DEXTER CONSTRUCTION COMPANY LIMITED

APPENDIX D

Welshtown Quarry Water Management Plan

927 Rocky Lake Drive | P.O Box 48100 | Bedford, NS B4A 3Z2
TEL: (902) 835-3381 | FAX: (902) 835-7300 | **www.municipalgroup.ca**

DEXTER CONSTRUCTION COMPANY LIMITED

WATER MANAGEMENT PLAN

WELSHTOWN QUARRY

Upper Clyde Road, Welshtown, Shelburne County, Nova Scotia

Date: November 10, 2021

INTRODUCTION

The Welshtown Quarry is a rural Nova Scotia quarry that is seasonally operated on a periodic basis during the construction season to meet demand within the local construction industry. Site operations are anticipated to occur for several weeks during periods of activity, which may include 1-2 blasts during years in which the site is active. A typical project (often Nova Scotia Department of Public Works contract) will require crushing activities at the quarry for a period of two to three weeks at a time. Following crushing activities, aggregate products are loaded and hauled from the quarry for several weeks, or as required by the project. During periods of inactivity the site is stabilized and maintained as a typical rural Nova Scotia Quarry, with occasional inspections to verify the integrity of environmental controls.

Operations at the site are undertaken in accordance with industry standards and best practices to minimize impacts to surface water, groundwater, and nearby wetlands. Plans for stormwater management, erosion and sediment control, water monitoring, and operational water usage are described in detail below. Applicable mapping has been attached.

The rate of quarry development will progress slowly, gradually increasing at a rate consistent with aggregate demand in the area. Dexter will regularly assess this Water Management Strategy for adequacy, effectiveness, and compliance. Based on these regular assessments, if adjustments to the Water Management Strategy are warranted then Dexter will engage NSE on the proposed changes.

WATER MANAGEMENT STRATEGY

Erosion and Sediment Control Strategies

Erosion and sediment control (ESC) at the site will be in accordance with industry accepted best practices, with a focus on erosion prevention. The NSE ESC Handbook for Construction Sites will be used as a guide for ESC strategies implemented at the site. The following ESC strategies will be implemented:

- Offsite surface water flow will be directed around active areas via berms, diversion ditches, or swales to minimize the amount of runoff flowing over working areas of the site.
- The amount of exposed soil shall be kept to a minimum. Grubbing will be limited to areas that are anticipated for short term quarry expansion.
- Working areas will be stabilized. The quarry floor, equipment setup areas, and stockpile locations will be graveled.
- Drainage ditches, swales, and culverts will be used to manage any runoff originating onsite so that flow through the site is separate and distinct from vehicle and equipment traffic.
- Runoff from exposed and/or unstable slopes (i.e. overburden) will be directed to vegetated areas or site water management infrastructure. If runoff from exposed and/or unstable slopes is towards sensitive environmental habitats, then they will be re-vegetated or otherwise stabilized.
- Vegetated buffers will be maintained around identified, sensitive environmental habitats (wetlands and watercourses).

- Silt fence will be installed between disturbed areas and sensitive environmental features (wetlands, watercourses, etc.) at the discretion of the Quarry Superintendent.

Water Control Strategies

Runoff from precipitation events and spring melt will be managed to reduce scour, flooding, and sediment loading on downgradient surface water systems. The following water management strategies will be implemented at the site;

- The site will be constructed such that the initial 3-5 feet below the quarry floor (sub-drill) will be fractured bedrock. This fractured surface will generally allow surface water runoff originating onsite to be temporarily retained within the quarry floor. Surface water retained in the quarry floor discharges to the east of the quarry through an established drainage corridor.
- The quarry floor will be contoured where necessary so that surface water runoff that does not infiltrate the fractured quarry floor will flow to the established drainage corridor.
- Small amounts of surface water originating near the perimeter of the site will be directed offsite to vegetated areas around the site.
- ESC strategies (noted above) will be implemented to mitigate scour, flooding, and sediment loading on downgradient surface water systems.
- A settling pond will be constructed in the southeastern portion of the proposed quarry expansion area to collect and temporarily retain surface water runoff prior to discharge towards the Roseway River. Design considerations and assumptions will include:
    - Erosion and Sediment Control Plans and strategies applied at the site will limit the amount of surface water runoff contributing to the settling pond to that which originates in the active area of the site.
    - Blasting will generally include 3-5 feet of sub-drill which will result in a fractured quarry floor that is anticipated to retain a significant amount of the runoff originating onsite, reducing the actual amount of water that the settling ponds will be required to manage.
    - The results of surface water monitoring at the site will be used to validate the effectiveness of the settling pond and provide insight into when the settling pond capacity may need to be increased to account for the increasing frequency and intensity of precipitation events due to climate change.
- Surface water monitoring will be conducted according to the Water Monitoring Plan outlined below to verify compliance with site discharge limits identified in the Industrial Approval.
- During periods of site activity, water management controls will be inspected on a regular basis, in particular following heavy rainfall events. Any noted deficiencies will be reported to the Quarry Superintendent and will be repaired at first opportunity.
- During periods of site inactivity, water management controls will be inspected as part of regular internal environmental inspections and audits (at least on an annual basis). Any noted deficiencies that require urgent attention will be reported to the Quarry Superintendent and be repaired in a timely manner. If the site is observed to be stable and maintenance of the compromised controls is not imperative, then the controls will be repaired at first opportunity during the following period of site activity.

OPERATIONAL CONSIDERATIONS

Pumping Requirements

The quarry excavation will not enter the groundwater table, so ongoing pumping requirements will not be required. The quarry is free draining such that little / no runoff is retained on the quarry floor. Given the nature of the quarry, pumping of retained surface water will not be required during operational periods.

Dust Suppression Water Usage

Water spray will be used for dust suppression at the site when required, and may include;

- During periods of heavy activity and/or dry or windy periods, water spray or another approved dust suppressant may be used to reduce the re-suspension of dust on unpaved roads and work areas.
- Portable crushing spreads have been retrofitted with a water spray system to reduce the generation of dust during crushing activities.

Water for dust control will typically be drawn from surface water runoff retained in the site settling pond(s), or from surface water runoff retained in the fractured quarry floor. Alternatively, if necessary, water may be imported to the site via water trucks.

A dust suppressant (ex. calcium chloride) would typically be used for dust control on unpaved roads and work areas rather than water since a single application of dust suppressant will generally be effective for several days. A single water truck may occasionally be used to spray select working areas throughout the course of a day. When operating, the crusher dust suppression system requires approximately 15,000 liters of water per day. Water usage is anticipated to be below 23,000 liters per day on average.

Overall, it is anticipated that water usage for dust suppression will not be withdrawn from a source, at a frequency, or at a volume that would require a water withdrawal approval.

Aggregate Washing

If aggregate washing is required it will be conducted using a closed loop approach such that all wash water is retained onsite. A series of permanent or temporary wash ponds would be constructed on site. Water retained onsite in the settling pond would be used to fill / replenish the wash ponds when necessary. The wash water will be circulated through the series of wash ponds and reused for aggregate washing.

Alternatives to aggregate washing may reduce the need to wash aggregate onsite include importing washed aggregate from a different site, or the use of a dry air separator where appropriate.

Overall, if aggregate washing is required, it is anticipated that water will not be withdrawn from a source, at a frequency, or at a volume that would require a water withdrawal approval.

WATER MONITORING PLAN

Surface Water Quality Monitoring

Surface water quality monitoring will be conducted as per the Terms and Conditions of the Industrial Approval and is intended validate the effectiveness of environmental controls and strategies implemented at the site and assess potential changes in surface water quality around the site. Proposed surface water monitoring locations are identified on Figure 1 – Proposed Water Monitoring Locations.

It is proposed that surface water quality monitoring be conducted on a quarterly basis for TSS and pH. Additionally, for the first year water samples will also be analyzed for general chemistry and metals to establish baseline water quality and identify potential contaminants of concern. A quarterly sample collection frequency is consistent with Dexter's experience operating similar rural NS quarries. The proposed surface water monitoring locations include;

- SW-1 Upstream (background) on Unnamed Watercourse, south of the quarry
- SW-2 Site discharge from established drainage corridor
- SW-3 Downstream on Unnamed Watercourse, prior to discharge into the Roseway River

Surface Water Monitoring Plan Summary

ID	LOCATION	PARAMETERS	INITIATION TIMELINE	FREQUENCY
SW-1	Upstream (background) on Unnamed Watercourse, south of the quarry	TSS, pH General Chemistry and Metals (collected for 1 year to establish baseline)	Upon NSE issuance of amended Industrial Approval	Quarterly (while the site is seasonally accessible[1])
SW-2	Site discharge from established drainage corridor			
SW-3	Downstream on Unnamed Watercourse, prior to discharge into the Roseway River			

[1] If seasonal access is maintained; Dexter's intent is to conduct four rounds of samples collection per year, with samples collected quarterly (Q1: Jan-Feb-Mar / Q2: Apr-May-Jun / Q3: Jul-Aug-Sep / Q4: Oct-Nov-Dec).

Groundwater Monitoring

Groundwater monitoring will be conducted as per the Terms and Conditions of the Industrial Approval. It is proposed that 3 groundwater monitoring wells be installed at the site to monitor groundwater quality and quantity around the quarry. The proposed groundwater monitoring stations will be situated around the proposed quarry expansion area, between the quarry and residential drinking water wells, and including upgradient locations and downgradient locations. Proposed groundwater monitoring locations are identified on Figure 1 – Proposed Water Monitoring Locations.

Initially three groundwater monitoring stations would be established (MW-1, MW-2, MW-3). These groundwater monitoring stations would be installed upon NSE issuance of an amended Industrial Approval, and prior to the quarry advancing into the proposed expansion area. Additional groundwater monitoring wells will be considered when the quarry extends beyond the quarry mid-development phase.

It is proposed that groundwater monitoring be conducted on a quarterly basis until two years of baseline data has been established, and then annually thereafter. This sample collection frequency is consistent

with Dexter's experience operating similar rural NS quarries. The proposed groundwater monitoring locations include;

MW-1 Northeast of the quarry, downgradient, between site operations and the nearest residential drinking water wells on Upper Clyde Road

MW-2 East of the quarry, downgradient, between site operations and the nearest residential drinking water wells on Upper Clyde Road

MW-3 West of the quarry, upgradient

Groundwater Monitoring Plan Summary

ID	LOCATION[1]	PARAMETERS	INITIATION TIMELINE	FREQUENCY
MW-1	Northeast of the quarry, downgradient, between site operations and the nearest residential drinking water wells on Upper Clyde Road	General Chemistry and Metals	Upon issuance of amended Industrial Approval, and prior to the quarry advancing into the proposed quarry expansion area	Quarterly (for the first two years after installation, while the site is seasonally accessible[2]) and then annual thereafter.
MW-2	East of the quarry, downgradient, between site operations and the nearest residential drinking water wells on Upper Clyde Road			
MW-3	West of the quarry, upgradient			
MW-x	MW-1 / MW-2 / MW-3	Elevation	When wells have been constructed	Monthly

[1] Monitoring well locations are approximate. Actual monitoring well locations to be confirmed in the field prior to installation.

[2] If seasonal access is maintained, Dexter's intent is to conduct four rounds of samples collection per year, with samples collected quarterly (Q1: Jan-Feb-Mar / Q2: Apr-May-Jun / Q3: Jul-Aug-Sep / Q4: Oct-Nov-Dec).

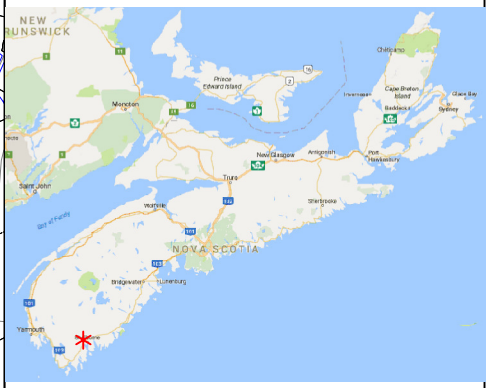
CONCLUSION

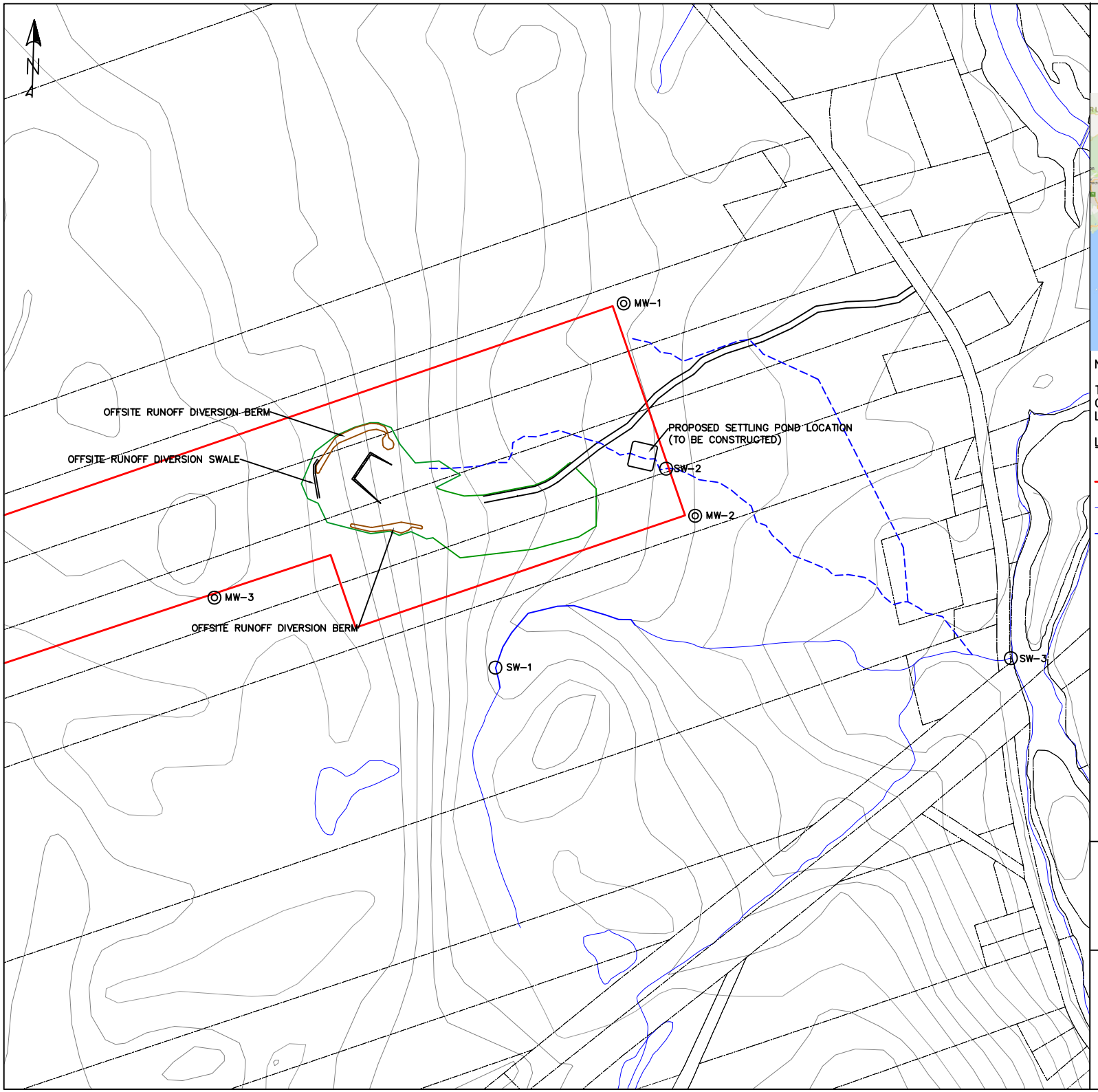
This Water Management Plan is provided to support operations at the Welshtown Quarry. Subject to changing site conditions and/or additional information obtained through the various monitoring programs associated with the quarry, this Plan may be updated, amended, or otherwise revised to better reflect the scope of the quarry operations. Changes to this Strategy shall be in consultation with Dexter's Environmental Management Team and engagement with Nova Scotia Environment.

WELSHTOWN QUARRY

FIGURE 1 – PROPOSED WATER MONITORING LOCATIONS

DATE: June 9, 2021 DRAWN BY: RHETT THOMPSON, P.ENG





NOTES:

TOPOGRAPHIC DATA OBTAINED FROM NS GEOMATICS CENTER 1:10,000 TOPOGRAPHIC MAP. TOPOGRAPHY LINES ARE AT 5 METER INTERVALS

LEGEND

- QUARRY EXPANSION AREA
- MAPPED WATERCOURSES (1:10,000)
- SURVEYED DRAINAGE CORRIDORS
- PROPOSED SURFACE WATER MONITORING STN
- PROPOSED GROUNDWATER MONITORING WELL

0 200 400 Meters

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APPENDIX E

Welshtown Quarry – Fish and Fish Habitat Assessment

927 Rocky Lake Drive | P.O Box 48100 | Bedford, NS B4A 3Z2
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Fish Habitat and Stream Survey

Welshtown Quarry Expansion

10740 Upper Clyde Road, Welshtown, Shelburne County, Nova Scotia

September 2021

Report to:

Dexter Construction Company Limited
Bedford, Nova Scotia

Prepared by:

Envirosphere Consultants Limited
P.O. 2906 | Unit 5 – 120 Morison Drive
Windsor, Nova Scotia B0N 2T0
Tel: (902) 798-4022 | Fax: (902) 798-2614
www.envirosphere.com

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Dexter Construction Company Limited is proposing to expand an existing quarry located on Upper Clyde Road, Welshtown, Shelburne County, Nova Scotia. An Environmental Assessment for the expansion of the quarry was conducted and a Registration Document submitted to Nova Scotia Environment (NSE) in 2020. In December of 2020, it was identified by NSE that additional information was required for the water resource component of the assessment including a fish and fish habitat survey for Wetland 12 and the associated watercourse (Tributary 1). The current study was undertaken to identify the presence/absence of fish species and the quality of fish habitat in the unnamed tributary adjacent to the quarry property – associated with Wetland 12 - and any additional tributaries (Tributaries 2 and 3) to the main stream that could potentially be exposed to environmental contaminants. Electro-seining and minnow traps were set for fish; and standard water quality sampling was conducted. Carried out on June 2 and 3, 2021, the survey found acceptable habitat and presence of fish in waters surveyed.

The only fish species found was brook trout (*Salvelinus fontinalis*). Small numbers of juveniles and occasionally larger individuals were found overall. Water quality and stream conditions were acceptable for fish. Flows were moderate in Tributary 1 and Tributary 2 and were low in Tributary 3. Water quality was generally acceptable 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. Waters had moderate to high dissolved oxygen, and low conductivity with the exception of Tributary 3 which had low dissolved oxygen and moderate conductivity. The quality of fish habitat in terms of streambed composition; accessibility by fish through the absence of barriers to fish passage; and key water quality parameters was suitable for fish in all watercourses. A powerline utility corridor and a hanging culvert on the Upper Clyde Road may be barriers to fish passage during low flow seasons.

INTRODUCTION

Dexter Construction Company Limited, Bedford, Nova Scotia (Dexter), is proposing to expand an existing quarry in the vicinity of Welshtown, Shelburne County, Nova Scotia. A Registration Document for the proposed Welshtown Quarry expansion was completed and submitted to Nova Scotia Environment (NSE) in 2020 and it was concluded that additional information was required to supplement the Environmental Assessment. One requirement identified was a baseline survey for fish and fish habitat in an unnamed watercourse (Tributary 1) on an adjacent property immediately south of Wetland 12, a wetland identified in the original Environmental Assessment. Envirosphere Consultants Ltd. was contracted by Dexter to assess fish and fish habitat in Wetland 12 and the associated watercourse in relation to the quarry expansion. A biological assessment of Tributary 1 was conducted, which entailed a walkover of the stream, partial walkover of tributaries, and overall survey for fish species present as well as an assessment of the quality of fish habitat along the streams. Results of the assessment are presented in this report.

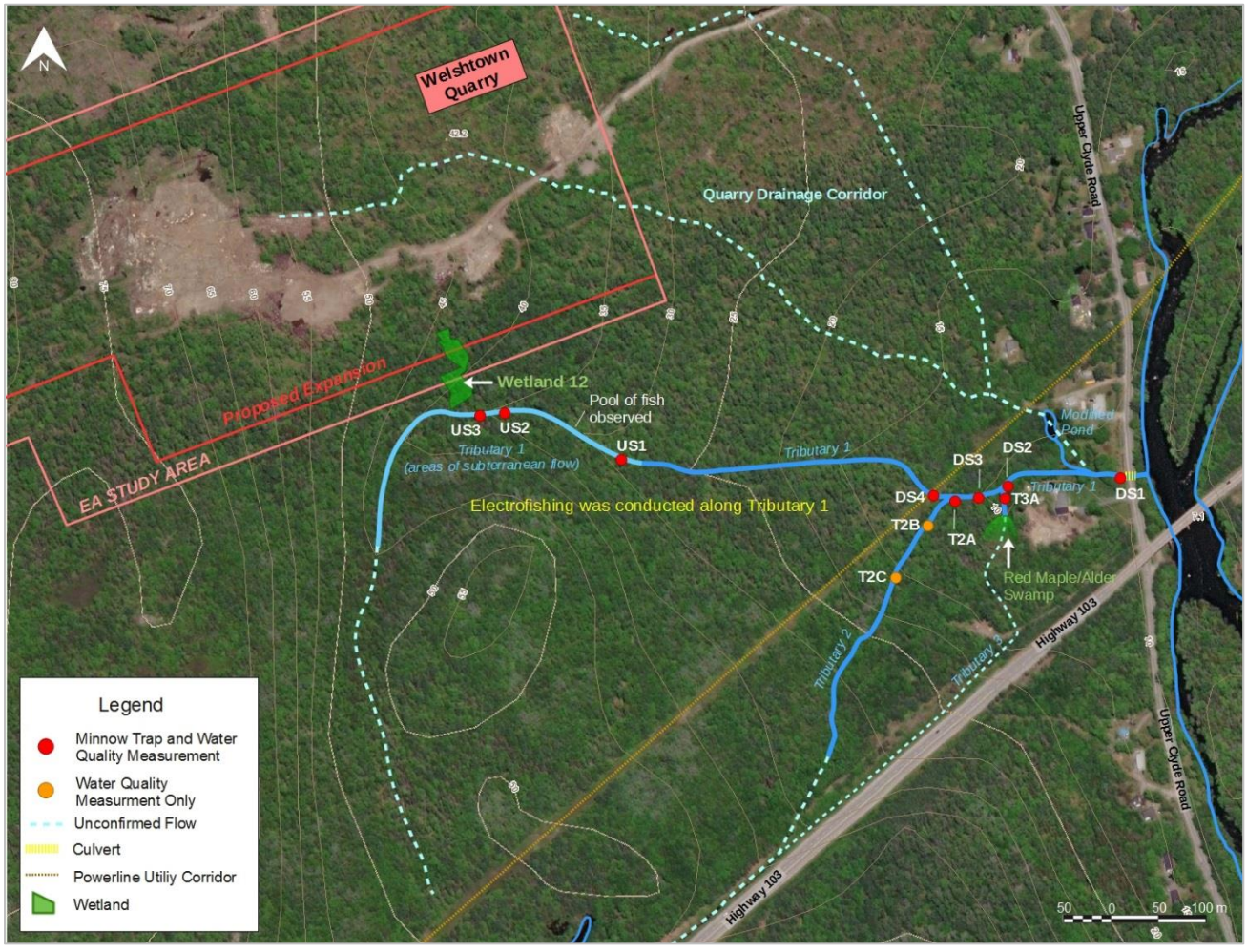

Figure 1. Project area and sampling sites, June 2 and 3, 2021. Dexter Welshtown Quarry, Welshtown, Nova Scotia.

STUDY AREA

The Welshtown Quarry is located on Upper Clyde Road, approximately 2 km northwest of the Town of Shelburne, at approximately UTM Zone 20, NAD83, Easting 310276 and Northing 4849985. The scope of this fish and fish habitat assessment encompasses an unnamed stream (Tributary 1) and associated areas located adjacent to the Dexter Welshtown Quarry in the vicinity of Welshtown, Shelburne County, Nova Scotia. The unnamed stream is in the Roseway River secondary watershed (1EC-3) and is primarily a first-order stream becoming a second-order stream and then joining other small flowages prior to connecting with the Roseway River. The Roseway River system is known to support various fish species including brook trout, and possibly Atlantic salmon in addition to other freshwater fish typical of the area, including yellow perch, and the introduced chain pickerel and smallmouth bass (NSDFA 2020). These species could also occur in associated tributaries. The unnamed stream (Tributary 1) and a wetland (Wetland 12) are the main areas considered in this report (Figure 1). The stream likely begins in a wetland southwest of the quarry property and flows north before sharply turning to flow east, before running approximately 1.3 kilometers to the Roseway River. At its closest approach, Tributary 1 is within 50 m from the proposed expansion area. Wetland 12, one of its headwater sources lies between the quarry and Tributary 1.

SURVEY APPROACH

Environmental Biologist, Heather Levy (B.Sc. Bio & B.Sc. (H) Env.Sci.) and Environmental Professional, Hayley Doyle (B.Sc. Env.Sci.) of Envirosphere Consultants Limited visited the site on June 2 and 3, 2021, and performed a walkover and assessment of the target watercourse and surrounding area.

During the survey, the team obtained GPS coordinates of any flowages, defined stream channels, and junctions associated with the target stream, which is a tributary to the Roseway River (Figure 1). Water quality sampling followed standard procedures at each site. Temperature, dissolved oxygen, and specific conductivity were measured with a YSI Model 85 handheld oxygen meter[1]. At each site, physical characteristics of the stream were recorded, including substrate type, stream cover (% shade, % overhang), bank type and stability, depth and width. Photographs of the stream and substrate were taken at all locations showing upstream and downstream views.

Fish surveys (electrofishing and minnow traps) were conducted under DFO Permit 700015068, #322937 (Maritimes Region). Electrofishing[2] was conducted along Tributary 1 at Site DS4, located upstream of the Upper Clyde Road culvert[3] leading to the Roseway River (Figure 1). Minnow traps were placed along Tributary 1 at three upstream sites (US1, US2 and US3) as well as four downstream sites (DS1, DS2, DS3 and DS4). Two additional traps were placed in tributaries to the main stream, one in Tributary 2, and a second in Tributary 3. Photographs were taken of species collected from minnow traps. Weather was periods of sun with occasional clouds on both survey days (June 2 and 3, 2021), and ideal for sampling and observations. Water levels and flows were low to moderate.

[1] The YSI meter is calibrated annually for temperature against a thermometer traceable to a US National Institute for Standards and Technology (NIST) standard and specific conductivity is checked regularly against certified reference standards.

[2] A Smith-Root Model LR 20B backpack electrofisher was used for surveys.

[3] Based on a previous survey, the culvert below the Upper Clyde Road is known to be a hanging culvert.

RESULTS AND DISCUSSION

Site Descriptions

Tributary 1, likely originates in a wetland southwest of the Dexter Welshtown Quarry property. The tributary flows north, before sharply turning to flow east and southeast, eventually passing through a culvert at the Upper Clyde Road before discharging into the Roseway River (Figure 1). Two additional tributaries (Tributaries 2 and 3) were identified during the course of the survey, both originating from the southwest, flowing north and northeast before joining Tributary 1 and continuing as combined flow into the Roseway River. In particular, Tributary 2, not noted on some Provincial mapping, was discovered and partially ground-truthed during the site survey. This tributary was noted as a significant feature in the area, a main contributor of flow to lower portions of the stream. Another area consisting of a pond (likely modified or artificial) and associated flowage were also identified on a residential property adjacent to Tributary 1. Pond outflow joins Tributary 1 immediately above the Upper Clyde Road, before discharging into the Roseway River. Wetland 12, another area of interest for the study—as a contributor of flow to Tributary 1—was previously identified as a sphagnum slope swamp. It lies between the quarry and the upper-mid portion of Tributary 1.

Tributary 1

Tributary 1, likely originates in a swamp wetland complex which has been interrupted by a powerline utility corridor. The watercourse flows from the wetland towards the north through hardwood forest, then sharply turns toward the east running adjacent to Wetland 12 and the Dexter Welshtown Quarry property. Tributary 1 continues to flow east and southeast primarily through mixed wood forest and crosses through the small powerline utility corridor that runs northeast-southwest. Immediately prior to joining the Roseway River, Tributary 1 flows through a partially treed and grassy area abutting manicured lawns on a private, residential property, and then through a large concrete box culvert under Upper Clyde Road. Seven sites along Tributary 1 were selected to be assessed for fish and fish habitat as well as water quality (DS1, DS2, DS3, DS4, US1, US2 and US3). Water levels at the time of the survey were moderate to low.

DS1

Sampling site DS1 is located furthest downstream on Tributary 1, in a residential area with manicured lawns and riparian areas consisting of long grasses and occasional trees. The site is located immediately upstream of the concrete box culvert that runs under Upper Clyde Road (above the junction between Tributary 1 and the Roseway River), and below the junction with a flowage draining from a pond on an adjacent property (Figure 2). Channel stability was moderate as the stream bank was highly channelized through the residential area with banks formed with large boulders and cobble. Banks are vegetated with meadowsweet (*Spiraea* sp.), grasses, sedges, asters, cinnamon fern (*Osmundastrum cinnamomeum*) and mountain ash (*Sorbus* sp.) with an overstory of maple (*Acer* spp.). A mixed bottom substrate of cobble and gravel, with occasional boulder, sand and fines was interspersed throughout. The large boulders lining the stream channel provide areas of cover for fish although minimal overhanging vegetation was present. Electrofishing was conducted and minnow traps deployed at this sampling site. Water temperature was 14.0 °C and dissolved oxygen was high at 11.0 mg/L (Table 1). The water was clear with a slight brown tan/colour at the time of the survey.

DS2

Site DS2 is located on Tributary 1, immediately below its junction with Tributary 3 (Figure 3). The site, located upstream of the residential homes along Upper Clyde Road, is surrounded by a mixed wood forest consisting predominantly of red maple (*Acer rubrum*). The bottom substrate was gravel with occasional sand and fines with woody debris, leaf litter, and organic matter present on the streambed. Fallen branches and logs were also noted across the stream (Figure 3). Banks had minimal overhanging vegetation and were covered in grasses, mosses, starflower (*Lysimachia borealis*), Indian cucumber root (*Medeola virginiana*), wild lily-of-the-valley (*Maianthemum canadense*), white pine (*Pinus strobus*), fir, and maple seedlings. Exposed tree roots, woody debris, undercut banks and pool areas provided many areas for fish cover and the canopy cover of mixed coniferous/deciduous trees (fir, spruce, white pine, maple) provided significant shade to the stream. Minnow traps were used at this sampling site. Water temperature was 13.7 °C and dissolved oxygen was high at 9.45 mg/L (Table 1).

DS3

Site DS3 along Tributary 1, is located below the junction of Tributaries 1 and 2 and at a location where a fallen spruce tree creates a natural deflection of flow (Figure 4). The section of stream sampled is surrounded by mixed wood forest consisting of red maple (*Acer rubrum*), white pine (*Pinus strobus*), spruce, fir and oak. The forest floor consisted of New York fern (*Parathelypteris noveborancensis*), wild sarsparilla (*Aralia nudicaulis*), starflower (*Lysimachia borealis*), inkberry (*Ilex glabra*), grasses, sedges and asters. Banks had minimal overhanging vegetation and were covered in sphagnum mosses. Within the stream, banks were heavily undercut and the stream features many deep, shaded pools by fallen trees and woody debris. Bottom substrate at the time of sampling was gravelly sand with fines and occasional boulder. Minnow traps were used at this site. Water temperature was 14.7 °C and dissolved oxygen was high at 8.9 mg/L (Table 1).

DS4

Site DS4 is located immediately downstream of the powerline utility corridor and adjacent to the forest edge (Figure 5). The powerline utility corridor is an open area vegetated with Rhodora (*Rhododendron canadense*), inkberry (*Illex glabra*), Labrador tea (*Rhododendron groenlandicum*), sheep laurel (*Kalmia angustifolia*), alders (*Alnus* sp.), cinnamon fern (*Osmundastrum cinnamomeum*), serviceberry (*Amelanchier arborea*), huckleberry (*Gaylussacia* sp.), blue flag (*Iris* sp.), red maple seedlings (*Acer rubrum*), grasses and sphagnum. This area was determined to be a wetland, where water appeared to be running down the natural topography of the area and pooling within a basin-like wetland. There was no prominent channel of flow observed crossing through the wetland at the time of the survey (Figure 5); instead, Tributary 1 appeared to be spreading out into the wetland and re-channelizing downstream at the forest edge (DS4). The sampling site had 50% overhanging vegetation and a minnow trap was placed in a pool downstream of the wetland. Water temperature was 11.3 °C; dissolved oxygen was moderate to low at 6.4 mg/L (Table 1).

US1

Site US1 is located in a deep stretch of stream (approximately 300 m above the junction of Tributaries 1 and 2) and surrounded by a mixed coniferous/hardwood forest consisting of red maple, white pine and fir. The site had a bottom substrate of sandy gravel overlain with leaf litter and woody debris and boulder was present along the edges of the stream. Several fallen trees and logs were noted within the stream above and below the sampling site. Banks had sparse overhanging vegetation and the channel and riparian

area displayed grasses, cinnamon fern (*Osmundastrum cinnamomeum*), New York fern (*Parathelypteris noveborancensis*), wild lily-of-the-valley (*Maianthemum canadense*), white pine (*Pinus stribus*) and fir seedlings and the forest floor consisted of leaf litter and woody debris, wild lily-of-the-valley (*Maianthemum canadense*), and sphagnum moss (Figure 6). A minnow trap was placed in the pool of an undercut bank. Immediately upstream of the site, Tributary 1 becomes subterranean (Figure 6) before opening up again where a shallow pool of unidentified fish species was observed during the survey. Water temperature was 12.3 ˚C; dissolved oxygen was moderate at 7.4 mg/L (Table 1).

US2

Site US2 is located on Tributary 1 at a location easily accessible from the Welshtown Quarry property. During the sampling period, the stream channel was approximately 2 m wide having an average depth of 12 cm and a bottom substrate of cobble and boulder (Figure 7). Adjacent areas were forested with a mixed coniferous/deciduous canopy consisting of maple, spruce, fir and pine. Grasses, ferns, alders and mosses along the banks provided little shade over the stream. A minnow trap was placed in water at this site. Water temperature was 13.2 ˚C and dissolved oxygen was low at 4.8 mg/L (Table 1).

US3

Sampling site US3 is the furthest upstream along Tributary 1 and is the nearest site to the Welshtown Quarry property, and the previously identified Wetland 12. The site is also located approximately within 10 m to a cut line where logging activity adjacent to the quarry property has occurred, likely between the July 8, 2020 Environmental Assessment site visit and the June 2 and 3, 2021 site visits. Sampling was conducted in a run with clear and coloured (tan/brown) water, having a slow flow. The site had a bottom substrate of cobble and boulder with some sandy mud as well as in-stream vegetation, organics, woody debris and algae (Figure 8). Banks were stable and displayed grasses, moss, ferns, asters, threeleaf goldthread (*Coptis trifolia*), wild lily-of-the-valley (*Maianthemum canadense*), and Canadian bunchberry (*Cornus Canadensis*). Adjacent areas were forested to the south with a mixed coniferous/hardwood canopy; a logging cutline occurred to the north. Water temperature was 11.1 ˚C; dissolved oxygen was moderate at 8.3 mg/L (Table 1).

Upstream of the sampling site, the stream became intermittently subterranean and areas of channelized stream at the surface appeared be ideal fish habitat, although no fish were visually observed during the time of the survey (Figure 9).

Figure 2. Downstream site along Tributary 1 (DS1), upstream of a concrete box culvert where the stream connects with the Roseway River. June 2, 2021.

Figure 3. Tributary 1 at the junction with Tributary 3 (DS2), looking upstream (*left photo*) and downstream (*right photo*) from the sampling site. June 2, 2021.

Figure 4. Tributary 1 where a fallen spruce tree is creating a natural deflector (DS3), looking downstream toward the fallen tree and minnow trap placed in the stream. June 2, 2021.

Figure 5. Tributary 1 at the powerline utility corridor (DS4) looking downstream (*left photo*) and at the wetland-basin (*right photo*). June 2, 2021

Figure 6. Tributary 1 is at sampling site US1 surrounded by mixed wood forest (*left photo*) and becomes subterranean upstream (*right photo*). June 2, 2021

Figure 7. Tributary 1 at sampling site US2 where the stream was most easily accessible from the quarry property. June 2, 2021.

Figure 8. Furthest upstream site along Tributary 1 (US3) (*left photo*) and the logged area between the stream and quarry property (*right photo*). June 2, 2021.

Figure 9. Upper portions of Tributary 1 where the stream becomes intermittently subterranean (*left photo*) while other areas showing channelized flow (*right photo*). June 3, 2021.

Wetland 12

Wetland 12 was identified and delineated during site visits for the Environmental Assessment in 2020. The wetland was noted to be a sphagnum slope swamp and suspected as a contributor of flow to Tributary 1, though the presence of Tributary 1 was not confirmed at the time[4]. The swamp extends from the base of the quarry berm to Tributary 1 and intermittent runoff from the berm provides the main water source to Wetland 12, in addition to local surface and groundwater. Presence of suspended sediment residues at the ground surface at the upslope end of the wetland indicate transport into the area from berm runoff. Prior to the establishment of the existing quarry, Wetland 12 would likely have received additional water supply, as its catchment area would have been larger, however the present size and condition of Wetland 12 reduces its overall significance to Tributary 1. No channelization or flow was noted in the wetland, and consequently there is no fish habitat present. Water draining from the slope swamp would be a contributor of flow to the upper-mid portions of Tributary 1; however, a relatively insignificant one.

[4] In 2020, the brook ran dry near the Upper Clyde Road for the first time in 70 years (J. Bower, personal communication, 2021).

Recently, (i.e., since the September 2020 survey) the area between the quarry and Tributary 1 was logged by the previous landowner under wood rights that were retained in the agreement of purchase and sale (Figure 8, right photo). The forest removal will further reduce the maintenance of Wetland 12, although it may lead to flashier runoff in the wetland as well as in Tributary 1 during heavy rainfall and snowmelt events.

Tributary 2

Tributary 2 flows from southwest to northeast through mixed wood forest before joining with Tributary 1 downstream of the DS4 site location (Figure 1). Tributary 2 is a permanent stream with a defined channel and vegetated banks having a substrate bottom of gravel, cobble and boulder. One minnow trap was placed in Tributary 2. The stream featured moderate water levels with moderate flow and several areas where large boulders created step-pools within the stream.

T2A

Site T2A is on Tributary 2 and is located at the junction with Tributary 1 (Figure 1). A large boulder in the middle of the stream was observed to be directing flow to carve out a large deep pool where Tributary 2 and Tributary 1 join (Figure 10). The stream channel featured undercut banks and was 60-70% shaded by mixed coniferous/deciduous (spruce, fir, maple, oak) canopy. Sparse overhanging woodland plants including grasses, sedges, asters, wild sarsaparilla (*Aralia nudicaulis*), starflower (*Lysimachia borealis*), wild lily-of-the-valley (*Maianthemum canadense)*, and sphagnum moss covered banks. Substrate consisted primarily of gravel with occasional boulder, cobble and woody debris, leaf litter and in-stream vegetation present in the stream. A minnow trap was placed in the deep pool immediately below the boulder. Water temperature was 14.2 $^{\circ}$C and dissolved oxygen was high at 8.6 mg/L (Table 1).

T2B

Site T2B is located on Tributary 2 where a large wood structure, possibly the remains of a wooden bridge, crosses the stream, creating a barrier to fish passage (Figure 11). Sampling was conducted on the downstream side of the barrier in a pool approximately 3 meters wide and 50 cm deep, having a mixed bottom substrate of boulder, cobble, and gravel. There was occasional in-stream vegetation on boulders and woody debris present in the stream. The stream channel was significantly shaded by a mixed canopy of mixed coniferous and deciduous trees (maple and spruce). Banks were mainly stable and vegetated with mosses, wild lily-of-the-valley (*Maianthemum canadense*), wild sarsaparilla (*Aralia nudicaulis*), cinnamon fern (*Osmundastrum cinnamomeum*) and sphagnum. No minnow trap was used at this site. Water temperature was 14.3°C and dissolved oxygen was high at 9.1 mg/L (Table 1).

T2C

Site T2C is the furthest upstream site on Tributary 2. The sampling site was located upstream of an old logging road and bridge that crosses the stream. The general topography was more steeply sloped going upstream than that of the downstream sites. Large amounts of litter including tires, cans, buckets, fishing line and rope were present in the riparian zone, and areas of the stream were blocked by debris. The stream bed was predominantly boulder with cobble, gravel and occasional sand with several step-pool areas posing potential fish barriers (Figure 12). The sampling site had a stream width of approximately 1.5 m and banks were vegetated with mosses, ferns including New York fern (*Parathelypteris noveboracensis*), cinnamon fern (*Osmundastrum cinnamomeum*) and crested wood fern (*Dryopteris cristata*), American witch hazel (*Hamamelis virginiana*), wild lily-of-the-valley (*Maianthemum canadense*), fir, oak and maple.

Minnow traps were not deployed at this site. Water temperature was 15.5 ˚C and dissolved oxygen was high at 8.9 mg/L (Table 1).

Figure 10. Tributary 2 at sampling site T2A where the stream joins Tributary 1. Flow over a large boulder created a deep pool. June 2, 2021.

Figure 11. Tributary 2 where a large wood structure covered in moss crosses the stream (T2B). June 2, 2021.

Figure 12. Tributary 2 where a series of boulders and the natural topography create step pools in the stream (T2C) (*left photo*), looking upstream toward an artificially constructed dam (*right photo*). June 2, 2021.

Tributary 3

Tributary 3 is a small stream that flows southwest to northeast and then turns to flow north before joining Tributary 1 approximately 150 m upstream of the Upper Clyde Road culvert (Figure 1). Much of the lower portions of the Tributary 3 near the junction with Tributary 1 are within an alder/red maple swamp, while upper portions of the watercourse are surrounded by mixed wood forest. One minnow trap was placed in Tributary 3 at the time of the survey. The stream featured low water levels with slow flow.

T3A

Site T3A is located on Tributary 3 immediately upstream of the junction with Tributary 1 (Figure 1). Sampling was conducted in a slow flowing run about 50 cm wide and 15 cm deep having a bottom substrate of sand, silt and fines (Figure 13). The site had occasional in-stream vegetation (aquatic plants) and woody debris and organics were present in the stream. The stream channel was 5 % shaded and banks were vegetated with grasses, sedges, asters, alders, red maple (*Acer rubrum*) and white pine (*Pinus stribus*). A minnow trap was deployed at this site. Upstream of the sampling site, the stream became less defined moving through the alder/red maple swamp (Figure 13). Water temperature was 13.9 ˚C; dissolved oxygen was low at 2.8 mg/L (Table 1).

Figure 13. Tributary 3 (T3A) looking downstream toward the junction with Tributary 1 (*left photo*) and upstream of site T3A, showing an alder/red maple swamp (*right photo*). June 2, 2021.

Pond

A small pond was observed on an adjacent residential property to Tributary 1 located along Upper Clyde Road. The pond appeared to be artificial with an outlet channel flowing south to connect to Tributary 1 approximately 40 m upstream of the Upper Clyde Road culvert (Figure 14). During the time of the survey, water in the outflow stream was stagnant and algae was present.

Figure 14. Modified pond on residential property (*left photo;* June 3, 2021) and the junction of the pond outflow with Tributary 1 (*right photo*; June 2, 2021).

Fish Populations

Assessment for fish by electrofishing was completed along Tributary 1, near Site DS4. Minnow traps were placed at sites DS1, DS2, DS3, DS4, US1, US2, US3 along Tributary 1 as well as at sites T2A and T3A within Tributary 2 and Tributary 3, respectively.

Six (6) juvenile brook trout, ranging from 8 to 16 cm in length, were observed via electrofishing and in minnow traps at sites assessed along Tributary 1 (Table 1; Figure 15). Fish were also observed swimming in a pool between sampling sites US1 and US2 (Figure 1). Suitable fish habitat was present along the reach of the brook, continuing beyond US3 (the sampling site furthest upstream), providing refugia (e.g., undercut banks, aquatic plants, overhanging vegetation, areas of subterranean flow, etc.), acceptable water quality (i.e., moderate to high dissolved oxygen), and nutrient sources.

Brook trout, ranging from 11 to 13 cm in length, were observed in minnow traps placed in Tributary 2 and Tributary 3. Suitable fish habitat was present in Tributary 2 and beyond the furthest upstream point (T2C), while Tributary 3 did not display ideal fish habitat despite the observation of fish.

Waters within the project area are considered acceptable for trout survival, possibly as juvenile nursery habitat in terms of water quality, and there is potential that a population could maintain itself there. It is expected that trout could occur throughout the system, especially during times of high water levels. During low flow times, however, trout could be locked in pools for periods of time and would be susceptible to predators. Presence of trout in Tributary 1 and associated tributaries would require appropriate management measures in the watershed, to minimize harm to fish species and fish habitat.

Figure 15. Brook trout observed in minnow traps placed at site DS4 (*left photo*) and at site US1 (*right photo*).

Table 1. Summary of fish observations obtained by electrofishing, minnow traps and visually. June 2 and June 3, 2021. Unnamed stream adjacent to the Dexter Welshtown Quarry property, Welshtown, Nova Scotia. Site Locations are shown in Figure 1.

Location	Method	Species	Approximate Size (cm)	Number of Individuals	Total
TRIBUTARY 1					
DS1	Electrofishing	Brook trout	Unknown	2	3
	Minnow trap	Brook trout	16	1	
DS2	Minnow trap	None			
DS3*	Minnow trap	None			
DS4*	Minnow trap	None			
US1	Minnow trap	Brook trout	9	1	2
		Brook trout	10	1	
	Visual observation	Fish species – no ID	Unknown	Unknown	Unknown
US2	Minnow trap	None			
US3	Minnow trap	Brook trout	8	1	1
TRIBUTARY 2					
T2A	Minnow trap	Brook trout	11	2	4
		Brook trout	13	1	
		Brook trout	13	1	
TRIBUTARY 3					
T3A	Minnow trap	Brook trout	12	1	1

*Minnow traps were placed in the water for approximately 8-10 hours

Water Quality

Water quality measures for all sites sampled on June 2 and 3, 2021 are presented in Table 2.

Temperature: Temperature is a key variable of suitable habitat for cold water fish species including salmonids. Water temperatures during the time of the survey were cool, ranging from 11.1 °C[5] (Site US3) to 15.5 °C (Site T2C), and were acceptable for fish.

Dissolved Oxygen (DO): Dissolved oxygen enters streams from the surrounding air and as a product of photosynthesis from aquatic plants, and it 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 in cold freshwater ecosystems for the protection of aquatic life, 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 were generally suitable for fish at all sampling sites, with the exception of sites DS4, US2, and T3A, where dissolved oxygen levels were noted to be below the acceptable guideline of > 6.5 mg/L. Dissolved oxygen concentrations ranged from 4.8-11.0 mg/L on Tributary 1. Concentrations on Tributary 2 ranged from 8.6-9.1 mg/L and Tributary 3 was 2.8 mg/L (Table 2).

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). 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 Tributary 1 and Tributary 2 were all low with specific conductivity values (µs/cm @ 25 °C) in Tributary 1 ranging from 33.0-72.2 µs/cm while those in Tributary 2 slightly higher ranging from 72.6-85.7 µs/cm. (Table 2). Tributary 3 had a moderate specific conductivity level with a value of 276.6 µs/cm. The higher conductivity level on Tributary 3 in comparison to Tributaries 1 and 2 may reflect the relatively finer streambed substrates observed in Tributary 3.

[5] Water quality sampling at sites US3 and DS4 were conducted June 3, 2021.

Table 2. Water quality measurements in watercourses adjacent to the Dexter Welshtown Quarry property, Welshtown, Nova Scotia, June 2, 2021. 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)
		Northing	Easting					
TRIBUTARY 1								
DS1	Furthest downstream point. Upper Clyde Road.	4849719	311252	14.0	11.0	102.4	55.2	70.1
DS2	Junction with Tributary 3	4849708	311135	13.7	9.4	90.3	56.6	72.2
DS3	Natural deflector	4849689	311109	14.7	8.9	88.9	56.7	71.2
DS4*	Junction with Tributary 2	4849701	311090	11.3	6.4	51.5	33.3	44.9
US1	Undercut bank downstream of a pool of unidentified fish	4849747	310732	12.3	7.4	69.9	24.9	33.0
US2	Location easily accessible from the Welshtown Quarry property	4849803	310610	13.2	4.8	46.3	27.2	35.1
US3*	Furthest upstream point nearest Wetland 12	4849802	310584	11.1	8.3	74.5	43.9	59.9
TRIBUTARY 2								
T2A	Tributary 2 at junction with Tributary 1	4849697	311076	14.2	8.6	83.3	57.3	72.6
T2B	Potential fish barrier (old bridge foundation)	4849672	311056	14.3	9.1	88.9	58.2	73.3
T2C	Upstream Tributary 2	4849614	311033	15.5	8.9	89.2	70.0	85.7
TRIBUTARY 3								
T3A	Tributary 3 at junction with Tributary 1	4849696	311135	13.9	2.8	28.4	216.4	276.6

* Water Quality measurements taken June 3, 2021

CONCLUSIONS

Water quality, forest cover, and stream habitat were acceptable at sampling sites on a watercourse, located south of the proposed expansion area for the Dexter Welshtown Quarry and the focus for the project (Tributary 1). Flows and water levels were typical for the time of year, and fish (juvenile brook trout) were present along sections of Tributary 1; and juvenile brook trout were observed in Tributary 2 and Tributary 3. The quality of fish habitat in terms of streambed composition, accessibility by fish (i.e. no barriers), and key water quality parameters was generally suitable for fish in all sampled watercourses. A powerline utility corridor and a hanging culvert on the Upper Clyde Road may be barriers to fish passage during low flow seasons. The only fish species found during the survey was brook trout (*Salvelinus fontinalis*). Small numbers of juveniles and occasionally larger individuals were found overall. Various amphibians of all life stages, aquatic insects and other invertebrates, which are food for birds and other animals in the local ecosystem are also expected to occur throughout. Although areas of Tributary 1 alternate between a channelized watercourse and areas of subterranean flow, brook trout were observed in upper portions of the watercourse including in areas nearest to the Welshtown Quarry property, indicating they moved upstream during times of higher water levels. Contributions to flow from Wetland 12 into Tributary 1 are small, in part due to the establishment of the quarry in past, which reduced its catchment area. The smaller catchment area and consequently reduction in water supply to the area reduced its importance initially and recent logging by others through Wetland 12 has reduced its importance further as a source to Tributary 1.

RECOMMENDATIONS

Recent logging activity in Wetland 12, noted in the June 2 and 3, 2021 survey, between Tributary 1 and the Dexter Welshtown Quarry property will impact the function of the wetland and may result in suspended sediments or contaminants derived from quarry activities impacting the adjacent freshwater habitat, through surface runoff. Natural vegetation within the wetland and immediate surrounding area should be maintained for proper function of any wetland. It is recommended that the landowner who conducted the logging be informed of the presence of the wetland and stream, and the need to maintain a buffer adjacent to Tributary 1. There should be at least a 20 m width buffer[6] along the watercourse for logging, to reduce potential sedimentation impacts. Surface runoff from the quarry floor should be managed on site to control sediment levels before leaving the site. If possible, fish communities should be monitored occasionally in Tributary 1 near the quarry, and water quality should be monitored to ensure it continues to meet guidelines for maintenance of Freshwater Aquatic Life (CCME 1999).

[6] See Section 40 of the NS Forests Act, regarding Special Management Zones for watercourses on or adjacent to forest land.

REFERENCES

CCME (Canadian Council of Ministers of the Environment) 1999. Canadian Water Quality Guidelines for the Protection of Aquatic Life.

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