# SD 09

## Monitoring of the Effects of Sediment Deposition in Wetlands 6 and 15, Year 1 (2020)

Atlantic Gold
A St Barbara Ltd Company

# Monitoring of the Effects of Sediment Deposition in Wetlands 6 and 15, Touquoy Mine, Nova Scotia: Year 1 (2020)

Results of the Wetland Monitoring Program Plan for Water Approval – Wetland Alteration #2016-095967-04

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## Table of Contents



**LIST OF FIGURES**



**LIST OF APPENDICES**

# Executive Summary

In 2019, Stantec Consulting Ltd. (Stantec) was retained by Atlantic Mining NS Inc (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) and two associated wetlands (Wetlands 6 and 15) at the Touquoy Mine, Moose River Gold Mines, 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). A site visit was conducted, and a summary report was prepared and submitted to NSE in December 2019. The summary report included recommendations for a multi-year follow-up monitoring program to observe if sediment and erosion control mitigation measures implemented by AMNS have been effective in preventing siltation events and if affected areas are naturally restoring to baseline conditions (Stantec 2019). A detailed wetland monitoring program plan was incorporated into the Water Approval – Wetland Alteration (#2016-095967-04). The follow-up monitoring program is for years one, three, and five after the initial site visit (i.e., 2020, 2022, 2024). This report encompasses Year 1 (2020) of this program.

**Wetland 6**

In Wetland 6, the Year 1 monitoring results undertaken by Stantec for the bog plant community supports the findings of the 2019 site visit. Localized mortality of sphagnum moss was recorded at three locations in Wetland 6. The total affected area as of 2020 was 793 $m^2$. The cover of sphagnum moss in good condition in the affected quadrats was 13% on average as compared to 87% on average in the reference quadrats. Total vascular plant cover in affected quadrats was slightly reduced at 41% on average, as compared with 49% on average in the reference quadrats. There was little change to species richness or plant species composition. Detailed information collected in Year 1 will be compared to similar information collected in Years 3 and 5 to assess the recovery of the open bog plant community.

Comparison of the largely qualitative information collected in 2019 versus the quantitative information collected in 2020 suggests that the condition of the vegetation in the affected areas of the bog have not changed substantively between 2019 and 2020 (Stantec 2019). Qualitative observations of interstitial water turbidity in subsamples of the affected and reference quadrats in 2020 revealed that turbid water was associated with both the affected and reference quadrats although the water in the reference quadrats was generally less turbid than the water in the affected quadrats. The presence of turbid water in both the affected and reference quadrats makes it difficult to attribute the high levels of sphagnum moss mortality entirely to sediment deposition in the bog. Other factors such as dry growing seasons may also cause mortality in sphagnum moss. It is also possible that sphagnum moss mortality in affected areas in 2020 was attributable to a combination of sediment deposition and dry growing conditions.

Quantitative monitoring (rather than qualitative monitoring) of interstitial water turbidity at all of the monitoring quadrats over time would help to more accurately determine whether there are large differences in the amount of sediment in the interstitial water of the affected and reference quadrats. It would also help to determine if the sediment is gradually flushed out of the bog or remains trapped in the sphagnum moss and peat. The scheduled monitoring in the bog community in Years 3 and 5 will aid in determining if recovery of the plant community is occurring. It is recommended that further samples of interstitial water be collected in August 2021 so that a comparison can be made to data collected in in Years 3 and 5 of the bog community monitoring program.

The aquatic plant community and sediment deposition results from 2020 suggest that sediment deposition may have had less influence on aquatic plant cover than water depth. The lower cover of aquatic vegetation at the northern end of the still water area where sediment deposition was highest may be attributed more to the deeper water found in this area than to the amount of sediment deposited there. Continued monitoring of the aquatic vegetation cover will aid in determining whether sediment thickness or water depth plays a greater role in determining aquatic plant cover.

**Wetland 15**

The Year 1 monitoring results for Wetland 15 undertaken by Stantec suggest that the effects of sediment deposition were highly localized and mainly limited to ground vegetation species. The effects to ground vegetation species were moderate with an average total ground vegetation cover in the affected quadrats of 52% on average compared to 93% on average in the reference quadrats. Similar to observations in 2019, less than 10% of the 0.32 ha area where sediment deposits were observed was visible on the wetland substrate in 2020. These results are consistent with the observations made during the 2019 wetland investigation. Continued monitoring in Years 3 and 5 will provide information regarding the rate at which ground vegetation species recolonize the areas covered by sediment.

# 1.0 INTRODUCTION

In 2019, Stantec Consulting Ltd. (Stantec) was retained by Atlantic Mining NS Inc. (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) and two associated wetlands (Wetlands 6 and 15) at the Touquoy Mine, NS. The potential effects to Watercourse #4 and Wetlands 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). An initial site visit was conducted, and a summary report was prepared and submitted to NSE (Stantec 2019). The summary report included recommendations for a multi-year follow-up monitoring program to observe if sediment and erosion control mitigation measures implemented by AMNS have been effective in preventing siltation events and if affected areas are naturally restoring to baseline conditions in Watercourse #4, Wetland 6, and Wetland 15. The follow-up monitoring program for Watercourse #4, Wetland 6 and 15 is planned for Years 1, 3, and 5 after the initial site visit (i.e., 2020, 2022, 2024).

In April 2020, NSE requested a detailed wetland monitoring program plan based on these recommendations for review and approval (April 29, 2020). It was accepted by NSE on July 20, 2020 and incorporated into the Water Approval – Wetland Alteration (#2016-095967-04). As requested by NSE, monitoring data from McCallum Environmental Ltd. (McCallum) (2020) was reviewed to determine if it would be useful in determining reference areas for this follow-up monitoring program.

This report encompasses Year 1 (2020) of the monitoring program. The wetland monitoring program plan approved by NSE, as well as the recommendations for monitoring in Watercourse #4 in the 2019 summary report were followed in Year 1. The monitoring program included the following activities:

- Monitoring of substrate composition (i.e., percentage of each substrate type) at eight locations in Watercourse #4 where silt deposits were identified in the 2019 site visit to document relative changes.
- Monitoring of species composition and distribution of aquatic plants in relation to water depth and silt/sediment thickness at five transects in Watercourse #4 in slow flowing habitats containing only fine substrates to determine if silt deposition has influenced aquatic plant cover and its recovery.
- Review of drone aerial imagery in Wetland 6 to document and monitor recovery of potential areas of sphagnum mortality.
- Review of drone aerial imagery within the portion of Watercourse 4 that flows through Wetland 6 to determine overall distribution of aquatic plant communities,
- Establishment of eight 1 m X 1 m monitoring quadrats in Wetland 6 placed at representative locations of sphagnum moss staining and bleaching and eight reference quadrants in areas of similar habitat unaffected by sediment deposition to document recovery based on colonization by healthy vegetation over time.
- Establishment of five 1 m X 1 m and 2 m X 2 m monitoring quadrats in Wetland 15, placed at representative locations where silt deposits are currently present and five 1 m X 1 m and 2 m X 2 m reference monitoring quadrats in areas the support similar plant communities that have not been affected by sediment deposition to document recovery based on colonization by healthy vegetation over time.

Stantec understands that there have been additional silt events in 2020 at the Tailings Management Facility (TMF) Haul Road prior to the Year 1 monitoring program which may be reflected in the results of the program.

# 2.0 BACKGROUND

The following section presents a high-level description of the habitat within Watercourse #4, Wetland 6 and 15 and a summary of the siltation effects based on information provided in Stantec's 2019 assessment report (Stantec 2019).

## 2.1 WATERCOURSE #4

As discussed in Stantec's 2019 report, Watercourse #4 is a small second order stream which discharges into Moose River within the Fish River-Lake Charlotte Watershed (Figure 2.1). The watercourse is ephemeral upstream of the Admin Road, and fish habitat throughout the remainder of the surveyed area of Watercourse 4 generally consists of swift moving sections of water with small boulder and organic substrates and slow-moving pond-like sections (i.e., Wetland 6) with organic/fine sediments and aquatic vegetation. Fish habitat in all surveyed reaches appears to be suitable for supporting various coldwater and warmwater species of fish.

In initial surveys of Watercourse #4 grey silt was observed to replace the finer substrates that were likely present between the coarser substrates (i.e., boulders) swift-moving habitats prior to the siltation events (Stantec 2019). Overall, the potential effects of siltation on fish and fish habitat in Watercourse #4 were thought to be reversible (Stantec 2019).

## 2.2 WETLAND 6

Wetland 6 is a wetland complex that is composed of a mixture of treed bog, open bog, mixedwood treed swamp, and shallow water. In 2019, the field assessment found no evidence of adverse effects to sphagnum moss or vascular plant species in either the treed bog or the mixedwood treed swamp plant communities, however effects to open bog and shallow water plant communities were observed (Stantec 2019) (Figure 2.2).

Open bog is found in low-lying areas near the large still waters in the southern half of Wetland 6 (Stantec 2019). 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 (*Carex stricta*), 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 (*Chamaedaphne calyculata*), sweet gale (*Myrica gale*), and pale bog laurel (*Kalmia polifolia*).

Shallow water plant communities are found in still waters that flow north to south through the wetland (Stantec 2019). 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 burreed (*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. This difference in aquatic plant community cover and species richness in the northern and southern areas of the still water was thought to be indicative of potential adverse effects caused by silt accumulation.

During the assessment of Wetland 6 in 2019, dead and stressed plants were observed within parts of the open bog plant community (Stantec 2019). In low lying areas, there was heavy mortality of sphagnum moss and light to moderate mortality of graminoids. Sphagnum moss in the affected areas was typically stained grey when dead, whereas heavily stressed sphagnum plants were bleached to a light yellow color with the living portions of surviving plants 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. 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.

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.

The 2019 wetland assessment for Wetland 6 (Stantec 2019) recommended the following:

- Monitor quadrats placed at representative locations of sphagnum moss staining and bleaching to document recovery based on colonization by healthy plants over time
- Assess overall distribution of aquatic plant communities by using visual analysis of imagery taken annually with a drone to measure the distribution of aquatic plants
- Determine the influence of environmental features such as water depth and silt thickness on the distribution and abundance of aquatic plants

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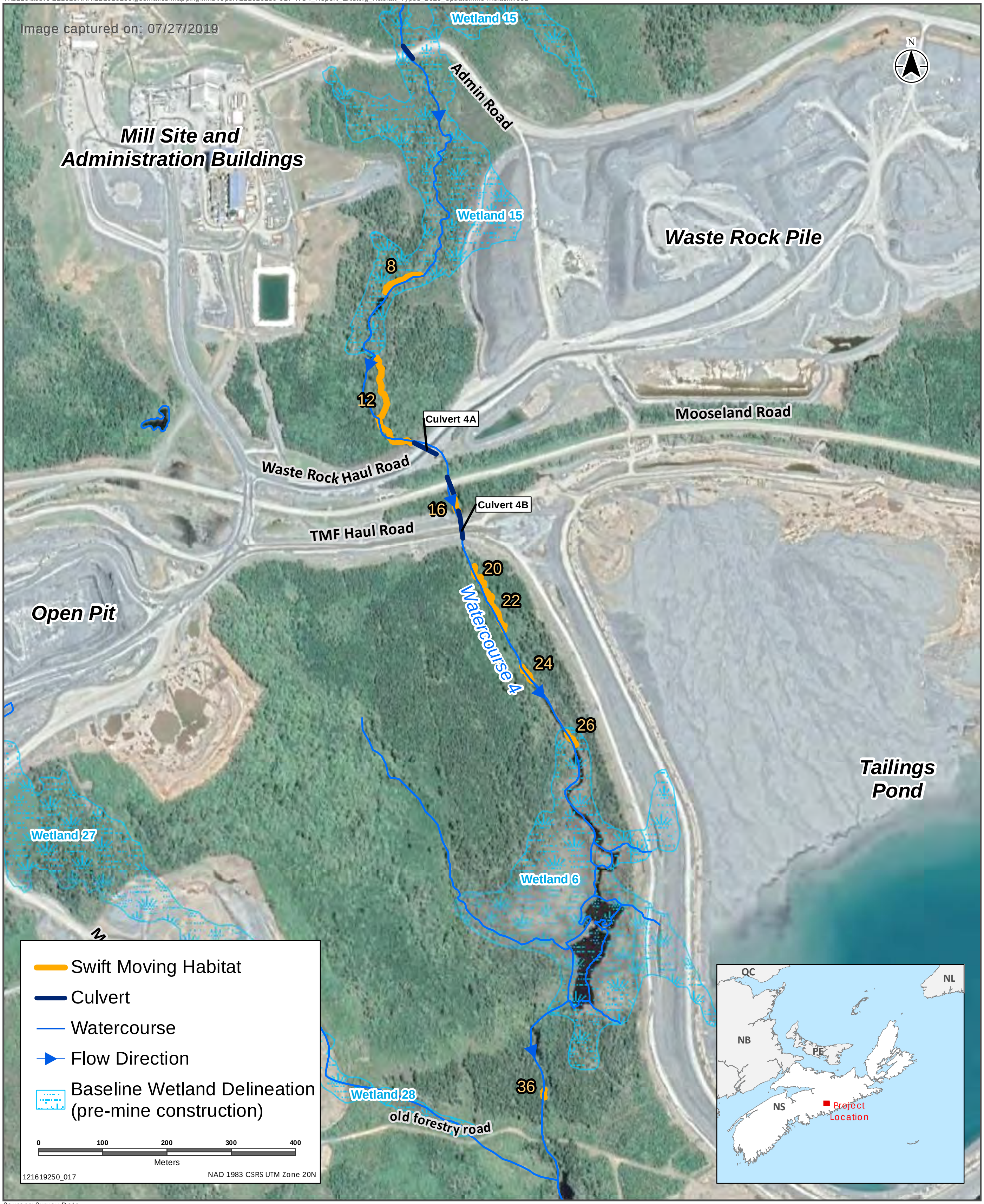


Sources: Survey Data

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.

Fish Habitat in Watercourse #4 Assessed for Siltation Effects in 2020 (Year 1), Touquoy Mine, Nova Scotia

Figure 2.1

Stantec

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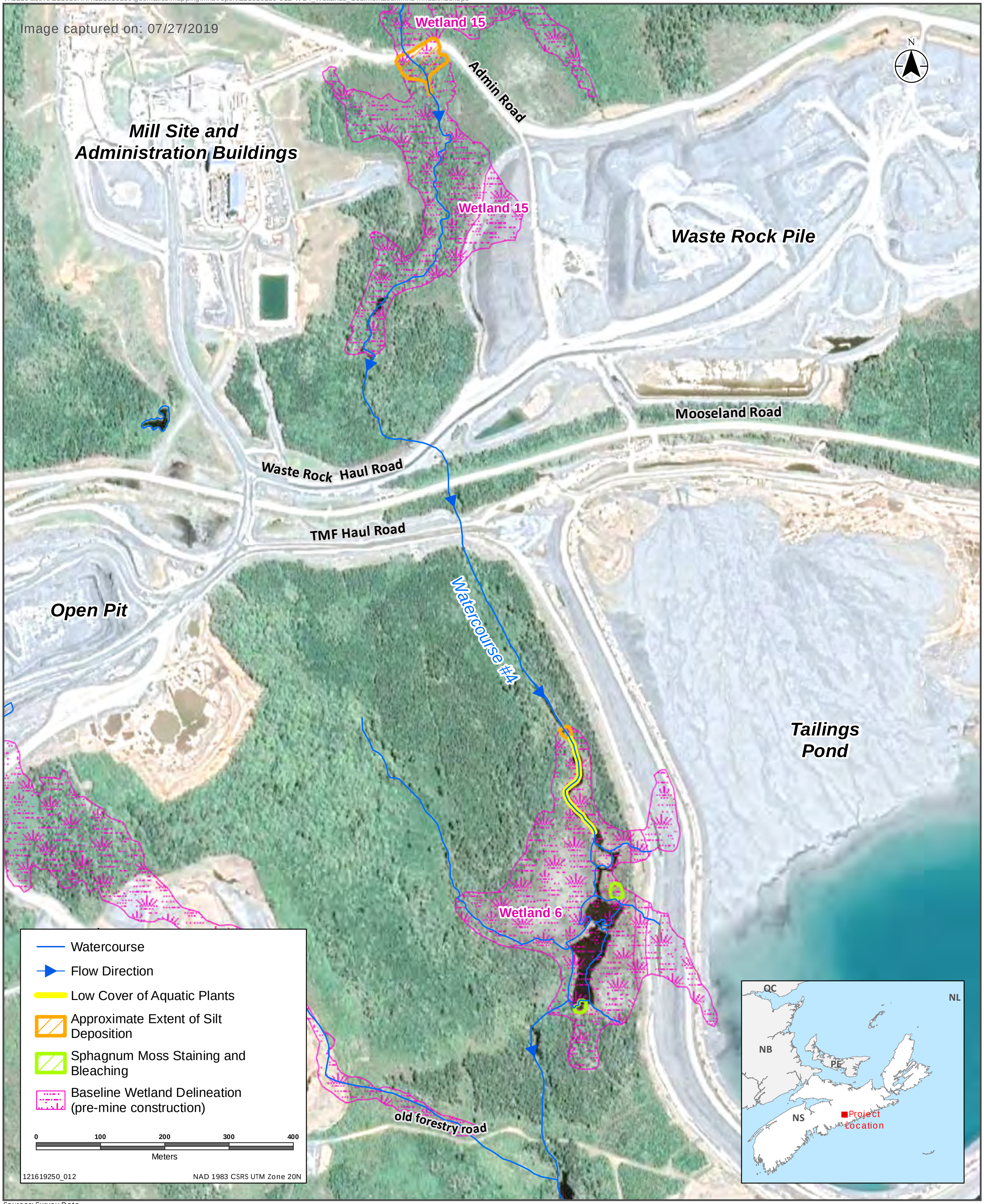



Sources: Survey Data

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

**Potential Siltation Effects to Wetland 6 and 15 in Year 0 (2019), Touquoy Mine, Nova Scotia**



Figure 2.2

## 2.3 WETLAND 15

Wetland 15 is a mixedwood treed stream swamp. It is characterized by an open tree canopy composed largely of balsam fir (*Abies balsamea*), red maple (*Acer rubrum*) and black spruce (*Picea mariana*). The shrub understory is dense and is dominated by speckled alder (*Alnus incana*) along with lesser amounts of northern wild raisin (*Viburnum nudum*). The ground vegetation layer is quite heterogenous and is dominated by a variety of species including interrupted fern (*Osmunda claytoniana*), three-seeded sedge (*Carex trisperma*), and sphagnum moss as well as hairy flat-top white aster (*Doellingeria umbellata*), common lady fern (*Athyrium filix-femina*), tall meadow-rue (*Thalictrum pubescens*), and bladder sedge (*Carex intumescens*) (Stantec 2019).

In 2019, grey silt deposits were observed in areas of Wetland 15 adjacent to the Admin Road (Stantec 2019). 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 (Stantec 2019). 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 Watercourse #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 was approximately 0.32 ha, as shown on Figure 2.2, and silt was 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 (Stantec 2019), 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. In 2019, the overall effect of the silt deposits on Wetland 15 plant communities and wetland functions appeared to be minor (Stantec 2019).

The 2019 wetland assessment for Wetland 15 recommended that monitoring quadrats be placed at representative locations in the northern end of the wetland where silt deposits were present to document the recovery based on colonization by healthy vegetation over time (Stantec 2019).

# 3.0 ASSESSMENT OF WATERCOURSE 4 AND WETLANDS 6 AND 15

This section describes the methods and results of the assessments conducted in Watercourse #4 and Wetlands 6 and 15 in Year 1, 2020.

## 3.1 METHODS

The following section describes the methods that were used to assess the effects of silt on the recovery of the open bog wetland and shallow water plant communities in Wetland 6 and the forested wetland habitat in Wetland 15.

### 3.1.1 Watercourse #4

In 2019, swift-flowing habitat types in Watercourse #4 were found to contain primarily coarse substrates (e.g., cobble, boulder) (Stantec 2019). In Watercourse #4, seven swift-flowing habitats where silt deposits were identified in the 2019 surveys (Habitat Unit (HU) ID 8, 16, 20, 22, 24, 26, 36; Stantec 2019) were selected for monitoring in Year 1 (2020) (Figure 2.1). One additional swift-flowing location that was negligibly affected by silt in 2019 (HU 12) was selected as a reference site to verify that the visual substrate composition assessment was consistent between years. The same aquatic biologist that conducted the assessments in 2019 conducted the monitoring in 2020.

Substrate composition (i.e., percentage of each substrate type) at each location was visually assessed on September 30, 2020. The substrate composition in Year 1 was compared to the original substrate composition in Year 0 (i.e., 2019) to document relative changes (e.g., natural removal or additional covering) within these swift-flowing habitats. Substrate composition for a site during follow-up monitoring was deemed to be consistent with the original substrate composition in Year 0 if it was within 10% of the original estimate.

See below for the monitoring methods for the portion of Watercourse #4 within Wetland 6.

### 3.1.2 Wetland 6

A review of existing information, drone aerial imagery, and in-field assessments of open bog wetland and shallow water plant communities were used to assess the recovery of Wetland 6 following siltation events.

#### 3.1.2.1 Open Bog Habitat

Ongoing wetland plant community monitoring is being conducted in Wetland 6 by McCallum Environmental Ltd (McCallum 2020). Four transects, each containing four quadrats have been established in the wetland and have been monitored since 2016. The data were reviewed by Stantec to determine suitability to use for documenting the recovery of vegetation in Wetland 6.

An AMNS drone was used to collect aerial imagery of Wetland 6 on August 6, 2020. The aerial imagery collected by AMNS was georeferenced and uploaded onto a datalogger. The imagery was examined to determine if areas of sphagnum moss mortality and/or staining can be detected on the imagery and to supplement in-field monitoring in subsequent years (i.e., Years 3 and 5). To verify the accuracy of the imagery, the drone imagery was superimposed over locations where areas of sphagnum moss mortality and/or staining were known to occur based on the Year 0 field surveys in 2019 and then field verified again in 2020.

Areas of high sphagnum moss mortality in the bog plant community were derived by Stantec from the visual assessment of drone imagery described above. In the open bog plant community, eight, 1 m X 1 m quadrats were placed by Stantec at representative locations of sphagnum moss mortality (staining) and morbidity (bleaching) on August 19, 2020 to document recovery based on colonization by healthy plants over time. These quadrats are referred to as affected quadrats. Figure 3.1 shows the distribution of the affected quadrats in Wetland 6.

For spatial comparison within each monitoring year, another eight, 1 m X 1 m quadrats were established in similar habitat in areas of Wetland 6 apparently unaffected by sediment deposition. These are referred to as reference quadrats. The locations of the reference quadrats are also presented in Figure 3.1. The corners of monitoring plots were marked with wooden stakes and their locations were recorded using GPS coordinates so that they can be revisited for monitoring in Years 3 and 5. A photo was taken of each quadrat.

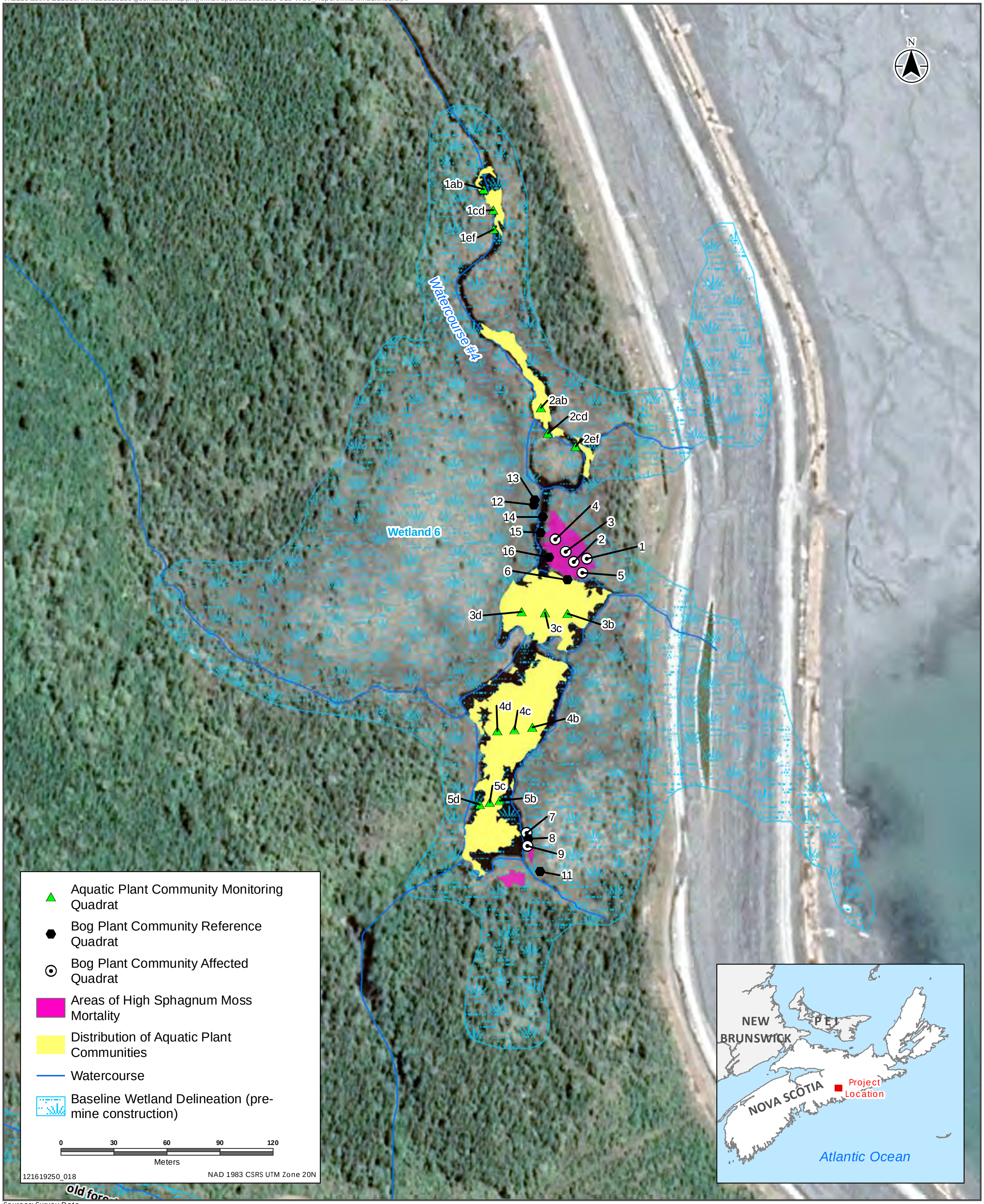
The percent cover of each vascular plant species found in each affected and reference quadrat was estimated by Stantec. Cover was estimated relative to the area of the quadrat (absolute cover) rather than relative to other vegetation in the quadrat (relative cover). As such, total plant cover can exceed 100% in instances where multiple layers of plant cover occur. Sphagnum moss (*Sphagnum* spp.) cover was further broken down into three categories, healthy, unhealthy, and dead. Color was used to help assign plants to these categories. Healthy plants were typically green or reddish in color depending on species. Unhealthy (bleached) plants were yellowish white with green or yellow branch tips and were moist. Dead plants were gray and dry. Sphagnum moss species are difficult to identify, typically requiring microscopic examination of the plants for identification to species. As such, it is challenging to efficiently and accurately collect abundance data by species. Therefore, sphagnum moss cover was estimated at the level of genus rather than species.

The reference quadrats provide information regarding what the species composition of an unstressed bog plant community can be expected to be in this area in any given monitoring year. Monitoring of changes in species composition over time in the reference quadrats provide information on the rate of vegetation change in unstressed bog plant communities. This can then be compared with the species composition and rates of vegetation change in the affected bog plant communities. This is used to determine if there are large differences between affected and reference sites and if species composition is recovering to a state similar to the reference site.

Monitoring surveys were conducted by Stantec in August 2020 for consistency with Year 0 (2019) and because most species are sufficiently developed and in flower or fruit at this time to facilitate identification. The rate at which plants grow has slowed by August so timing of subsequent monitoring surveys is less critical. Surveys carried out in Years 3 and 5 will be conducted within one week of the Year 1 survey date, if practicable.

Data collected from the affected quadrats will be compared with data from the reference quadrats to determine if recovery is occurring over space and time as measured using plant species composition and mortality rates.

During the 2020 field surveys water samples were collected from the edges of five quadrats affected by heavy sphagnum moss mortality and four of the reference quadrats to see if there were visual differences in the level of water turbidity between these quadrats. Samples of wet sphagnum moss were collected from the edges of five quadrats affected by heavy sphagnum moss mortality and from four of the reference quadrats. The moss samples were squeezed and the expelled water was collected in a clear plastic container to visually assess turbidity. Turbidity observations were classified into three visual categories, no visible turbidity, slight turbidity and turbid. This procedure, which was not part of the monitoring program, was conducted on an ad hoc and qualitative basis to help determine if differences in sphagnum moss mortality could be related to the presence of sediment.




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.

Distribution of Areas of High Sphagnum Moss Mortality, Aquatic Plant Communities and Locations of Vegetation Monitoring Quadrats in Wetland 6

Figure 3.1

#### 3.1.2.2 Shallow Water Habitat

The assessment of shallow water habitat in Wetland 6 consisted of an aquatic plant species composition and distribution assessment, silt deposition characterization and mapping of aquatic plant distribution completed by Stantec.

##### Plant Community Composition and Silt Deposition

In open water slow flowing habitats (still water) in Watercourse #4 which contained only fine substrates, the species composition and distribution of aquatic plants were estimated at various locations on August 19, 2020. Information regarding water depth and silt/sediment thickness was also collected at these locations on October 2, 2020 and was related to the plant community data to assist in determining if silt deposition has influenced aquatic plant cover and its recovery. The field surveys were timed to not be conducted immediately following heavy precipitation events so that visibility through the water column was not potentially impeded by suspended sediment.

In total, five transects were established throughout Wetland 6. Two transects were established parallel to the stream banks where the stream is narrow (habitat units 27 to 29; Stantec 2019) and three transects were established perpendicular to the stream banks where the stream is wide (habitat units 30 to 31; Stantec 2019).

Stakes were driven into Wetland 6 on either side of Watercourse #4 at the locations where sediment cores, depth measurements and aquatic plant community descriptions were taken. The location of each stake was recorded using a sub-metre accurate GPS unit to facilitate relocation of the stakes. A 50 m tape was strung between the two stakes to mark the location of the quadrats along the transect for more accurate year to year comparisons. In addition, the location of each sampling quadrat was marked with a sub-metre accurate GPS unit. Three 1 m x 1 m quadrats were spaced equally along each transect (Figure 3.1). On August 19, 2020, submergent, emergent and floating leaved aquatic plant species were identified, and the cover provided by the plant species was estimated in each quadrat. A photo was taken of each monitoring quadrat. On October 2, 2020, the thicknesses of silt deposits were assessed with a sediment corer by visually distinguishing between the different soil horizons within each quadrat. Water depth was also recorded within each quadrat.

##### Drone Imagery

Aerial imagery using a drone was collected on August 6, 2020 by AMNS to map the distribution and area of aquatic plant communities in the portion of Watercourse #4 that flows through Wetland 6 so that imagery collected in subsequent years (Year 3 and 5) can be overlaid with the imagery collected in Year 1 to document the recovery (i.e., locations and area) of aquatic vegetation within Watercourse #4 (i.e., $m^2$ of aquatic plant community coverage). The drone imagery was taken under conditions of low wind and low water turbidity to increase the visibility of the aquatic vegetation, and when aquatic vegetation cover was well developed.

The resolution of the imagery allowed the boundaries of the aquatic plant community to be visually delineated from the resultant imagery to identify the distribution of aquatic plant communities. A Stantec biologist experienced in air photo interpretation of plant communities analyzed the imagery and delineated the boundaries of the aquatic plant communities on hard copy of the drone imagery. The resultant polygons were then digitized.

### 3.1.3 Wetland 15

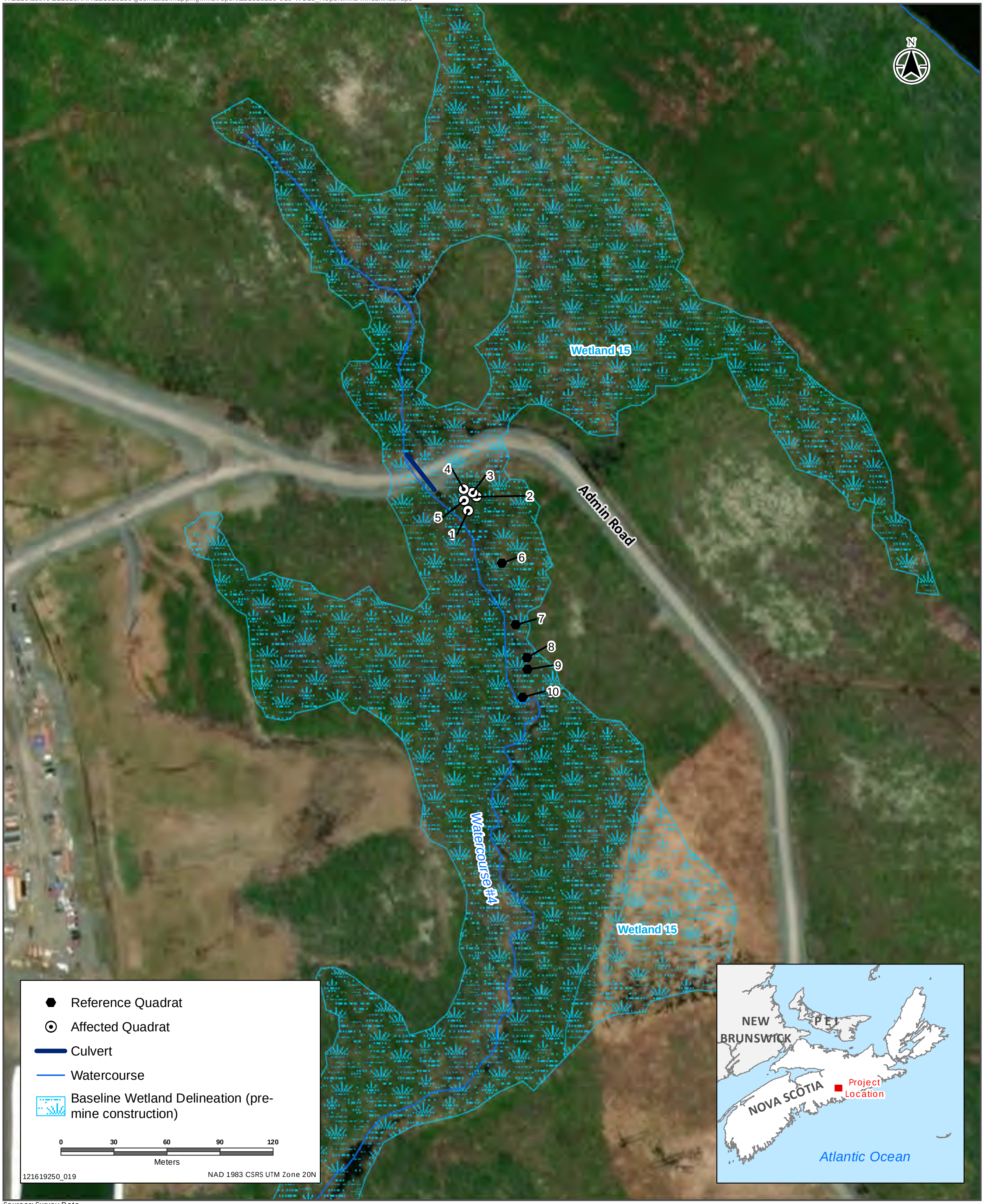
Ongoing wetland plant community monitoring has been conducted in Wetland 15 by McCallum Environmental Ltd. Two transects, each containing four quadrats, have been established in the wetland and have been monitored since 2016. Detailed vegetation data are available for these transects. A review of the data collected at these sites indicates that one of these transects is situated in the northern tip of Wetland 15 where siltation was evident in 2019 (Stantec 2019), affecting 5 to 10% of the surface of the wetland affected in this area. It is unlikely that the four monitoring plots established by McCallum Environmental Ltd. in this area are situated in depressions where siltation occurred. Therefore, new monitoring plots were selected for the present program in areas where siltation was observed in 2019 to monitor the effects of the sediment deposition event. Data collected annually by McCallum Environmental Ltd. were incorporated into this monitoring report to assess possible effects of the 2019 sediment deposition event on plant communities that are found adjacent to areas where sediment was deposited in 2019.

The methodology used by Stantec for monitoring in Wetland 15 is different than in Wetland 6 because of differences in the structure of the two wetlands. The portion of Wetland 15 that was affected by the 2019 sediment deposition event is occupied by forested wetland, whereas the portion of Wetland 6 where adverse effects associated with sediment deposition was evident is either open bog or shallow water wetland. In Wetland 15, five nested 1 m X 1 m and 2 m X 2 m study quadrats were placed at representative locations in the northern end of the wetland where silt deposits were observed in 2019 to document recovery based on colonization by healthy vegetation over time (Figure 3.2). These quadrats are referred to as affected quadrats. The 1 m X 1 m quadrat of each of the five sampling locations was centered on a spot where sediment had been deposited. Similarly, five nested 1 m X 1 m and 2 m X 2 m quadrats were placed in portions of Wetland 15 that support the same wetland type and were not affected by siltation in 2019 (Figure 3.2). These quadrats are referred to as reference quadrats.

At each sampling site, a 1 m X 1 m quadrat was nested inside a 2 m X 2 m quadrat. In the 1 m X 1 m quadrats, the percent cover of all plant species less than 2 m in height was estimated along with the cover of exposed sediment, leaf litter, woody debris, and open water. In the 2 m X 2 m quadrats the cover of all plants taller than 2 m in height were estimated. In addition, the diameter at breast height (DBH) of all trees and shrubs present in the 2 m X 2 m quadrat were measured with a diameter tape. Each tree or shrub was identified to species and was classified as living or dead.

The monitoring site visit was conducted on August 19, 2020 for consistency with Year 0 and to facilitate comparison across monitoring years. Surveys carried out in Years 3 and 5 should be conducted within one week of the Year 1 survey date, if possible.

Data collected from the affected quadrats will be compared with data from the reference quadrats to determine if recovery is occurring over space and time as measured using plant species composition and mortality rates. No statistical analysis was conducted.




Sources: Survey Data

Service Layer Credits: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community 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.

Distribution of Wetland Monitoring Quadrats in Wetland 15

Stantec

ASSESSMENT OF WETLAND 6, TOUQUOY GOLD PROJECT, NS

Figure 3.2

## 3.2 RESULTS

### 3.2.1 Watercourse #4

There was negligible change (<10%) in the substrate composition at reference site HU12, indicating the visual assessment of substrate composition was consistent between years (Table B-1, Appendix B). Overall, a reduction in small particle sizes (organics and fines) were observed, with a corresponding increase in large particle sizes (i.e., gravel, cobble, boulder) at all the monitoring locations where fines (i.e., silt) were observed in 2019, with the exception of HU24 (Table B-1, Appendix B).

For the six locations with a reduction in fine substrates compared to Year 0, a reduction or no change in embeddedness was noted, which suggests that these areas have begun to recover, or remained stable from 2019 to 2020. Where silt was observed, the affected area was small (<1 $m^2$), was typically located at the edges of the watercourse or in slower moving depositional areas, and appeared to be stable or covered by leaves/debris (e.g., HU8, 16, 20 and 22). At HU36 a negligible amount of silt was observed and aquatic moss on rocks was free of silt. Photos of representative habitat and noticeable silt deposits are provided in Appendix A.1.

The substrate composition at the remaining site, HU24, was 100% silt in Year 0 (2019) and no change was observed in Year 1 (2020). This may have been due to the lower water velocity and gradient at this location relative to the other swift-flowing locations (Appendix A.1, Photos 11 to 12). Given the large proportion of fines/silt and lack of baseline data, the original substrate composition at this location is unclear and makes it challenging to assess recovery of substrates. The silt at this location appeared to be stable as a brown film or algae (i.e., periphyton) was apparent (Appendix A.1, Photo 11). Aquatic vegetation was noted, indicating finer substrates may have been present during baseline (Appendix A.1, Photos 11 and 12).

### 3.2.2 Wetland 6

The following section provides a review of existing information, drone aerial imagery and in-field assessments of open bog and shallow water plant communities that were used to assess the recovery of Wetland 6 following siltation events.

#### 3.2.2.1 Open Bog Habitat

Ongoing wetland plant community monitoring conducted in Wetland 6 by McCallum was reviewed by Stantec to determine if the available data could be used to assist in documenting the recovery of Wetland 6. Detailed vegetation data was available for two of the transects and general observations were available for the other two transects previously established by McCallum which were located in treed bog or mixedwood treed swamp. A review of the data collected at these sites as well as photographs of the monitoring plots indicates that these monitoring plots are not located in the open bog plant community where effects associated with sediment deposition were evident in 2019. As such, effective siltation monitoring for the open bog areas (where adverse effects were noted) cannot be conducted using these monitoring plots. These monitoring transects can be used to help to determine if adverse effects have occurred in the treed bog and mixedwood treed swamp plant communities in Wetland 6. The results from the McCallum monitoring transects suggests that no adverse effects of siltation were observed for the treed bog or mixedwood treed swamp plant communities in which these monitoring transects were established.

A drone survey was conducted to document the distribution of areas of high sphagnum moss mortality in Wetland 6. Areas of heavy sphagnum moss mortality were visible on the imagery and consisted of three patches with a total area of 793 $m^2$. Figure 3.1 shows the distribution of areas of high sphagnum moss mortality as derived from drone imagery obtained on August 6, 2020. The distribution of these areas was consistent with areas of sphagnum moss mortality and/or staining observed in 2019; however, the areas are not directly comparable. The areas of high sphagnum moss mortality identified in 2019 were not derived from high quality drone imagery. Drone imagery will be collected again in years 3 and 5 which will permit direct comparison to document recovery of the areas of heavy sphagnum moss mortality.

Wetland plant community monitoring quadrats for affected areas were established by Stantec inside the areas of heavy sphagnum moss mortality observed from the drone imagery (Figure 3.2), while reference quadrats were established outside these areas (i.e., in unaffected areas). Photographs of the monitoring quadrats are presented in Appendix A.2.

The bog plant community monitoring data collected in 2020 for Wetland 6 is presented in Appendix B (Table B.2). A substantial reduction in vegetation cover in the affected quadrats versus the reference quadrats was observed. The average total cover of vegetation in the affected quadrats was 82% versus 143% in the reference quadrats.

Most of the reduction in total plant cover was attributable to increased mortality of sphagnum moss. The cover of dead sphagnum moss (gray stained) ranged from 5% to 90% in the affected quadrats with an average of 53%. In the reference quadrats the cover of dead sphagnum moss ranged from 1% to 10% with an average of 3.4%. The average cover of unhealthy sphagnum moss (bleached) was 28% in the affected quadrats compared to 6.4% in the reference quadrats. The average cover of live sphagnum moss in good condition was 13% in the affected quadrats and 87% in the reference quadrats.

Vascular plants present in the areas of high sphagnum moss mortality were not as heavily affected as the sphagnum moss. The average total cover of vascular plants in the affected quadrats was 41% compared to 49% in the reference quadrats and the plant species compositions in the affected and reference quadrats were similar. The most abundant species in descending order in the affected quadrats were sphagnum moss (41%), sweet gale (11%), leatherleaf (9.7%), large cranberry (6.1%), bog rosemary (5.5%), northern pitcher plant (2.7%), and three-leaved false Solomon's seal (*Maianthemum trifolium*) (1.5%). The most abundant plant species in descending order of abundance in the reference quadrats were sphagnum moss (94%), leatherleaf (18%), sweet gale (10%), small cranberry (8.9%), bog rosemary (2.7%), northern pitcher plant (1.9%), and three-leaved false Solomon's seal (1.2%).

The ad hoc observations of interstitial water turbidity in the affected and reference quadrats revealed that grey turbid water was associated with four of five affected quadrats and two of four sampled reference quadrats. The remaining quadrats produced slightly turbid water. None of the quadrats produced clear water. These data suggest that both the affected and reference quadrats were exposed to suspended sediment but responded differently.

To appropriately match wetland plant communities, the reference quadrats were generally located near the affected sets of quadrats along the edges of Watercourse #4 since similar habitat types were not present elsewhere in the wetland. When the locations were chosen they appeared to be suitable reference areas. In the reference plots, high water events may have removed silt from the surfaces of the sphagnum moss, however not from the interstitial spaces between the plants. As both the reference and affected quadrats appeared to be exposed to sediment, the levels of sediment deposition may have had little effect on the health of the sphagnum moss, this further supports the hypothesis that high mortality may have been attributable to the dry summers that have occurred over the last three years as was initially suspected in 2019. As a result, additional recommendations for future monitoring are described in Section 5.

#### 3.2.2.2 Aquatic Habitat

##### Plant Community Composition and Silt Deposition

Overall, aquatic plant communities in Wetland 6 were dominated by water bulrush and narrow-leaved bur-reed, and numerous fish were observed within the weed beds and undercut banks of the wetland. Water depths ranged from 0.15 to 0.41 m during the August 19, 2020 survey and 0.15 to 0.34 m during the October 2, 2020 survey, indicating water levels were similar during both surveys. In total, 15 sediment cores were collected throughout 350 m of slow flowing habitats in Watercourse #4 and wetland 6 (Figure 3.2). Sediments generally consisted of brown organic floc, brown or dark brown muck, a dark grey mixture of muck and silt, or light grey silt. Grey silt layers were able to be visually assessed by using the sediment cores in most instances, with the exception of some cores which had grey silt streaks mixed with brown muck. The first layer of sediment in all of the cores was a dark brown/organic floc (Appendix B, Table B.3) The layer ranged from 0.5 to 8 cm in depth. The results of the sediment core surveys and the aquatic plant monitoring are presented in Appendix B, Tables B.3 and B.4, respectively.

Transect 1 was located near the northern (i.e., upstream most) end of the still water (Figure 2). Water depth on the sampling date ranged from 38 to 41 cm with an average depth of 39 cm. Silt thickness ranged from 4.5 cm to 8.5 cm thick with an average thickness of 6.3 cm. Dark and light grey silt was apparent in two of the three quadrats sampled (Appendix A.2, Photo 16). Beneath the grey silt layer was brown or dark brown muck which likely accumulated prior to the siltation events. The aquatic plant community found along this transect was moderately dense with an average total cover of 68%. Species richness was low with only one species found in two quadrats and three species found in one quadrat. Narrow-leaved burreed was the most abundant species followed by water bulrush, and greater bladderwort (*Utricularia macrorhiza*).

Transect 2 was situated in an area with shallower water (average depth 30 cm). Silt thickness along this transect averaged 6.0 cm with a range of 4.0 to 7.4 cm. Dark and light grey silt was apparent in two of the three quadrats sampled (Appendix A.2, Photo 17). The vegetation along this transect was denser and had greater species richness. Average total plant cover was 95% and species richness ranged from 3 to 4 species. Water bulrush and narrow-leaved burred were the most abundant species. Other less common species were variegated pond-lily, greater bladderwort, and flat-leaved bladderwort (*Utricularia intermedia*).

Transect 3 was located on a wide shallow pool. Average water depth on the survey date was 19 cm. At T3 the layer of defined silt was not as apparent and appeared to be more mixed with the dark brown muck or was apparent as clumps in the sediment core (Appendix A.2, Photo 18). This was likely a result of the very high density of vegetation along this transect. When the core tube was pushed into the sediment, it dragged the stems and roots of the aquatic plants through the sediment column, which also dragged the surface sediments with them causing a streaking of the gray sediments through the underlying brown sediments. No accurate measure of sediment thickness is available for this transect. Average total plant cover was higher than found along Transect 2 (103%). Species richness ranged from three to four species. The dominant species were water bulrush and narrow-leaved burreed. Small amounts of ribbon-leaved pondweed and red-disked yellow pond-lily (*Nuphar lutea* var. *rubrodisca*) were also present.

Transect 4 was also found in an area with shallow water. Water depth along this transect averaged 24 cm. The same sediment streaking noted in Transect 3 was also encountered along this transect so it was not possible to get accurate measures of sediment thickness from this transect. A representative sediment core is shown in (Appendix A.2, Photo 19). The aquatic plant beds along this transect were composed largely of narrow-leaved burreeed and water bulrush along with a small amount of variegated pond-lily. Species richness was lower than was found in Transects 2 and 3, ranging from 2 to 3 species.

Transect 5 is found at the southern end of the still water in an area with deeper water and a stonier substrate. Average water depth along this transect was 33 cm. A small layer of defined silt was apparent along this transect and ranged from 0 to 1.5 cm with an average thickness of 1.0 cm (Appendix A.2, Photo 20), which is much lower than found in Transects 1 and 2 at the inflow to the wetland. This transect had the lowest average total plant cover (64%). Water bulrush and narrow-leaved burreed were the most abundant species. Variegated pond-lily was present in small amounts. Species richness was 3 species in all the quadrats.

Overall, the first layer of sediment in all of the cores was a dark brown/organic floc indicating a recovery to natural sediment types. Aquatic plant cover was lowest in Transect 5 (average total cover 64%) and Transect 1 (average total cover 68%) and highest in Transect 3 (average total cover 103%), Transect 4 (average total cover 98%) and Transect 2 (average total cover 95%). The thickest sediment deposits were found in Transect 1 (average thickness 6.3 cm) and Transect 2 (average thickness 6.0 cm) while the thinnest sediment deposits were in Transect 5 (average thickness 1.0 cm). There appears to be no obvious relationship between sediment thickness and aquatic plant total cover based on the information gathered in Year 1. There appears to be a weak relationship between water depth and total aquatic plant cover with total aquatic plant cover decreasing with increasing water depth. The northern end of the still water which had the thickest sediment deposits also had deeper water than the central portion of the still water.

Figure 3.2 shows the distribution of aquatic plant communities in the shallow water wetland areas of Wetland 6 as derived from the drone aerial imagery collected in July 2020. Aquatic plant community beds that could be mapped from the imagery covered an area of 5,099 $m^2$. The area and distribution of aquatic plant community beds will be measured again in Years 3 and 5 of the monitoring program to determine if there are changes in the areas of these beds that might indicate changes in aquatic plant communities that may be associated with sediment deposition events.

### 3.2.3 Wetland 15

The ground vegetation species composition in Wetland 15 was heterogenous between the sampling quadrats, particularly in the areas affected by sediment deposition (Appendix B; Table B.5). Sorensen Similarity coefficients (Krebs 1999) were calculated within the affected quadrats and within the reference quadrats. Sorenson Similarity coefficient scores range from 0% (completely dissimilar) to 100% (identical). The Sorensen Similarity coefficient scores derived from comparisons of ground vegetation species composition within the affected area quadrats ranged from 20% to 52% and averaged 33%. Sorensen Similarity coefficients derived from comparisons of ground vegetation species composition within the reference area quadrats ranged from 50% to 70% and averaged 58% indicating that the vegetation in these quadrats was more similar to each other than the species composition in the affected area quadrats. Without pre-disturbance ground vegetation species composition data, it is not possible to determine whether the lower level of similarity between quadrats in the affected plots is caused by the deposition of sediment in these areas or is due to natural variations in species composition within the wetland.

A comparison of total ground vegetation cover in the affected and reference plots indicates that ground vegetation cover was typically lower in the affected quadrats (range 14% to 100%, average 52%) than in the reference quadrats (range 61% to 119%, average 93%) (Appendix B; Table B.5). There is not a good linear relationship between sediment cover and total vegetation cover suggesting that factors other than sediment cover are important in determining the amount of ground vegetation cover.

Ground vegetation species richness was similar in the affected and reference quadrats indicating that the sediment deposition had not adversely affected the ability of the affected areas to support ground vegetation species. This may be attributable to the patchy nature of the sediment deposits. In most of the affected quadrats only 10% of the ground surface was covered by sediment in 2020. These results are consistent with the observations made during the 2019 wetland investigation.

Given the highly variable nature of the ground vegetation species composition, it is difficult to determine if some ground vegetation species were more adversely affected by the sediment deposition than others. A comparison of the abundance of four ground vegetation species found in both the affected and reference quadrats revealed that three of the species (balsam fir, dwarf dogwood and sphagnum moss) decreased in abundance in the affected quadrats relative to the reference quadrats while one species (northern wild raisin) increased in abundance.

Shrub cover was somewhat higher in the affected quadrats (average total cover 75%) than in the reference quadrats (average total cover 60%) (Appendix B; Table B.6). Total basal area of living woody plants was also higher in the affected quadrats (average total basal area of living woody plants 12 $cm^2/m^2$) than in the reference quadrats (average total basal area of living woody plants 5.2 $cm^2/m^2$) (Appendix B; Table B.7). The proportion of the total basal area composed of dead basal area was higher in the affected quadrats (19%) than in the reference quadrats (4.8%). This may indicate that conditions in the affected quadrats were more stressful than in the reference quadrats. However, the higher proportion of dead basal area in the affected area could also reflect the heavier intraspecific and interspecific competition associated with the denser cover of shrubs in the affected quadrats.

Shrub species composition was different in the affected and reference quadrats. The most abundant species of the shrub layer in the affected quadrats were speckled alder and balsam fir. In the reference quadrats the most abundant species of the shrub layer were northern wild raisin and red maple.

# 4.0 SUMMARY AND DISCUSSION

## 4.1 WATERCOURSE #4

Overall, the results from Year 1 monitoring of Watercourse #4 suggest that six of the seven swift-flowing habitats are returning to their pre-siltation substrate composition. Silt that was observed at sites appeared to be stable. Habitats where there is lower water velocity and gradient, such as HU24, may require more time to restore to pre-disturbance substrate composition given the lower velocities relative to other areas. These areas will continue to be monitored following a similar methodology as part of a subsequent program conducted in Year 3.

## 4.2 WETLAND 6

In Wetland 6, the Year 1 monitoring results for the open bog plant community supports the findings of the 2019 site visit. Localized mortality of sphagnum moss was recorded at three locations in Wetland 6 and the total area affected in 2020 was 793 $m^2$. The cover of sphagnum moss in good condition was reduced from an average of 87% in the reference quadrats to 13% in the affected quadrats. Total vascular plant cover experienced a relatively small reduction from 49% to 41% and there was little change to species richness or plant species composition when the affected quadrats are compared to the reference quadrats. Information regarding recovery of the open bog plant community will not be available until the Year 3 and Year 5 monitoring data are available.

Comparison of the largely qualitative information collected in 2019 versus the quantitative information collected in 2020 suggests that the condition of the vegetation in the affected areas of the bog have not changed substantively between 2019 and 2020. Qualitative observations of interstitial water turbidity in subsamples of the affected and reference quadrats in 2020 revealed that turbid water was associated with both the affected and reference quadrats although the water in the reference quadrats was generally less turbid than the water in the affected quadrats. The presence of turbid water in both the affected and reference quadrats makes it difficult to attribute the high levels of sphagnum moss mortality entirely to sediment deposition in the bog. Other factors such as dry growing seasons may also cause mortality in sphagnum moss. The month of July in 2019 and the month of June in 2020 received approximately half the normal rainfall (Government of Canada no date). It is also possible that sphagnum moss mortality in affected areas in 2020 was attributable to a combination of sediment deposition and dry growing conditions.

Quantitative monitoring (rather than qualitative monitoring) of interstitial water turbidity at all of the monitoring quadrats over time would help to more accurately determine whether there are large differences in the amount of sediment in the interstitial water of the affected and reference quadrats. It would also help to determine if the sediment is gradually flushed out of the bog or remains trapped in the sphagnum moss and peat. The scheduled monitoring in the bog community in Years 3 and 5 will aid in determining if recovery of the plant community is occurring.

The aquatic plant community and sediment deposition results from 2020 suggest that sediment deposition may have had less influence on aquatic plant cover than water depth. The lower cover of aquatic vegetation at the northern end of the still water area where sediment deposition was highest may be attributed to the deeper water found in this area than to the amount of sediment deposited there. Continued monitoring of the aquatic vegetation cover should help to determine whether sediment thickness or water depth plays a greater role in determining aquatic plant cover.

## 4.3 WETLAND 15

The Year 1 monitoring results for Wetland 15 suggest that the effects of sediment deposition were highly localized and mainly limited to ground vegetation species. The effects to ground vegetation species were moderate with an average total ground vegetation cover in the affected quadrats of 52% on average compared to 93% on average in the reference quadrats. The relatively limited adverse effects on wetland vegetation are probably attributable to the patchy distribution of sediment deposits in Wetland 15. Within the monitoring quadrats less than 10% of the ground surface was covered by sediment deposits. Continued monitoring in Years 3 and 5 will provide information regarding the rate at which ground vegetation species recolonize the areas covered by sediment.

# 5.0 RECOMMENDATIONS

It is recommended that the existing monitoring program being conducted by Stantec is continued in Years 3 (2022) and 5 (2024) to monitor recovery of aquatic habitat in Watercourse #4, recovery of bog and aquatic plant communities affected by sediment deposition in Wetland 6 and to monitor recovery of the mixedwood treed swamp plant community in Wetland 15.

The drone imagery was successful in mapping the distribution of the aquatic plant beds in Wetland 6 and Watercourse #4 as well as identifying areas of high sphagnum moss mortality. Drone imagery should be collected again in Years 3 and 5 and will be used to determine if the area of sphagnum mortality or the distribution of aquatic plant community beds have changed in size.

It is recommended that samples of interstitial water be collected from the upper 10 cm of the wetland surface and measured for turbidity in Wetland 6 by Stantec. Samples of interstitial water will be collected from the edges of the affected and reference quadrats. In addition, eight samples will be collected from a bog that is unaffected by anthropogenic activities. The purpose of sampling will be to further confirm that the areas of high sphagnum moss mortality are associated with areas of heavier sediment deposition and not a result of changes in water level resulting from recent prolonged summer low flow events. It will also provide a way to determine if sediment deposited on the bog surface is stored or is washed from the bog surface by precipitation events. The sampling conducted in 2020 indicated that sediment appeared to be present in both the affected and reference quadrats. Collection of water samples in a bog unaffected by anthropogenic activities will provide baseline turbidity data for bog interstitial water. It is recommended that further samples of interstitial water be collected in August 2021 so that a comparison can be made to data collected in in Years 3 and 5 of the bog community monitoring program.

# 6.0 CLOSURE

Should you have any questions regarding the information contained herein, please do not hesitate to contact the undersigned.

Regards,

Stantec Consulting Ltd.

Originally signed by

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# APPENDIX A

## A.1 Watercourse #4 Photo Log
## A.2 Wetlands 6 and 15 Photo Log

**Appendix A.1 Watercourse #4 Photo Log**

**Watercourse #4 Swift-Flowing Habitats in Year 1 of Follow-Up Monitoring (September 30, 2020)**

**Photo 1** **Representative Habitat in Year 1 – HU8**

**Photo 2** **Small Stable Deposit of Silt Along Stream Bank – HU8**

**Photo 3** **Representative Habitat in Year 1 – HU16**

**Photo 4** **Small Stable Deposit of Silt In Stream Bed – HU16**

**Appendix A.1 Watercourse #4 Photo Log**

<table>
<tr><th colspan="2">Watercourse #4 Swift-Flowing Habitats in Year 1 of Follow-Up Monitoring (September 30, 2020)</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 5 Small Stable Deposit of Silt in Debris Jam – HU16</td><td>Photo 6 Representative Habitat in Year 1 – HU20</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 7 Small Stable Deposit of Silt Along Stream Bank – HU20</td><td>Photo 8 Representative Habitat in Year 1 – HU22</td></tr>
</table>

## Appendix A.1 Watercourse #4 Photo Log

<table>
<tr><th colspan="2">Watercourse #4 Swift-Flowing Habitats in Year 1 of Follow-Up Monitoring (September 30, 2020)</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 9 Small Stable Deposit of Silt in Debris Jam – HU22</td><td>Photo 10 Small Stable Deposit of Silt Along Stream Bank – HU22</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 11 Representative Habitat in Year 1 – HU24</td><td>Photo 12 Aquatic Vegetation - HU24</td></tr>
</table>

**Watercourse #4 Swift-Flowing Habitats in Year 1 of Follow-Up Monitoring (September 30, 2020)**

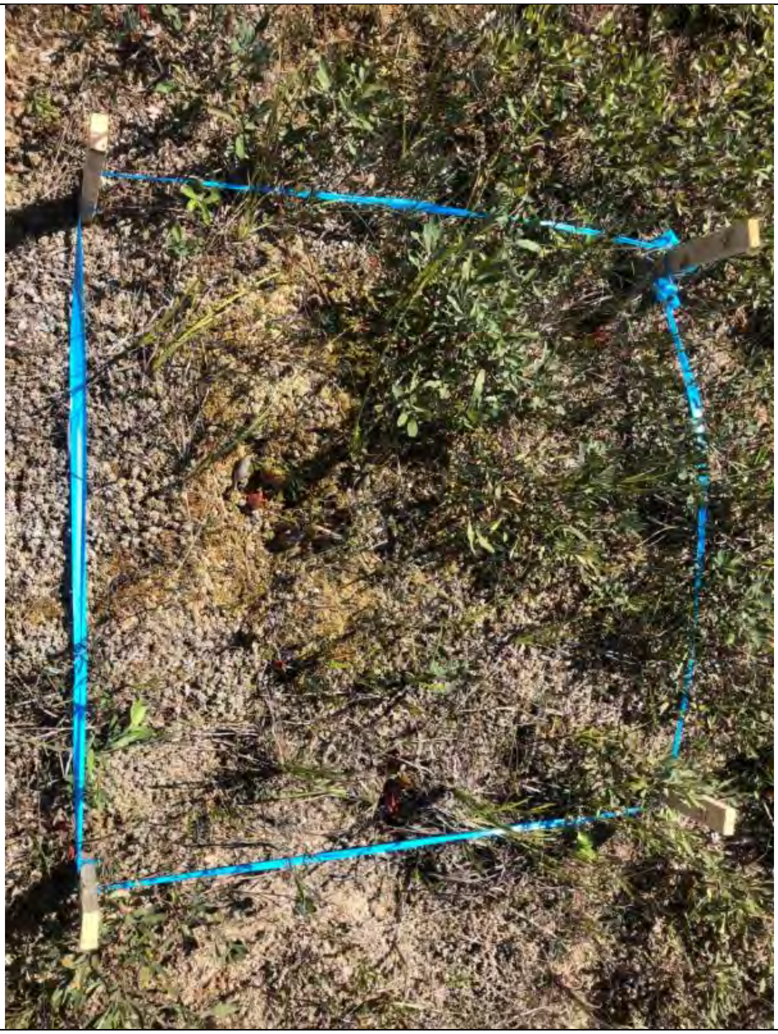
**Photo 13** **Representative Habitat in Year 1 – HU26**

**Photo 14** **Coarse Substrates with Small Stable Pockets of Silt in Crevices – HU26**

**Photo 15** **Representative Habitat in Year 1 – HU36**

**Photo 16** **Unaffected Substrate in Year 1 – HU26**

## Appendix A.2 Wetlands 6 and 15 Photo Log

<table>
<tr><th colspan="4">Wetland 6 Open Bog Monitoring Quadrats</th></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Photo 1</td><td>Quadrat 1 Affected Vegetation Plot. Photo taken August 20, 2020.</td><td>Photo 2</td><td>Quadrat 2 Affected Vegetation Plot. Photo taken August 20, 2020.</td></tr>
</table>

| Wetland 6 Open Bog Monitoring Quadrats | | | |
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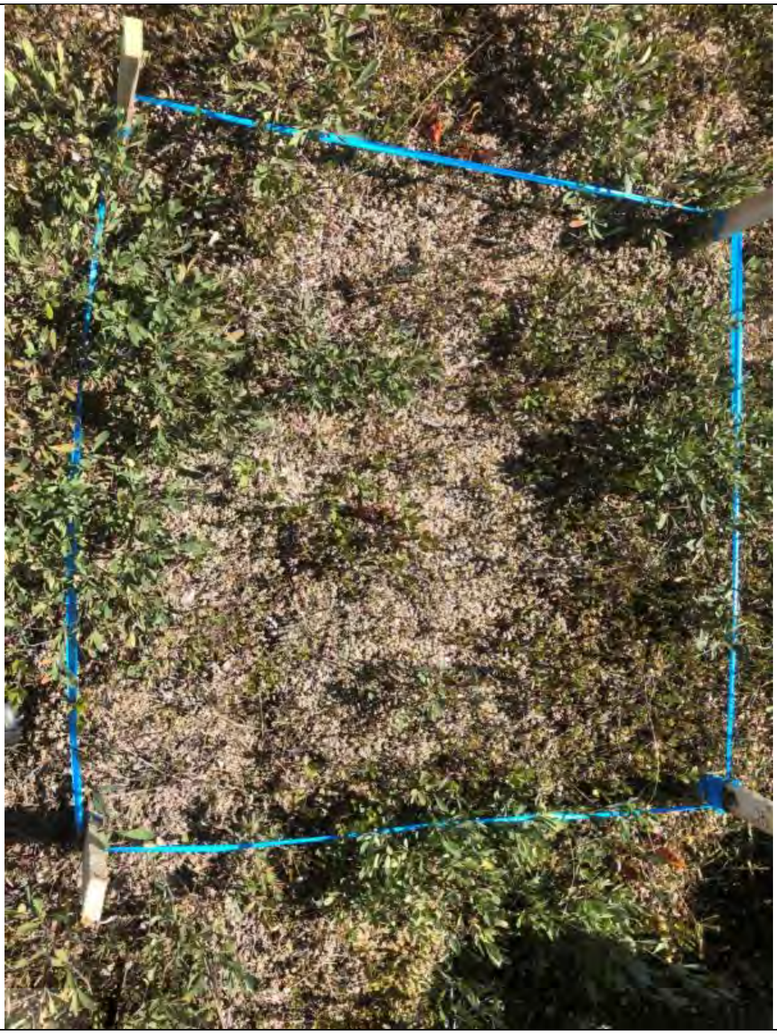
|  | |  | |
| **Photo 3** | **Quadrat 3 Affected Vegetation Plot. Photo taken August 20, 2020.** | **Photo 4** | **Quadrat 4 Affected Vegetation Plot. Photo taken August 20, 2020.** |

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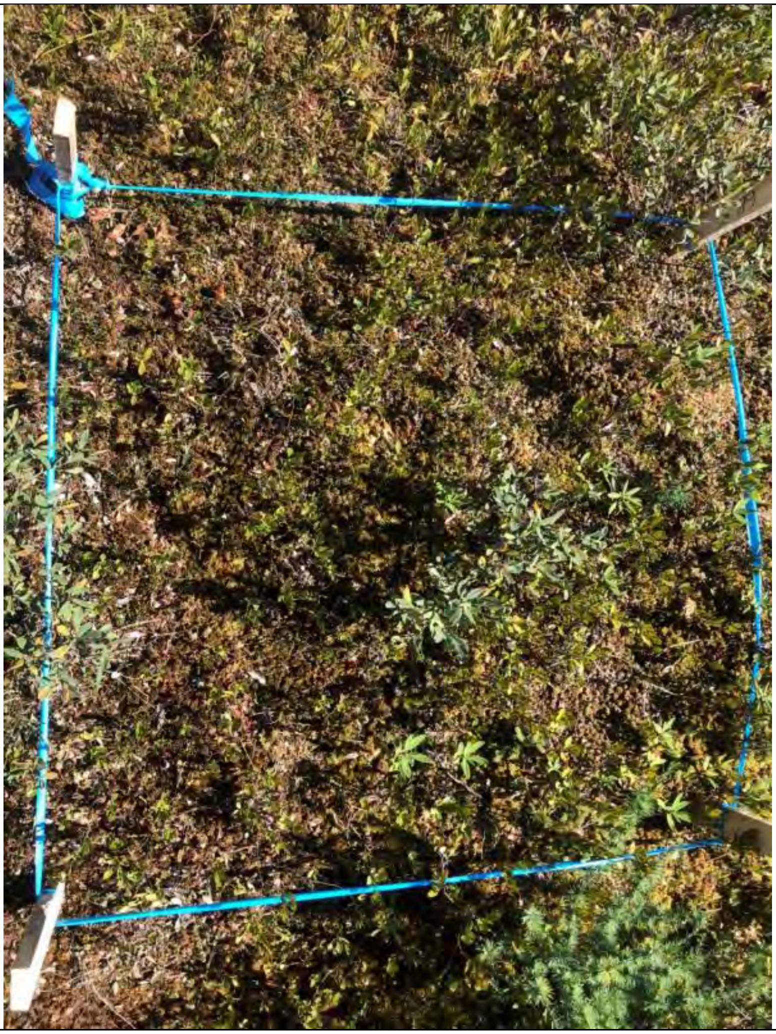
<tr><td></td><td></td></tr>
<tr><td>Photo 5 Quadrat 5 Affected Vegetation Plot. Photo taken August 20, 2020.</td><td>Photo 6 Quadrat 6 Reference Vegetation Plot. Photo taken August 20, 2020.</td></tr>
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| Wetland 6 Open Bog Monitoring Quadrats | | | |
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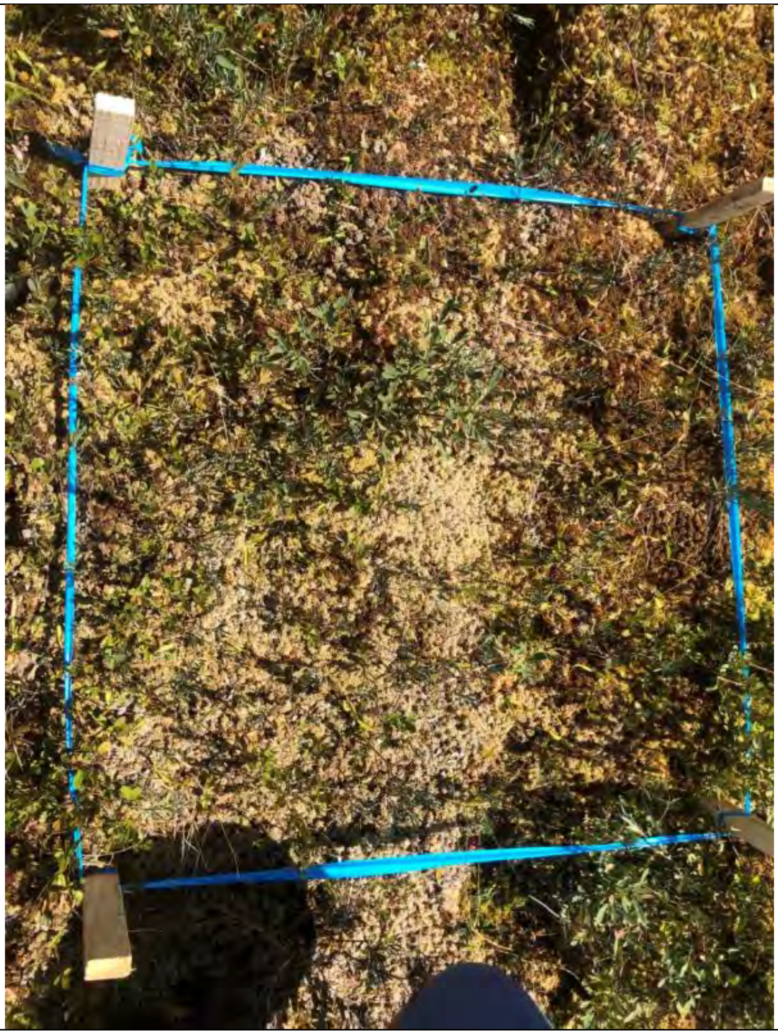
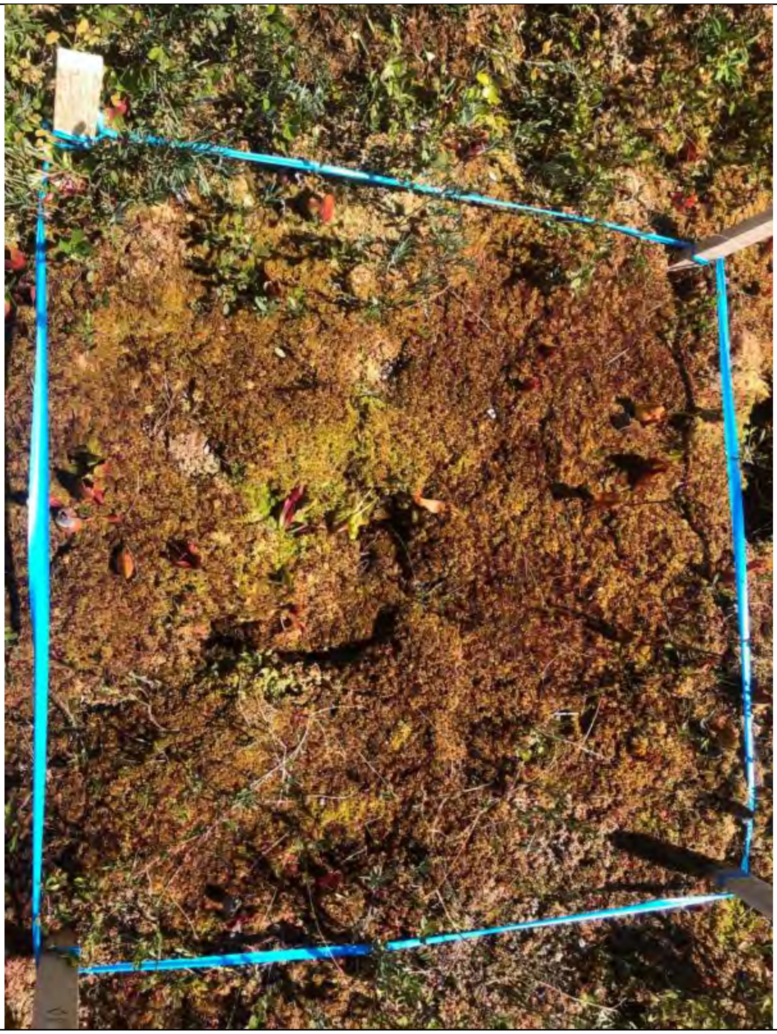
|  | |  | |
| **Photo 7** | **Quadrat 7 Affected Vegetation Plot. Photo taken August 20, 2020.** | **Photo 8** | **Quadrat 8 Reference Vegetation Plot. Photo taken August 20, 2020.** |

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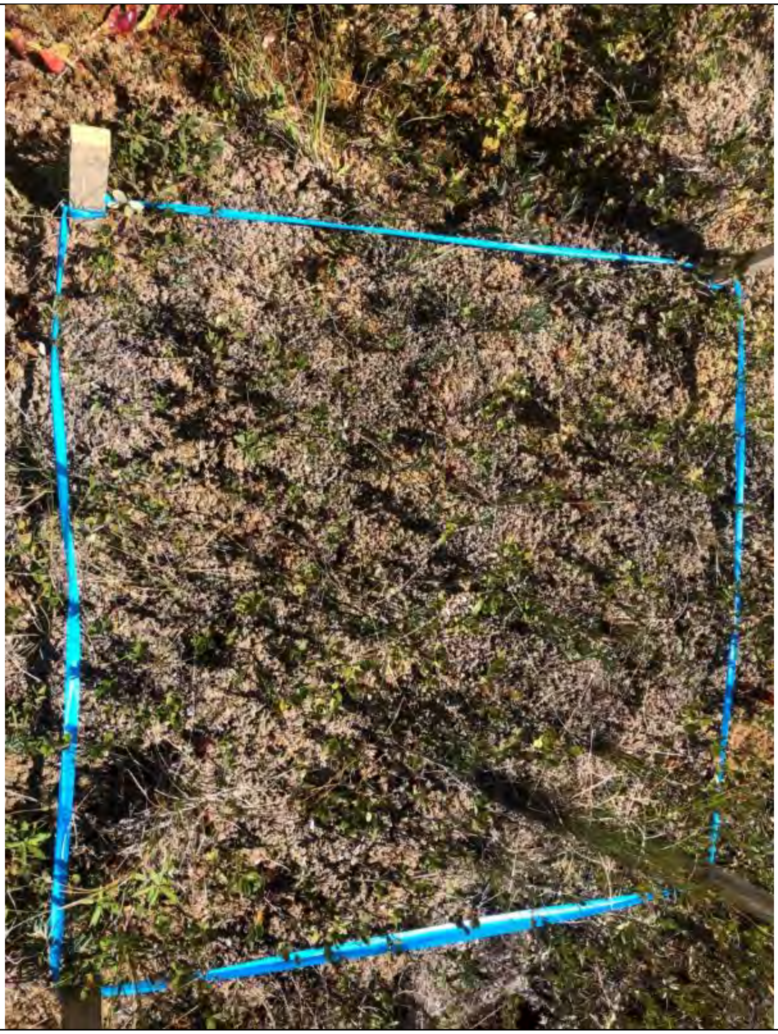
<tr><td></td><td></td></tr>
<tr><td>Photo 9   Quadrat 9 Affected Vegetation Plot. Photo taken August 20, 2020.</td><td>Photo 10   Quadrat 11 Reference Vegetation Plot. Photo taken August 20, 2020.</td></tr>
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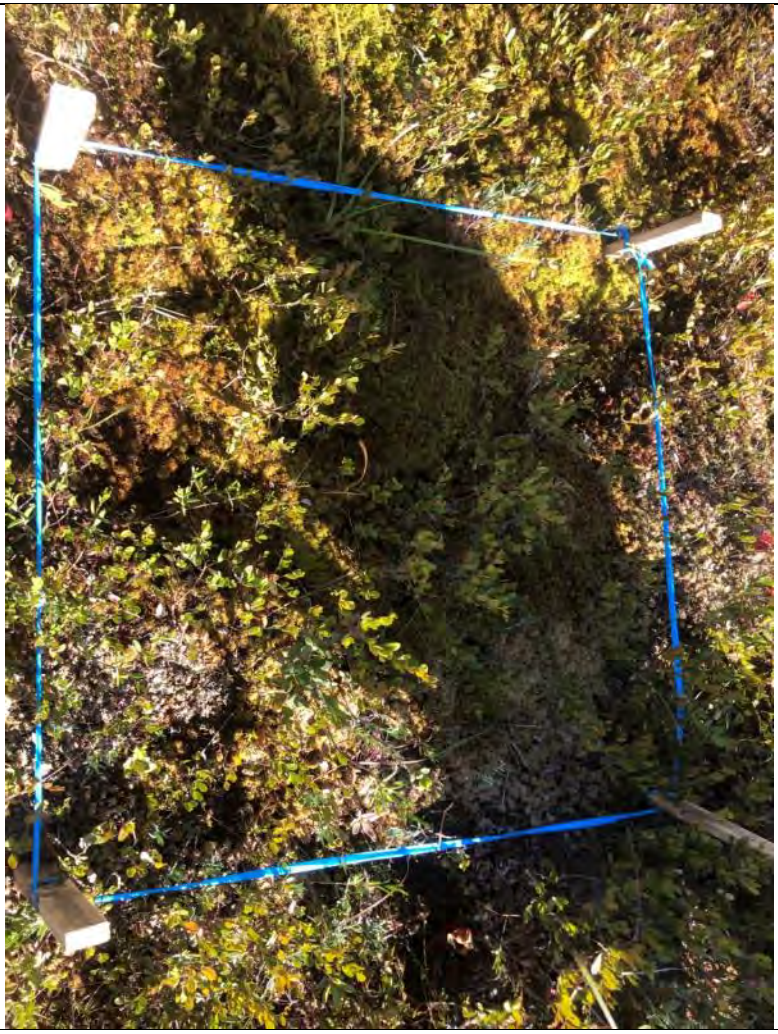
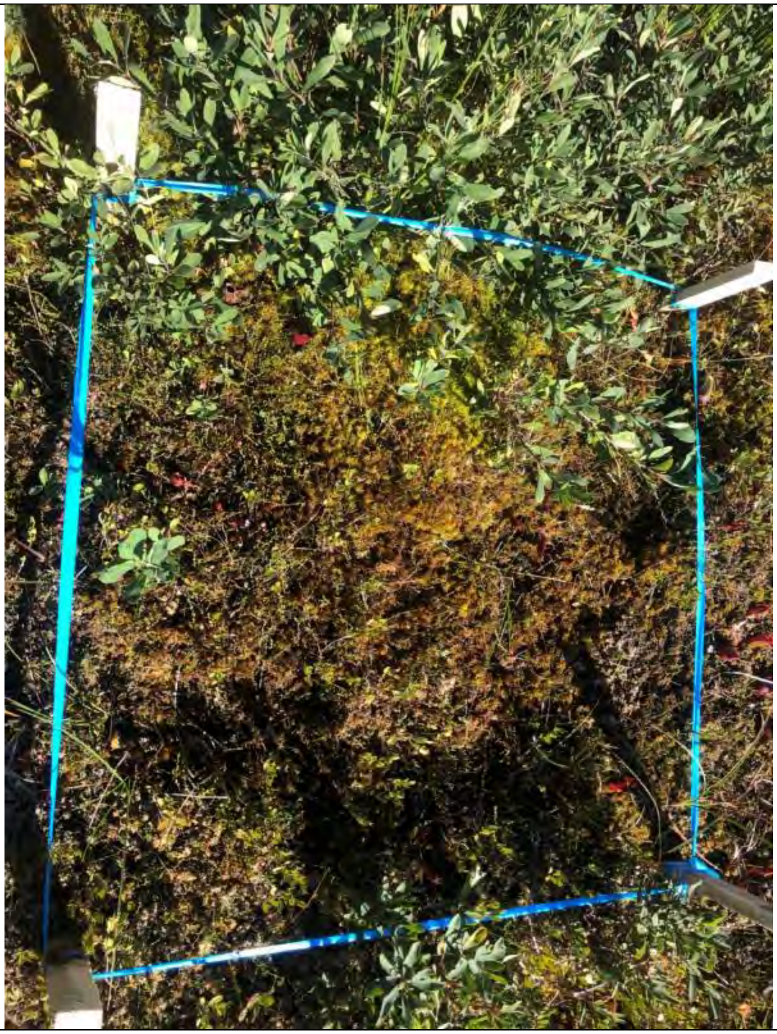
<tr><td></td><td></td></tr>
<tr><td>Photo 11   Quadrat 12 Reference Vegetation Plot. Photo taken August 20, 2020.</td><td>Photo 12   Quadrat 13 Reference Vegetation Plot. Photo taken August 20, 2020.</td></tr>
</table>

<table>
<tr><th colspan="4">Wetland 6 Open Bog Monitoring Quadrats</th></tr>
<tr><td colspan="2"></td><td colspan="2"></td></tr>
<tr><td>Photo 13</td><td>Quadrat 14 Reference Vegetation Plot. Photo taken August 20, 2020.</td><td>Photo 14</td><td>Quadrat 15 Reference Vegetation Plot. Photo taken August 20, 2020.</td></tr>
</table>

| Wetland 6 Open Bog Monitoring Quadrats | |
|---|---|
|  | |
| **Photo 15** **Quadrat 16 Reference Vegetation Plot. Photo taken August 20, 2020.** | |

| Watercourse #4 Slow-Flowing Habitats | |
|---|---|
|  |  |
| **Photo 16** **T1 Sediment Core. Photo taken October 2, 2020.** | **Photo 17** **T2 Sediment Core. Photo taken October 2, 2020.** |

**Watercourse #4 Slow-Flowing Habitats**

**Photo 18** T3 Sediment Core. Photo taken October 2, 2020.

**Photo 19** T4 Sediment Core. Photo taken October 2, 2020.

**Appendix A.2 Wetlands 6 and 15 Photo Log**

| Watercourse #4 Slow-Flowing Habitats | |
|---|---|
|  | |
| **Photo 20** **T5 Sediment Core. Photo taken October 2, 2020.** | |

**Wetland 15 Vegetation Monitoring Quadrats**

| | | | |
|---|---|---|---|
| **Photo 21** | **Quadrat 1 Affected Vegetation Plot. Photo taken August 21, 2020.** | **Photo 22** | **Quadrat 2 Affected Vegetation Plot. Photo taken August 21, 2020.** |

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<tr><th colspan="2">Wetland 15 Vegetation Monitoring Quadrats</th></tr>
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<tr><td>Photo 23 Quadrat 3 Affected Vegetation Plot. Photo taken August 21, 2020.</td><td>Photo 24 Quadrat 4 Affected Vegetation Plot. Photo taken August 21, 2020.</td></tr>
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**Wetland 15 Vegetation Monitoring Quadrats**


| | | | |
|---|---|---|---|
| **Photo 25** | **Quadrat 5 Affected Vegetation Plot. Photo taken August 21, 2020.** | **Photo 26** | **Quadrat 6 Reference Vegetation Plot. Photo taken August 21, 2020.** |

**Wetland 15 Vegetation Monitoring Quadrats**

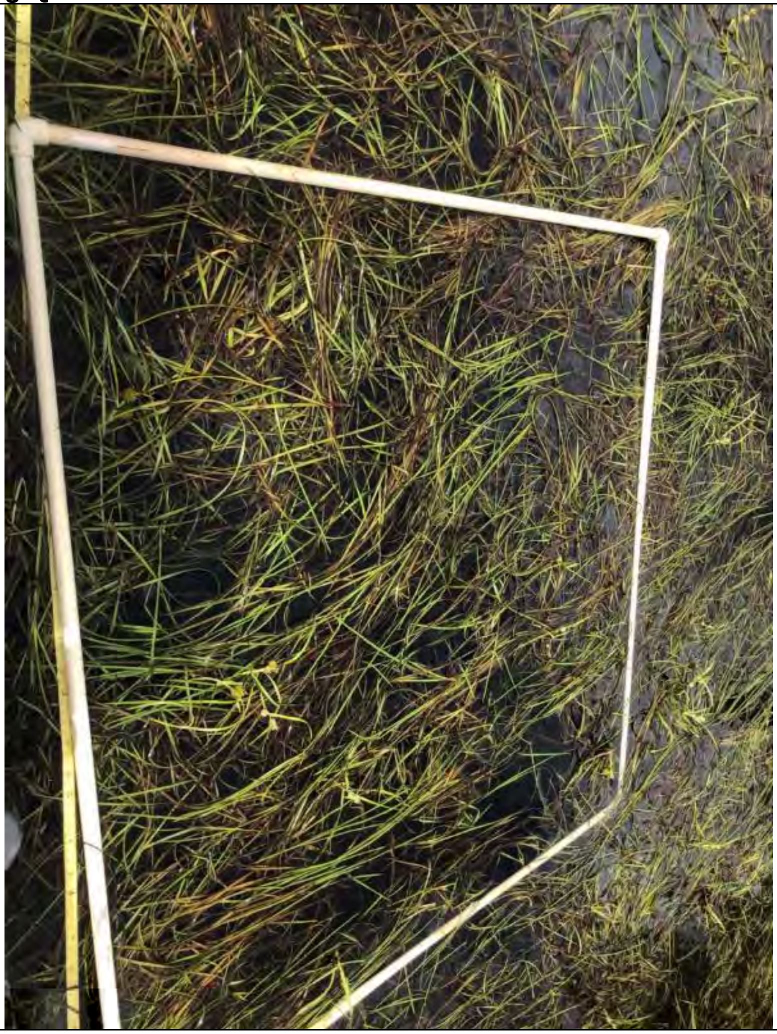
**Photo 27** **Quadrat 7 Reference Vegetation Plot. Photo taken August 21, 2020.**

**Photo 28** **Quadrat 8 Reference Vegetation Plot. Photo taken August 21, 2020.**

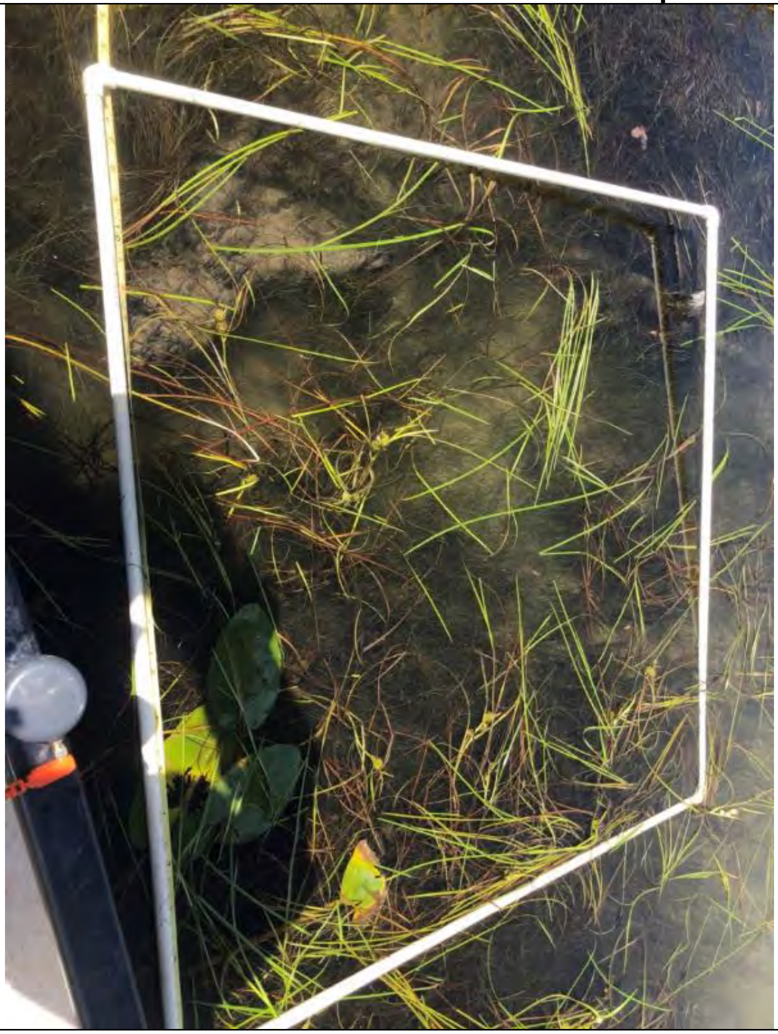
**Wetland 15 Vegetation Monitoring Quadrats**

**Photo 29** — **Quadrat 9 Reference Vegetation Plot. Photo taken August 21, 2020.**

**Photo 30** — **Quadrat 10 Reference Vegetation Plot. Photo taken August 21, 2020.**

| Aquatic Plant Monitoring Quadrats | |
|---|---|
|  |  |
| **Photo 31** **Quadrat 1ab Vegetation Plot. Photo taken August 19, 2020.** | **Photo 32** **Quadrat 1cd Vegetation Plot. Photo taken August 19, 2020.** |

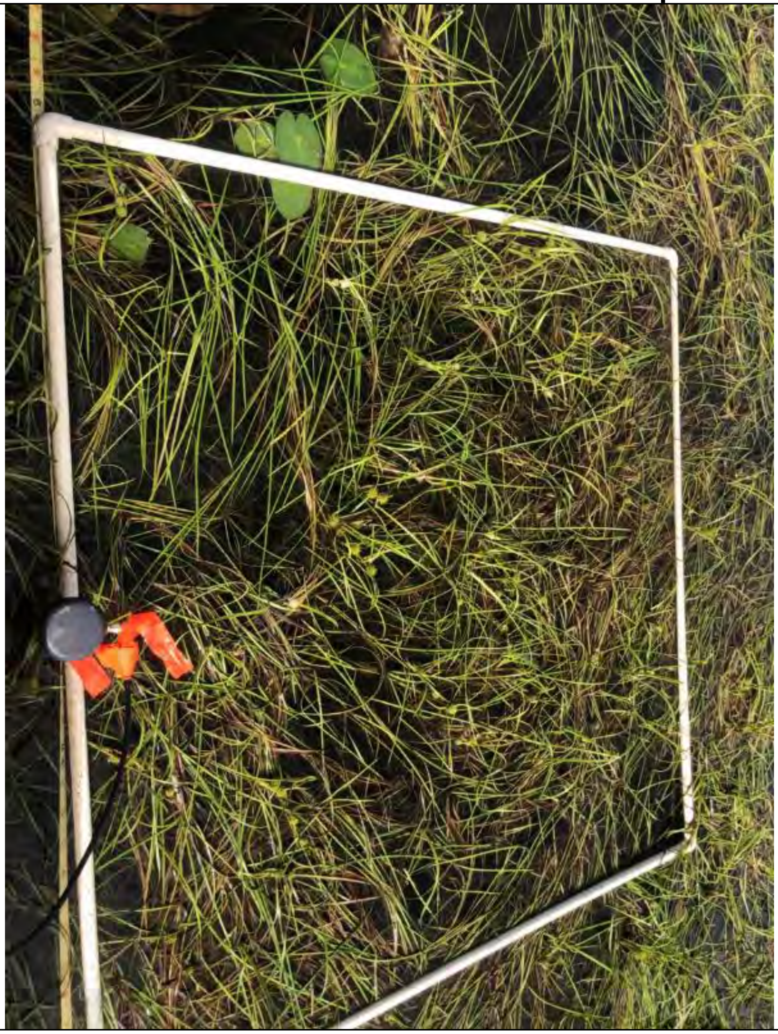
<table>
<tr><th colspan="2">Aquatic Plant Monitoring Quadrats</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 33 Quadrat 1ef Vegetation Plot. Photo taken August 19, 2020.</td><td>Photo 34 Quadrat 2ab Vegetation Plot. Photo taken August 19, 2020.</td></tr>
</table>

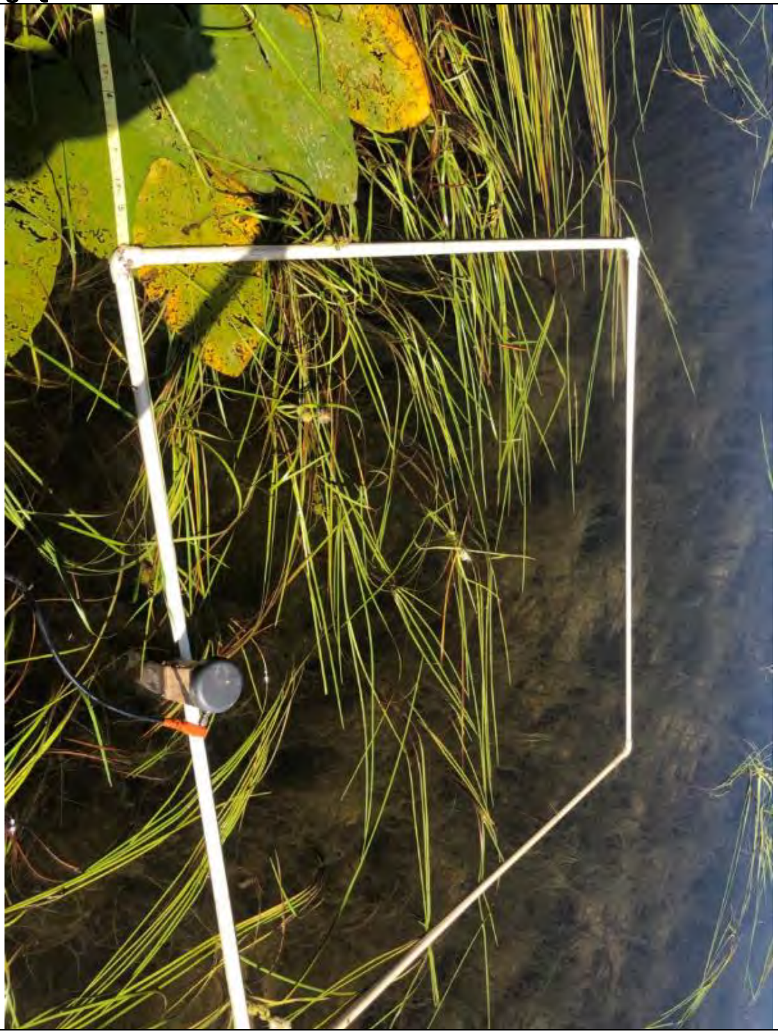
| Aquatic Plant Monitoring Quadrats | |
|---|---|
|  |  |
| **Photo 35** **Quadrat 2cd Vegetation Plot. Photo taken August 19, 2020.** | **Photo 36** **Quadrat 2ef Vegetation Plot. Photo taken August 19, 2020.** |

<table>
<tr><th colspan="2">Aquatic Plant Monitoring Quadrats</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 37 Quadrat 3b Vegetation Plot. Photo taken August 19, 2020.</td><td>Photo 38 Quadrat 3c Vegetation Plot. Photo taken August 19, 2020.</td></tr>
</table>

Appendix A.2 Wetlands 6 and 15 Photo Log

<table>
<tr><th colspan="2">Aquatic Plant Monitoring Quadrats</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Photo 39 Quadrat 3d Vegetation Plot. Photo taken August 19, 2020.</td><td>Photo 40 Quadrat 4b Vegetation Plot. Photo taken August 19, 2020.</td></tr>
</table>

| Aquatic Plant Monitoring Quadrats | |
| --- | --- |
|  |  |
| **Photo 41** **Quadrat 4c Vegetation Plot. Photo taken August 19, 2020.** | **Photo 42** **Quadrat 4d Vegetation Plot. Photo taken August 19, 2020.** |

| Aquatic Plant Monitoring Quadrats | | | |
|---|---|---|---|
|  | |  | |
| **Photo 43** | **T4 Vegetation Transect. Photo taken August 19, 2020.** | **Photo 44** | **Quadrat 5b Vegetation Plot. Photo taken August 19, 2020.** |

**Aquatic Plant Monitoring Quadrats**

**Photo 45** **Quadrat 5c Vegetation Plot. Photo taken August 19, 2020.**

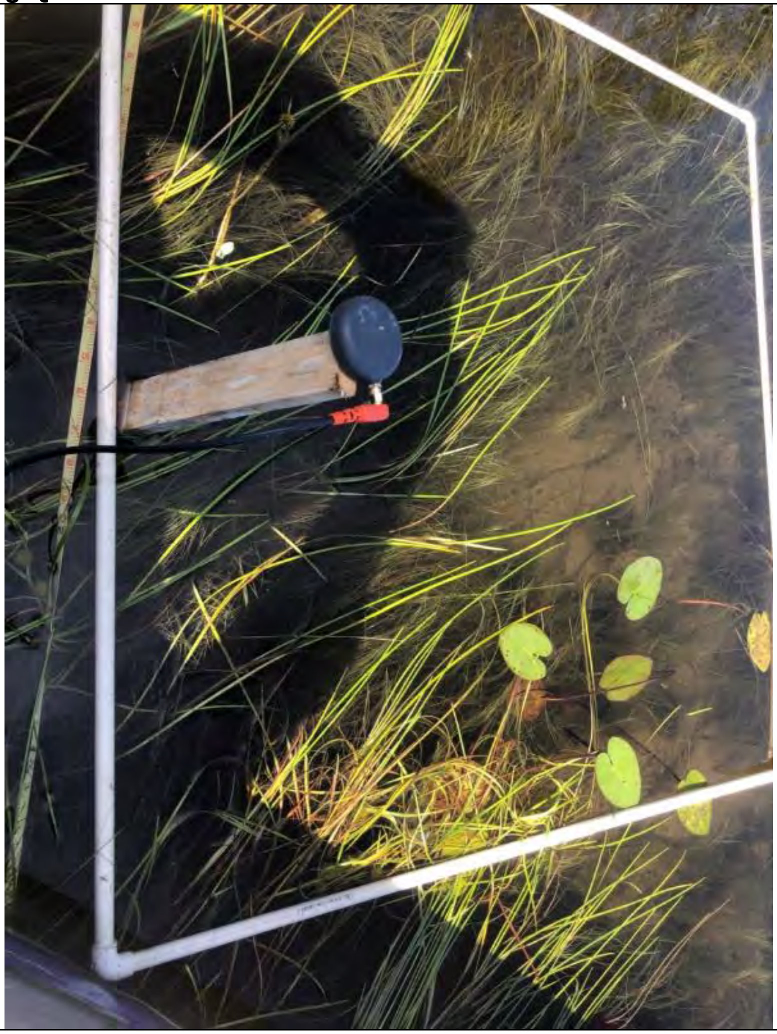


**Photo 46** **Quadrat 5d Vegetation Plot. Photo taken August 19, 2020.**

# APPENDIX B

## Field Data

**Table B-1. Substrate Composition and Embeddedness in Year 0 and 1 for Swift-Flowing Habitats in Watercourse #4**

| Habitat Unit (HU) | Longitude | Latitude | Survey Date | Dominant Habitat Unit Type | Substrate (%) | | | | | | | | | Embeddedness |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | 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 | |
| 8 | 44.98879 | -62.9322 | 2019 | run | 60 | 15 | 0 | 5 | 5 | 5 | 10 | 0 | 0 | Medium (25-50%) |
| | | | 2020 | | 50 | 0 | 0 | 0 | 0 | 5 | 45 | 0 | 0 | Medium (25-50%) |
| 12 | 44.98667 | -62.9317 | 2019 | run | 0 | 0 | 0 | 15 | 25 | 30 | 30 | 0 | 0 | High (50-75%) |
| | | | 2020 | | 0 | 0 | 0 | 10 | 20 | 35 | 35 | 0 | 0 | Medium (25-50%) |
| 16 | 44.98595 | -62.9309 | 2019 | riffle | 0 | 15 | 0 | 5 | 20 | 30 | 30 | 0 | 0 | Low (<25%) |
| | | | 2020 | | 0 | 5 | 5 | 10 | 20 | 35 | 25 | 0 | 0 | Low (<25%) |
| 20 | 44.98495 | -62.9305 | 2019 | riffle | 0 | 20 | 0 | 0 | 0 | 40 | 40 | 0 | 0 | Medium (25-50%) |
| | | | 2020 | | 0 | 5 | 5 | 0 | 15 | 40 | 35 | 0 | 0 | Low (<25%) |
| 22 | 44.9846 | -62.9303 | 2019 | riffle | 5 | 30 | 0 | 0 | 0 | 20 | 50 | 0 | 0 | Medium (25-50%) |
| | | | 2020 | | 0 | 15 | 0 | 5 | 5 | 35 | 40 | 0 | 0 | Medium (25-50%) |
| 24 | 44.98354 | -62.9295 | 2019 | run | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Very High (>75%) |
| | | | 2020 | | 0 | 100 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Very High (>75%) |
| 26 | 44.98262 | -62.9287 | 2019 | run | 0 | 50 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | Medium (25-50%) |
| | | | 2020 | | 0 | 30 | 0 | 0 | 5 | 15 | 45 | 5 | 0 | Low (<25%) |
| 36 | 44.97761 | -62.9291 | 2019 | run | 20 | 30 | 0 | 0 | 0 | 0 | 50 | 0 | 0 | Medium (25-50%) |
| | | | 2020 | | 15 | 10 | 5 | 0 | 5 | 25 | 40 | 0 | 0 | Medium (25-50%) |

Note: HU12 was selected as the reference site to verify that the visual substrate composition assessment was consistent between years.

**Table B.2 - Ground Vegetation Species Cover in Affected and Reference Quadrats in the Bog Plant Community in Wetland 6**

| | Cover (%) Affected Quadrat Number | | | | | | | | | Cover (%) Reference Quadrat Number | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **7** | **9** | **10** | **Mean Cover** | **6** | **8** | **11** | **12** | **13** | **14** | **15** | **16** | **Mean Cover** |
| *Andromeda polifolia* | 12 | 10 | 1 | 2 | 3 | 10 | 3 | 3 | 5.5 | 0.5 | 7 | 6 | 2 | 1 | 4 | 1 | 0.5 | 2.7 |
| *Carex oligosperma* | 0 | 0.5 | 0 | 0 | 0.5 | 0.5 | 5 | 0 | 0.81 | 0 | 0.5 | 1 | 0 | 0.5 | 0.5 | 0.5 | 0.5 | 0.44 |
| *Carex stricta* | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.25 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Carex trisperma* | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 2 | 0.31 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Chamaedaphne calyculata* | 4 | 10 | 0 | 8 | 1 | 10 | 25 | 20 | 9.7 | 20 | 3 | 0 | 25 | 5 | 25 | 30 | 35 | 18 |
| *Drosera intermedia* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.12 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Drosera rotundifolia* | 0.5 | 0.5 | 0.5 | 1 | 0.5 | 0.5 | 0 | 1 | 0.56 | 0.5 | 1 | 0.5 | 0 | 0 | 0.5 | 0 | 0.5 | 0.37 |
| *Eriophorum sp.* | 0 | 0 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0.12 | 0.5 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0.12 |
| *Eriophorum virginicum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 | 0.06 |
| *Gaultheria procumbens* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.06 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Gaylussacia bigeloviana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 20 | 0 | 0 | 0 | 0 | 0 | 2.6 |
| *Kalmia angustifolia* | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0.06 | 5 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.62 |
| *Kalmia polifolia* | 0 | 0 | 0 | 0 | 0 | 2 | 0.5 | 2 | 0.56 | 0 | 3 | 1 | 0 | 0 | 0 | 1 | 0.5 | 0.69 |
| *Larix laricina* | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 | 0.06 | 1 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0.19 |
| *Ledum groenlandicum* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.12 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 0.62 |
| *Maianthemum trifoliolata* | 0.5 | 0.5 | 0 | 0.5 | 0.5 | 10 | 0 | 0 | 1.5 | 0.5 | 0 | 7 | 0 | 0 | 0 | 2 | 0.5 | 1.2 |
| *Myrica gale* | 20 | 12 | 10 | 25 | 15 | 6 | 0.5 | 0 | 11 | 7 | 0 | 20 | 0 | 12 | 20 | 20 | 3 | 10 |
| *Photinia melanocarpa* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0 | 0.06 |
| *Picea mariana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.12 |
| *Rhododendron canadense* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 | 0.06 |
| *Rhyncospora alba* | 0 | 0 | 0 | 0.5 | 0.5 | 0 | 0 | 0 | 0.12 | 0 | 0.5 | 0 | 0 | 0.5 | 0.5 | 0 | 0 | 0.19 |
| *Sarracenia purpurea* | 4 | 3 | 5 | 1 | 3 | 0 | 2 | 4 | 2.7 | 1 | 7 | 2 | 0.5 | 3 | 0.5 | 0.5 | 0.5 | 1.88 |
| Unhealthy (bleached) Sphagnum spp | 15 | 25 | 20 | 70 | 2 | 65 | 20 | 10 | 28 | 5 | 4 | 2 | 15 | 10 | 5 | 5 | 5 | 6.4 |
| Dead (stained) Sphagnum spp. | 55 | 40 | 68 | 5 | 90 | 5 | 80 | 80 | 53 | 2 | 3 | 1 | 10 | 2 | 3 | 5 | 1 | 3.4 |
| Healthy Sphagnum spp. | 15 | 20 | 10 | 20 | 1 | 30 | 0 | 8 | 13 | 90 | 90 | 85 | 75 | 88 | 90 | 85 | 94 | 87 |
| *Trichophorum cespitosum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0 | 0 | 0 | 0 | 0.06 |
| *Vaccinium macrocarpon* | 2 | 3 | 25 | 15 | 4 | 0 | 0 | 0 | 6.1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Vaccinium oxycoccos* | 0.5 | 1 | 0 | 2 | 0 | 0.5 | 0 | 3 | 0.88 | 15 | 2 | 12 | 2 | 15 | 3 | 20 | 2 | 8.9 |
| Species Richness | 11 | 10 | 7 | 12 | 12 | 9 | 8 | 9 | 9.7 | 13 | 12 | 11 | 7 | 8 | 10 | 9 | 11 | 10 |
| Litter | 15 | 2 | 0.5 | 2 | 5 | 1 | 2 | 0.5 | 3.5 | 1 | | | 0 | 0 | 1 | 2 | 0.5 | 0.75 |
| Total Cover All Species | 76 | 86 | 72 | 146 | 32.5 | 135 | 57.5 | 53.5 | 82 | 148 | 120 | 157 | 121 | 135 | 150 | 165 | 147 | 143 |
| Total Cover Vascular Plants | 46 | 41 | 42 | 56 | 29.5 | 39.5 | 37.5 | 35.5 | 42 | 53 | 25.5 | 70 | 30.5 | 37 | 54.5 | 75 | 47 | 49 |
| Total Cover Living Sphagnum | 30 | 45 | 30 | 90 | 3 | 95 | 20 | 18 | 41 | 95 | 94 | 87 | 90 | 98 | 95 | 90 | 100 | 94 |
| Turbidity of Interstitial Water | T | T | T | T | S | nd | nd | nd | | S | nd | nd | nd | nd | T | T | S | |

T = Turbid

S = Slightly Turbid

nd = No Data

Table B.3 - Raw Sediment Core Data, October 20, 2020, Watercourse #4/Wetland 6

| Transect Orientation | Transect Number | Plot | Sediment Layer | Sediment Description | Sediment Depth (cm) | Comments |
|---|---|---|---|---|---|---|
| Parallel | 1 | AB | 1 | Dark brown organic floc | 1.5 | |
| Parallel | 1 | AB | 2 | Light grey silt mixed with brown muck | 1.5 | |
| Parallel | 1 | AB | 3 | Dark grey silt | 4 | |
| Parallel | 1 | AB | 4 | Light grey silt | 3 | |
| Parallel | 1 | AB | 5 | Brown muck with sand | 7 | |
| Parallel | 1 | CD | 1 | Dark brown organic floc | 1.5 | |
| Parallel | 1 | CD | 2 | Brown muck | 3.5 | |
| Parallel | 1 | CD | 3 | Grey silt | 4.5 | |
| Parallel | 1 | CD | 4 | Brown muck | 8 | |
| Parallel | 1 | EF | 1 | Dark brown organic floc | 3.5 | |
| Parallel | 1 | EF | 2 | Dark grey silt | 2.5 | |
| Parallel | 1 | EF | 3 | Light grey silt | 3.5 | |
| Parallel | 1 | EF | 4 | Dark brown muck | 9 | |
| Parallel | 2 | AB | 1 | Dark brown organic floc | 2.5 | Taken from less weedy area |
| Parallel | 2 | AB | 2 | Grey silt | 4 | Taken from less weedy area |
| Parallel | 2 | AB | 3 | Brown muck | 13 | Taken from less weedy area |
| Parallel | 2 | CD | 1 | Dark brown organic floc | 0.5 | |
| Parallel | 2 | CD | 2 | Grey silt | 6.5 | |
| Parallel | 2 | EF | 1 | Dark brown organic floc | 1.6 | Taken from spot with no weeds |
| Parallel | 2 | EF | 2 | Dark grey silt | 0.9 | Taken from spot with no weeds |
| Parallel | 2 | EF | 3 | Light grey silt | 6.5 | Taken from spot with no weeds |
| Parallel | 2 | EF | 4 | Dark brown muck | 6 | Taken from spot with no weeds |
| Perpendicular | 3 | B | 1 | Dark brown organic floc | 7 | |
| Perpendicular | 3 | B | 2 | Dark grey muck, with clumps of grey | 6.5 | |
| Perpendicular | 3 | B | 3 | Brown muck | 13.5 | |
| Perpendicular | 3 | C | 1 | Dark brown organic floc | 3 | |
| Perpendicular | 3 | C | 2 | Dark grey muck, lots of aquatic vegetation | 8 | |
| Perpendicular | 3 | D | 1 | Dark brown organic floc | 4 | |
| Perpendicular | 3 | D | 2 | Dark brown muck | 4 | |
| Perpendicular | 3 | D | 3 | Brown muck mixed with silt | 6 | |
| Perpendicular | 4 | B | 1 | Dark brown organic floc | 8 | |
| Perpendicular | 4 | B | 2 | Brown muck | 16 | |
| Perpendicular | 4 | C | 1 | Dark brown organic floc | 3 | |
| Perpendicular | 4 | C | 2 | Dark grey muck with intermittent streaks of light grey | 8 | |
| Perpendicular | 4 | C | 3 | Dark brown muck | 13 | |
| Perpendicular | 4 | D | 1 | Dark brown organic floc | 5.5 | |
| Perpendicular | 4 | D | 2 | | 21 | |
| Perpendicular | 5 | B | 1 | Dark brown organic floc | 0.5 | |
| Perpendicular | 5 | B | 2 | Grey silt | 1.5 | |
| Perpendicular | 5 | B | 3 | Brown muck | 12 | |
| Perpendicular | 5 | C | 1 | Dark brown organic floc | 4 | |
| Perpendicular | 5 | C | 2 | Darker brown muck | 0.5 | |
| Perpendicular | 5 | C | 3 | Brown muck | 1 | |
| Perpendicular | 5 | C | 4 | Brown muck | 15.5 | |
| Perpendicular | 5 | D | 1 | Dark brown organic floc | 1.5 | |
| Perpendicular | 5 | D | 2 | Grey silt | 1.5 | |
| Perpendicular | 5 | D | 3 | Brown muck | 10 | |

**Table B.4 - Aquatic Plant Cover, Sediment Thickness and Water Depth in Sampling Transects in Wetland 6**

| | Cover (%) | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Transect 1 | | | | Transect 2 | | | | Transect 3 | | | | Transect 4 | | | | Transect 5 | | | |
| **Species** | **1ab** | **1cd** | **1ef** | **Mean Cover** | **2ab** | **2cd** | **2ef** | **Mean Cover** | **3b** | **3c** | **3d** | **Mean Cover** | **4b** | **4c** | **4d** | **Mean Cove** | **5b** | **5c** | **5d** | **Mean Cover** |
| *Nuphar lutea var. rubrodisca* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0 | 0.5 | 0.33 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Nuphar lutea var. variegata* | 0 | 0 | 0 | 0 | 0 | 5 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 8 | 3 | 2 | 2 | 5 | 3 |
| *Potamogeton epihydrus* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 6 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Schoenoplectus subterminalis* | 0 | 0 | 35 | 12 | 55 | 60 | 80 | 65 | 60 | 80 | 70 | 70 | 80 | 20 | 15 | 38 | 15 | 70 | 50 | 45 |
| *Sparganium angustifolium* | 85 | 70 | 6 | 54 | 60 | 15 | 3 | 26 | 40 | 25 | 25 | 30 | 20 | 80 | 70 | 57 | 20 | 12 | 15 | 16 |
| *Utricularia intermedia* | 0 | 0 | 0 | 0 | 0 | 0 | 0.5 | 0.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Utricularia macrorhiza* | 0 | 0 | 8 | 2.7 | 0.5 | 0 | 0 | 0.17 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Cover | 85 | 70 | 49 | 68 | 116 | 80 | 88.5 | 95 | 100.5 | 111 | 98.5 | 103 | 100 | 101 | 93 | 98 | 37 | 84 | 70 | 64 |
| Species Richness | 1 | 1 | 3 | 1.7 | 3 | 3 | 4 | 3.3 | 3 | 3 | 4 | 3.3 | 2 | 3 | 3 | 2.7 | 3 | 3 | 3 | 3 |
| Sediment Thickness (cm) | 8.5 | 4.5 | 6 | 6.3 | 4 | 6.5 | 7.4 | 6 | nd | nd | nd | nd | nd | nd | nd | nd | 1.5 | 1.5 | 0 | 1 |
| Water Depth (cm) | 38 | 38 | 41 | 39 | 31 | 25 | 34 | 30 | 24 | 15 | 18 | 19 | 30 | 23 | 20 | 24 | 37 | 36 | 26 | 33 |

nd = No Data

**Table B.5 - Ground Vegetation Cover in Affected and Reference Quadrats in Wetland 15**

| | Cover (%) Affected Quadrat Number | | | | | | Cover (%) Reference Quadrat Number | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **Mean Cover** | **6** | **7** | **8** | **9** | **10** | **Mean Cover** |
| *Abies balsamea* | 4 | 0 | 8 | 1 | 0 | 2.6 | 6 | 0 | 0.5 | 15 | 0 | 4.3 |
| *Alnus incana* | 0 | 4 | 0 | 10 | 0 | 2.8 | 3 | 0 | 0 | 0 | 15 | 3.6 |
| *Acer rubrum* | 0 | 0 | 0 | 0.5 | 0 | 0.1 | 0 | 0 | 3 | 2 | 0 | 1 |
| *Aralia nudicaulis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0.2 |
| *Calamagrostis canadensis* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.5 | 0 | 0.5 | 2 | 0.8 |
| *Carex stricta* | 0 | 0 | 0 | 0 | 0 | 0 | 30 | 8 | 25 | 35 | 15 | 22.6 |
| *Carex trisperma* | 8 | 0 | 0 | 3 | 0 | 2.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Cornus canadensis* | 0.5 | 1 | 0 | 0 | 0 | 0.3 | 0.5 | 7 | 12 | 2 | 0 | 4.3 |
| *Dicranum sp.* | 0 | 0 | 3 | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Dryopteris cristata* | 0 | 0.5 | 0 | 0 | 4 | 0.9 | 0 | 0 | 0 | 2 | 0 | 0.4 |
| *Dryopteris X bootii* | 0 | 0 | 0 | 0 | 15 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Eurybia radula* | 1 | 0 | 0.5 | 0 | 0 | 0.3 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Hylocomium splendens* | 0 | 1 | 0 | 1 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ilex verticillata* | 0 | 0 | 0.5 | 0.5 | 0 | 0.2 | 20 | 8 | 0 | 0 | 0 | 5.6 |
| *Kalmia angustifolia* | 0 | 0 | 0 | 0 | 0 | 0 | 5 | 12 | 0.5 | 0 | 2 | 3.9 |
| *Linnaea borealis* | 0.5 | 0 | 0 | 0 | 0 | 0.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Liverwort sp.* | 0 | 3 | 0 | 0 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Lycopus uniflorus* | 1 | 0 | 0 | 0 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| *moss sp.* | 0 | 0 | 3 | 15 | 5 | 4.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Oclemena acuminata* | 0 | 0 | 1 | 20 | 0 | 4.2 | 0 | 0.5 | 0 | 0 | 0 | 0.1 |
| *Osmunda cinnamomea* | 0 | 0 | 0 | 0 | 45 | 9 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Picea mariana* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 15 | 0 | 3 |
| *Pleurozium schreberi* | 0 | 2 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0.5 | 0 | 0 | 0.1 |
| *Polytrichum sp.* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 0 | 0 | 0.6 |
| *Rosa nitida* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.5 | 0.5 | 0.6 |
| *Rubus hispidus* | 1 | 0.5 | 2 | 2 | 2 | 1.5 | 8 | 12 | 2 | 12 | 20 | 10.8 |
| *Rubus idaeus* | 0 | 0 | 0 | 3 | 0 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Rubus pubescens* | 0 | 1 | 7 | 0 | 1 | 1.8 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Seedling* | 0 | 0.5 | 0 | 0.5 | 0 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Solidago rugosa* | 6 | 0 | 0 | 0 | 20 | 5.2 | 0 | 0 | 0 | 0 | 4 | 0.8 |
| *Solidago uliginosum* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0.4 |
| *Sphagnum spp.* | 3 | 0.5 | 0 | 0 | 0.5 | 0.8 | 20 | 40 | 50 | 10 | 2 | 24.4 |
| *Thelypteris noveboracensis* | 0 | 0 | 0 | 4 | 7 | 2.2 | 0 | 0 | 15 | 0 | 0 | 3 |
| *Trientalis borealis* | 0 | 0 | 0.5 | 0 | 0.5 | 0.2 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Vaccinium angustifolium* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.2 |
| *Viburnum nudum* | 0 | 0 | 2 | 15 | 0 | 3.4 | 0 | 1 | 7 | 2 | 0 | 2 |
| *Viola cucculata* | 20 | 0 | 0 | 0 | 0 | 4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Total Cover | 45 | 14 | 27.5 | 75.5 | 100 | 52.4 | 93.5 | 92 | 119 | 99 | 60.5 | 92.8 |
| Species Richness | 10 | 10 | 10 | 13 | 10 | 10.6 | 9 | 11 | 11 | 13 | 8 | 10.4 |
| Bare Ground | 2 | 0 | 0 | 0 | 0 | 0.4 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sediment | 20 | 15 | 10 | 10 | 10 | 13 | 0 | 0 | 0 | 0 | 0 | 0 |
| Litter | 20 | 65 | 80 | 20 | 65 | 50 | 50 | 55 | 30 | 45 | 90 | 54 |
| Fine Woody Debris | 3 | 30 | 12 | 4 | 2 | 10.2 | 0.5 | 0.5 | 0.5 | 1 | 3 | 1.1 |
| Course Woody Debris | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0.4 |

**Table B.6 - Cover of Shrubs in Affected Quadrats and Reference Quadrats in Wetland 15**

| | Cover (%) Affected Quadrat Number | | | | | | Cover (%) Reference Quadrat Number | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **1** | **2** | **3** | **4** | **5** | **Cove r** | **6** | **7** | **8** | **9** | **10** | **Mean Cover** |
| *Abies balsamea* | 2 | 35 | 20 | 20 | 25 | 20.4 | 0 | 0 | 25 | 25 | 0 | 10 |
| *Alnus incana* | 80 | 50 | 25 | 40 | 0 | 39 | 6 | 0 | 0 | 0 | 35 | 8.2 |
| *Acer rubrum* | 0 | 0 | 0 | 0 | 0 | 0 | 4 | 15 | 10 | 10 | 25 | 12.8 |
| *Betula allegheniensis* | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 60 | 0 | 0 | 0 | 12 |
| *Betula papyrifera* | 0 | 0 | 15 | 0 | 0 | 3 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ilex verticillata* | 0 | 0 | 25 | 0 | 0 | 5 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Picea mariana* | 5 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Viburnum nudum* | 0 | 0 | 0 | 0 | 35 | 7 | 5 | 2 | 25 | 25 | 30 | 17.4 |
| Total Cover | 87 | 85 | 85 | 60 | 60 | 75 | 15 | 77 | 60 | 60 | 90 | 60 |

**Table B.7 - Shrub Basal Area in the Affected Quadrats and Reference Quadrats in Wetland 15**

| | | Basal Area (cm2/m2) Affected Quadrat Number | | | | | | Basal Area (cm2/m2) Reference Quadrat Number | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | | **1** | **2** | **3** | **4** | **5** | **Mean Cover** | **6** | **7** | **8** | **9** | **10** | **Cover** |
| *Abies balsamea* | Living | 0 | 27.1 | 0 | 0.95 | 0 | 5.6 | 8.81 | 0 | 0 | 2.99 | 0 | 2.36 |
| | Dead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Alnus incana* | Living | 0 | 25.1 | 0 | 1.63 | 0 | 5.35 | 0.2 | 0 | 0 | 0 | 2.06 | 0.45 |
| | Dead | 0 | 9.43 | 0 | 0.39 | 0 | 1.96 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Acer rubrum* | Living | 0 | 0 | 0 | 0 | 0 | 0 | 0.44 | 0 | 0 | 0 | 0 | 0.09 |
| | Dead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Ilex verticillata* | Living | 0 | 0 | 0.2 | 0 | 0 | 0.04 | 0.79 | 0 | 0 | 0 | 0 | 0.16 |
| | Dead | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| *Viburnum nudum* | Living | 0 | 0 | 0 | 0 | 3.66 | 0.73 | 0.84 | 0.56 | 0 | 2.25 | 6.85 | 2.1 |
| | Dead | 0 | 0 | 0 | 0 | 1.36 | 0.27 | 0.38 | 0 | 0 | 0 | 0.86 | 0.25 |
| Total | Living | 0 | 52.2 | 0.2 | 2.58 | 3.66 | 11.7 | 11.1 | 0.56 | 0 | 5.24 | 8.91 | 5.16 |
| | Dead | 0 | 9.43 | 0 | 0.39 | 1.36 | 2.24 | 0.38 | 0 | 0 | 0 | 0.86 | 0.25 |