection of Aquatic life (Table 4). Low total phosphorus levels at all sites reflect ultra-oligotrophic conditions (e.g., low primary productivity) in the streams.

Table 2. Characteristics of surface water sampling sites and locations from unnamed streams 1 and 2, Rose, Nova Scotia, July 13 and September 12, 2022. Site Locations shown in Figure 1.

Site Name	Geographic Coordinates (UTM) Zone 20 | Nad 83		Site Description
	Easting	Northing	
UNNAMED STREAM 1			
US1	5048488	441809	Furthest upstream site, to the southeast of Westchester Quarry.
US2	5048778	441711	Site along unnamed stream immediately adjacent to the Westchester Quarry.
US Pond	5048933	441725	Ponding of water above the Westchester Quarry access road
DS1 (SW1)	5049052	441667	Site situated between the quarry access road and Westchester Road. Water Quality sampling site SW1.
DS2	5049184	441619	Downstream site, below Westchester Road.
DS3	5049311	441610	Furthest downstream site, below Westchester Road.
UNNAMED STREAM 2			
2-US1	5048728	442398	Furthest upstream site.
2-DS1 (SWC1)	5049035	442340	Site located above Westchester Road. Water Quality sampling site SWC1.
2-DS2	5049147	442340	Downstream site, below Westchester Road.
2-DS2B	5049221	442308	Furthest downstream site, below Westchester Road.

Table 3. Water quality measurements from unnamed streams 1 and 2, Rose, Nova Scotia, on September 12, 2022 and incidental measurements, July 13, 2022 (bracketed values)[4]. Site Locations shown in Figure 1. Other water quality results are presented in Appendix B.

Site Location	UNNAMED STREAM 1						UNNAMED STREAM 2				Freshwater Aquatic Life Guideline
	US1	US2	US Pond	DS1 (SW1)	DS2	DS3	2-US1	2-DS1 (SWC1)	2-DS2	2-DS2B	
WATER QUALITY PARAMETER											
Temperature (°C)	14.1	14.7	14.1	14.9 (15.7)	15.7 (15.6)	15.7	13.9	15.5 (17.0)	15.7 (17.0)	16.1	>20° C[3]
Dissolved Oxygen (mg/L)	8.9	**3.7**	**4.4**	7.6 (9.2)	**5.8** (6.9)	7.2	8.3	7.0 (**6.3**)	7.7 (**5.9**)	8.7	6.5 to 9.5 mg/L[2]
Dissolved Oxygen (% saturation)	88.3	36.1	42.5	75.7 (92.1)	58.1 (70.2)	73.3	80.1	69.7 (67.5)	77.8 (64.0)	88.7	--
Conductivity (µs/cm)	45.1	51.1	131.6	150.9 (112.3)	133.4 (103.8)	120.3	34.7	34.8 (30.2)	39.0 (31.0)	39.1	--
Specific Conductivity (25°C) (µs/cm)	56.9	63.8	168.4	187.2 (137.4)	162.6 (127.1)	146.3	43.9	42.5 (35.8)	46.7 (35.7)	47.1	--
TSS (mg/L)	2.5	5.0	18.0	1.0 (10.0)	3.0	0.5	4.0	6.0 (2.5)	3.0	1.0	--
pH	7.1	7.2	7.6	7.8 (7.6)	7.6	7.6	7.0	7.0 (7.1)	7.1	7.3	6.5 to 9[1]

1. CCME, Canadian Council of Ministers of the Environment. 1999.
2. CCME, Canadian Council of Ministers of the Environment. 1999. >9.5 *mg/L early life stages; >6.5 mg/L other, cold water ecosystems.*
3. Thresholds of 20° C are used as indicators of stress to aquatic species, particularly salmonids (DFO 2012).
4. Water sampling was not conducted at some sites on July 13, 2022 due to extreme heat and the resulting safety concerns.

Table 4. Metals and nutrient measurements from unnamed streams 1 and 2, Rose, Nova Scotia. Samples collected on September 12, 2022. Site Locations shown in Figure 1.

Shaded values exceeded the Canadian Drinking Water Quality Guidelines. *Bolded values exceeded the Freshwater Aquatic Life Guidelines.*

Parameter	Unit	UNNAMED STREAM 1			UNNAMED STREAM 2		Freshwater Aquatic Life Guideline
		US1	US2	DS3	2-US1	2-DS2	
Chemical Oxygen Demand	mg/L	13	25	<3	4	<3	--
Total Organic Carbon	mg/L	3.1	4.2	2.2	1.0	0.87	--
Total Phosphorus	mg/L	0.106	0.069	0.046	0.033	0.031	<0.004[3]
Total Kjeldahl Nitrogen	mg/L	0.14	0.16	0.12	<0.10	<0.10	32.8[4]
Total Aluminum	µg/L	**119**	**254**	65	17	17	100[1]
Total Antimony	µg/L	<2	<2	<2	<2	<2	--
Total Arsenic	µg/L	<2	<2	<2	<2	<2	5[1]
Total Barium	µg/L	11	14	24	7	6	1000[2]
Total Beryllium	µg/L	**<2**	**<2**	**<2**	**<2**	**<2**	0.13[2]
Total Bismuth	µg/L	<2	<2	<2	<2	<2	--
Total Boron	µg/L	<5	6	11	<5	<5	1200[2]
Total Cadmium	µg/L	<0.09	<0.09	<0.09	<0.09	<0.09	0.09[1]
Total Chromium	µg/L	<1	<1	<1	<1	<1	--
Total Cobalt	µg/L	<1	<1	<1	<1	<1	--
Total Copper	µg/L	<1	<1	1	<1	<1	2[1]
Total Iron	µg/L	155	**386**	89	100	<50	300[1]
Total Lead	µg/L	**1.2**	0.7	<0.5	<0.5	<0.5	1[1]
Total Manganese	µg/L	49	124	4	49	3	--
Total Molybdenum	µg/L	<2	<2	3	<2	<2	73[1]
Total Nickel	µg/L	<2	<2	<2	<2	<2	110[1]
Total Selenium	µg/L	<1	<1	<1	<1	<1	1[1]
Total Silver	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.25[1]
Total Strontium	µg/L	16	20	55	13	11	--
Total Thallium	µg/L	<0.1	<0.1	<0.1	<0.1	<0.1	0.8[1]
Total Tin	µg/L	<2	<2	<2	<2	<2	--
Total Titanium	µg/L	6	12	5	<2	<2	--
Total Uranium	µg/L	<0.2	<0.2	0.5	<0.2	<0.2	15[1]
Total Vanadium	µg/L	<2	<2	<2	<2	<2	--
Total Zinc	µg/L	<5	<5	<5	<5	<5	30[1]

1. CCME, Canadian Council of Ministers of the Environment. 1999.
2. BCMECCS, British Columbia Ministry of Environment and Climate Change Strategy. 2021.
3. Canadian trigger range for total phosphorous (µg/L) <4 = ultra-oligotrophic trophic (CCME, 2004)
4. For nitrate (as N), the 30-d average concentration to protect freshwater aquatic life is 3.0 mg/L and the maximum concentration is 32.8 mg/L. For nitrate (as N), the 30-d average concentration to protect marine aquatic life 3.7* mg/L (Nordin & Pommen, 2009).

HABITAT SUMMARY

Unnamed Stream 1

Water quality, forest cover, and fish habitat at sampling sites were generally acceptable on unnamed stream 1, the watercourse located adjacent to the east of the Westchester Quarry. Substate was primarily gravel-cobble in upper and lower reaches of the stream with cooler temperatures and mixed forest shaded areas as well as instream woody debris and large boulders scattered throughout. Habitat in the stream was predominantly riffles and runs, as a result of the natural steep gradient of the area with lower reaches of the stream supporting trout populations. Upper reaches of the stream (upstream of Westchester Road) are currently inaccessible to fish—however they have potential to support brook trout populations seasonally if fish barriers are removed or the area becomes accessible to fish. The upper reaches could also potentially support spawning and migration habitat during times of higher water levels due to the presence of groundwater influence (upwelling, cool temperatures and high dissolved oxygen) and substrate composition (gravel-cobble) observed during the surveys. The upper reaches lack overwintering and rearing habitat during low flow seasons as a result of the natural fish barriers (i.e., steep gradients, waterfalls and debris jams), low water levels and lack of sufficient instream cover and back eddies observed during the survey. The old road/trail crossing and associated blocked culvert has created an area of unsuitable fish habitat, which could be remediated. The substrate at site US Pond also consisted of predominantly fines with slightly turbid water. Both areas are currently inaccessible to fish however may indirectly contribute to sedimentation downstream during high flows/flushing events.

The quality of fish habitat, key water quality parameters and forest cover in unnamed stream 2 was generally suitable for fish. Flows and water levels were typical for the time of year, and fish (juvenile brook trout) were present in lower sections of the stream (below Westchester Road). Instream substrate was primarily gravel with little to no areas of sedimentation noted during the 2022 survey. The culvert on Westchester Road is currently a barrier to fish passage, however if remediated, unnamed stream 2 would be acceptable fish habitat for spawning and migration with potential areas of rearing and overwintering habitat located in lower reaches of the stream.

CONCLUSIONS

Fish habitat (both direct and indirect) is present in each watercourse, providing refugia (e.g., undercut banks, aquatic plants, overhanging vegetation, etc.), acceptable water quality (i.e., areas with moderate to high dissolved oxygen), nutrient sources, and other input sources (e.g., from groundwater seepage and wet areas in upper reaches of the streams). Waters within the project area are considered acceptable for trout survival, possibly as juvenile nursery areas in terms of water quality. Trout were observed in lower reaches below Westchester Road during fish survey days. No other fish species were noted.

The upper reaches of both streams (above Westchester Road) were determined to not be accessible to fish such as salmonids. Upstream areas would, however, provide indirect support to fish populations downstream through inputs of nutrients and detritus. Presence of trout in the streams requires increased care for work in the area to minimize harm to the species and the habitat. A 30 m buffer is in place between the quarry and unnamed stream 1.

MITIGATION MEASURES

Fish and fish habitat is present in unnamed streams 1 and 2. Mitigation measures to reduce the risk of potential impacts to identified fish and fish habitat are:

- Maintain the established 30 m buffer between the Westchester Quarry and all streams (e.g., unnamed stream 1).
- Implement sedimentation and erosion control measures along the quarry access road to prevent drainage into the pond area on unnamed stream 1. This may include a berm or diversion structure (e.g., straw bales, check dams, etc.). Contact NS ECC for further guidance.

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APPENDIX A: PHOTOS

Unnamed Stream 1

Photo 1. Site US1 on unnamed stream 1; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 2. Site US2 on unnamed stream 1; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 3. Site US Pond on unnamed stream 1; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 4. Site DS1 on unnamed stream 1; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 5. Site DS2 on unnamed stream 1; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 6. Site DS3 on unnamed stream 1; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 7. *Left photo*: Evidence of flowage down embankment leading to the streambed of unnamed stream 1. *Right photo*: wet patch on embankment. Area above site US2 adjacent to the Quarry. September 12, 2022.

Photo 8. Flocculated iron and manganese sheen on bottom substrate of unnamed stream 1 (below old road/trail), indicating groundwater influence. September 12, 2022.

Photo 9. Flooding immediately above old road/trail, below site US1. September 12, 2022.

Unnamed Stream 2

Photo 10. Site 2-US1 on unnamed stream 2; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 11. Site 2-DS1 on unnamed stream 2; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 12. Site 2-DS2 on unnamed stream 2; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 13. Site 2-DS2B on unnamed stream 2; upstream, downstream and substrate views (top left, top right and bottom photos). September 12, 2022.

Photo 14. *Left photo*: small wetland in riparian area at the toe of the slope. *Right photo*: Dried channel adjacent to unnamed stream 2; evidence of flow off slope during higher flow times. September 12, 2022.