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Assessment of Wetlands 6 and 15 and Watercourse 4

Atlantic Gold
A St Barbara Ltd Company

Assessment of Wetlands 6 and 15 and Watercourse 4, Touquoy Mine, Nova Scotia

Watercourse and Wetland Assessment to fulfill the requirements of Nova Scotia Environment Directives #12628894 and #12776418

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Sign-off Sheet

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Executive Summary

Stantec Consulting Ltd. (Stantec) was retained by Atlantic Mining NS Corp (AMNS) to assess potential effects of siltation from mine roads to a watercourse and associated wetlands on the Touquoy Mine site in Nova Scotia. The potential effects to Watercourse 4 and Wetlands 6 and 15 were assessed in response to inspection reports from Nova Scotia Environment (NSE), dated May 3 and July 23 2019 (NSE 2019a,b).

The watercourse and wetland assessments were conducted in July and August 2019. For the wetland surveys, an ecologist with wetland and plant expertise looked for evidence of adverse effects associated with silt discharge into the wetlands including silt deposits, plant mortality and plant morbidity. For the watercourse assessment an aquatic biologist documented existing fish community, fish habitat and water and sediment quality and noted evidence of siltation within the watercourse. The wetland and watercourse assessments indicated the silt observed is consistent with the grey silt that accumulates on the mine roads.

Plant communities in most sections of Wetlands 6 and 15 were in good condition at the time of the survey. Assessment results indicate that siltation may have caused limited areas of adverse effects where plant mortality and morbidity (i.e., bleaching) is evident. Overall functioning of Wetland 6 does not appear to have been substantially affected by siltation events. If further siltation is prevented from occurring, it is expected that new sphagnum moss will re-colonize the areas where mortality has occurred, and aquatic plants will re-colonize the bare substrate in the northern half of the still water within Wetland 6. Similarly, the overall effect of the silt deposits on plant communities in Wetland 15 and overall functioning appears to be minor and reversible as long as further inputs of silt are prevented.

For Watercourse 4, the highest silt deposits are evident at culverts immediately downstream of the Waste Rock Haul Road and TMF Haul Road and within the slow-moving section where it flows through Wetland 6. Fish were evident throughout the surveyed reaches of WC4 and were characteristic species for the stream habitat types. Based on the fish habitat and fish community survey conducted, it is unlikely that the siltation events have resulted in a substantial change in spawning, overwintering, rearing or migratory use by the fish species that reside within WC4. The habitat of many of the species present (i.e., American eel, brown bullhead, northern redbelly dace, white sucker, banded killifish) includes habitats with fine substrate. Generally, areas that would be anticipated to contain small substrate sizes (i.e., slow-moving sections though wetlands) still contain small substrate sizes. In swift-moving habitats grey silt has replaced the organic/fine substrate that was likely present between the coarser substrates (i.e., boulders) prior to the siltation events. In other areas, such as small pools, it is unclear whether the substrate has changed substantially from baseline conditions.

In all water samples, levels of total antimony, beryllium, boron, copper, lead, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium and zinc were below the Tier 1 Environmental Quality Standards (EQS) Freshwater in surface water. Concentrations were above the Tier 1 EQS

Freshwater in surface water for aluminum, arsenic, cadmium, iron and manganese but were within the maximum observed range for baseline pre-operation Industrial Approval (IA) stations for WC4 as a whole.

For sediment, levels of acid extractable antimony, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc in silt and sediment were below the freshwater sediment EQS in all samples. Concentrations of acid extractable arsenic, iron and manganese were above the freshwater sediment EQS for some samples but were generally within the maximum local baseline for soils, except for a few samples for arsenic and manganese. The results suggest that concentrations of arsenic, iron and manganese generally reflect the local surficial geology. Targeted silt samples did not consistently contain higher concentrations of arsenic, iron and manganese when compared to interval sediment samples, suggesting no direct relationship between the grey silt that was deposited and the elevated metal concentrations identified in sediment.

Overall, the effects of siltation are likely to be reversible as long as further siltation events are prevented. Direct intervention to remove silt from the affected watercourse and wetlands is not recommended as this could damage habitat and result in resuspension of silt deposits. Recommendations include follow-up monitoring and review of the effectiveness of erosion control measures. Specifically, monitoring of Wetlands 6 and 15 and Watercourse 4 for years 1, 3 and 5 (i.e., 2020, 2022, 2024) would track recovery of vegetation and changes in substrate in affected areas, and incorporating turbidity measurements into current rain event monitoring programs would confirm if mitigation is working as intended.

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1.0 INTRODUCTION

Stantec Consulting Ltd. (Stantec) was retained by Atlantic Mining NS Corporation (AMNS) to provide environmental services in relation to events that resulted in the release of silt from the mine site into a watercourse (Watercourse 4; WC4) and two associated wetlands (Wetlands 6 and 15) at the Touquoy Mine, NS. The potential effects to Watercourse 4 and Wetland 6 and 15 were assessed in response to two inspection reports from Nova Scotia Environment (NSE), dated May 3, 2019 and July 23, 2019 (NSE 2019a, b). The NSE directives required:

> *"a commitment to retain a Qualified Person to assess impacts (silt deposition) in Wetland 6/Watercourse 4 potentially resulting from the various silt events."*
>
> *"provide a report prepared by an Independent Qualified Professional detailing the findings of the wetland 6/wetland 15 and watercourse 4 assessment"*

Stantec provided Qualified Persons to assess the watercourse and wetlands and to prepare a report to address the NSE directive. The watercourse assessment was conducted by Jenny Reid (M.Sc.), an aquatic biologist with 13 years of experience, and the wetland assessment was conducted by Mike Crowell (M.Sc.), a terrestrial ecologist with 36 years of experience. This report provides a description of the site with respect to siltation events, an assessment of wetlands and watercourse, and provides overall conclusions and recommendations.

2.0 BACKGROUND

Figure 1 shows the mine site area in relation to roadways and environmental components that received silt: WC4 and Wetlands 6 and 15. The headwaters of WC4 flow through Wetland 15. Wetland 15 is located west of the Waste Rock Pile and east of the Mill Site and Administration Buildings. WC4 then flows south under the Waste Rock Haul Road, Mooseland Road and the Tailings Management Facility (TMF) Haul Road, then through Wetland 6 which is located to the west of the TMF. WC4 leaves the mine site and flows into the Otter Dam Flowage and into Moose River, which is part of the Fish River/Lake Charlotte Watershed. Five roads cross WC4 within the mine site, as follows:

- the Admin Road crosses at the uppermost portion of the watercourse;
- the Waste Rock Haul Road, Mooseland Road and TMF Haul Road cross the middle section of the watercourse; and
- an old forestry road crosses at the downstream extent of the surveyed area for the watercourse.

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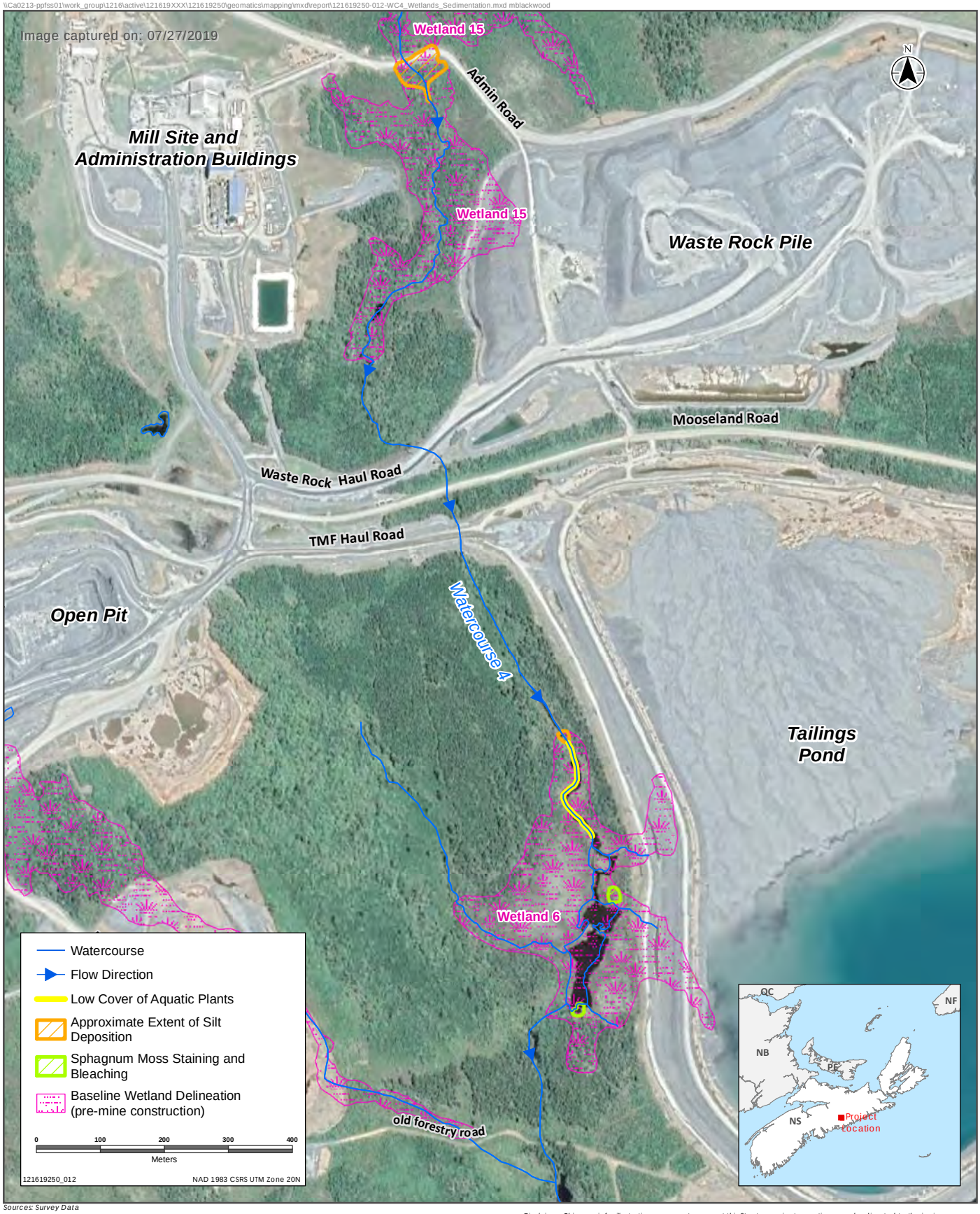

Sources: Survey Data

Service Layer Credits: Google Earth Image (July 27, 2019). Moose River Gold Mines, NS. CNES/Airbus [Obtained October 9, 2019]

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Wetlands Assessed for Siltation Effects in 2019, Touquoy Mine, Nova Scotia

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The Admin Road, Waste Rock Haul Road and TMF Haul Road were constructed and are maintained by AMNS using waste rock that is processed into crushed gravel and rockfill. Waste rock consists of greywackes and argillite rock. The gravel roadbed is continually pulverized into fine grey material by heavy rock truck and light vehicle traffic (Stantec 2019a). The fine material accumulates on the roads and regular road maintenance (i.e., grading) moves the material to the sides of the roadbeds next to road berms. During and following rain events and with snow melt, the fine grey material can be mobilized by surface runoff and can cause siltation events (Stantec 2019a), as has occurred in WC4. Site monitoring during and after rain events and adaptive mitigation is actively completed by on-site personnel to prevent siltation events.

To address siltation events that have been identified and reported by AMNS, the following mitigation measures were implemented to reduce the potential for future siltation to WC4 and associated Wetlands 6 and 15:

- installation of armour stone at the headwalls of Culvert 4a to reduce potential for erosion;
- construction of collection ponds and installation of dedicated pumping infrastructure to divert surface runoff from roadways near WC4 to the TMF;
- maintenance of grade/berms on roadways that cross WC4 to facilitate diversion of surface runoff to collection ponds for transfer to the TMF;
- implementation of a rain event checklist to confirm there is proper equipment in place to manage runoff volumes;
- scheduling removal of accumulated fines from the haul roads on an as needed basis;
- stabilization of fines accumulating on the outside of the road berms; and
- use of straw mulch or hydroseeding to temporarily stabilize exposed soils or silt.

3.0 ASSESSMENT OF WETLANDS 6 AND 15

This section describes the methods and results of assessments conducted on Wetlands 6 and 15.

3.1 METHODS

Wetlands 6 and 15 were surveyed on July 31 and August 1, 2019. At each wetland, an ecologist with wetland and plant expertise looked for evidence of adverse effects associated with silt discharge into the wetlands including silt deposits, plant mortality and plant morbidity. Baseline information (pre-mine construction) on the two wetlands was provided in advance by AMNS (McCallum Environmental 2019).

At Wetland 6 the main source of silt to the wetland appeared to be WC4. As such, the search for evidence of silt deposition and adverse effects associated with it was focused along the portion of WC4 that flows through this wetland. Locations where silt deposits or evidence of plant mortality or morbidity were encountered were recorded using a Garmin 650 GPS.

At Wetland 15 the potential source of silt in the wetland was runoff from the Admin Road leading to the mill and administrative facilities. The area adjacent to the Admin Road was inspected using a zigzag pattern search. Locations where silt deposits or evidence of plant mortality or morbidity were encountered were recorded using a Garmin 650 GPS. Silt deposits were small and numerous, so it was not feasible to document the locations of all deposits. Instead,

representative examples were marked with way points at intervals of roughly 10 m from the road until no more deposits were encountered.

The farthest locations from the access road where silt deposits were found were used to indicate the extent of silt deposition in the wetland. Silt deposits having the same distinctive grey color as those found in the forested portion of Wetland 15 were found along the banks of WC4 after the point where they were no longer present in the forested portion of the wetland. At this point the search for evidence of adverse effects to Wetland 15 associated with silt deposition was focused on the area adjacent to WC4.

3.2 RESULTS

3.2.1 Wetland 6

3.2.1.1 Description of Wetland

Wetland 6 is a wetland complex that is composed of a mixture of treed bog, open bog, mixedwood treed swamp, and shallow water. Treed bog occupies most of the wetland. This wetland plant community is characterized by the presence of a sparse tree canopy growing over a dense cover of shrubs, sphagnum moss and sedge. The tree layer is composed mainly of tamarack (*Larix laricina*) with small quantities of black spruce (*Picea mariana*) and eastern white pine (*Pinus strobus*) also present. The dense shrub understory is dominated by sweet gale (*Myrica gale*), leatherleaf (*Chamaedaphne calyculata*), speckled alder (*Alnus incana*), and white meadowsweet (*Spiraea alba*). Sphagnum moss (*Sphagnum* spp.) and tussock sedge (*Carex stricta*) are the dominant ground vegetation species.

Open bog is found in low-lying areas near the large still waters in the southern half of the wetland. This wetland type supports no tree cover, moderate shrub cover and a well-developed ground vegetation layer. The ground vegetation layer consists of a nearly continuous mat of sphagnum moss that is punctuated by patches of small cranberry (*Vaccinium oxycoccos*), tussock sedge, large cranberry (*Vaccinium macrocarpon*), few-seeded sedge (*Carex oligosperma*), and northern pitcher plant (*Sarracenia purpurea*). The shrub layer consists of a mixture of bog rosemary (*Andromeda polifolia*), leatherleaf, sweet gale, and pale bog laurel (*Kalmia polifolia*).

Mixedwood treed swamp forms a band along the wetland/upland interface where groundwater inputs maintain slightly higher fertility. The tree layer is moderately dense and is composed of a mixture of black spruce, tamarack, and red maple (*Acer rubrum*). The shrub layer is relatively dense but patchy. It consists largely of northern wild raisin (Viburnum nudum), mountain holly (*Nemopanthus mucronata*) and speckled alder along with lesser amounts of Labrador tea (*Ledum groenlandicum*) and saplings of balsam fir (*Abies balsamea*) and black spruce. The ground vegetation layer consists largely of tussock sedge, sphagnum moss, cinnamon fern (*Osmunda cinnamomea*), and bunchberry (*Cornus canadensis*).

Shallow water plant communities are found in still waters that flow north to south through the wetland. Vegetation cover is patchy with the greatest concentrations of vegetation found in the large shallow still waters in the southern half of the wetland. These areas support large patches of water bulrush (*Schoenoplectus subterminalis*) and small patches of narrow-leaved burred (*Sparganium angustifolium*), ribbon-leaved pondweed (*Potamogeton epihydrus*), and variegated pond-lily (*Nuphar lutea*). In the somewhat deeper northern still waters vegetation cover was restricted to scattered small patches of variegated pond-lily.

3.2.1.2 Evidence of Siltation and Effects

Photographs taken during the site assessment are provided in Appendix A and evidence of siltation and associated effects to the wetland are outlined on Figure 1.

During the site visit to Wetland 6, exposed deposits of silt were observed at the northern tip of the wetland. The area where these silt deposits were found was approximately 0.02 ha in size. These silt deposits were up to 5 cm thick and occurred in depressions adjacent to the inlet stream (WC4) (Appendix A, Photo 1) and occupied approximately 10% of the wetland surface. The deposits extended approximately 20 m downstream from the northern inlet of the wetland.

The northern half of the still water that passes through Wetland 6 contained less aquatic plant cover than the southern half. The bottom substrate in this area was grey in color suggesting that there has been substantial deposition of silt in this area. Plant cover in this area averages 10% and is composed mainly of variegated pond-lily (Appendix A, Photo 2). The average vegetation cover in the southern half of the still water is 65% and was composed of a mixture of water bulrush, narrow-leaved burred, ribbon-leaved pondweed, and variegated pond-lily (Appendix A, Photo 3). This difference in aquatic plant community cover and species richness may indicate that vegetative cover in the upper half of the stillwater may be affected by silt accumulation.

Dead and stressed plants were observed within parts of the open bog plant community. In low lying areas, there was heavy mortality of sphagnum moss and moderate mortality of graminoids (Appendix A, Photo 4). Moss in the affected areas was typically stained grey (Appendix A, Photo 5) or bleached white (Appendix A, Photo 6) and the living portions of surviving plants were restricted to the tips of the plants. Initially, it was thought that the mortality and stress might be attributable to dry growing conditions, however after a heavy rain event puddles of grey turbid water were observed in fresh footprints in these patches (Appendix A, Photo 7). When samples of wetted sphagnum moss were squeezed, grey turbid water was discharged, whereas under normal conditions, the water would typically be amber colored or stained black by fine organic matter.

Figure 1 shows the locations of patches where stressed/dead sphagnum moss was observed. In all instances these patches were found in low areas of the wetland that would be expected to flood frequently. Smaller patches of dead or stressed sphagnum moss were also found at various locations along the margins of the still waters typically within two meters of the edge of the water. Most vascular plants found in these patches (with the exceptions of sedges (*Carex* spp.) and cottongrasses (*Eriophorum* spp.) were in good health.

Sphagnum moss growing at higher elevations in the wetland appeared to be in good health with no grey staining or bleaching. When sphagnum moss from these areas was removed from the moss mat, the portions of the moss below the surface were stained grey and grey turbid water could be squeezed from the clumps of moss (Appendix A, Photo 8). Vascular plant species in higher elevation areas were in good health (Appendix A, Photo 9). No evidence of adverse effects to sphagnum moss or vascular plant species was observed in either the treed bog or the mixedwood treed swamp plant communities.

Siltation has resulted in some adverse effects to Wetland 6, including the following:

- a small area (0.02 ha) of heavy silt deposition at the point where WC 4 enters Wetland 6
- silt deposition in the northern still water that may have smothered aquatic plant communities

- mortality and morbidity (i.e., bleaching) of sphagnum moss and, to a lesser extent, sedges and cottongrasses in patches of low-lying bog

Plant communities in most of Wetland 6 are in good condition. If further silt inputs are eliminated, it is expected that new sphagnum moss will colonize the areas where mortality has occurred, and aquatic plants will colonize the bare substrate in the northern half of the still water.

It may require several growing seasons for the silt to be flushed from the sphagnum beds or for sphagnum growth to bury the silt coated sphagnum. The rate at which these changes will occur are difficult to predict and may best be determined through a follow-up monitoring program.

The overall functioning of the wetland does not appear to have been substantially affected by siltation events. There may be trophic status changes in the aquatic plant communities and low bog plant communities where the deposited silt has increased the availability of some minerals and may have increased the pH of the substrates.

3.2.2 Wetland 15

3.2.2.1 Description of Wetland

Wetland 15 is a mixedwood treed stream swamp. It is characterized by an open tree canopy composed largely of balsam fir, red maple, and black spruce. The shrub understory is dense and is dominated by speckled alder along with lesser amounts of northern wild raisin. The ground vegetation layer is dominated by a mixture of interrupted fern (*Osmunda claytoniana*), three-seeded sedge (*Carex trisperma*), and sphagnum moss along with lesser amounts of hairy flat-top white aster (*Doellingeria umbellata*), common lady fern (*Athyrium filix-femina*), tall meadow-rue (*Thalictrum pubescens*), and bladder sedge (*Carex intumescens*).

3.2.2.2 Evidence of Siltation and Effects

In Wetland 15, silt deposits were observed in areas of the wetland adjacent to the Admin Road. The silt consisted of grey deposits of silt. Areas of silt deposition based on the presence of grey silt were evident within the wetland approximately 90 m downgradient of the road.

Silt was restricted to depressions where silt laden water was able to pool (Appendix A, Photo 10). These deposits ranged in thickness from 0.2 to 3.0 cm. Within 90 m of the road, the proportion of the wetland surface covered by silt ranged from 5 to 10%. Areas of deposition were evident in the forested portion of the wetland along the banks of WC 4 to approximately 30 m into the forested portion of the wetland. Silt deposits located on the banks of the stream extended up to 120 m downstream of the road. The extent of silt deposition in Wetland 15 is approximately 0.32 ha, as shown on Figure 1, and silt is evident in less than 10% of this area.

Although the depressions that contained silt had few plants, similar depressions without silt were also poorly vegetated (Appendix A, Photo 11), so this may reflect natural conditions rather than an effect of siltation. As such, the amount of wetland vegetation lost to silt deposition does not appear to be high. Furthermore, vegetation adjacent to the areas of silt deposition appeared healthy and dense.

In many of the silt-laden depressions, several plant species were growing through the silt deposits. Over time, the depressions with silt deposits will be covered with fallen leaves and other organic matter which may improve these areas as habitat for plants.

The overall effect of the silt deposits on the Wetland 15 plant communities and wetland functions appears to be minor and reversible as long as further inputs of silt are prevented.

4.0 ASSESSMENT OF FISH AND FISH HABITAT

This section describes the fish and fish habitat assessment that was conducted on WC4.

4.1 METHODS

To characterize the existing conditions for fish and fish habitat in support of the WC4 assessment, field data were collected in 2019 and existing information was reviewed.

4.1.1 Field Data Collection

Fish and fish habitat surveys were conducted on July 31, August 1 and 14, 2019, in an approximately two km section of WC4 potentially affected by silt deposition.

Fish habitat information was collected and included: habitat type (riffle, run, pool), substrate composition, bank stability, and other habitat characteristics (riparian vegetation, cover, depth). The in situ water quality parameters measured included: water temperature, dissolved oxygen, and conductivity (all measured using a YSI ProPlus meter) and pH (measured using a Hanna Instruments 98127 pH meter). The furthest downstream section of WC4 could not be surveyed due to lack of land-owner permission. In situ water quality results were compared to the Canadian Water Quality Guidelines for Protection of Aquatic Life Freshwater (CWQG PAL) (CCME 2014).

The survey area was divided into four reaches to assess effects from silt-deposition. Reach 1, upstream of the Admin Road, Reach 2 from the Admin Road to the upstream end of culvert 4A at the TMF haul road, Reach 3 from the downstream end of culvert 4A at the TMF Haul Road to the end of Wetland 6 and Reach 4 from Wetland 6 to the old forestry road located at the end of mine site property (Figure 2).

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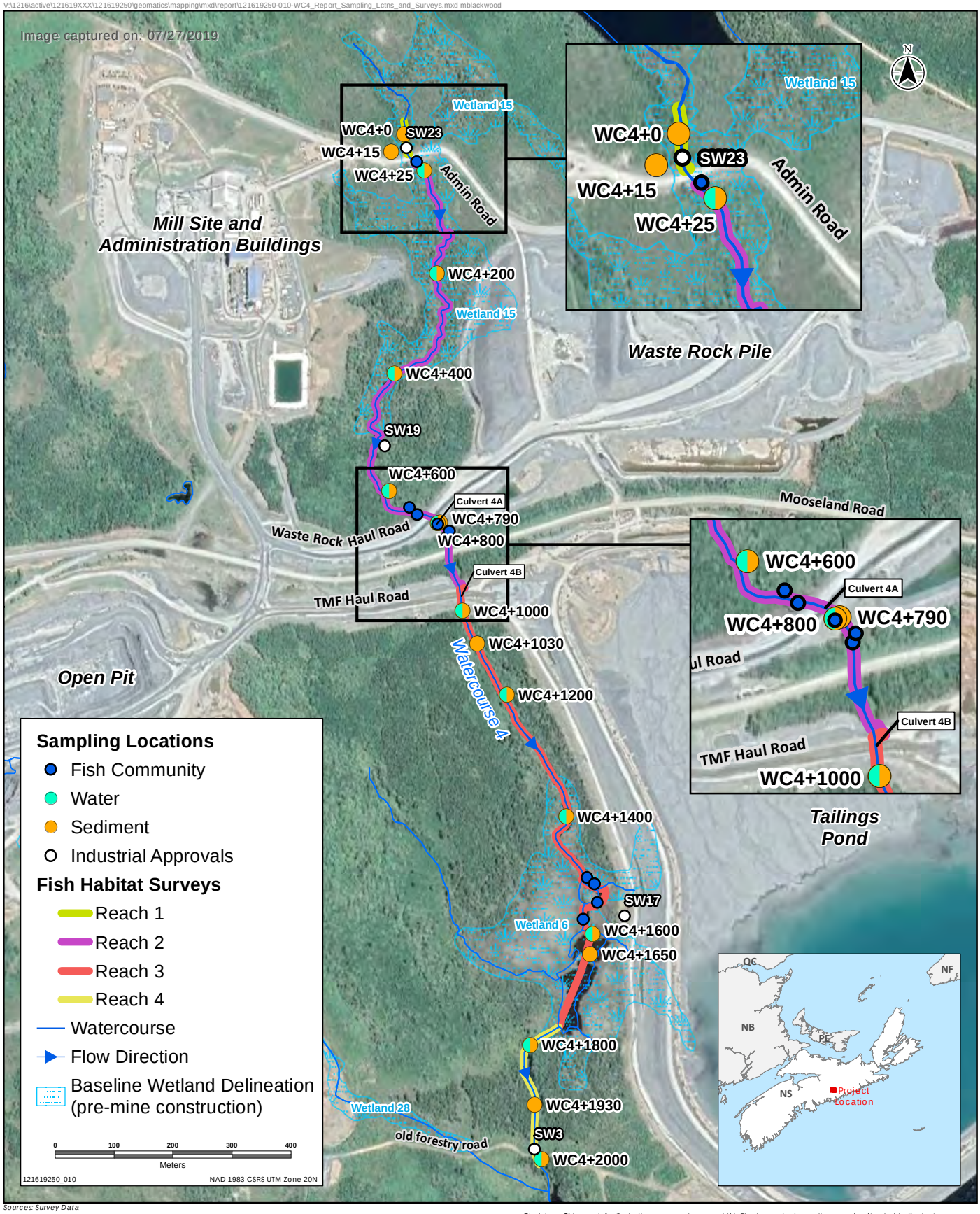

Sources: Survey Data

Service Layer Credits: Google Earth Image (July 27, 2019). Moose River Gold Mines, NS. CNES/Airbus [Obtained October 9, 2019]

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Watercourse 4 Assessed for Siltation Effects in 2019, Touquoy Mine, Nova Scotia

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Water and sediment samples were collected every 200 m throughout the survey area within WC4 to provide information about water and sediment chemistry since there was the potential for contaminant (e.g., metals) transfer into watercourse sediments as a result of siltation events. Targeted silt samples were also collected to assess trace metal concentrations in silt and differentiate between silt and fine stream sediments. Results were compared to the CWQG PAL or the Nova Scotia Environmental Quality Standards (EQS): Tier 1 EQS Freshwater and Freshwater Sediment EQS, as applicable (NSE 2014). Water and sediment samples were also compared to baseline water and soil chemistry (Stantec 2019b; Stantec 2018a; Stantec 2017; CRA 2007 and CRA 2007 unpublished data). Additional information relating to these studies are provided in Appendix D.

A fish community survey was conducted under Scientific/Educational Licence 321156 issued to Jenny Reid by Fisheries and Oceans Canada, using minnow traps within the area assessed in WC4 to determine the fish species present (Figure 2). Minnow traps baited with cat food were set for approximately 24 hours.

4.1.2 Review of Existing Information

A review was undertaken of existing information on fish habitat, water quality and sediment quality following the field data collection to support the interpretation of the results.

To provide baseline physical fish habitat conditions, a review of fish habitat information collected on WC4 between February 18, 2016 and May 3, 2017 (pre-mine construction) was provided by McCallum Environmental (October 2019, personal communication). The locations of the baseline fish habitat surveys were typically located around mine infrastructure (i.e., Waste Rock Haul Road and TMF Haul Road) of which a substantial portion of aquatic habitat has since been directly lost by construction of mine infrastructure (i.e., 130 m section surveyed and 60 m of that section was directly lost). As a result, there was insufficient information for comparison with results of the present assessment. Additionally, differences in methodology (i.e., substrate classification groupings, reach level versus habitat unit level survey) did not allow for a direct comparison.

To provide baseline concentrations for water and sediment chemistry comparisons, water chemistry results were compared to the pre-operation baseline Industrial Approval (IA) water quality data (Stantec 2019b) and sediment chemistry results were compared to baseline soil metal concentrations within the study area or WC4 (CRA 2007; Parks 2019, personal communication; Stantec 2018a; Stantec 2017). Determination of these baseline values are described further in Appendix D, Section D.2.2.

4.2 RESULTS

Water level conditions at the time of the survey (i.e., July 31, August 1, 14, 2019) were low and represented summer low flow conditions. On the afternoon of August 1, 2019, a short-intense thunderstorm with heavy rainfall occurred during the surveys. Photographs taken during the watercourse assessment are provided in Appendix B.

4.2.1 Fish Habitat and Evidence of Siltation

WC4 is a small second order stream which discharges into Moose River within the Fish River-Lake Charlotte Watershed. Although the plan was to collect background water quality samples in WC4 upstream of the Admin Road, there was no flow in this section due to low water levels. Consequently, this upstream area was not surveyed throughout the entire extent of the ephemeral channel and water samples were not collected.

Fish habitat throughout the remainder of the surveyed area of WC4 generally consisted of swift moving sections of water with small boulder and organic substrates and slow-moving pond-like sections (i.e., WL 6) with organic/fine sediments and aquatic vegetation (Figure 2). Fish habitat in all surveyed reaches appears to be suitable for supporting various coldwater and warmwater species of fish, and fish were observed, as indicated in Section 4.2.4.

4.2.1.1 Reach 1

Reach 1 is located upstream of the Admin Road. The watercourse channel of the surveyed area of Reach 1 was generally dry with pooled water in depressions at the time of the survey (Appendix B, Photo 1). Substrate was dominated by organics and large boulder substrate.

4.2.1.2 Reach 2

Reach 2 consists of both swift-moving and slow-moving sections of stream, ranging in bankfull width from 0.89 to 4.3 m. At the time of the fish habitat survey the average wetted width was 1.33 m and average bankfull width was 1.64 m. There was negligible flow within Reach 2 approximately 200 m downstream of the Admin Road (Appendix B, Photo 2). Banks were generally stable and riparian vegetation was dominated by grass (~40%) and shrubs (~40%). Substrate was dominated by fines (~40%) and organics (~30%) with some large boulder (~20%). Average total instream and overhead cover was ~30% and was primarily made up of instream aquatic vegetation (~20%). Representative photos can be found in Appendix B (Appendix B, Photos 3-12).

Brown silt was observed within Reach 2 downstream of the Admin Road within the intermittent portion of WC4 along the stream banks (Appendix B, Photo 13). This silt did not appear to be the same material as the silt that was observed on the mine roads, which was grey in colour. Approximately 80 m downstream a root mass plugged with debris accumulated the brown sediment (Appendix B, Photo 14). At 100 m downstream the brown sediment was no longer apparent within the riparian area and was apparent within the edges of the wetted channel (Appendix B, Photo 15). Small quantities of grey silt were apparent along the stream edges and depositional areas within Reach 2 (Photo 16, 18, and 19). Downstream of culvert 4A grey silt was visible within the pool and along the edges of the pool (Appendix B, Photo 17).

4.2.1.3 Reach 3

Reach 3 consists of both swift-moving and slow-moving sections of stream ranging in bankfull width from 2.05 to 15.3 m. At the time of the fish habitat surveys the average wetted width was 6.37 m and average channel width was 6.85 m. Banks were generally stable and riparian vegetation was dominated by

wetland plants (~50%) and shrubs (~20%). Substrate was dominated by fines (~70%) and organics (~10%) with some large boulder (~10%). Average total cover was ~60% and was primarily instream aquatic vegetation (~50%). Representative photos can be found in Appendix B (Photos 20-25).

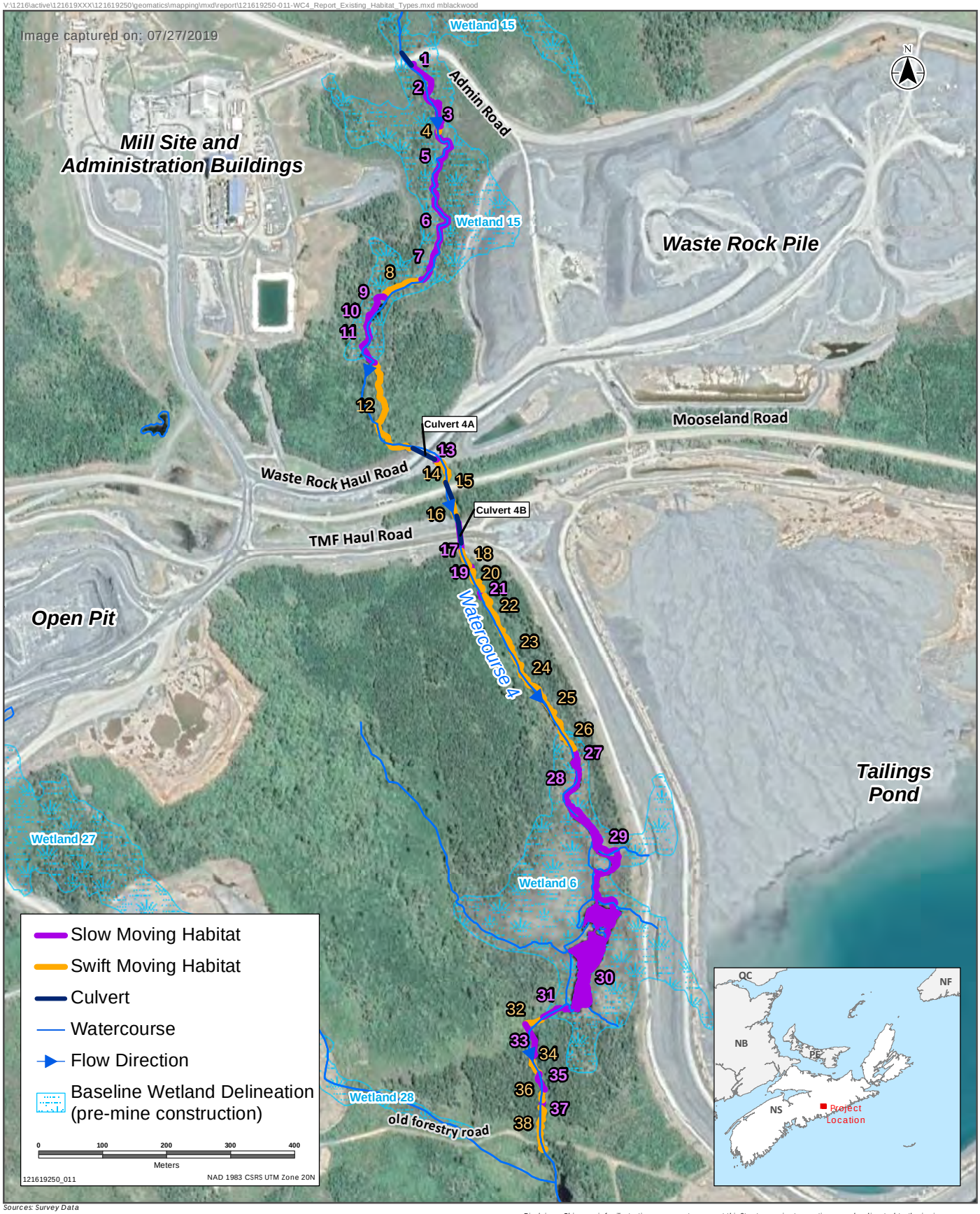
Grey silt was most prevalent within Reach 3. Grey silt was observed downstream of the TMF Haul road in the pool below culvert 4B (Appendix B, Photo 26). Fine grey silt was also observed along the bank edges within the swift-flowing sections, riparian areas and interstitial spaces between rocks (Appendix B, Photo 27-30). Water within the upstream end of this reach was generally clear and there were a few areas where increased turbidity was apparent (Appendix B, Photo 31). The substrate within the slow-moving fish habitat consisted of fine grey silt and this silt was also apparent within the riparian area of the watercourse (Appendix B, Photo 32-33).

Within the slow-moving section of Reach 3 the water appeared clear and further downstream the water showed signs of increased turbidity (Appendix B, Photos 34-36). Grey silt was observed within areas of some, but not all, areas of submergent aquatic vegetation and was not apparent in others (Appendix B, Photo 37-38). Similarly, grey silt was observed in some but not all areas of substrate (Appendix B, Photo 39-40). At the downstream end of Reach 3 fine grey silt was dried on the exposed rocks, which suggests that silt had been carried downstream in a previous high-water event (Appendix B, Photo 41).

4.2.1.4 Reach 4

Reach 4 consists of both swift-moving and slow-moving sections ranging in width from 2.7 to 5.8 m. At the time of the fish habitat surveys the average wetted width was 3.74 m and average channel width was 4.16 m. Banks were generally stable and riparian vegetation was dominated by conifer forest (~40%) and grass/shrubs (~30% each). Substrate was dominated by fines (~40%) and small boulder (~40%). Average total cover was ~30% and was primarily made up of instream aquatic vegetation (~15%). Representative photos of fish habitat in Reach 4 can be found in Appendix B (Appendix B, Photos 42 to 44).

Grey silt was observed within Reach 4. Fine grey silt was observed between rocks as well as in depositional areas of the watercourse (Appendix B, Photos 45-47). An old forestry road bridge is present at the downstream end of Reach 4 (Appendix B, Photo 48). Grey silt was also observed in the area of private property downstream of Reach 4; silt was visible within the interstitial spaces of rocks and within depositional areas (Appendix B, Photo 49).



Sources: Survey Data

Service Layer Credits: Google Earth Image (July 27, 2019). Moose River Gold Mines, NS. CNES/Airbus [Obtained October 9, 2019]

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Existing Fish Habitat Types in Watercourse 4 Assessed for Siltation Effects in 2019, Touquoy Mine, Nova Scotia

Figure 3

4.2.2 Water Quality

Water quality results for in situ measurements are provided in Appendix C (Table C.1) and results for samples collected are provided in Appendix D (Table D.1). The results are summarized below.

The in situ water quality results were compared to applicable CWQG PAL (freshwater).

- The dissolved oxygen concentration in WC4 ranged from 3.0 to 9.5 mg/L, and was below the CWQG PAL recommended minimum value of 9.5 mg/L for early life stages at ten of eleven sampling locations and was below the value for all life stages at six of eleven sampling locations (CCME 2014). Although some low dissolved oxygen concentrations were observed within the first 400 m of the survey, those dissolved oxygen concentrations were representative of intermittent flow conditions and streams flowing through wetlands (i.e., large masses of organic matter).
- The pH ranged from 5.3 to 7.8 and was below the CWQG PAL recommended range (6.5 – 9.0) at four of eleven sampling locations. Low pH conditions are similar to what has been observed during baseline sampling within Scraggy Lake and is characteristic of the surficial geology and watercourses in the area (Stantec 2019b).
- Water temperature at the time of sampling ranged from 15.0 to 27.7°C with the highest temperatures observed within the slow-moving sections of WC4 (within Wetland 6).
- Water conductivity ranged from 51 to 1173 µS/cm and was the highest at WC4+400 (Appendix C).

On August 1, 2019, a heavy rain event occurred and yet turbidity did not noticeably increase downstream in the swift-moving sections of WC4 near Culverts 4A and 4B. This suggests that the sediment and erosion control mitigation in place was sufficient for a rain event of that magnitude and duration. However, turbidity noticeably increased farther downstream in WC4 within Wetland 6 following the rainstorm, despite being located farther downstream from the road crossings. This may be a result of mobilization of prior silt accumulations within the riparian area of Wetland 6 (e.g., on sphagnum) or may reflect natural processes within that area because increased turbidity in this reach of WC4 was previously observed during baseline (i.e., pre-operation) sampling (Stantec 2019b).

Water samples were analyzed for metals with the following results:

- In all samples, levels of total antimony, beryllium, boron, copper, lead, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium and zinc were below the Tier 1 Environmental Quality Standards (EQS) Freshwater in surface water.
- Concentrations of the following metals were above the Tier 1 EQS Freshwater in surface water: aluminum, arsenic, cadmium, iron, manganese. However, when compared to the baseline IA concentrations, they were all within the maximum observed range for WC4 as a whole. Additional details and discussion are provided in Appendix D.

4.2.3 Sediment Quality

Additional results for sediment samples collected are provided in Appendix D (Table D.2). The main findings are summarized below:

- The targeted silt samples did not show higher concentrations of acid extractable metals than interval samples from sediments in WC4, inferring that the elevated concentrations of metals in sediment were likely not directly related to siltation events.

- In all samples, levels of antimony, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc in sediment were below the ESQ for Freshwater Sediment.
- Concentrations of the following metals were above the EQS Freshwater Sediment: arsenic in all samples; iron in 11 out of 17 samples; manganese in 15 out of 17 samples. Levels above these guidelines and background levels in soil suggest that concentrations of arsenic, iron and manganese generally reflect the local geology of soils and surface rock.

4.2.4 Fish Community

Various fish species and life stages (e.g., young of year to adult) were observed throughout the surveyed reaches of WC4. Minnow traps set within each reach for 24 hours captured American eel, brook trout, brown bullhead and northern redbelly dace under Scientific/Educational Licence 321156 (Table 1). Banded killifish and white sucker were also visually observed, although not captured in the traps. All of these species have also been found nearby in Scraggy Lake (Stantec 2018b; Stantec 2019c), which is within the same watershed as WC4.

Detailed catch data by trap and location are provided in Appendix C.

Table 1 Fish Species Captured[1] within Watercourse 4, Touquoy Mine, NS

Species	Total	Composition (%)
American eel *(Anguilla rostrata)*	4	12
Brook trout *(Salvelinus fontinalis)*	5	16
Brown bullhead *(Ameiurus nebulosus)*	2	6
Northern redbelly dace *(Chrosomus eos)*	21	66
Total	**32**	**100**

Note: [1] In addition to the captured species listed, banded killifish (*Fundulus diaphanus*) and white sucker (*Catostomus commersonii*) were visually observed but were not captured.

5.0 SUMMARY AND DISCUSSION

The purpose of the wetland and watercourse surveys was to assess potential effects of silt releases from the mine site into a watercourse (WC4) and associated Wetlands 6 and 15 at the Touquoy Mine, NS to address NSE Directives (NSE 2019a, b).

The watercourse and wetland assessments were conducted in July and August 2019. A summary of the main findings is provided below.

5.1 WETLANDS

Plant communities were in good condition at the time of the survey in most sections of Wetlands 6 and 15. Assessment results indicate that siltation has likely resulted in limited areas of adverse effects where plant mortality and morbidity (i.e., bleaching) were evident.

Overall functioning of Wetland 6 does not appear to have been substantially affected by siltation events. If further siltation is prevented from occurring, it is expected that new sphagnum moss will colonize the areas where mortality has occurred, and aquatic plants will colonize the bare substrate in the northern half of the still water within Wetland 6.

Similarly, the overall functioning of Wetland 15 and effects of the silt deposits on plant communities are observed to be minor and reversible so long as further inputs of silt are prevented.

Direct intervention to remove silt from the wetlands is not recommended as this could damage habitat and result in resuspension of silt.

5.2 FISH AND FISH HABITAT

Siltation is evident in WC4 within the surveyed area and the silt observed appears consistent with the grey silt that accumulates on the mine roads. Siltation is most evident in areas immediately downstream of the Waste Rock Haul Road at Culvert 4A and TMF Haul Road at Culvert 4B and within the slow-moving sections of WC 4 (Reach 3), where it flows through Wetland 6.

Overall, potential effects of siltation on fish and fish habitat in WC4 are likely reversible if further inputs of silt are prevented. Direct intervention to remove silt from WC4 is not recommended as this could damage habitat and result in resuspension of silt deposits.

In situ water quality parameters at the time of the survey were generally acceptable for aquatic life based on the CWQG PAL. Most of the stream was well oxygenated and the low dissolved oxygen concentrations observed were representative of those habitat types (e.g., intermittent flow / wetland) and low pH was characteristic of the surficial geology of watercourses in the area (Stantec 2018c). For surface waters, concentrations of total aluminum, arsenic, cadmium, iron and manganese were above the Tier 1 ESQ and turbidity was above the long-term CWQG PAL, but there were few exceedances when compared to baseline IA concentrations. When compared to the baseline IA concentrations observed in WC4 as a whole aluminum, arsenic, cadmium, iron, manganese and turbidity were all within the maximum observed ranges within WC4.

Targeted silt samples did not appear to contain higher concentrations of arsenic, iron and manganese when compared to interval samples, suggesting no direct relationship between the grey silt that was deposited and the elevated metal concentrations identified in sediment. For sediment, levels of acid extractable antimony, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc in silt and sediment were below the freshwater sediment EQS in all samples. Concentrations of acid extractable arsenic, iron and manganese were above the freshwater sediment EQS for some samples, but there were few concentrations of arsenic and some concentrations of iron which were above baseline soil concentrations. The results suggest that concentrations of arsenic, iron and manganese generally reflect the local surficial geology.

Fish were evident throughout the surveyed reaches of WC4 and were characteristic species for the stream habitat types. Based on the fish habitat and fish community survey conducted, it is unlikely that the siltation events have resulted in a substantial change in spawning, overwintering, rearing or migratory

use by the fish species that reside within WC4. The habitat of many of the species present (i.e., American eel, brown bullhead, northern redbelly dace, white sucker, banded killifish) includes habitats with fine substrate. Generally, areas that would be anticipated to contain small substrate sizes (i.e., slow-moving sections though wetlands) still contain small substrate sizes. In swift-moving habitats grey silt has replaced the organic/fine substrate that was likely present between the coarser substrates (i.e., boulders) prior to the siltation events.

6.0 RECOMMENDATIONS

Given that the effects of siltation to WC 4 and Wetlands 6 and 15 are considered to be reversible, physical removal of silt is not recommended because it would disrupt and potentially damage productive habitat and would have potential to resuspend silt. Areas currently affected by silt are expected to naturally restore over time.

Follow-up monitoring is recommended for Wetlands 15 and 6 and WC4 to confirm that the mitigation is effective in preventing siltation events and that affected areas are naturally restoring to baseline conditions.

The following monitoring is recommended to assist in confirming the effectiveness of erosion controls, to guide erosion mitigation and management, and to document restoration progress:

1. Establish a wetland monitoring program for Wetlands 6 and 15 and WC4 for years 1, 3 and 5 (i.e., 2020, 2022, 2024) to document changes and assess the rate of change.
   a. Wetland 6: monitoring quadrats placed at representative locations of sphagnum moss staining and bleaching would be used to document recovery based on colonization by healthy plants over time.
   b. Wetland 15, monitoring quadrats placed at representative locations in the northern end of the wetland where silt deposits are currently present would be used to document recovery based on colonization by healthy vegetation over time.
   c. Watercourse 4, monitoring substrate composition in swift-flowing habitat types where silt deposits are currently present would be used to document removal or covering over of fines (e.g., in the downstream pool of Culvert 4A).
2. Assess overall distribution of aquatic plant communities in Wetland 6/WC4 using visual analysis of imagery taken annually with a drone and supplemented with field surveys to confirm species composition and to measure environmental features such as water depth and silt thickness which may influence the distribution of aquatic plants. The drone survey would also be used to document and monitor recovery of potential areas of sphagnum mortality that may not have been captured during the 2019 wetland survey.
3. Incorporate turbidity measurements into current rain event monitoring programs to confirm if mitigation is working as intended.

At this time, the collection of additional water and sediment chemistry is not recommended as no relationship has been found between metal concentrations in silt deposits and concentrations found in water and sediments in WC4.

7.0 REFERENCES AND PERSONAL COMMUNICATIONS

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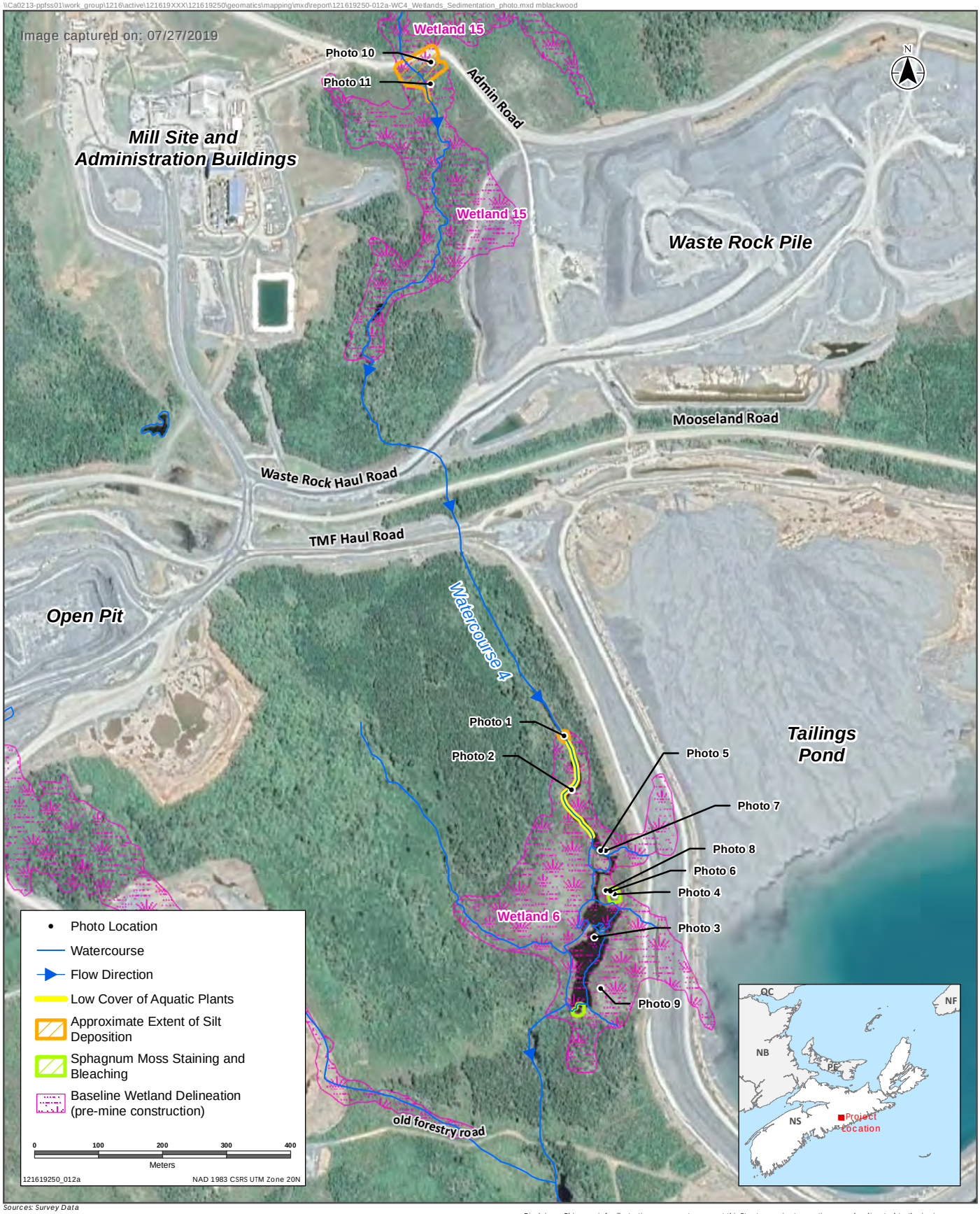
Appendix A WETLAND PHOTO LOG

ASSESSMENT OF WETLANDS 6 AND 15 AND WATERCOURSE 4, TOUQUOY MINE, NOVA SCOTIA



Sources: Survey Data

Service Layer Credits: Google Earth Image (July 27, 2019). Moose River Gold Mines, NS. CNES/Airbus [Obtained October 9, 2019]

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Wetland Survey Photo Locations

Stantec

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Assessment of Watercourse WC4 and Associated Wetlands**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 1 **Photo Location:** Wetland 6 **Survey Date:** 8/1/2019 **Comments:** Fine grey sediment deposits near edge of inlet stream in Wetland 6.	
Photograph ID: 2 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Poorly vegetated still water in northern half of Wetland 6.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Assessment of Watercourse WC4 and Associated Wetlands**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 3 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Well vegetated still water in southern half of Wetland 6.	
Photograph ID: 4 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Area of high sphagnum moss and graminoid mortality in Wetland 6.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Assessment of Watercourse WC4 and Associated Wetlands**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 5 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Staining of sphagnum moss.	
Photograph ID: 6 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Bleaching of sphagnum moss.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Assessment of Watercourse WC4 and Associated Wetlands**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 7 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Turbid water in footprint in Wetland 6.	
Photograph ID: 8 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Staining of sphagnum moss below peat surface in Wetland 6.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Assessment of Watercourse WC4 and Associated Wetlands**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 9 **Photo Location:** Wetland 6 **Survey Date:** 7/31/2019 **Comments:** Typical condition of wetland vegetation in Wetland 6.	
Photograph ID: 10 **Photo Location:** Wetland 15 **Survey Date:** 7/31/2019 **Comments:** Typical sediment deposit in depressional areas in Wetland 15.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Assessment of Watercourse WC4 and Associated Wetlands**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 11

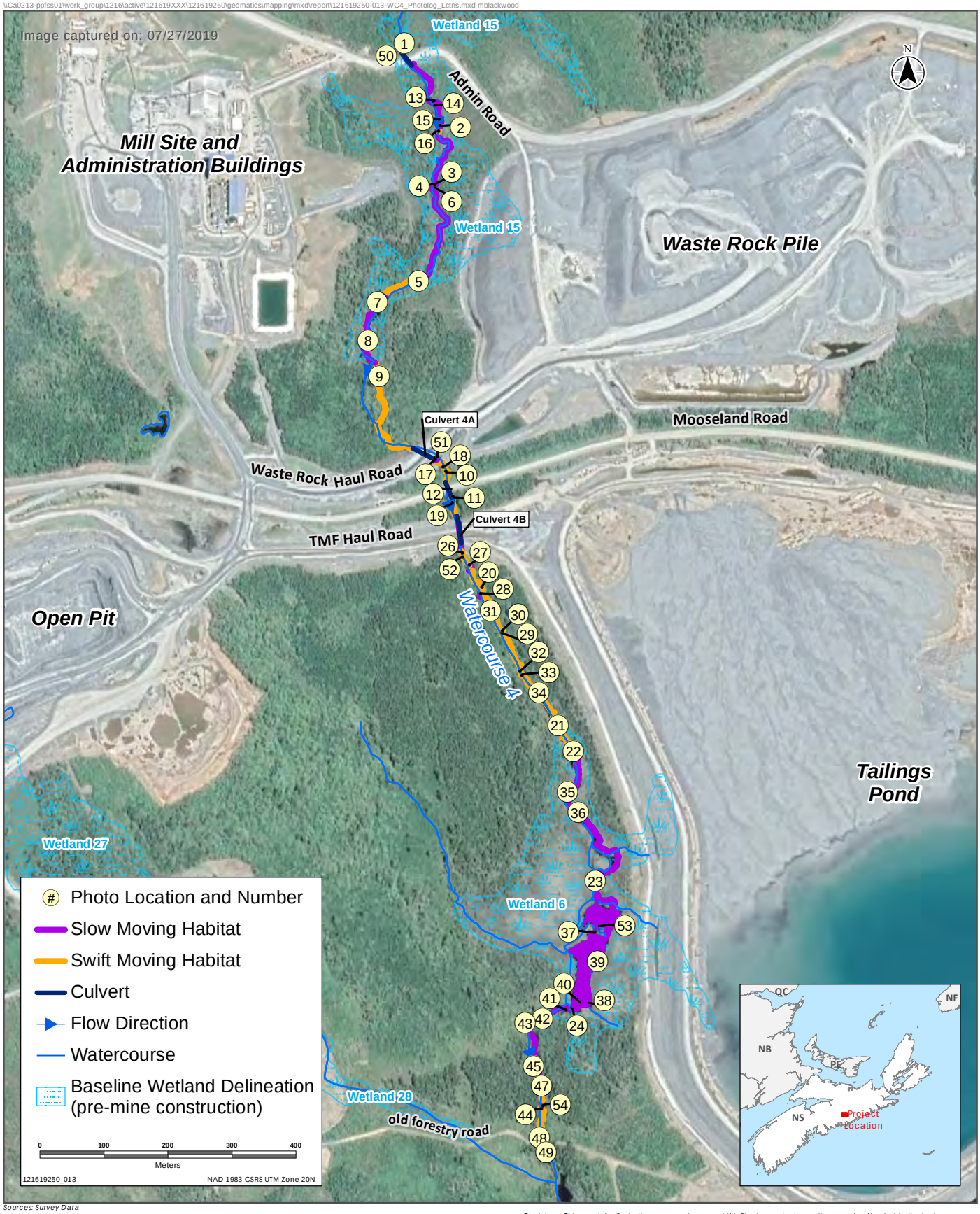
Photo Location:
Wetland 15

Survey Date:
7/31/2019

Comments:
Depressional area in Wetland 15 unaffected by sediment deposition.

Appendix B FISH HABITAT PHOTO LOG

ASSESSMENT OF WETLANDS 6 AND 15 AND WATERCOURSE 4, TOUQUOY MINE, NOVA SCOTIA



Sources: Survey Data

Service Layer Credits: Google Earth Image. Moose River Gold Mines, NS. CNES/Airbus [Obtained October 9, 2019]

Disclaimer: This map is for illustrative purposes to support this Stantec project; questions can be directed to the issuing agency.

Watercourse 4 Photo Locations

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 1 **Photo Location:** Watercourse 4, Reach 1 **Direction:** Upstream **Survey Date:** 8/1/2019 **Comments:** Illustrating reference conditions of fish habitat, upstream of the Admin Road.	
Photograph ID: 2 **Photo Location:** Watercourse 4, Reach 2 **Direction:** **Survey Date:** 7/31/2019 **Comments:** Representative intermittent stream fish habitat within 200 m of Admin Road Culvert. Negligible flow was observed.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 3 **Photo Location:** Watercourse 4, Reach 2 **Direction:** **Survey Date:** 7/31/2019 **Comments:** Representative fish habitat within area of WC4 with permanent flow.	
Photograph ID: 4 **Photo Location:** Watercourse 4, Reach 2 **Direction:** **Survey Date:** 7/31/2019 **Comments:** Representative fish habitat within area of WC4 with permanent flow.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 5 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Downstream **Survey Date:** 7/31/2019 **Comments:** Illustrating heavily vegetated riparian zones.	
Photograph ID: 6 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Left Bank **Survey Date:** 7/31/2019 **Comments:** Illustrating aquatic vegetation and substrates.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 7 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Downstream **Survey Date:** 7/31/2019 **Comments:** Representative slow-moving fish habitat. Abundant submerged aquatic vegetation within pool habitat.	
Photograph ID: 8 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Upstream **Survey Date:** 7/31/2019 **Comments:** Representative slow-moving fish habitat.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 9 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Upstream **Survey Date:** 7/31/2019 **Comments:** Representative flowing habitat.	
Photograph ID: 10 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Left Bank **Survey Date:** 7/31/2019 **Comments:** Representative swift-flowing fish habitat, downstream of Culvert 4A.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 11 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Downstream **Survey Date:** 8/14/2019 **Comments:** Representative fish habitat, downstream of Mooseland Road.	
Photograph ID: 12 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Upstream **Survey Date:** 8/14/2019 **Comments:** Illustrating perched outlets of twin corrugated steel culverts running under Mooseland Road.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 13 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Left Bank **Survey Date:** 7/31/2019 **Comments:** Fine sediment observed along edges of watercourse and within the riparian area above existing bankfull level.	
Photograph ID: 14 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Upstream **Survey Date:** 7/31/2019 **Comments:** Illustrating a sediment plugged root mass through which the watercourse filters.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 15 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Left Bank **Survey Date:** 7/31/2019 **Comments:** Brown sediment deposited along banks within wetted channel, however no longer apparent within riparian area.	
Photograph ID: 16 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Upstream **Survey Date:** 7/31/2019 **Comments:** Illustrating areas of deposition along banks.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 17 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Upstream **Survey Date:** 7/31/2019 **Comments:** Silt deposition downstream of Culvert 4A within the pool and along edges. Minnow traps used to assess fish community are shown.	
Photograph ID: 18 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Upstream **Survey Date:** 8/14/2019 **Comments:** Illustrating deposition of grey silt, riparian vegetation and substrate. Downstream of Waste Rock Haul Road at Culvert 4A.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 19 **Photo Location:** Watercourse 4, Reach 2 **Direction:** Left Bank **Survey Date:** 8/14/2019 **Comments:** Illustrating deposition of grey silt localized to one area near the bank. Downstream of the culvert on Mooseland Road.	
Photograph ID: 20 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Downstream **Survey Date:** 8/14/2019 **Comments:** Representative swift-moving fish habitat.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 21 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Downstream **Survey Date:** 8/1/2019 **Comments:** Representative swift-moving fish habitat.	
Photograph ID: 22 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Upstream **Survey Date:** 8/1/2019 **Comments:** Visual signs of turbidity within slow-moving section.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 23 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Downstream **Survey Date:** 8/1/2019 **Comments:** Representative slow-moving habitat, within Wetland 6.	
Photograph ID: 24 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Upstream **Survey Date:** 8/1/2019 **Comments:** Representative slow-moving habitat, within Wetland 6.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 25	
Photo Location: Watercourse 4, Reach 3	
Direction:	
Survey Date: 8/1/2019	
Comments: Representative fish habitat. Aquatic vegetation is abundant.	

Photograph ID: 26	
Photo Location: Watercourse 4, Reach 3	
Direction: Upstream	
Survey Date: 8/14/2019	
Comments: Illustrating baffled concrete Culvert 4B at the TMF Haul Road, and the downstream pool laden with mine sediment.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 27 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Left Bank **Survey Date:** 8/14/2019 **Comments:** Grey silt deposition along left bank, downstream of Culver 4B.	
Photograph ID: 28 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Right Bank **Survey Date:** 8/14/2019 **Comments:** Illustrating deposition of grey silt along the banks and throughout the watercourse.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 29 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Upstream **Survey Date:** 8/14/2019 **Comments:** Grey silt observed within depositional areas near the banks and within rock crevices.	
Photograph ID: 30 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Right Bank **Survey Date:** 8/14/2019 **Comments:** Fine grey silt within spaces of coarse substrates within flowing water sections.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 31 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Downstream **Survey Date:** 8/14/2019 **Comments:** Grey silt along Watercourse 4 banks and turbid water.	
Photograph ID: 32 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Left Bank **Survey Date:** 8/14/2019 **Comments:** Illustrating deposition of grey silt along the banks.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 33 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Right Bank **Survey Date:** 8/14/2019 **Comments:** Fish habitat heavliy affected by grey silt.	
Photograph ID: 34 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Upstream **Survey Date:** 8/14/2019 **Comments:** Water appears clear, with substrate composed of fines.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 35 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Upstream **Survey Date:** 8/1/2019 **Comments:** Visual signs of turbidity within slow-moving section.	
Photograph ID: 36 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Left Bank **Survey Date:** 8/14/2019 **Comments:** Visual signs of turbidity within slow-moving section.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 37 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Right Bank **Survey Date:** 8/1/2019 **Comments:** Grey silt observed within areas with submergent aquatic vegetation within Wetland 6.	
Photograph ID: 38 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Right Bank **Survey Date:** 8/1/2019 **Comments:** Representative slow-moving fish habitat. Aquatic vegetation is abundant.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 39 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Left Bank **Survey Date:** 8/1/2019 **Comments:** Grey silt within slow-moving section.	
Photograph ID: 40 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Substrate **Survey Date:** 8/1/2019 **Comments:** Organic soils within the downstream most section of Reach 3. Appear to be unnaffected by the siltation.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 41 **Photo Location:** Watercourse 4, Reach 3 **Direction:** Substrate **Survey Date:** 8/1/2019 **Comments:** Grey silt dried on a rock at the downstream end of Reach 3.	
Photograph ID: 42 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Upstream **Survey Date:** 8/1/2019 **Comments:** Representative fish habitat, showing aquatic vegetation and substrate.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 43 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Downstream **Survey Date:** 8/1/2019 **Comments:** Representative fish habitat within slow-moving sections.	
Photograph ID: 44 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Downstream **Survey Date:** 8/1/2019 **Comments:** Representative swift-moving fish habitat.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 45 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Downstream **Survey Date:** 8/1/2019 **Comments:** Grey silt observed between rocks.	
Photograph ID: 46 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Downstream **Survey Date:** 8/1/2019 **Comments:** Illustrating turbid water and deposition of fine sediments.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 47 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Right Bank **Survey Date:** 8/1/2019 **Comments:** Grey silt within slow-moving sections.	
Photograph ID: 48 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Downstream **Survey Date:** 8/1/2019 **Comments:** Illustrating bridge crossing at old forestrry road.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 49 **Photo Location:** Watercourse 4, Reach 4 **Direction:** Upstream **Survey Date:** 8/1/2019 **Comments:** Fish habitat downstream of old forestry road. Small amounts of grey silt were apparent between cobble and boulder substrates and depositional areas.	
Photograph ID: 50 **Photo Location:** Watercourse 4, Reach 1 **Direction:** **Survey Date:** 8/1/2019 **Comments:** Pooled water adjacent to Admin Road.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 51 **Photo Location:** Watercourse 4, Reach 2 **Direction:** **Survey Date:** 8/1/2019 **Comments:** WC4-14 Sediment Sample.	
Photograph ID: 52 **Photo Location:** Watercourse 4, Reach 3 **Direction:** **Survey Date:** 8/14/2019 **Comments:** WC4-15, Sediment Sample from depositional area.	

Client:	**Atlantic Mining NS Corporation**	**Project:**	**Asssessment of Watercourse WC4**
Site Name:	**Touquoy Mine**	**Site Location:**	**Moose River, Nova Scotia**

Photograph ID: 53 **Photo Location:** Watercourse 4, Reach 3 **Direction:** **Survey Date:** 8/1/2019 **Comments:** Sediment collected for sample WC4-13 from Wetland 6 consisting of fine and organic substrates.	
Photograph ID: 54 **Photo Location:** Watercourse 4, Reach 4 **Direction:** **Survey Date:** 8/1/2019 **Comments:** Fine sediments collected between rocks for sediment sample WC4-12.	

Appendix C FIELD DATA

ASSESSMENT OF WETLANDS 6 AND 15 AND WATERCOURSE 4, TOUQUOY MINE, NOVA SCOTIA

Table C.1 In Situ Water Quality Data from Watercourse WC-4, Touquoy Mine, NS

Sample ID	Site ID	Sample Date	Dissolved Oxygen (mg/L) [1]	Dissolved Oxygen (%)	Specific Conductivity (µs/cm)	Temperature (°C)	pH[2]	Comments
WC4-01	WC4+0	2019-07-31	No water	No water	No water	No water	No water	No water
WC4-2	WC4+25	2019-07-31	3	34	248.1	19.9	5.3	Brown precipitate. Negligible flow.
WC4-3	WC4+200	2019-07-31	3.6	40	157.5	20.1	6	-
WC4-4	WC4+400	2019-07-31	4.9	51	156.9	16.8	6.5	-
WC4-05	WC4+600	2019-07-31	7.3	83	129.3	21.1	6.7	-
WC4-06	WC4+800	2019-07-31	6.7	74	1173.0	19.8	6.8	Sample collected immediately following rain storm.
WC4-07	WC4+1000	2019-08-14	9.5	95	904.0	15	6.7	-
WC4-07A	WC4+1200	2019-08-14	7.7	79	953.0	16.2	6.3	Taken below Waste Rock Haul Road at Culvert 4a
WC4-08	WC4+1400	2019-08-01	7.6	93	733.0	23.4	7.7	Noticeable increase in turbidity since rainfall event.
WC4-09	WC4+1600	2019-08-01	5.9	75	730.0	27.7	7.8	-
WC4-10	WC4+1800	2019-08-01	4.4	54	674.0	24.1	6.7	-
WC4-11	WC4+2000	2019-08-01	6.1	70	653.0	20.8	6.4	-

Notes:
[1] CWQG PAL lowest acceptable dissolved oxygen concentration:
Warm Water Biota: early life stages = 6.0 mg/L
Warm Water Biota: other life stages = 5.5 mg/L
Cold Water Biota: early life stages = 9.5 mg/L
Cold Water Biota: other life stages = 6.5 mg/L
[2] CWQG PAL guideline is 6.5 - 9.0

Table C.2 Fish Species Summary Data from Watercourse 4, Touquoy Mine, NS

Fish Species	Reach 2						Reach 3				Grand Total
	WC4+25	WC4+545	WC4+760	WC4+800	WC4+825	WC4+830	WC4+1510	WC4+1525	WC4+1555	WC4+1585	
American eel *(Anguilla rostrata)*	-	-	-	-	-	-	1	-	3	-	4
Brook trout *(Salvelinus fontinalis*)	4	-	-	1	-	-	-	-	-	-	5
Brown bullhead *(Ameiurus nebulosus)*	-	-	-	-	-	-	-	-	-	2	2
Northern redbelly dace *(Chrosomus eos)*	-	-	-	-	-	-	5	3	-	13	21

Notes: "-" = not present

Table C.3 - Habitat Units

							Left Bank Stability (%)			Right Bank Stability (%)			Left Stream Bank Riparian Composition (%)						
Map Label	Reach ID	Latitude	Longitude	Survey Date	Dominant Habitat Unit Type	Length (m)	Unstable	Moderately Stable	Stable	Unstable	Moderately Stable	Stable	Bare	Grass	Shrub	Conifer	Deciduous	Wetland
1	2	-62.93168	44.992061	2019-07-3	pool (unclassified)	7	0	15	35	0	0	50	10	20	10	10	0	0
2	2	-62.93128	44.991554	2019-07-3	glide (no thalweg <0.5	79	0	0	50	0	0	50	20	5	25	0	0	0
3	2	-62.9312	44.991513	2019-07-3	glide (no thalweg <0.5	65	0	0	50	0	0	50	0	20	30	0	0	0
4	2	-62.93115	44.991126	2019-07-3	run (unclassified)	10	0	0	50	0	0	50	0	30	10	10	0	0
5	2	-62.93123	44.990088	2019-07-3	glide (no thalweg <0.5	145	0	0	50	0	0	50	0	25	25	0	0	0
6	2	-62.93123	44.990088	2019-07-3	glide (no thalweg <0.5	76	0	0	50	0	0	50	0	25	25	0	0	0
7	2	-62.9315	44.98905	2019-07-3	glide (no thalweg <0.5	62	0	0	50	0	0	50	0	25	20	5	0	0
8	2	-62.93223	44.988793	2019-07-3	run (unclassified)	74	0	0	50	0	0	50	0	25	20	5	0	0
9	2	-62.93243	44.988632	2019-07-3	pool (unclassified)	34	0	0	50	0	0	50	0	15	15	10	5	5
10	2	-62.93255	44.988444	2019-07-3	flat	26	0	0	50	0	0	50	0	10	20	10	0	10
11	2	-62.93242	44.98788	2019-07-3	flat	75	0	0	50	0	0	50	0	25	15	5	0	5
12	2	-62.93174	44.986674	2019-07-3	run (unclassified)	176	0	0	50	0	0	50	0	25	5	20	0	0
13	2	-62.93123	44.986519	2019-08-1	pool (unclassified)	6	0	0	50	0	0	50	45	5	0	0	0	0
14	2	-62.93118	44.986468	2019-08-1	riffle	29	0	0	50	0	0	50	35	10	5	0	0	0
15	2	-62.93097	44.986347	2019-08-1	run (unclassified)	20	0	0	50	0	0	50	0	10	15	25	0	0
16	2	-62.93088	44.985947	2019-08-1	riffle	30	0	0	50	0	0	50	0	20	10	20	0	0
17	3	-62.9307	44.985224	2019-08-1	pool (unclassified)	8	0	0	50	0	0	50	45	5	0	0	0	0
18	3	-62.9307	44.985233	2019-08-1	riffle	28	0	0	50	0	0	50	0	5	15	25	5	0
19	3	-62.93053	44.984978	2019-08-1	pool (unclassified)	15	0	0	50	0	0	50	0	5	15	25	5	0
20	3	-62.93048	44.984948	2019-08-1	riffle	51	0	0	50	0	0	50	0	5	15	25	5	0
21	3	-62.93034	44.984643	2019-08-1	pool (unclassified)	10	0	0	50	0	0	50	0	5	15	30	0	0
22	3	-62.93025	44.984602	2019-08-1	riffle	78	0	0	50	0	0	50	0	15	15	15	5	0
23	3	-62.92989	44.984052	2019-08-1	run (unclassified)	71	0	0	50	0	0	50	0	10	30	10	0	0
24	3	-62.92954	44.983538	2019-08-1	run (unclassified)	33	0	0	50	0	0	50	0	15	25	10	0	0
25	3	-62.92933	44.983344	2019-08-1	run (unclassified)	115	0	0	50	0	0	50	0	15	25	10	0	0
26	3	-62.92866	44.982618	2019-08-1	run (unclassified)	24	0	0	50	0	0	50	0	15	25	10	0	0
27	3	-62.92846	44.982394	2019-08-0	glide (no thalweg <0.5	29	0	0	50	0	0	50	0	0	0	0	5	45
28	3	-62.9284	44.982178	2019-08-0	glide (no thalweg <0.5	94	0	0	50	0	0	50	0	0	0	0	5	45
29	3	-62.92841	44.981564	2019-08-0	glide (no thalweg <0.5	200	0	0	50	0	0	50	0	0	0	0	5	45
30	3	-62.92801	44.980386	2019-08-0	pool (unclassified)	184	0	0	50	0	0	50	0	0	0	0	5	45
31	4	-62.92875	44.978798	2019-08-0	glide (no thalweg <0.5	32	0	0	50	0	0	50	0	20	15	15	0	0
32	4	-62.92912	44.978637	2019-08-0	run (unclassified)	32	0	0	50	0	0	50	0	20	15	15	0	0
33	4	-62.92945	44.97857	2019-08-0	glide (no thalweg <0.5	59	0	0	50	0	0	50	0	5	20	25	0	0
34	4	-62.92932	44.978109	2019-08-0	run (unclassified)	31	0	0	50	0	0	50	0	5	5	40	0	0
35	4	-62.92917	44.977876	2019-08-0	pool (unclassified)	30	0	0	50	0	0	50	0	5	5	40	0	0
36	4	-62.9291	44.977607	2019-08-0	run (unclassified)	14	0	0	50	0	0	50	0	25	5	20	0	0
37	4	-62.92911	44.977496	2019-08-0	pool (unclassified)	10	0	25	25	0	25	25	0	30	0	20	0	0
38	4	-62.92914	44.977398	2019-08-0	riffle	88	0	0	50	0	10	40	0	15	25	10	0	0

Table C.3 - Habitat Units

	Right Stream Bank Riparian Composition (%)						Substrate (%)										
Map Label	Bare	Grass	Shrub	Conifer	Deciduous	Wetland	Organics	Fines (<0.06mm)	Sand (0.06-2 mm)	Small Gravel (2-16 mm)	Large Gravel (17-64 mm)	Cobble (65-256 mm)	Small Boulder (257-1000mm)	Large Boulder (>1000mm)	Bedrock	Embeddedness	Total Cover (% survey area)
1	10	30	10	0	0	0	80	0	0	0	0	0	0	20	0	Medium (25-50%)	40
2	20	5	25	0	0	0	40	40	0	0	0	0	20	0	0	High (50-75%)	20
3	0	20	30	0	0	0	40	40	0	0	0	0	20	0	0	High (50-75%)	10
4	0	10	5	35	0	0	20	60	0	0	0	0	20	0	0	High (50-75%)	10
5	0	25	25	0	0	0	0	100	0	0	0	0	0	0	0	Very High (>75%)	10
6	0	25	25	0	0	0	0	80	0	0	0	0	20	0	0	Medium (25-50%)	10
7	0	20	25	5	0	0	0	80	0	0	0	0	20	0	0	Medium (25-50%)	10
8	0	20	25	5	0	0	60	15	0	5	5	5	10	0	0	Medium (25-50%)	10
9	0	20	10	10	0	10	100	0	0	0	0	0	0	0	0	Very High (>75%)	90
10	0	10	30	0	0	10	100	0	0	0	0	0	0	0	0	Very High (>75%)	90
11	0	20	15	5	0	10	100	0	0	0	0	0	0	0	0	Very High (>75%)	90
12	0	30	10	5	5	0	0	0	0	15	25	30	30	0	0	High (50-75%)	50
13	45	0	5	0	0	0	0	55	0	0	0	30	15	0	0	High (50-75%)	0
14	20	25	5	0	0	0	0	10	0	0	20	20	50	8	0	Medium (25-50%)	20
15	0	10	10	30	0	0	0	10	0	0	20	20	50	8	0	Medium (25-50%)	60
16	0	30	10	5	5	0	0	15	0	5	20	30	30	0	0	Low (<25%)	30
17	10	10	0	30	0	0	20	60	0	0	0	20	0	0	0	High (50-75%)	5
18	0	5	15	25	5	0	0	20	0	0	0	30	50	0	0	Medium (25-50%)	40
19	0	5	15	25	5	0	0	90	0	0	0	0	10	0	0	Medium (25-50%)	40
20	0	5	15	25	5	0	0	20	0	0	0	40	40	0	0	Medium (25-50%)	40
21	0	5	15	30	0	0	0	90	0	0	0	0	10	0	0	Medium (25-50%)	10
22	0	15	15	15	5	0	5	30	0	0	0	20	50	0	0	Medium (25-50%)	60
23	0	10	30	10	0	0	0	95	0	0	0	0	0	5	0	Very High (>75%)	50
24	0	15	30	5	0	0	0	100	0	0	0	0	0	0	0	Very High (>75%)	40
25	0	15	30	5	0	0	0	95	0	0	0	0	5	0	0	High (50-75%)	40
26	0	15	30	5	0	0	0	50	0	0	0	0	50	0	0	Medium (25-50%)	10
27	0	0	0	5	0	45	20	80	0	0	0	0	0	0	0	Very High (>75%)	50
28	0	0	0	5	0	45	20	75	0	0	0	0	5	0	0	Medium (25-50%)	65
29	0	0	0	5	0	45	20	80	0	0	0	0	0	0	0	Very High (>75%)	90
30	0	0	0	5	0	45	15	80	0	0	0	0	0	5	0	High (50-75%)	90
31	0	20	15	15	0	0	10	30	0	0	0	10	50	0	0	High (50-75%)	25
32	0	20	15	15	0	0	5	25	0	0	0	10	60	0	0	High (50-75%)	25
33	0	10	15	25	0	0	10	90	0	0	0	0	0	0	0	Very High (>75%)	30
34	0	20	10	20	0	0	0	60	0	0	0	0	40	0	0	Medium (25-50%)	30
35	0	25	5	20	0	0	10	70	0	0	0	0	20	0	0	Medium (25-50%)	30
36	0	25	5	20	0	0	20	30	0	0	0	0	50	0	0	Medium (25-50%)	40
37	0	30	0	20	0	0	20	30	0	0	0	0	50	0	0	Medium (25-50%)	40
38	0	15	25	10	0	0	30	10	0	5	0	5	50	0	0	Medium (25-50%)	40

Table C.3 - Habitat Units

	Overhead Cover (%)				Instream Cover (%)					Aquatic Vegetation Composition (%)					
Map Label	Undercut Bank	Grass/Forbe	Tree/Shrub	Large Woody Debris	Large Woody Debris	Small Woody Debris	Boulders	Water Visibility	Aquatic Vegetation	Emergent	Floating Leafed	Free Floating	Submerged	Filamentous Algae	Macrophytic Algae
1	0	0	0	0	0	0	15	10	30	0	0	0	0	0	100
2	5	0	10	0	0	5	0	0	0	0	0	0	0	0	0
3	0	0	10	0	0	5	0	0	0	0	0	0	0	0	0
4	0	2	5	0	0	0	5	0	5	0	0	0	3	0	0
5	0	5	5	0	2	0	0	0	5	0	0	0	100	0	0
6	0	5	5	0	2	0	0	0	5	0	0	0	100	0	0
7	0	5	5	0	2	0	0	0	5	0	10	0	85	0	5
8	0	5	5	0	2	0	0	0	5	0	10	0	90	0	0
9	0	0	5	5	5	0	0	0	90	0	10	0	90	0	0
10	0	0	5	0	10	5	0	0	80	0	5	0	95	0	0
11	0	0	5	0	10	5	0	0	80	0	5	0	95	0	0
12	0	10	5	5	0	0	0	0	30	0	0	0	100	0	0
13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	5	5	10	0	60	0	0	0	100	0	0
15	5	0	20	0	5	5	10	0	60	0	0	0	100	0	0
16	5	0	5	0	5	5	10	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	5	0	0	0	0	0	0	0	0
18	0	0	15	10	10	0	0	0	5	0	0	0	100	0	0
19	0	0	20	10	10	0	0	0	0	0	0	0	0	0	0
20	0	0	30	5	0	0	0	0	20	0	0	0	100	0	0
21	0	0	10	5	0	0	0	0	0	0	0	0	0	0	0
22	0	0	40	5	0	5	5	5	20	0	0	0	100	0	0
23	0	0	40	0	0	10	0	0	0	0	0	0	0	0	0
24	0	0	5	0	0	0	0	0	10	10	10	0	80	0	0
25	0	0	5	0	0	0	0	0	35	5	0	0	95	0	0
26	0	0	5	0	5	0	0	0	5	100	0	0	0	0	0
27	0	0	5	0	0	0	0	30	45	0	5	0	95	0	0
28	0	0	5	0	0	0	0	30	65	0	10	0	85	5	0
29	0	0	0	0	0	0	0	40	90	5	10	0	75	0	0
30	0	0	0	0	0	0	0	0	90	5	10	0	75	0	0
31	0	0	0	0	0	0	25	0	10	0	0	0	10	0	0
32	0	0	0	0	0	0	25	0	10	0	0	0	10	0	0
33	0	0	5	5	5	0	0	0	20	0	40	0	60	0	0
34	0	0	5	0	5	0	10	0	5	0	100	0	0	0	0
35	5	0	5	10	10	0	5	0	15	0	100	0	0	0	0
36	5	0	10	10	0	5	5	0	20	0	0	0	100	0	0
37	5	0	10	10	0	5	5	0	20	0	0	0	100	0	0
38	5	0	10	10	0	5	5	0	20	0	0	0	100	0	0

Table C.3 - Habitat Units

		Width (m)		Wet Depth from Left Bank (m)			
Map Label	Comments	Wet Width (m)	Channel Width (m)	25%	50%	75%	Bankfull Maximum Depth (m)
1	lots of brown floc in pool, no obvious grey silty deposition.	3	3.4	0.53	0	0.6	0.6
2	Fine sediment along edges of watercourse into riparian area above existing high water mark.						
3	Signs of brown sediment deposited along banks within wetted channel, however no longer apparent within riparian area.						
4	-	0.82	0.89	0.03	0.03	0.01	0.03
5	-	0.55	1.8	0.03	0.04	0.01	0.07
6	-	1.83	1.91	0.21	0.18	0.16	0.24
7	Stream appears to be flowing						
8	Stream appears to be flowing						
9	Pond	8	8.1	0.5	0.7	0.4	
10	-	2.5	2.6	0.5	0.6	0.4	0.6
11	brown organics on surface	3	3.1	0.3	0.5	0.4	0.5
12	-	1.6	1.8	0.13	0.1	0.1	0.13
13	Pool below culvert.	3.7	4.3	0.19	0.39	0.37	0.39
14	Submergent aquatic vegetation is moss.	1.13	2	0.08	0.12	0.09	0.13
15	Few signs of sediment, one location in depositional area. Submergent aquatic vegetation is moss.	1.73	1.84	0.03	0.05	0.05	0.11
16	Few signs of sediment. One location in depositional area near bank, not apparent between rocks. Steeper gradient 2%.	1.1	1.62	0.05	0.03	0.06	0.07
17	White sucker observed. Pool filled with sediment.	8	8.5	0.3	1	0.3	1
18	Submergent aquatic vegetation is moss, juvenile white sucker observed.	1.35	4.22	0.07	0.08	0.04	0.13
19	-	1.74	2.62	0.09	0.13	0.1	0.15
20	Submergent aquatic vegetation is moss.	1.8	2.3	0.02	0.11	0.1	0.15
21	Sediment in throughout and along edges.	2.32	4.1	0.09	0.02	0.14	0.23
22	Sedimentation in depositional areas near back and in rock crevices. Decent flow. Submergent aquatic vegetation is moss.	2.5	2.05	0.02	0.1	0.02	0.12
23	No noticeable turbidity	0.93	2.1	0.06	0.09	0.05	0.1
24	Reach heavily affected by fine sedimentation.	2	5.5	0.12	0.19	0.15	0.4
25	-	4	4.5	0.2	0.25	0.15	0.25
26	-	1.98	3.27	0.1	0.22	0.02	0.23
27	Difficult to see over 0.5 m due to water clarity	15	15.3	0.3	0.5	0.4	
28	-	7.3	7.6	0.2	0.5	0.35	0.5
29	-	7	7	0.3	1	0.5	1
30	Fine grey sediment present throughout most of Pond in patches between weed beds. Young of the year observed, bullheads and suckers observed.	13	13.1	0.3	0.5	0.4	0.5
31	Grey sediment in depositional areas between rocks, very slow flow, neglible.	2.4	2.7	0.2	0.19	0.16	0.24
32	Grey sediment in depositional areas between rocks, yoy bullhead observed. Aquatic veg is moss.	2.3	3.7	0.2	0.19	0.16	0.24
33	Obvious signs of sedimentation throughout. Fine grey sediment	5.5	5.6	0.2	0.4	0.1	0.6
34	grey sediment observed between rocks, in depositions areas	3.2	3.9	0.28	0.25	0.21	0.32
35	grey sediment observed, lots in slow moving section	5.75	5.8	0.4	0.6	0.3	0.6
36	Grey coloured sediment observed. Sample WC4-12 for sediment only, at least 6" deep in parts.	3.41	3.65	0.15	0.1	0.15	0.25
37	Grey coloured sediment observed. Sample WC4-12 for sediment only, at least 6" deep in parts.	3.41	3.65	0.15	0.1	0.15	0.25
38	Submergent vegetation is mossy	3.15	3.55	0.09	0.15	0.07	0.22

Appendix D WATER AND SEDIMENT SAMPLE CHEMISTRY RESULTS

APPENDIX D
WATER AND SEDIMENT SAMPLE CHEMISTRY RESULTS

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D.1 INTRODUCTION

Water and sediment samples were collected within Watercourse 4 (WC4) to provide an understanding of water and sediment chemistry throughout the length of WC4 to address the potential for siltation events to transfer contaminants (e.g., metals) into the surface water and sediments.

This appendix provides the methods and results for water and sediment chemistry sampling. A high-level summary of the main findings is provided in the main body of the report.

D.2 METHODS

D.2.1 Field Data Collection

Water and sediment samples were collected every 200 m throughout the survey area within WC4 to provide information on water and sediment chemistry throughout the length of WC4.

At the time of sample collection, a sample identifier (ID) was assigned and then a Location ID was assigned for analysis of results to correspond with the distance along WC4 relative to the most upstream sampling location, and the type of sample collected (e.g., water = W and sediment = S). For example, WC+1030S indicates that a sediment sample (S) was collected approximately 1030 m downstream of the first sample collected in WC4. In addition to these interval samples, targeted sediment samples were collected where silt was the dominant grain size, including Location IDs: WC4+15, WC4+800S, WC4+1030S, WC4+1650S, and WC4+1930S.

Water samples were collected during a period of low flow when water levels were very low and were representative of the conditions on the day of collection. Water samples were analyzed for general chemistry and trace metals. Sediment samples were analyzed for extractable trace metals and mercury. Sample analyses were conducted by Bureau Veritas in Bedford, NS.

The analytical results were compared to baseline water and sediment quality data (see Section D.2.2), the Canadian Water Quality Guidelines for the Protection of Aquatic Life (freshwater, CWQG PAL; CCME 2014) and Nova Scotia Environmental Quality Standards (EQS; NSE 2013) - Tier 1 EQS Freshwater and Freshwater Sediment EQS, as applicable. Comparisons are also presented to a site-specific water quality guideline for arsenic of 30 µg/L for the protection of aquatic life in Moose River (Intrinsik 2019), into which WC4 flows. It is Stantec's understanding that this site-specific guideline is under review by regulators.

D.2.2 Review of Existing Information

A review of existing water and sediment quality data was undertaken following the field data collection to support interpretation of results. Baseline data provide context to evaluate results for the present study in relation to local geology, prior to Project activities (i.e., historical activities prior to operation of the Touquoy Mine).

D.2.2.1 Baseline Water

Baseline water quality data were drawn from pre-operational results collected from surface water monitoring stations SW23, SW19 and SW3 (see locations on Figure 2) that are part of the Industrial Approval (IA) for the Touquoy Mine. These "baseline IA" data were used for comparison with results from the present program that were above the Tier 1 EQS Freshwater or CWQG PAL (Stantec 2019b).

Previous communication between AMNS and NSE established that water quality data that were collected prior to October 4, 2017 would be considered as pre-operation baseline for stations SW23, SW19 and SW3. Therefore, the following time periods were selected for determine baseline IA concentrations for the present study, based on the available samples: April 28, 2017 to September 21, 2017 for SW23, March 15, 2016 and September 21, 2017 for SW19, and April 19. 2016 and September 21, 2017 for SW3. Review of baseline IA data from these three stations showed that metal concentrations in water vary throughout WC4. Therefore, results of the present study were compared with the closest baseline IA station, as well as WC4 as a whole (i.e., maximum value from SW23, SW19 or SW3). The baseline IA average, minimum and maximum water quality concentrations are summarized in Table D.1.

Table D.1 Pre-Operation Baseline Water Quality Concentrations for Touquoy Mine IA for Parameters that were above Tier 1 EQS Freshwater[1] or CWQG PAL[2].

Parameter	Industrial Approval Monitoring Station		
	SW23	SW19	SW3
	Average (Range)	Average (Range)	Average (Range)
Total Aluminum (µg/L)[1]	265 (220 to 310)	1,170 (140 to 15,000)	445 (30 to 2,500)
Total Arsenic (µg/L) [1]	3.6 (<1 to 7.0)	8.3 (<1 to 87)	11 (<1 to 38)
Total Cadmium (µg/L) [1]	0.023 (0.017 to 0.029)	0.041 (0.01 to 0.35)	0.014 (<0.01 to 0.057)
Total Iron (µg/L) [1]	540 (300 to 710)	2,240 (190 to 30,000)	741 (160 to 2,100)
Total Manganese (µg/L) [1]	98 (53 to 140)	401 (28 to 4,800)	182 (28 to 890)
Turbidity (NTU) [2]	0.8 (0.7 to 1.2)	30 (0.33 to 470)	6.8 (0.99 to 37)

D.2.2.2 Baseline Soil

Baseline sediment data were drawn from baseline soil data collected prior to the development of the Touquoy Mine. These baseline data were used for comparison with the results from the present program which were above the Freshwater Sediment EQS (NSE 2014).

As described in Section D.3.2, three parameters (arsenic, iron and manganese) were identified for comparison as they were above their respective Freshwater Sediment EQS. Information on these metals in soils was drawn from the Touquoy Environmental Assessment Registration Document (CRA 2007a), the Touquoy Focus Report (CRA 2007b) and The Background Update for Phase II Environmental Site Assessment at the Former Moose River and Former G&K Mining Stamp Mills, Touquoy Gold Project, Moose River, NS (Stantec 2018a). The soil quality data presented in the Touquoy Focus Report were limited to arsenic, however, additional metals were analyzed in the same soil samples and data were

obtained from Jeff Parks (personal communication). The results for samples collected in the local area are presented on Table D.2. The baseline data indicates that arsenic, iron and manganese concentrations in soil vary widely along WC4.

The following baseline concentrations in soils near WC4 were determined to represent pre-construction soil levels in arsenic, iron, and manganese for comparison with sediment concentrations for these metals in WC4 collected in the present study:

- An arsenic baseline concentration of 300 mg/kg in soil was applied based on the upper limit of naturally occurring concentrations of arsenic in soils (i.e., excluding historical tailings) in the local area (range <2 to 300 mg/kg) (CRA 2007; Stantec 2018a; Stantec 2017).
- An iron baseline concentration of 51,100 mg/kg was applied based on the maximum of the natural range of naturally occurring concentrations of iron in soils near WC4; the naturally occurring range of concentrations in the local area is 1,000 to 83,600 mg/kg (Parks 2019, personal communication; Table D.2).
- A manganese baseline concentration of 290 mg/kg was applied based on the maximum of the natural range of naturally occurring concentrations of manganese near WC4; the naturally occurring range of concentrations in the local area is 15 to 4,350 mg/kg (Parks 2019, personal communication; Table D.2).

Table D.2 Pre-Operation Baseline Soil Quality Concentrations in the Local Area (Parks 2019, personal communication)

Sample ID	Northing (NAD83 UTM Zone 21N)	Easting (NAD83 UTM Zone 21N)	As (mg/kg)	Fe (mg/kg)	Mn (mg/kg)
NSE Tier 1 EQS (Sediment)			**17**	**43766**	**1100**
SS-07-58	4980492	504584	39	11200	150
SS-07-59	4980677	504505	31	28100	78
SS-07-60	4981442	504258	11	32400	198
SS-07-61*	4981528	504217	4550	47100	245
SS-07-62	4980547	504763	34	21700	161
SS-07-63	4980739	504698	23	26100	266
SS-07-64	4981494	504447	21	49200	353
SS-07-65	4981592	504412	107	52300	649
SS-07-66	4980607	504946	8	17000	274
SS-07-67	4980789	504884	30	51500	200
SS-07-68	4980994	504825	144	32500	838
SS-07-69	4981369	504703	88	20900	405
SS-07-70	4981461	504670	34	34200	173
SS-07-71	4981561	504645	90	21200	232
SS-07-72	4982514	504327	<2	1200	34
SS-07-73	4980912	504959	19	20500	303

Table D.2 Pre-Operation Baseline Soil Quality Concentrations in the Local Area (Parks 2019, personal communication)

Sample ID	Northing (NAD83 UTM Zone 21N)	Easting (NAD83 UTM Zone 21N)	As (mg/kg)	Fe (mg/kg)	Mn (mg/kg)
NSE Tier 1 EQS (Sediment)			**17**	**43766**	**1100**
SS-07-74	4980912	504959	17	19800	286
SS-07-75	4981007	504916	31	22100	738
SS-07-76	4981404	504801	27	26500	528
SS-07-77	4981492	504764	17	49200	136
SS-07-78	4980852	505073	28	35000	705
SS-07-79	4981714	504809	13	21700	4350
SS-07-80	4981805	504774	4	11900	316
SS-07-81	4981912	504745	11	28100	436
SS-07-82	4981912	504745	9	26500	432
SS-07-83	4981996	504706	7	26600	1085
SS-07-84	4982095	504682	8	21300	804
SS-07-85	4982193	504642	7	26300	1290
SS-07-86	4982380	504581	<2	15200	248
SS-07-87	4982572	504509	4	8800	114
SS-07-88	4980356	505455	23	40500	257
SS-07-89	4980546	505390	20	28800	287
SS-07-90	4980729	505335	4	19200	241
SS-07-91	4980922	505273	8	19100	290
SS-07-92	4981116	505214	31	56300	263
SS-07-93	4981305	505144	120	38400	450
SS-07-94	4981472	505084	18	44900	276
SS-07-95	4981684	505013	8	27000	1575
SS-07-96	4981799	504992	8	29500	920
SS-07-97	4981857	504954	8	27500	412
SS-07-98	4981959	504927	10	29600	424
SS-07-99	4982064	504898	7	14800	181
SS-07-100	4982149	504872	14	24000	405
SS-07-101	4982262	504827	3	15800	258
SS-07-102	4982450	504777	9	24400	327
SS-07-103	4982632	504704	4	16800	201

Table D.2 Pre-Operation Baseline Soil Quality Concentrations in the Local Area (Parks 2019, personal communication)

Sample ID	Northing (NAD83 UTM Zone 21N)	Easting (NAD83 UTM Zone 21N)	As (mg/kg)	Fe (mg/kg)	Mn (mg/kg)
NSE Tier 1 EQS (Sediment)			**17**	**43766**	**1100**
SS-07-104	4980245	505716	19	43500	163
SS-07-105	4980411	505640	5	21700	180
SS-07-106	4980992	505463	11	30100	74
SS-07-107	4981180	505403	38	41800	156
SS-07-108	4981558	505268	24	36000	197
SS-07-109	4981741	505208	10	22800	597
SS-07-110	4981839	505194	5	14700	511
SS-07-111	4981938	505143	9	29400	494
SS-07-112	4982020	505116	8	20900	1200
SS-07-113	4982133	505082	15	31900	1145
SS-07-114	4982224	505049	11	26100	765
SS-07-115	4982313	505031	2	23400	500
SS-07-116	4982513	504972	9	29600	421
SS-07-117	4980092	505965	9	14700	237
SS-07-118	4980295	505900	13	30800	83
SS-07-119	4980482	505840	4	13200	193
SS-07-120	4981043	505650	6	10800	48
SS-07-121	4981237	505594	62	50900	234
SS-07-122	4981417	505534	71	51100	171
SS-07-123	4981623	505440	116	28700	80
SS-07-124	4981810	505394	4	11100	123
SS-07-125	4981999	505343	9	18200	244
SS-07-126	4982180	505277	16	51100	180
SS-07-127	4982403	505212	<2	8900	62
SS-07-128	4982572	505152	5	37900	421
SS-07-129	4979964	506225	9	35500	497
SS-07-130	4980163	506152	4	21500	327
SS-07-131	4980342	506077	3	23800	488
SS-07-132	4980529	506035	<2	19100	91
SS-07-133	4980733	505954	8	29300	72

Table D.2 Pre-Operation Baseline Soil Quality Concentrations in the Local Area (Parks 2019, personal communication)

Sample ID	Northing (NAD83 UTM Zone 21N)	Easting (NAD83 UTM Zone 21N)	As (mg/kg)	Fe (mg/kg)	Mn (mg/kg)
NSE Tier 1 EQS (Sediment)			**17**	**43766**	**1100**
SS-07-134	4981113	505835	6	33500	111
SS-07-135	4981488	505719	25	29500	794
SS-07-136	4981695	505632	33	25900	108
SS-07-137	4981865	505593	11	35200	200
SS-07-138	4982060	505524	9	31400	276
SS-07-139	4982270	505476	11	46600	195
SS-07-140	4982445	505397	12	28500	405
SS-07-141	4980035	506399	21	83600	101
SS-07-142	4980791	506152	12	20200	261
SS-07-143	4980791	506152	2	22000	256
SS-07-144	4980982	506084	7	40000	354
SS-07-145	4981162	506026	11	37400	231
SS-07-146	4981360	505953	5	16900	126
SS-07-147	4981540	505911	10	24500	635
SS-07-148	4981738	505841	18	46700	215
SS-07-149	4981945	505769	<2	11200	159
SS-07-150	4982122	505717	7	28900	194
SS-07-151	4982298	505646	6	32300	370
SS-07-152	4980473	506467	<2	1000	27
SS-07-153	4980646	506405	15	35300	112
SS-07-154	4980852	506341	<2	1900	27
SS-07-155	4981046	506288	5	34600	277
SS-07-156	4981218	506219	4	36000	262
SS-07-157	4981420	506165	18	40900	210
SS-07-158	4981808	506031	8	36200	204
SS-07-159	4981989	505971	6	23200	197
SS-07-160	4980184	506787	5	21700	49
SS-07-161	4980718	506602	12	30600	106
SS-07-162	4980901	506528	5	13700	107
SS-07-163	4981300	506410	15	26100	421

Table D.2 Pre-Operation Baseline Soil Quality Concentrations in the Local Area (Parks 2019, personal communication)

Sample ID	Northing (NAD83 UTM Zone 21N)	Easting (NAD83 UTM Zone 21N)	As (mg/kg)	Fe (mg/kg)	Mn (mg/kg)
NSE Tier 1 EQS (Sediment)			**17**	**43766**	**1100**
SS-07-164	4981496	506333	7	16800	249
SS-07-165	4981682	506285	4	19300	284
SS-07-166	4981866	506216	11	26500	251
SS-07-167	4982055	506151	11	18000	203
SS-07-168	4982055	506151	11	21500	281
SS-07-169	4980593	506821	6	32500	84
SS-07-170	4980795	506784	9	47000	111
SS-07-171	4980970	506734	<2	1000	13
SS-07-172	4980970	506734	<2	1800	15
SS-07-173	4981348	506606	18	22500	231
SS-07-174	4981548	506537	3	10400	156
SS-07-175	4981732	506486	5	13300	228
SS-07-176	4981931	506407	9	24700	346

Note: **Bold** indicates sample near WC4; Sample ID SS-07-61 not included in baseline soil concentrations as it was located near the old McGregor Stamp Mill

D.3 RESULTS

This section describes the results of water and sediment chemistry as it relates to the fish habitat assessment in the main document.

D.3.1 Water Chemistry

Results of the water quality samples are provided in Table D.3. These results were compared to the applicable Tier 1 EQS Freshwater or CWQG PAL and baseline concentrations as explained in Section D.2.2.

A background water sample was planned for collection upstream of the Admin Road at the time of the sampling as WC4 but was not collected because the channel was dry at that location.

There were no exceedances of the Tier 1 EQS Freshwater in surface water for total antimony, beryllium, boron, copper, lead, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium and zinc.

The following parameters were above the Tier 1 EQS Freshwater:

- Total aluminum at all eleven locations (Table D.3, Figure D.1);
- Total cadmium at nine of eleven locations (Table D.3, Figure D.2);
- Total iron at four of eleven locations (Table D.3, Figure D.3);
- Total manganese at two of eleven locations (Table D.3, Figure D.4); and
- Total arsenic at seven of eleven locations, however, only two of eleven locations were above the proposed site-specific guideline (Intrinsik 2019; Table D.3, Figure D.5),

The following parameters were above the average or maximum observed baseline IA concentrations in WC4:

- Total cadmium at two of eleven stations (WC4+25W and WC4+200W) were above the average and baseline IA concentration at SW23 the nearest upstream station, with one sample above the maximum baseline IA concentration, but were not above the maximum within WC4 when compared to WC4 as a whole.
- Total iron at three of eleven stations (WC4+25W, WC4+200W and WC4+1400S) were above the average baseline concentrations for iron at the nearest upstream station but were not above the maximum within WC4 when compared to WC4 as a whole.
- Total manganese at two of eleven stations were above the average and maximum concentrations for manganese at SW23, and seven out of eleven were above the baseline IA average but not the maximum. None were above the maximum baseline IA manganese concentrations when compared to WC4 as a whole.
- Total arsenic at six of eleven stations were above the baseline IA average concentrations for arsenic, and above the maximum at SW23 at two of eleven stations. None were above the maximum baseline IA arsenic concentrations when compared to WC4 as a whole.

The increased concentrations of trace metals at WC4+25W may have been a result of the presence of a brown precipitate within the vicinity of where the sample was collected (Appendix C, Table C.2.). No precipitate was noted at WC4+200W.

Table D.3 Water Quality Sample Results from Watercourse 4, Touquoy Mine, Nova Scotia

BV Labs ID			KLL137	KLL138	KLL139	KLL140	KLL141	KNX302	KNX301	KLL142	KLL143	KLL144	KLL145	Reporting Detection Limit
Sampling Date			7/31/2019	7/31/2019	7/31/2019	7/31/2019	8/1/2019	8/14/2019	8/14/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	
COC Number			D41109	D41109	D41109	D41109	D41109	D38698	D38698	D41109	D41109	D41109	D41109	
Sample ID			WC4-2	WC4-3	WC4-4	WC4-5	WC4-6	WC4-07	WC4-07A	WC4-8	WC4-9	WC4-10	WC4-11	
Location ID			WC4+25W	WC4+200W	WC4+400W	WC4+600W	WC4+800W	WC4+1000W	WC4+1200W	WC4+1400W	WC4+1600W	WC4+1800W	WC4+2000W	
Calculated Parameters	**UNITS**	**Tier 1 EQS**												
Anion Sum	me/L	-	2.44	1.52	19.0	15.9	14.7	10.3	11.3	9.23	8.15	7.48	7.12	N/A
Bicarb. Alkalinity (calc. as CaCO3)	mg/L	-	48	33	120	84	84	84	83	70	71	60	57	1
Calculated TDS	mg/L	-	150	91	1200	1100	980	670	730	610	520	480	460	1
Carb. Alkalinity (calc. as CaCO3)	mg/L	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1
Cation Sum	me/L	-	2.73	1.47	18.8	17.0	15.7	10.5	11.6	9.76	8.39	7.90	7.34	N/A
Hardness (CaCO3)	mg/L	-	100	53	900	820	750	500	550	460	390	370	340	1
Ion Balance (% Difference)	%	-	5.61	1.67	0.530	3.37	3.19	1.15	1.23	2.79	1.45	2.73	1.52	N/A
Langelier Index (@ 20C)	N/A	-	-1.20	-1.70	0.569	0.323	0.0990	0.356	0.172	0.199	0.152	0.155	-0.222	
Langelier Index (@ 4C)	N/A	-	-1.45	-1.95	0.324	0.0770	-0.147	0.109	-0.0760	-0.0490	-0.096	-0.093	-0.470	
Nitrate (N)	mg/L	-	<0.050	0.11	2.9	1.9	1.5	1.0	1.1	0.81	0.19	<0.050	0.11	0.05
Saturation pH (@ 20C)	N/A	-	8.23	8.66	7.04	7.22	7.25	7.38	7.36	7.49	7.53	7.62	7.68	
Saturation pH (@ 4C)	N/A	-	8.48	8.91	7.28	7.46	7.49	7.63	7.61	7.74	7.78	7.87	7.93	
Total Alkalinity (Total as CaCO3)	mg/L	-	48	33	120	85	84	85	83	70	72	60	57	5
Dissolved Chloride (Cl-)	mg/L	-	44	26	10	10	9.5	16	17	12	14	15	13	1
Colour	TCU	-	46	48	11	14	12	10	12	14	17	18	16	5
Nitrate + Nitrite (N)	mg/L	-	<0.050	0.11	3.0	1.9	1.5	1.0	1.1	0.82	0.19	<0.050	0.11	0.05
Nitrite (N)	mg/L	-	<0.010	<0.010	0.017	<0.010	<0.010	<0.010	<0.010	0.011	<0.010	<0.010	<0.010	0.01
Nitrogen (Ammonia Nitrogen)	mg/L	-	0.14	0.40	<0.050	<0.050	0.055	<0.050	0.079	0.094	0.066	<0.050	0.073	0.05
Total Organic Carbon (C)	mg/L	-	5.6	7.3	4.4	4.6	5.3	3.8	3.9	4.9	6.0	6.9	5.4	0.5
Orthophosphate (P)	mg/L	-	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010	0.01
pH	pH	-	7.03	6.96	7.60	7.54	7.35	7.74	7.53	7.69	7.68	7.78	7.46	N/A
Reactive Silica (SiO2)	mg/L	-	6.1	7.5	7.1	6.8	6.0	6.8	7.2	5.2	3.7	2.1	3.0	0.5
Dissolved Sulphate (SO4)	mg/L	-	11	5.9	770	660	610	390	440	360	300	280	270	10
Turbidity	NTU	varies[a]	**7.9**	**4.0**	**3.5**	0.52	**4.8**	0.52	0.81	**3.6**	1.8	1.3	0.96	0.1
Conductivity	uS/cm	-	260	150	1600	1400	1300	980	1000	860	750	710	680	1
Total Aluminum (Al)	ug/L	5	**92**	**93**	**29**	**43**	**170**	**18**	**16**	**450**	**47**	**32**	**27**	5
Total Antimony (Sb)	ug/L	20	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1
Total Arsenic (As)	ug/L	5.0	**72**	**24**	4.7	3.6	**6.8**	3.9	4.9	**29**	**33**	**15**	**13**	1
Total Barium (Ba)	ug/L	1000	30	12	55	57	52	34	38	27	19	18	19	1
Total Beryllium (Be)	ug/L	5.3	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1
Total Bismuth (Bi)	ug/L	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2

Table D.3 Water Quality Sample Results from Watercourse 4, Touquoy Mine, Nova Scotia

BV Labs ID			KLL137	KLL138	KLL139	KLL140	KLL141	KNX302	KNX301	KLL142	KLL143	KLL144	KLL145	Reporting Detection Limit
Sampling Date			7/31/2019	7/31/2019	7/31/2019	7/31/2019	8/1/2019	8/14/2019	8/14/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	
COC Number			D41109	D41109	D41109	D41109	D41109	D38698	D38698	D41109	D41109	D41109	D41109	
Sample ID			WC4-2	WC4-3	WC4-4	WC4-5	WC4-6	WC4-07	WC4-07A	WC4-8	WC4-9	WC4-10	WC4-11	
Location ID			WC4+25W	WC4+200W	WC4+400W	WC4+600W	WC4+800W	WC4+1000W	WC4+1200W	WC4+1400W	WC4+1600W	WC4+1800W	WC4+2000W	
Calculated Parameters	**UNITS**	**Tier 1 EQS**												
Total Boron (B)	ug/L	1200	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	50
Total Cadmium (Cd)	ug/L	0.01	**0.051**	**0.040**	**0.021**	**0.031**	**0.030**	**0.018**	**0.023**	**0.017**	**0.013**	<0.010	<0.010	0.01
Total Calcium (Ca)	ug/L	-	28000	14000	290000	260000	240000	160000	170000	140000	120000	120000	110000	100
Total Chromium (Cr)	ug/L	-	<1.0	<1.0	1.1	<1.0	1.3	<1.0	<1.0	1.2	<1.0	2.4	<1.0	1
Total Cobalt (Co)	ug/L	10	14	5.9	0.93	0.99	1.4	0.93	1.3	1.4	0.55	0.46	0.40	0.4
Total Copper (Cu)	ug/L	2	1.3	0.61	<0.50	<0.50	0.51	1.0	<0.50	0.87	0.55	0.84	0.53	0.5
Total Iron (Fe)	ug/L	300	**4300**	**1400**	160	130	**600**	130	230	**1300**	230	120	120	50
Total Lead (Pb)	ug/L	1	<0.50	0.52	<0.50	<0.50	<0.50	<0.50	<0.50	0.54	<0.50	<0.50	<0.50	0.5
Total Magnesium (Mg)	ug/L	-	7300	4100	45000	41000	39000	25000	28000	24000	20000	19000	18000	100
Total Manganese (Mn)	ug/L	820	**3800**	**3200**	380	240	280	420	410	690	320	230	310	2
Total Molybdenum (Mo)	ug/L	73	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2
Total Nickel (Ni)	ug/L	25	10	2.4	3.5	<2.0	2.2	2.3	2.5	2.4	<2.0	<2.0	<2.0	2
Total Phosphorus (P)	ug/L	-	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	<100	100
Total Potassium (K)	ug/L	-	830	670	9400	8100	7600	5100	5500	4800	4200	4000	3800	100
Total Selenium (Se)	ug/L	1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<0.50	<0.50	<1.0	<1.0	<1.0	<1.0	1
Total Silver (Ag)	ug/L	0.1	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.1
Total Sodium (Na)	ug/L	-	12000	7500	11000	10000	9900	12000	11000	11000	10000	10000	9400	100
Total Strontium (Sr)	ug/L	21000	84	46	700	630	580	370	410	340	290	270	250	2
Total Thallium (Tl)	ug/L	0.8	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.1
Total Tin (Sn)	ug/L	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2
Total Titanium (Ti)	ug/L	-	2.4	2.8	<2.0	<2.0	<2.0	<2.0	<2.0	4.4	<2.0	<2.0	<2.0	2
Total Uranium (U)	ug/L	300	<0.10	<0.10	4.4	3.6	3.2	1.4	1.6	1.4	0.89	0.62	0.51	0.1
Total Vanadium (V)	ug/L	6	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2
Total Zinc (Zn)	ug/L	30	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0	5

Note: **Bold** font indicates exceedance of applicable Canadian Water Quality Guidelines for the Protection of Aquatic Life (freshwater; CWQG PAL) or Nova Scotia Tier 1 Environmental Quality Standards (EQS) Freshwater
[a]CWQG PAL for short-term turbidity exposure (e.g., 24 hours) is 8 NTU and long-term turbidity exposure (e.g., 30 days) is 2 NTU.

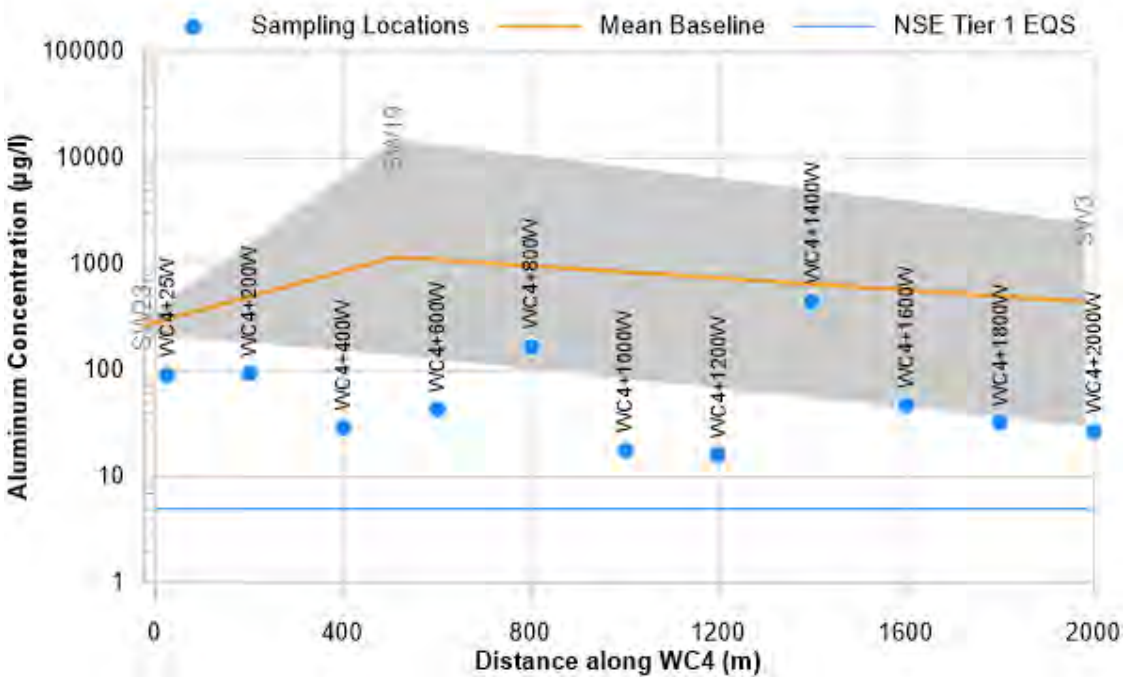

Figure D.1 **Concentrations of Total Aluminum in WC4 Surface Water** (Range of Baseline IA Shaded in Grey Derived from Stantec 2019b and Summarized in Table D.1)

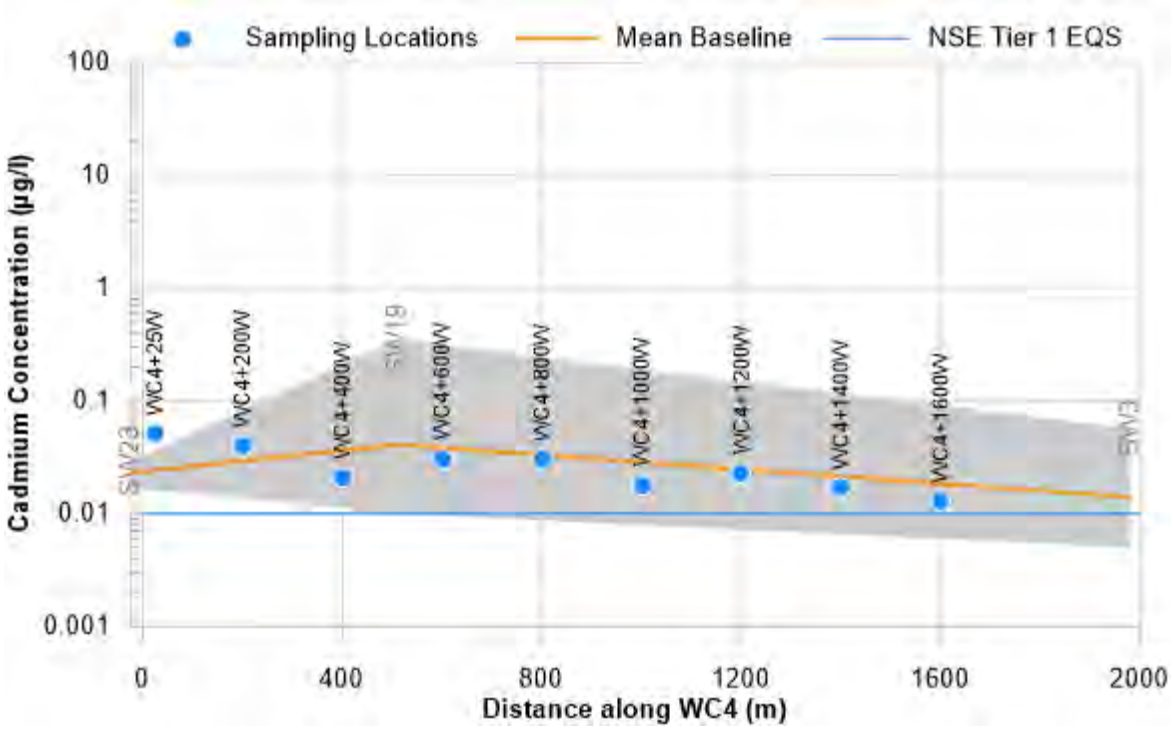

Figure D.2. **Concentrations of Total Cadmium in WC4 Surface Water** (Range of Baseline IA Shaded in Grey Derived from Stantec 2019b and Summarized in Table D.1)

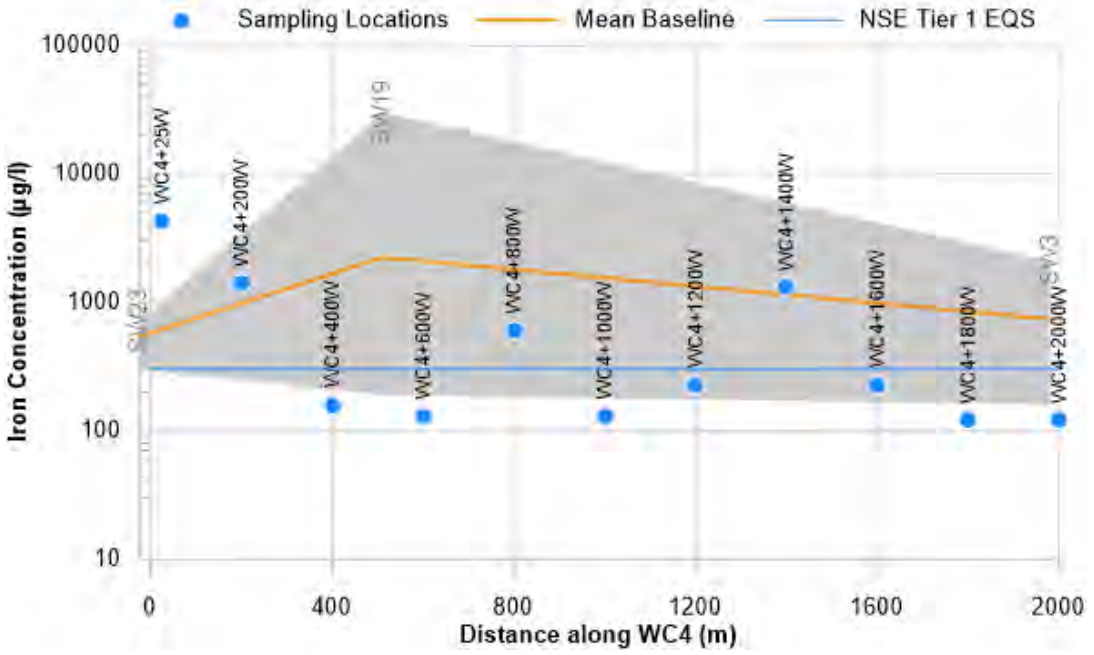

Figure D.3. Concentrations of Total Iron in WC4 Surface Water (Range of Baseline IA Shaded in Grey Derived from Stantec 2019b and Summarized in Table D.1)

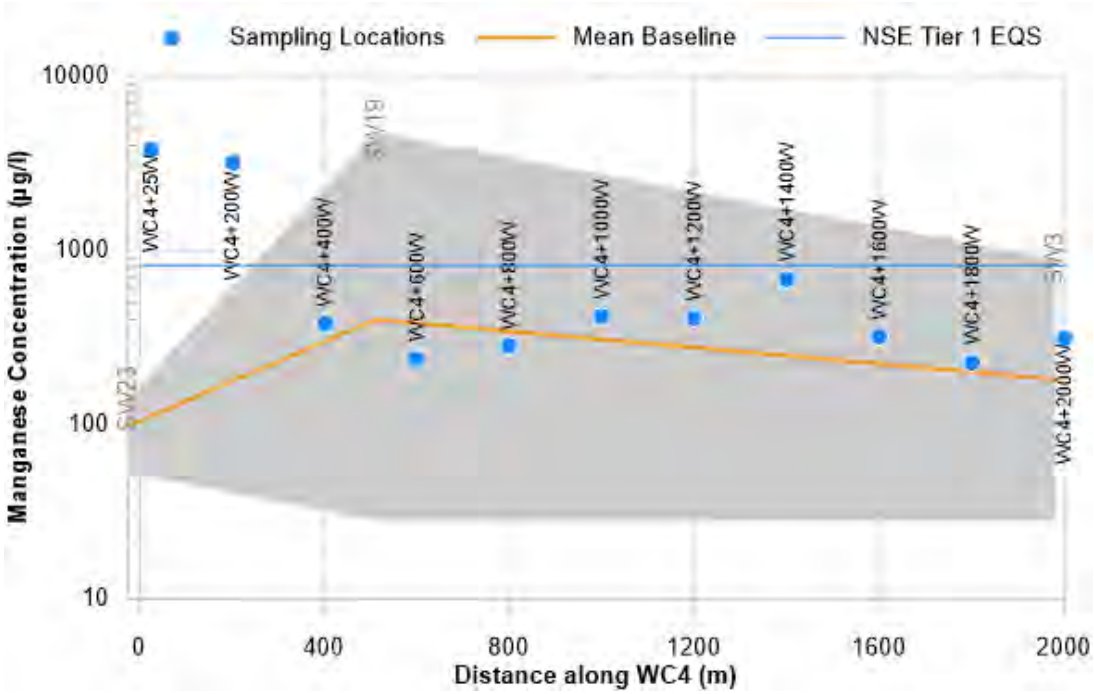

Figure D.4. Concentrations of Total Manganese in WC4 Surface Water (Range of Baseline IA Shaded in Grey Derived from Stantec 2019b and Summarized in Table D.1)

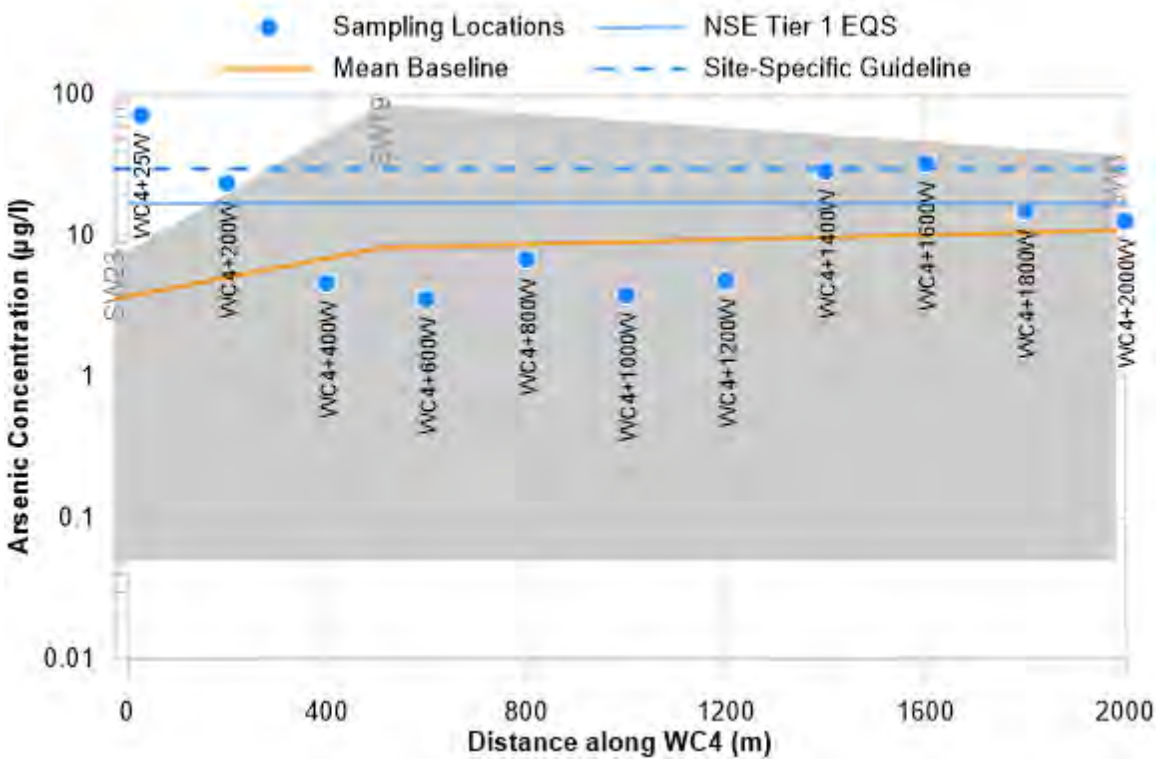

Figure D.5. Concentrations of Total Arsenic in WC4 Surface Water (Range of Baseline IA Shaded in Grey Derived from Stantec 2019b and Summarized in Table D.1)

For turbidity there were no exceedances of the CWQG PAL short-term turbidity guideline at the time of sampling, but there were exceedances of the CWQG PAL long-term turbidity guideline at five of eleven sampling locations.

Turbidity at two of eleven sampling stations were above the average and maximum baseline IA concentration at SW23 at the upstream most station and were not above the maximum when compared to WC4 as a whole (Figure D.6).

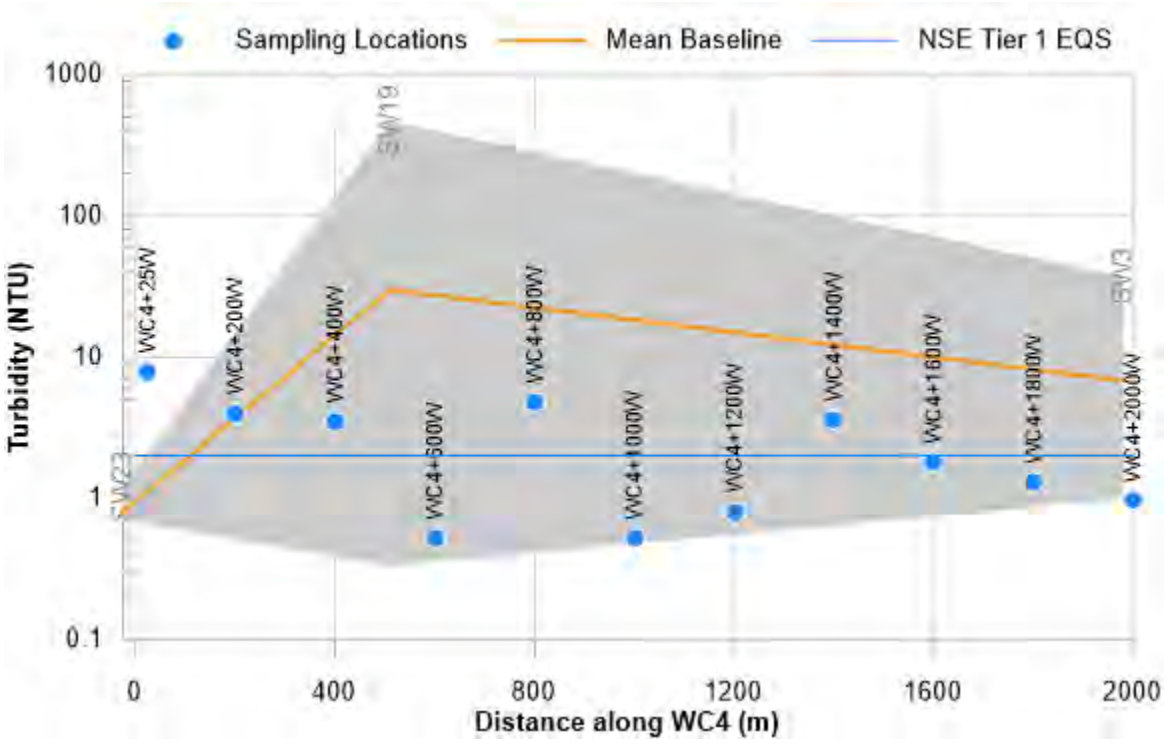

Figure D.6 **Turbidity Concentrations in WC4 Surface Water** (Range of Baseline IA Shaded in Grey Derived from Stantec 2019b)

D.3.2 Sediment Chemistry

The results for the sediment samples submitted are provided in Table D.4. The results were compared to applicable freshwater sediment EQS guidelines and baseline concentrations as explained in Section D.2.2.

Twelve sediment samples were collected at approximately 200 m intervals along WC4 from stream sediments (i.e., “Interval samples”) and are identified as follows: WC4+0S, WC4+25S, WC4+200S, WC4+400S, WC4+600S, WC4+800S, WC4+1000S, WC4+1200S, WC4+1400S, WC4+1600S, WC4+1800S and WC4+2000S.

Five additional silt samples were collected from depositional areas of fine grey silt (i.e., “Targeted silt samples”) as follows:

- WC4+15S was collected from a siltation retention pond upstream of the Admin Road (Appendix B, Photo 50),
- WC4+790S was collected immediately downstream of the Waste Rock Haul Road at Culvert 4A (Appendix B, Photo 51),
- WC4+1030S was collected from silt deposited along the edge of WC4 (Appendix B, Photo 52),
- WC4+1650S was collected from the substrate in WC4 within wetland 6 (Appendix B, Photo 53),
- WC4+1930S was collected from the fine silt between rock substrates within WC4 (Appendix B, Photo 54).

Concentrations of acid extractable antimony, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc in silt and sediment were below the freshwater sediment EQS in all samples.

The following parameters were above the freshwater sediment EQS:

- Total acid extractable arsenic all seventeen locations (Figure D.7);
- Total acid extractable iron at eleven out of seventeen locations (Figure D.8); and
- Total acid extractable manganese at thirteen of seventeen locations (Figure D.9).

The following parameters were above baseline soil concentrations:

- Total acid extractable arsenic at two of seventeen locations were above the baseline concentration for the study area (Figure D.7);
- Total acid extractable iron at six of seventeen stations were above the baseline concentration for WC4 (Figure D.8), however were not above the maximum within the study area;
- Total acid extractable manganese at all of seventeen locations were above the baseline concentration for WC4 (Figure D.9), and four out of seventeen were above the maximum within the study area.

Targeted silt samples do not appear to contain higher concentrations of arsenic, iron and manganese when compared to interval samples, suggesting no direct relationship between the grey silt that was deposited and the elevated metal concentrations identified in sediment. The results suggest that concentrations of arsenic, iron and manganese generally reflect the local surficial geology. However, manganese concentrations within sediments are higher than the baseline soil concentrations near WC4.

Table D.4 Sediment Chemistry Sample Results from Watercourse 4, Touquoy Mine, Nova Scotia

BV Labs ID			KLJ028	KRE265	KLI983	KLI984	KLI985	KLI986	KRE264	KLI987	KNX669	KNX671	KNX670	KLI988	KLI989	KLJ027	KLI990	KLI992	KLI991	Reporting Detection Limit
Sampling Date			8/1/2019	8/1/2019	7/31/2019	7/31/2019	7/31/2019	7/31/2019	8/1/2019	8/1/2019	8/14/2019	8/14/2019	8/14/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	
COC Number			D41111	D37852	D41110	D41110	D41110	D41110	D37852	D41110	D38697	D38697	D38697	D41110	D41110	D41111	D41110	D41110	D41110	
Sample ID			WC4-01	WC4-15	WC4-2	WC4-3	WC4-4	WC4-5	WC4-14	WC4-6	WC4-07A	WC4-15	WC4-07	WC4-8	WC4-9	WC4-13	WC4-10	WC4-12	WC4-11	
Location ID			WC4+0 S	WC4+15 S	WC4+25 S	WC4+200 S	WC4+400 S	WC4+600 S	WC4+790 S	WC4+800 S	WC4+1000 S	WC4+1030 S	WC4+1200 S	WC4+1400 S	WC4+1600 S	WC4+1650 S	WC4+1800 S	WC4+1930 S	WC4+2000 S	
Parameter	**Unit**	**EQS FS**																		
Acid Extractable Aluminum (Al)	mg/kg	-	15000	27000	18000	13000	14000	17000	24000	16000	21000	20000	23000	29000	22000	21000	28000	26000	17000	10
Acid Extractable Antimony (Sb)	mg/kg	25	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2
Acid Extractable Arsenic (As)	mg/kg	17	**99**	**150**	**430**	**87**	**150**	**63**	**94**	**670**	**220**	**210**	**110**	**130**	**150**	**93**	**200**	**210**	**200**	2
Acid Extractable Barium (Ba)	mg/kg	-	16	35	80	110	100	30	23	48	41	55	45	68	55	51	130	140	160	5
Acid Extractable Beryllium (Be)	mg/kg	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2
Acid Extractable Bismuth (Bi)	mg/kg	-	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2
Acid Extractable Boron (B)	mg/kg	-	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	<50	50
Acid Extractable Cadmium (Cd)	mg/kg	3.5	<0.30	<0.30	0.38	0.72	0.89	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	<0.30	0.33	0.31	0.66	0.85	0.55	0.3
Acid Extractable Chromium (Cr)	mg/kg	90	19	33	22	12	13	20	27	19	24	24	26	33	25	25	29	27	22	2
Acid Extractable Cobalt (Co)	mg/kg	-	6.9	20	130	24	50	13	16	40	25	31	20	23	19	17	59	65	49	1
Acid Extractable Copper (Cu)	mg/kg	197	3.8	27	11	20	23	6.0	20	10	31	28	23	25	23	22	29	27	23	2

BV Labs ID			KLJ028	KRE265	KLI983	KLI984	KLI985	KLI986	KRE264	KLI987	KNX669	KNX671	KNX670	KLI988	KLI989	KLJ027	KLI990	KLI992	KLI991	Reporting Detection Limit
Sampling Date			8/1/2019	8/1/2019	7/31/2019	7/31/2019	7/31/2019	7/31/2019	8/1/2019	8/1/2019	8/14/2019	8/14/2019	8/14/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	
COC Number			D41111	D37852	D41110	D41110	D41110	D41110	D37852	D41110	D38697	D38697	D38697	D41110	D41110	D41111	D41110	D41110	D41110	
Sample ID			WC4-01	WC4-15	WC4-2	WC4-3	WC4-4	WC4-5	WC4-14	WC4-6	WC4-07A	WC4-15	WC4-07	WC4-8	WC4-9	WC4-13	WC4-10	WC4-12	WC4-11	
Location ID			WC4+0 S	WC4+15 S	WC4+25 S	WC4+200 S	WC4+400 S	WC4+600 S	WC4+790 S	WC4+800 S	WC4+1000 S	WC4+1030 S	WC4+1200 S	WC4+1400 S	WC4+1600 S	WC4+1650 S	WC4+1800 S	WC4+1930 S	WC4+2000 S	
Parameter	**Unit**	**EQS FS**																		
Acid Extractable Iron (Fe)	mg/kg	43766	30000	**55000**	**54000**	20000	29000	34000	**48000**	**56000**	**45000**	**45000**	**46000**	**59000**	**47000**	43000	**57000**	**53000**	43000	50
Acid Extractable Lead (Pb)	mg/kg	91.3	12	22	31	29	47	14	14	23	16	20	14	18	23	21	33	33	29	0.5
Acid Extractable Lithium (Li)	mg/kg	-	27	47	33	16	16	27	41	26	36	35	40	48	36	35	43	39	31	2
Acid Extractable Manganese (Mn)	mg/kg	1100	420	870	**11000**	**1700**	**2900**	**2200**	1100	**4300**	**2000**	**3500**	**1500**	**1600**	1100	**1200**	**9600**	**11000**	**12000**	2
Acid Extractable Mercury (Hg)	mg/kg	0.486	<0.10	<0.10	<0.10	0.26	0.23	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.10	0.13	0.12	0.13	0.11	0.1
Acid Extractable Molybdenum (Mo)	mg/kg	-	<2.0	<2.0	<2.0	<2.0	2.2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	2.8	2
Acid Extractable Nickel (Ni)	mg/kg	75	18	41	30	17	33	22	33	23	35	32	32	41	37	33	57	54	40	2
Acid Extractable Rubidium (Rb)	mg/kg	-	2.5	6.9	3.1	5.0	6.1	3.2	4.3	<2.0	4.6	5.0	5.2	6.5	6.3	6.3	9.6	8.7	7.1	2
Acid Extractable Selenium (Se)	mg/kg	2	<1.0	<1.0	<1.0	1.9	1.2	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	1
Acid Extractable Silver (Ag)	mg/kg	1	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	0.5
Acid Extractable Strontium (Sr)	mg/kg	-	<5.0	15	9.2	34	40	13	17	8.8	14	15	13	10	25	14	24	24	22	5

BV Labs ID			KLJ028	KRE265	KLI983	KLI984	KLI985	KLI986	KRE264	KLI987	KNX669	KNX671	KNX670	KLI988	KLI989	KLJ027	KLI990	KLI992	KLI991	Reporting Detection Limit
Sampling Date			8/1/2019	8/1/2019	7/31/2019	7/31/2019	7/31/2019	7/31/2019	8/1/2019	8/1/2019	8/14/2019	8/14/2019	8/14/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	8/1/2019	
COC Number			D41111	D37852	D41110	D41110	D41110	D41110	D37852	D41110	D38697	D38697	D38697	D41110	D41110	D41111	D41110	D41110	D41110	
Sample ID			WC4-01	WC4-15	WC4-2	WC4-3	WC4-4	WC4-5	WC4-14	WC4-6	WC4-07A	WC4-15	WC4-07	WC4-8	WC4-9	WC4-13	WC4-10	WC4-12	WC4-11	
Location ID			WC4+0S	WC4+15S	WC4+25S	WC4+200S	WC4+400S	WC4+600S	WC4+790S	WC4+800S	WC4+1000S	WC4+1030S	WC4+1200S	WC4+1400S	WC4+1600S	WC4+1650S	WC4+1800S	WC4+1930S	WC4+2000S	
Parameter	**Unit**	**EQS FS**																		
Acid Extractable Thallium (Tl)	mg/kg	-	<0.10	<0.10	0.22	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	0.15	0.20	0.17	0.1
Acid Extractable Tin (Sn)	mg/kg	-	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	2.4	<1.0	<1.0	<1.0	2.0	1
Acid Extractable Uranium (U)	mg/kg	-	0.68	1.0	0.64	1.1	5.6	2.2	0.78	1.0	1.1	1.2	0.88	1.3	2.6	1.7	4.0	3.3	2.5	0.1
Acid Extractable Vanadium (V)	mg/kg	-	14	22	18	11	14	15	18	18	18	19	19	24	19	18	25	23	20	2
Acid Extractable Zinc (Zn)	mg/kg	315	61	110	83	65	79	82	98	85	96	100	97	120	110	100	160	170	120	5

Note: **Bold** font indicates exceedance of Nova Scotia Environmental Quality Standards (EQS) for Freshwater Sediment (FS)

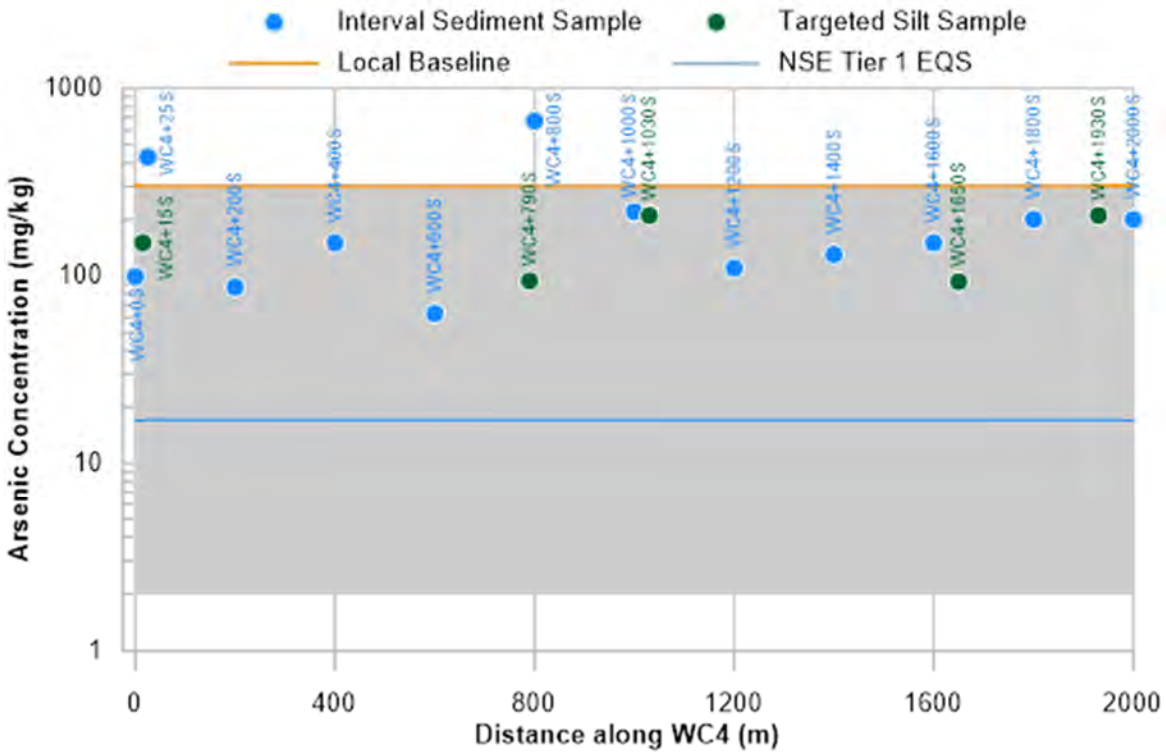

Figure D.7 **Concentrations of Total Extractable Arsenic in WC4 Sediment** (Baseline Soil Range Shaded in Grey Derived from CRA 2007 and Stantec 2018a)

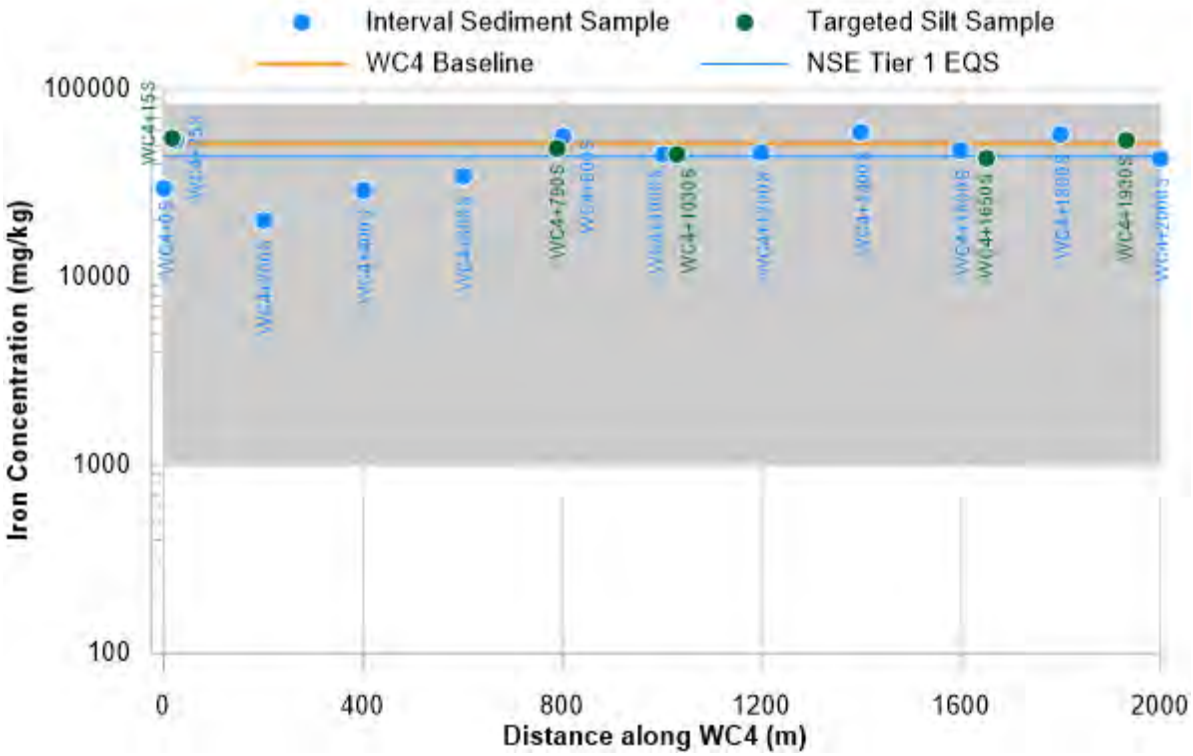

Figure D.8 **Concentrations of Total Extractable Iron in WC4 Sediment** (Baseline Soil Range Shaded in Grey Derived from Parks 2019, personal communication)

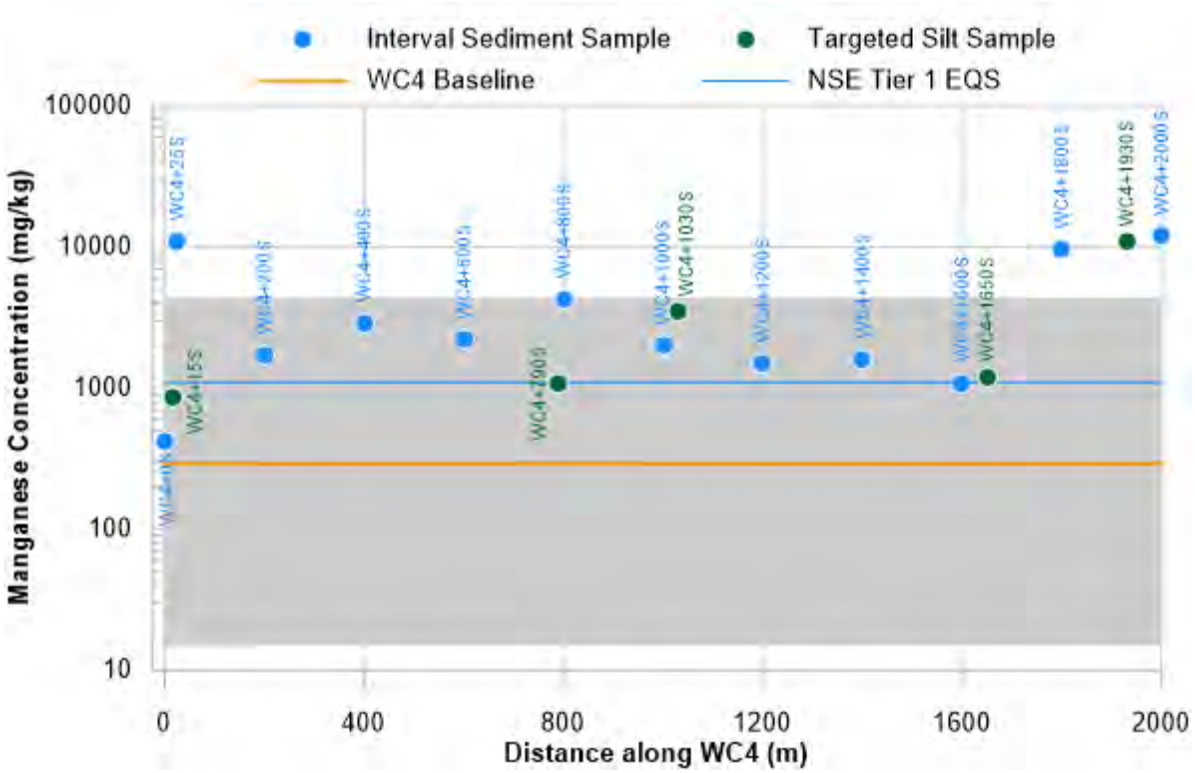

Figure D.9 Concentrations of Total Extractable Manganese in WC4 Sediment (Baseline Soil Range Shaded in Grey Derived from Parks 2019, personal communication)

D.4 SUMMARY AND DISCUSSION

For surface waters, there were no exceedances of the Tier 1 EQS Freshwater in surface water for total antimony, beryllium, boron, copper, lead, molybdenum, nickel, selenium, silver, strontium, thallium, uranium, vanadium and zinc. Concentrations of total aluminum, arsenic, cadmium, iron and manganese were above the Tier 1 ESQ and turbidity was above the long-term CWQG PAL. There were few exceedances when compared to IA baseline concentrations. When compared to the baseline IA concentrations observed in WC4 as a whole, aluminum, arsenic, cadmium, iron, manganese and turbidity were all within the maximum observed ranges.

For further context on arsenic concentrations in water samples, total arsenic is frequently found as soluble arsenic (i.e., dissolved) within the aquatic environment (CCME 2001). The two most common forms of inorganic arsenic are the pentavalent form (arsenate) and trivalent (arsenite) form (Wang et al. 2018). The toxicity of arsenic varies based on its oxidative state (Wang et al. 2018). Arsenate is associated with aerobic conditions and is less acutely and chronically toxic to aquatic life, whereas arsenite is associated with anaerobic conditions and is more toxic to aquatic life (Wang et al. 2018). The in situ water quality data indicate that the waters within WC4 are generally well oxygenated, suggesting that arsenate, which is the less toxic form of arsenic to aquatic life, is likely to be the common form present in WC4.

For sediment, levels of acid extractable antimony, cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc in silt and sediment were below the freshwater sediment EQS in all samples. However, concentrations of acid extractable arsenic, iron and manganese were above the Freshwater sediment EQS for some samples but were generally within the range of local baseline for soils, except for a few samples for arsenic and manganese (Stantec 2018a; Stantec 2017; CRA 2007; Parks 2019, personal communication). Targeted silt samples did not appear to contain higher concentrations of arsenic, iron and manganese when compared to interval samples, suggesting no direct relationship between the grey silt that was deposited and the elevated metal concentrations identified in sediment.

D.5 REFERENCES

References are provided in the main document.