Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Wetland Loss and Disturbance Monitoring Report

TEMP-2018-03

KEEYASK

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2018-03

WETLAND LOSS AND DISTURBANCE MONITORING

Prepared for

Manitoba Hydro

By

ECOSTEM Ltd.

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SUMMARY

Background

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014. The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. Monitoring results will help the KHLP, government regulators, members of local First Nation communities, and the general public understand how construction and operation of the generating station are affecting the environment, and whether or not more needs to be done to reduce harmful effects.

This report describes the results of wetland loss and disturbance monitoring conducted during the fourth summer of Project construction.

Why is the study being done?

Wetlands are land areas where the ground is usually either wet or under shallow water. Wetlands are important for the ecosystem and people for many reasons, such as protecting shorelines, adding to the variety of habitat types and providing good areas to find wildlife. Several medicinal or country food plants used by Members of the partner First Nations (e.g., sweet flag [*wekes*, *wekas* or *wihkis* in Cree], and tamarack) are either only or mostly found in wetlands. In the Keeyask region, marsh off the Nelson River (i.e., off-system marsh) is a very important wetland type, mostly because it is rare and it provides the only very good habitat for some kinds of plants and animals. Off-system marshes are usually good areas to hunt moose and waterfowl.

Wetland habitat at Wetland 40

What was done?

Mapping and characterization of the various wetlands in the Project footprint area was done as part of the existing environment section of the EIS. Since it is impossible to avoid all of the wetlands given the size of the Project footprint, mitigation is provided to help reduce Project effects.

As construction proceeds, this monitoring study documents impacts on, and mitigation related to, wetlands that are very important parts of the ecosystem. This is to make sure the EIS predictions are accurate and that no additional unanticipated impacts are occurring. Following the end of construction, Project effects on all wetland types will be evaluated.

Off-system marsh was the only very important wetland type identified by the EIS. Off-system marsh and its habitat occur within a waterbody. The area surrounding these waterbodies is important for the off-system marsh and its habitat because these areas affect each other, and in most cases the surrounding area is peatland, another type of wetland. For these reasons, each monitored wetland includes the entire waterbody, plus a 100 m buffer of the waterbody. In total, 42 off-system marsh wetlands are being monitored by this study.

In each year of construction, aerial and foot surveys are carried out in and near the monitored wetlands that are close to the Project construction areas. On August 2017, 39 of the 42 monitored wetlands were surveyed from a helicopter because they were within 1 km of the existing Project footprint. Eleven of these wetlands were also within 100 m of existing Project clearing or disturbance and did not have a wide band of dense vegetation separating them from these areas; as such, they had the potential to be impacted by construction activities. These 11 wetlands were surveyed on foot between August 23 and 31, 2017.

What was found?

A total of 4.19 ha of Project clearing or disturbance was found within seven of the 42 monitored wetlands (i.e., marsh habitat or their buffers), with the vast majority (4.09 ha) of this being within the planned Project footprint. This was expected since a portion of these wetlands overlapped a permanent Project feature such as a dyke, a road or reservoir clearing.

Six of the wetlands had Project clearing in a portion of their marsh habitat buffers. One of these also had a very small amount (0.11 ha) of clearing in its marsh habitat where taller vegetation had been cleared for the future reservoir area. A very small area (<0.1 ha) in a seventh wetland had been disturbed by sediment from an excavated material placement area being deposited in an area with standing water. All of this deposition was in the marsh habitat buffer.

Areas burned in the 2013 wildfire (which was unrelated to the Project) were of interest for the wetland monitoring because runoff from Project areas could be carried over burned bare mineral areas rather than being trapped by mosses and other ground plants. Seven of the 11 ground surveyed wetlands either overlapped recently burned areas or the burned areas were between the wetland and Project clearing.

Future impacts were deemed possible for eight of the wetlands located within 100 m of actual Project clearing or disturbance. At four wetlands, exposed mineral slopes between the wetland

and a Project feature (e.g., dyke, excavated material placement area) had been created by either the 2013 wildfire or Project clearing. These exposed mineral slopes pose a risk in that heavy rains could carry sediment or other materials into the marsh habitat in the future. At four other wetlands, runoff from an access road or from nearby clearing unrelated to the Project had the potential to have future effects on the marsh habitat.

What does it mean?

To date, there have been no unanticipated impacts on the wetlands being monitored by this study. While some Project clearing or disturbance occurred in a small portion of seven wetlands, it was expected that there would be some impacts at wetlands overlapping the planned Project footprint or those close to active construction areas. Erosion control or other mitigation measures have been recommended where there are potential risks to an off-system marsh or its habitat.

What will be done next?

Off-system marsh wetland monitoring, including the effectiveness of mitigation measures, will continue in 2018. Where needed, additional mitigation measures will be recommended after the 2018 surveys.

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STUDY TEAM

Dr. James Ehnes was the project manager and study designer.

Fieldwork in 2017 was conducted by Nathan Ricard, Brock Epp and Barry Flett (TCN).

Data analysis and report writing in 2017 were completed by Brock Epp and James Ehnes. GIS analysis and cartography was completed by Nathan Ricard.

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1.0 INTRODUCTION

Construction of the Keeyask Generation Project (the Project), a 695-megawatt hydroelectric generating station (GS) and associated facilities, began in July 2014. The Project is located at Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake, 35 km upstream of the existing Kettle GS.

The *Keeyask Generation Project Response to EIS Guidelines* (the EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project (KHLP 2012a). Technical supporting information for the terrestrial environment, including a description of the environmental setting, effects and mitigation, and a summary of proposed monitoring and follow-up programs is provided in the *Keeyask Generation Project Environmental Impact Statement Terrestrial Supporting Volume* (TE SV; KHLP 2012b). The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP) was developed as part of the licensing process for the Project (KHLP 2015). Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, which is wetland monitoring.

A wetland is a land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant factor shaping soil attributes and vegetation distribution and composition. Wetland functions are the natural properties or processes that are associated with wetlands, stated in ways that describe what they do for the ecosystem.

Wetlands typically make relatively high contributions to ecosystem function. EIS studies found that off-system marsh is a particularly important wetland type in the Keeyask region. This is based on the contributions that off-system marsh makes to the range of wetland functions.

As described in the Project's TEMP, two studies are monitoring Project effects on wetland function. During construction, the Wetland Loss and Disturbance study is monitoring direct Project effects on wetlands due to habitat loss and disturbance (see KHLP 2015, Section 2.5.2). During operation, the Long-Term Effects on Wetlands study will monitor long-term direct and indirect Project effects on wetland function (see KHLP 2015, Section 2.5.3). The Created Wetlands study will monitor the efficacy of mitigation measures implemented to create 12 ha of off-system marsh (see KHLP 2015, Section 8.1).

This report presents 2017 results for the Wetland Loss and Disturbance study.

The goal of the Wetland Loss and Disturbance study is to determine direct Project effects on wetland function during construction. Based on this goal, the objectives of this study are to:

- Verify the implementation and effectiveness of off-system marsh protection measures; and,
- Locate and quantify direct Project effects on wetland function during construction based on wetland quality scores.

This report addresses the first of these objectives based on monitoring conducted from 2015 to 2017. A synthesis report completed following the end of construction will provide a detailed

evaluation of effects on off-system marshes as well as addressing the second study objective. ECOSTEM (2016, 2017b) provides results for the wetland loss and disturbance monitoring conducted in 2015 and 2016.

2.0 METHODS

2.1 INTRODUCTION

Section 2.5.2 of the TEMP details the methods for the Wetland Loss and Disturbance study, which began in 2015. The following summarizes the activities conducted in 2017. The methods were the same as in 2015 and 2016.

Prior to describing the activities, some terminology is defined to assist the reader. In the terrestrial habitat, ecosystems and plant studies, clearing refers to complete vegetation removal in a patch that was at least 400 m^2 in size. For this study, even though the portion of the cleared area that falls within a wetland or its buffer can be much smaller than 400 m^2, the term clearing is used as it refers to the entire area cleared (including areas outside the wetland and its buffer). Disturbance refers to either physical disturbance in intact vegetation (e.g., machinery trail, test pits, sediment deposition), use of a pre-existing trail, or a clearing smaller than 400 m^2. "Impacts" refer to what the Project does in terms of the question of interest (e.g., vegetation clearing), while "effects" refer to the consequences relative to the question of interest (e.g., marsh habitat loss, reduced wetland function).

The overall amounts and locations of off-system marsh can change from year to year in response to water level variations and other factors. As water depths and variations are key determinants of where marsh can occur, this was the primary factor used to identify off-system marsh habitat.

Studies completed for the environmental impact statement (EIS) had mapped the locations of the off-system marshes located in Study Zone 4 (Map 2-1) as of 2012. As the waterbodies containing mapped off-system marsh were generally shallower than 2 m, the entire waterbody containing a mapped marsh, and its shore zone, was considered to be off-system marsh habitat.

Marsh habitat is sensitive to human impacts such as physical disturbance or hydrological alterations. Off-system marsh and its habitat occurs within a waterbody. The area surrounding these waterbodies are important for the off-system marsh and its habitat because these areas are linked together, and in most cases consist of other types of wetlands such as peatlands. For these reasons, each monitored wetland includes the entire waterbody, plus a 100 m buffer of the waterbody.

On this basis, references to a monitored wetland in the Wetland Loss and Disturbance study include the marsh habitat (i.e., a waterbody containing off-system marsh, and its shore zone) and its 100 m buffer zone. The marsh habitat buffer zones around most of the monitored wetlands were partially or entirely comprised of a mixture of peatlands and other wetlands.

EIS studies identified the waterbodies in Study Zone 3 (Map 2-1) that contained off-system marsh as of 2010, which was the date of the EIS mapping. All of these waterbodies are included in the construction monitoring for the Wetland Loss and Disturbance study. At each waterbody, the marsh habitat includes the waterbody and its shore zone. Since marsh habitat can be affected by Project impacts in the surrounding area, and because most of the marsh habitat buffers are designated as environmentally sensitive sites to be avoided whenever possible in the Project's environmental protection plans (EnvPPs), each monitored wetland includes the marsh habitat and a 100 m buffer around it. Each of these buffered waterbodies is referred to as a monitored wetland and assigned a wetland ID (e.g., Wetland 17).

2.2 PROJECT AREAS

In this study, four distinct Project areas are used when reporting on where Project clearing or disturbance occurred. This is being done to facilitate future comparisons with EIS predictions.

The first two areas are a subdivision of the footprint licensed for Project use under the Project's Environment Act Licence (i.e., licensed Project footprint): the planned Project footprint and the possibly disturbed Project footprint. The planned Project footprint is largely comprised of permanent Project features. There is little to no opportunity to reduce Project impacts in these areas.

The possibly disturbed Project footprint provided for some of the unknown components of the Project design at the time the Project was being licensed (e.g., the actual volume of suitable material available in each borrow area, or the actual area needed for each of the Excavated Material Placement Areas (EMPAs)). There is some flexibility in locating clearing, disturbance or material placement within the possibly disturbed Project footprint. Project EnvPPs include provisions to minimize clearing or disturbance within the possibly Project footprint, and the avoidance of environmentally sensitive sites to the extent feasible within this area.

After the Project was licensed, several additional areas (called "subsequently approved Project areas" in this report) were approved for Project use by Manitoba Conservation and Water Stewardship (now Manitoba Sustainable Development (MSD)). This is the third type of Project area. These subsequently approved areas primarily included the former KIP start-up camp (which was originally planned as only a temporary camp for the KIP) and trails that were used to access reservoir clearing areas. The trails were evaluated for potential effects by terrestrial specialists prior to their submission for approval to MSD, and their locations modified to alleviate any ecological concerns that were identified at that time. Given the modifications recommended by terrestrial specialists, the subsequently approved areas were not a concern from the terrestrial ecosystem health perspective.

An important consideration for the evaluations of the subsequently approved areas was how these areas would alter predicted cumulative effects, which was largely related to the characteristics of the areas and the amount of the licensed Project footprint that was expected to remain undisturbed at the end of construction. It was expected that a large proportion of the

licensed Project footprint would remain undisturbed because the EIS intentionally erred on the side of overestimating the amount of habitat loss and disturbance. As of September 2016, the vast majority (90%) of the possibly disturbed Project footprint had not been impacted by the Project (ECOSTEM 2017).

This report refers to the licensed Project footprint and the subsequently approved areas as the "approved Project footprint".

The last type of Project area for reporting clearing or disturbance includes any areas outside the approved Project footprint.

It was expected that portions of a particular wetland (Section 2.1) that overlapped the planned Project footprint would be lost or disturbed. Project impacts on the off-system marshes and/or their buffers were assessed during the EIS and were expected to be minimal outside of the planned Project footprint. This study monitors the area actually impacted by the Project in comparison to the amount assessed for the Project in the EIS.

2.3 DATA COLLECTION

To meet the first study objective (Section 1.0), the Wetland Loss and Disturbance study includes annual surveys during construction. Mapping and analysis for the second objective will be completed after construction completion.

For the first study objective, the wetlands selected for monitoring were all off-system marsh wetland located in Study Zone 3 (Map 2-1). Wetlands outside of Study Zone 2 (i.e., the areas of direct and indirect terrestrial habitat effects; Map 2-1) were included because, while unlikely, it is possible for some hydrological effects to extend for a considerable distance beyond the licensed Project footprint. Although not a focus of this study, it is important to document when potential hydrological effects occur.

Map 2-1 shows the 42 wetlands being monitored for this study objective. Each of the monitored wetlands was assigned a unique identifier for the monitoring (e.g., Wetland 21).

In each construction year, surveys are conducted at all of the monitored wetlands that are within approximately 1 km of the Project clearing or disturbance existing at the time of the surveys. The 1 km distance was used for two reasons: physical disturbance may not be visible in the digital orthorectified images (DOIs) used to select the wetlands (see below); and additional area may have been cleared between the time the DOIs were acquired and when the fieldwork would be conducted.

The wetlands to be surveyed in 2017 were selected in two stages. The first stage selected all of the wetlands that were within 1 km of documented Project clearing in September 2016 (ECOSTEM 2017a) as a DOI from summer 2017 was not available prior to the surveys. In the second stage of wetland selection, an aerial survey added any other of the monitored wetlands that were within 1 km of Project clearing or disturbance that happened after September 2016.

The second stage was necessary because additional clearing or disturbance may have occurred between the documented 2016 state and when surveys were conducted in 2017.

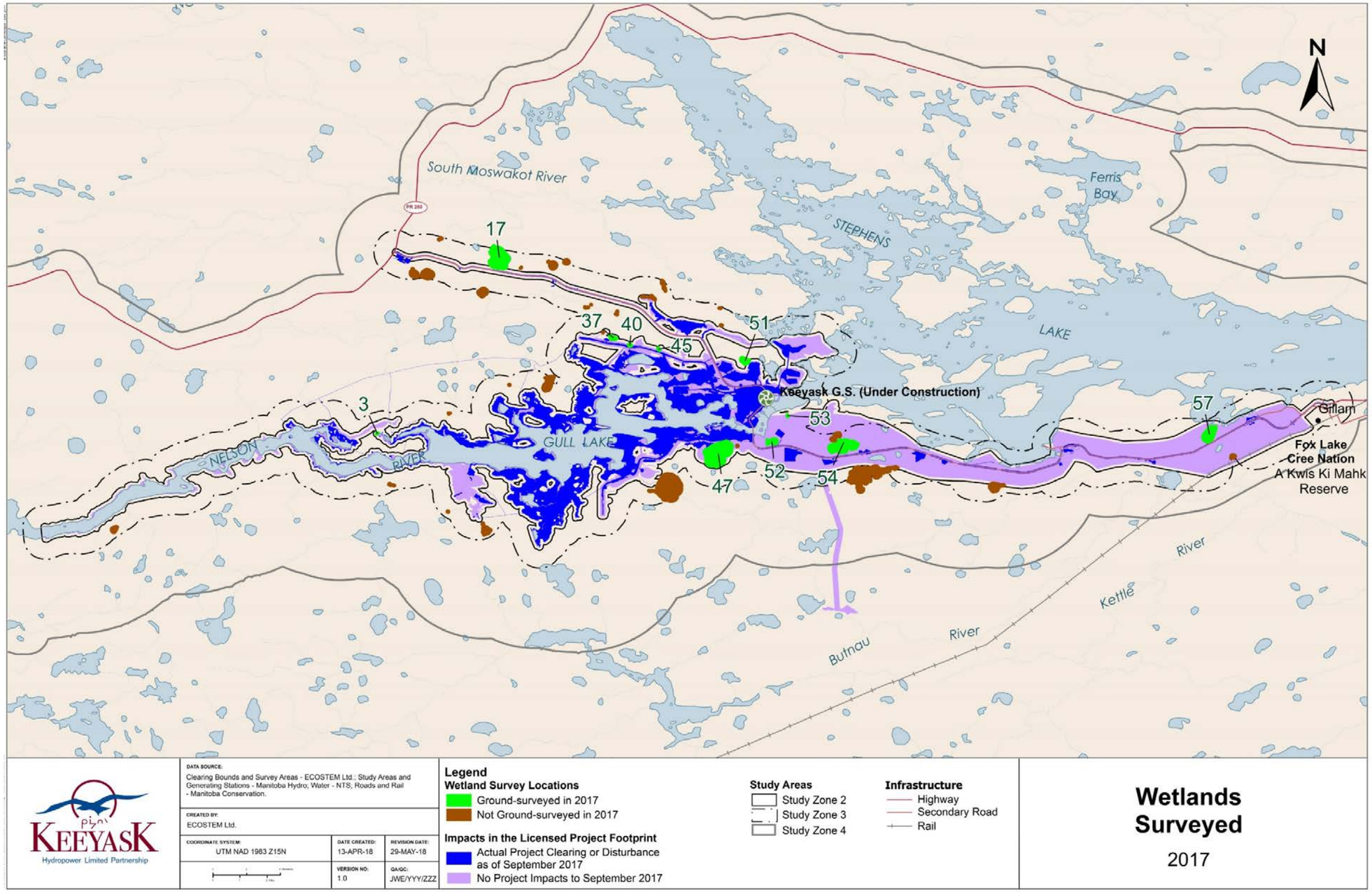
In 2017, the first stage selection identified 39 wetlands for inclusion. No additional wetlands were identified during the second stage aerial surveys. Twelve of these 39 wetlands were within 100 m of existing clearing or disturbance.

Ground surveys on August 23 and 31, 2017 documented mitigation measures and possible Project effects at 11 wetlands (Map 2-1). The twelfth wetland (Wetland 42) within 100 m of existing clearing or disturbance was not ground-surveyed in 2017 because clearing or disturbance was separated from the marsh habitat buffer by approximately 90 m of relatively dense natural ground cover and vegetation.

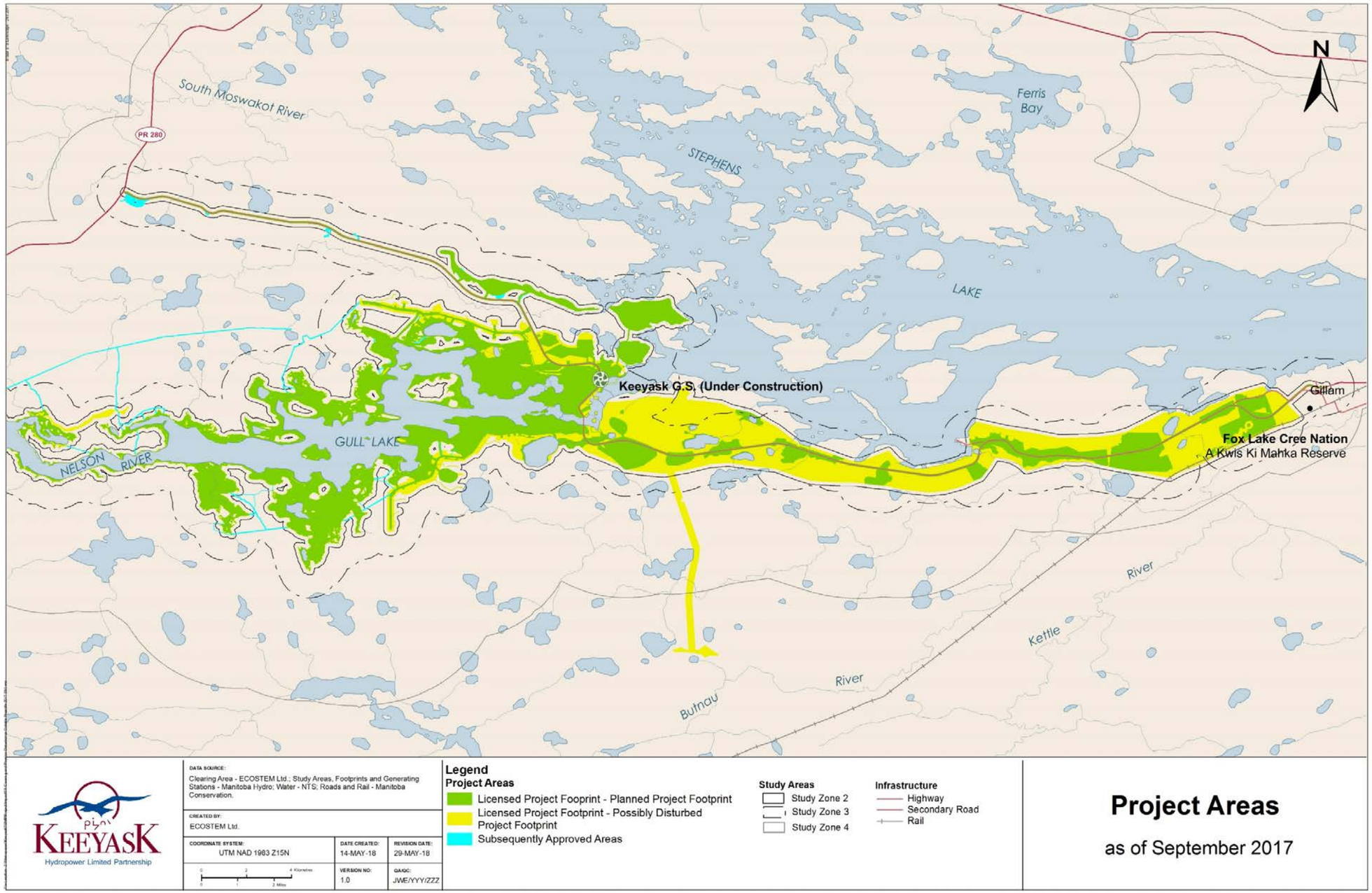
Conditions in the relevant wetlands were recorded with geo-referenced photographs, marked-up maps and/or notes. The nature of works to control Project-related erosion, siltation, and surface hydrological alteration were recorded, as well as any erosion, siltation, or surface hydrological alteration.

The spatial extent of impacts on the surveyed wetlands were mapped in a GIS. The base map for most of the wetlands was a DOI created from Worldview 2 imagery acquired on July 11, 2017.

Areas burned in the 2013 wildfire (which was unrelated to the Project) were of interest for the wetland monitoring because runoff from Project areas could be carried over burned bare mineral areas rather than being trapped by mosses and other ground plants. A GIS was used to map the percentage of the buffer in each wetland that was burned in the 2013 wildfire.



Map 2-1: Monitored off-system marsh wetlands, showing those that were ground-surveyed in 2017



Map 2-2: Project areas as of September 2017

3.0 RESULTS

Aerial surveys conducted on August 31, 2017 found that 12 of the 42 wetlands being monitored during construction were within 100 m of Project clearing or disturbance at the time of the surveys (Map 2-1). These included Wetlands 3, 17, 37, 40, 42, 45, 47, 51, 52, 53, 54 and 57. Figure 3-1 to Figure 3-6 provide aerial views of these 12 wetlands. Project impacts were not expected for one of these wetlands as it was separated from the Project footprint by a 90 m wide band of undisturbed ground cover and vegetation. Ground surveys were conducted in the remaining 11 wetlands.

No new clearing occurred in any of the buffers or marsh habitat between the 2016 and 2017 off-system marsh monitoring surveys.

Only one marsh habitat buffer had been disturbed between the 2016 and 2017 surveys. At Wetland 51, sediment from an excavated material placement area (EMPA) adjacent to the marsh habitat buffer was being deposited into the buffer.

Table 3-1 summarizes the primary noteworthy findings for the wetlands being monitored by this study. Of the 4.19 ha of Project clearing or disturbance within wetlands, 0.10 ha was in marsh habitat while the rest was in the marsh habitat buffer.

To date, all recorded impacts in wetlands have been within the licensed Project footprint, with the vast majority being in the planned Project footprint. Of the 4.19 ha of impacted area, 3.91 ha was within the planned Project footprint while 0.28 ha was within the possibly disturbed Project footprint (Table 3-2).

Table 3-1: Impacts and potential future effects in the wetlands within 100 m of Project clearing or disturbance, as of September, 2017

Wetland ID[1]	Wetland Area (ha)			Area (ha) Impacted[2] by Project Clearing and Disturbance			Other Project Impacts up to 2017	2013 Burn in Buffer (%)[3]	Noteworthy Potential Additional Future Effects or Effects Outside of the Monitored Wetlands
	Total	Marsh Habitat	Buffer	Total	Marsh Habitat	Buffer			
3	5.0	1.0	4.0	0.364	0.105	0.260	None	90	None
17	135.1	97.4	37.7	-	-	-	None	85	Water flow from a road culvert
37	17.0	4.1	12.9	0.006	-	0.006	None	5	Runoff from EMPA slope
40	7.9	1.2	6.7	1.754	-	1.754	None	10	Runoff from dyke slope through vegetated area
42	15.7	2.9	12.8	-	-	-	None	50	Runoff from borrow area clearing through vegetated area
45	7.3	0.8	6.5	0.236	-	0.236	None	50	Runoff from dyke clearing through burned area
47	189.7	140.7	49.0	1.033	-	1.033	None	0	Runoff from dyke clearing through drainage channels into marsh
51	25.7	10.5	15.2	0.005	-	0.005[4]	None	20	Deposition of sediment or other materials into the marsh habitat buffer or other wetlands from EMPA.
52	28.4	9.1	19.4	-	-	-	None	0	Hydrological effects from a road culvert
53	5.5	0.3	5.2	-	-	-	None	0	None
54	113.1	70.1	43.0	-	-	-	None	0	None
57	64.6	37.6	27.0	0.793	-	0.793	None	0	None
All	615.2	375.7	239.5	4.190	0.105	4.086			

Notes:
[1] All wetlands except Wetland 42 were ground sampled in 2017. Bold font identifies wetlands that were also ground sampled in 2016.
[2] All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2018) for the mapping.
[3] Percentage of total buffer area that burned in the 2013 wildfire (which was unrelated to the Project).
[4] Area is an arbitrary value to capture sediment deposited in patches of standing water intermingled in surface peat.

Table 3-2: Project clearing or disturbance in the wetlands within 100 m of Project clearing or disturbance as of September, 2017, by Project area

Wetland ID	Area (ha) Impacted by Project Clearing and Disturbance[1]		
	Total	Planned Project Footprint	Possibly Disturbed Project Footprint
3	0.364	0.117	0.247
17	-	-	-
37	0.006	-	0.006
40	1.754	1.754	-
42	-	-	-
45	0.236	0.236	-
47	1.033	1.015	0.018
51	0.005	-	0.005[2]
52	-	-	-
53	-	-	-
54	-	-	-
57	0.793	0.793	0.00
All	4.190	3.914	0.276

Notes:
[1] All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2018) for the mapping.
[2] Area is an arbitrary value to capture sediment deposited in patches of standing water intermingled in surface peat.

Wetland 3 (August 31)

Wetland 17 (September 19)

Figure 3-1: Aerial views of Wetlands 3 and 17 in 2017

Wetland 37

Wetland 40

Figure 3-2: Aerial views of Wetlands 37 and 40 on September 19, 2017

Wetland 42

Wetland 45

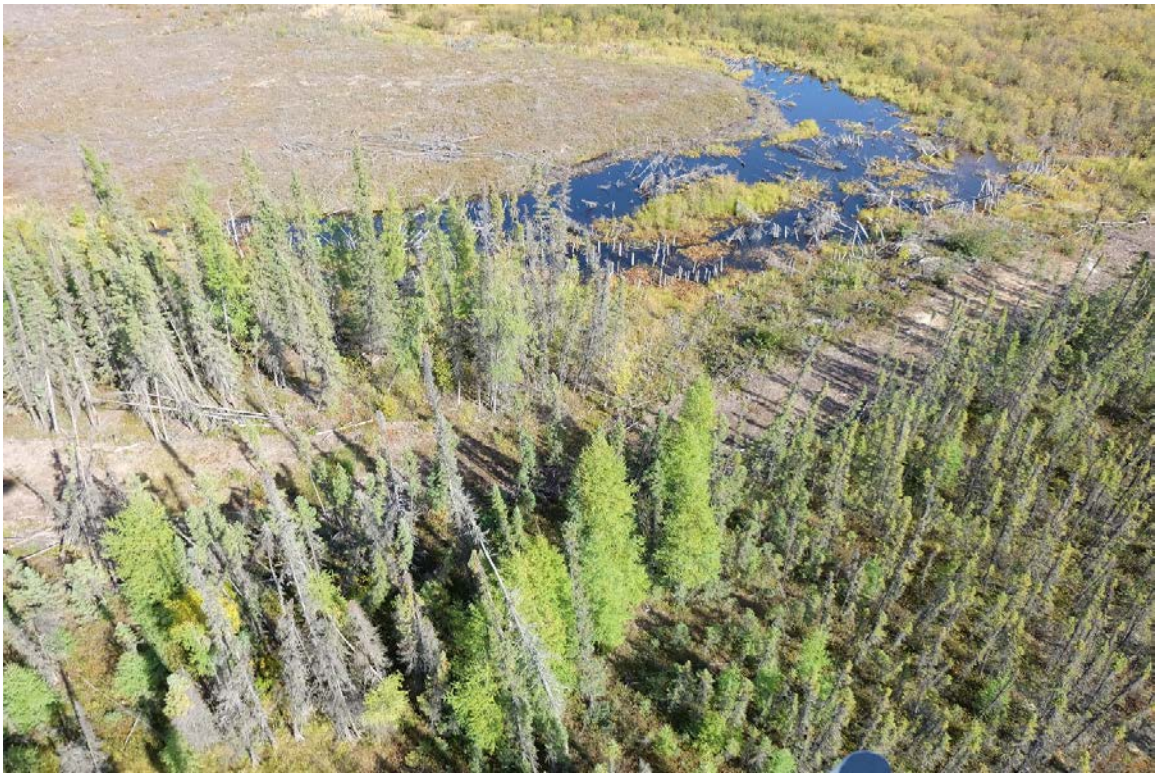
Figure 3-3: Aerial views of Wetlands 42 and 45 on August 31, 2017

Wetland 47 (September 19)

Wetland 51 (August 31)

Figure 3-4: Aerial views of Wetlands 47 and 51 in 2017

Wetland 52



Wetland 53

Figure 3-5: Aerial views of buffers in Wetlands 52 and 53 on September 19, 2017

Wetland 54

Wetland 57

Figure 3-6: Aerial views of Wetlands 54 and 57 on September 19, 2017

3.1 WETLAND 3

Wetland 3 (Figure 3-1) is 5.0 ha in size (Table 3-1), and located about 1 km from the Nelson River, approximately 21 km west of the generating station site (Map 2-1). This wetland has a direct surface water connection to the Nelson River through a lake and then a short stream. Marsh habitat comprised 1.1 ha of the wetland's total area. A 2013 wildfire burned approximately 90% of the marsh habitat buffer (*i.e.*, a 100 m buffer of the marsh habitat; see Section 2.0) included in Wetland 3.

No Project clearing or disturbance was observed in Wetland 3 during the 2015 survey.

By 2016, a band of trees ranging from approximately 1 to 10 m wide in the marsh habitat and buffer had been removed by reservoir clearing (Map 3-1; Figure 3-7). This clearing, which was located along the shoreline, impacted 0.36 ha of the total 5.0 ha Wetland 3 area (Table 3-2). Approximately 0.25 ha of this clearing was within the possibly disturbed Project footprint.

Approximately 0.26 ha of the cleared area was in the marsh habitat buffer and 0.10 ha was in the marsh habitat (Table 3-1). Cleared trees were visible where collapsed or collapsing peatlands had become part of the marsh habitat (Figure 3-8).

No further clearing or disturbance was observed in this wetland during the August 2017 surveys. It was noted that water levels were lower than in previous years, as evidenced by areas of exposed aquatic vegetation, mineral soil and sediment.

Figure 3-7: Aerial view of cleared trees in the marsh habitat of Wetland 3 on August 31, 2017

Figure 3-8: Cleared trees along the Nelson River shoreline in the marsh habitat of Wetland 3 on August 31, 2017

3.2 WETLAND 17

Wetland 17 (Figure 3-1) is 135.1 ha in size and located on the southwest shore of a small lake located at approximately kilometre 6 along the north access road (NAR). Marsh habitat comprised 97.5 ha of the wetland's total area. Approximately 85% of the marsh habitat buffer burned in the 2013 wildfire.

Project disturbance or clearing has not been observed within Wetland 17 up to the time of the 2017 surveys (Map 3-1). A small natural depression between the NAR and the lake near the south end of the marsh has the potential to carry runoff water towards the marsh. There were no obvious signs of median water level changes from 2015 to 2017.

Some shrub and white birch mortality were observed in 2015 along the south side of this marsh at the shoreline (Figure 3-9), with some of the dead stems emerging from the water. The cause of this vegetation mortality was unclear. Some possibilities include the 2013 wildfire, depth to groundwater changes after the wildfire, ground slumping after massive ground ice below the peat had melted (see next paragraph), or indirect hydrological effects of nearby construction. No incremental changes were observed in these locations in 2016 or 2017.

Shoreline slumping around the southwestern edge of the marsh in Wetland 17 (Figure 3-9) was observed in 2015. Given its distance from the NAR, this slumping was likely caused by melting massive ground ice in peat (which the EIS showed was naturally occurring in the region). Ground ice melting was likely accelerated in locations burned during the 2013 wildfire. No incremental changes were observed in these locations in 2016 or 2017.

Future surveys will continue to monitor these locations.

View along the shore of Wetland 17

Ground slump along the southwestern edge of Wetland 17 (likely due to melting ground ice in peat plateau bog)

Figure 3-9: Ground photos of Wetland 17 on August 23, 2017

Shrub mortality at Wetland 17

Figure 3-9: Continued...

3.3 WETLAND 37

Wetland 37 (Figure 3-2) is 17.0 ha in size, and located near the north dyke, adjacent to EMPA D3-E (Map 3-1). Marsh habitat comprised 4.1 ha of the wetland's total area. Approximately 5% of the marsh habitat buffer burned in the 2013 wildfire.

No Project clearing or disturbance was observed in Wetland 37 in 2015.

The 2016 ground survey found that a very small amount of EMPA clearing in the possibly disturbed Project footprint (< 0.01 ha; Table 3-1) extended into the buffer portion of the wetland. Ground surveys in 2017 found no further changes to the EMPA since the previous survey, and no new impacts on the wetland were observed.

View along the shores of Wetland 37 (August 31)

Aerial view of Wetland 37 looking northeast (September 19)

Figure 3-10: Ground and aerial photos of Wetland 37 in 2017

3.4 WETLAND 40

Wetland 40 (Figure 3-2) is 7.9 ha in size, and located along the north dyke, approximately 750 m east of Wetland 37 (Map 2-1). Marsh habitat comprised 1.2 ha of the wetland's total area. Approximately 10% of the marsh habitat buffer burned in the 2013 wildfire.

The 2013 wildfire burned areas south and east of this wetland.

There was no Project clearing or disturbance observed within Wetland 40 during the 2015 ground survey.

By the time of the 2016 survey, planned Project clearing for the dyke (Figure 3-11; Map 3-1) had extended through the buffer to approximately 3 m away from the southern portion of the marsh habitat (Figure 3-12). All of this 1.75 ha of clearing was within the planned Project footprint (Table 3-2). By the end of August, 2017, development of the north dyke within the cleared area continued, but no impact to the wetland was observed. It was noted that water levels in the marsh habitat at the time of the survey appeared to be lower than typical for reasons discussed in Section 4.0.

It was also noted in 2016 that a shallow slope leading from the dyke clearing to the water's edge should be monitored for the potential to transport sediment from the exposed mineral of the dyke into the marsh.

No sedimentation or runoff from the dyke was observed as of the 2017 surveys. The mineral slope facing the marsh remained shallow (Figure 3-11), and it appeared that risk of sedimentation due to runoff was low under current conditions. At the time of the surveys, no sediment control measures (e.g., silt fences) had been implemented. These areas will be monitored for any future effects from runoff.

View along the shores of Wetland 40

Exposed mineral slope adjacent to Wetland 40

Figure 3-11: Ground photos of Wetland 40 on August 31, 2017

Figure 3-12: Aerial view of dyke clearing (all within the planned Project footprint) at Wetland 40 on September 19, 2017

3.5 WETLAND 42

Wetland 42 (Figure 3-3) is 15.5 ha in size, and located approximately 750 m north of the NAR at kilometer 14, at the northwestern end of Borrow Area KM15 (Map 2-1). Marsh habitat comprised 2.9 ha of the wetland's total area. Approximately 50% of the marsh habitat buffer burned in the 2013 wildfire.

There was no Project clearing or disturbance observed near Wetland 42 during the 2015 aerial survey.

Ground surveys were not conducted at Wetland 42 in 2016 due to safety-related access restrictions. Aerial surveys in 2016 found that clearing for Borrow Area KM15 had expanded northwest towards Wetland 42 since 2015 (Map 3-1). At the time of the 2016 surveys, clearing was still approximately 90 m away from the marsh habitat buffer. Project disturbance within the wetland was not visible in the DOIs or aerial photos.

During the 2016 aerial survey, it was noted that there was a significant slope extending downwards from Borrow Area KM15 clearing to the southern edge of the wetland (Figure 3-13).

A sediment control recommendation was not made given that the band of undisturbed vegetation between the exposed mineral area and the marsh buffer was approximately 90 m wide.

Up to the time of the 2017 surveys, there were no signs of erosion along the slope to the wetland. Also, there were no apparent changes in the undisturbed vegetation between the wetland and the cleared area in G-1, and no new clearing or excavation in the nearby portion of G-1. The band of intact vegetation will continue to be monitored in order to determine if there is any erosion or surface runoff from the slope into the marsh.

Figure 3-13: Aerial view of Wetland 42 from the north on August 31, 2017

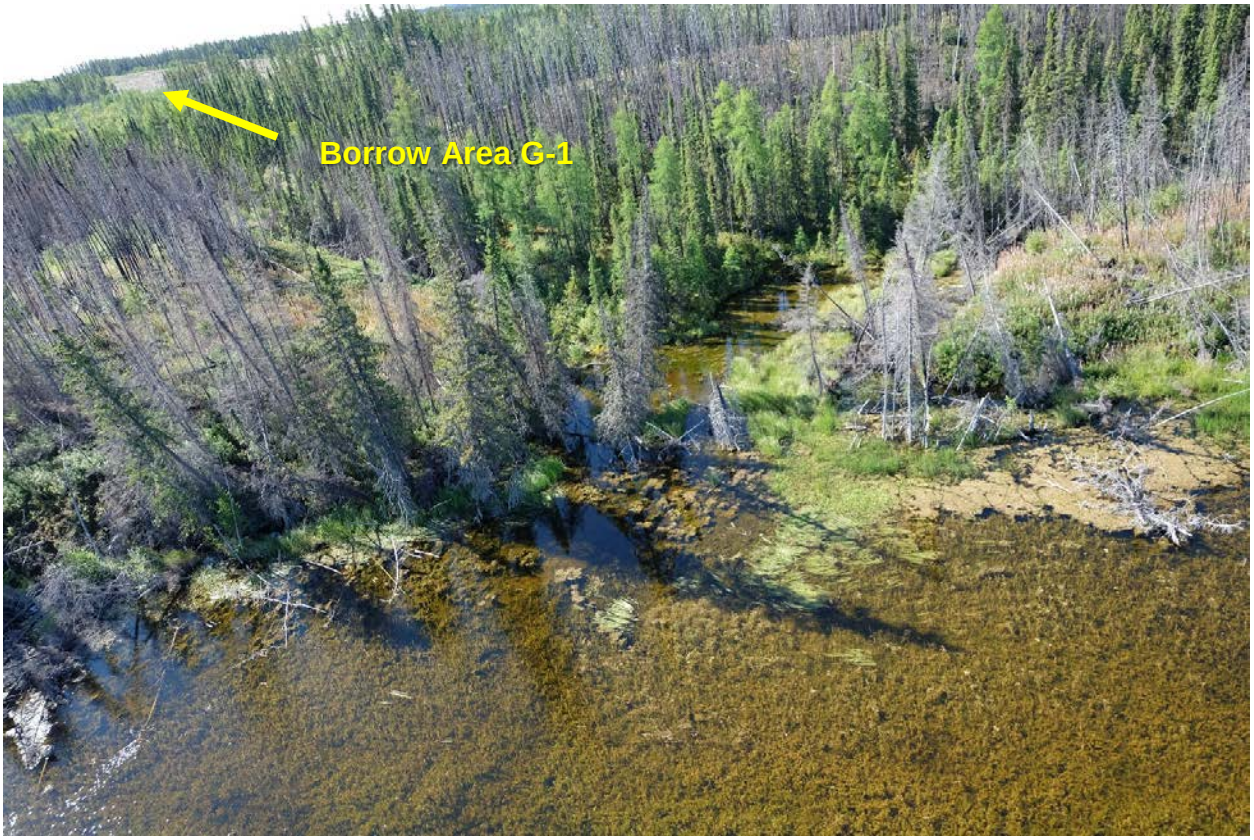


Figure 3-14: View of marsh at base of slope leading to clearing in Borrow Area G-1, visible in upper-right corner of photo, on August 22, 2016

3.6 WETLAND 45

Wetland 45 (Figure 3-3) is 7.3 ha in size, and located along the north dyke, approximately 1.5 km east of Wetland 40 (Map 2-1). Marsh habitat comprised 0.8 ha of the wetland's total area. Approximately 50% of the marsh habitat buffer burned in the 2013 wildfire. Some of the burned area was between the planned north dyke and the marsh habitat, and some sites within this area had either a thin layer of organic matter or exposed mineral substrate.

At the time of the 2015 ground survey, north dyke clearing extended approximately 3 m into the buffer on the south side of Wetland 45 for about 60 m. All of this clearing was within the planned Project footprint. No other Project clearing or disturbance was observed next to this wetland in 2015.

By the time of the 2016 ground survey, north dyke clearing had extended approximately 25 m into the marsh habitat buffer (Figure 3-15 and Figure 3-16; Map 3-1). All of this 0.24 ha of clearing was within the planned Project footprint (Table 3-2) and no other Project impacts were noted at that time. All of the dyke clearing within Wetland 45 was also within the above noted burned area.

As of the end of August, 2017, no further clearing had occurred within the marsh habitat buffer, although dyke construction continued within the cleared area.

A 15% slope through the dyke clearing area to the marsh habitat creates the potential for future surface runoff to carry material into the marsh habitat. In addition to the slope containing exposed mineral material in the cleared area (Figure 3-16), the entire slope had been burned with some areas having virtually all vegetation removed. At the time of the 2017 surveys, no runoff or sedimentation was seen entering the marsh habitat. It was noted that there was a small hill between the wetland and the dyke, which may serve as a natural barrier to potential future runoff. These areas will continue to be monitored for potential runoff effects.

Figure 3-15: North dyke clearing (all within the planned Project footprint) at Wetland 45 in July 2017

Aerial view of Wetland 45 showing proximity to north dyke

View along the shore of Wetland 45

Figure 3-16: Ground and aerial photos of Wetland 45 on August 31, 2017

3.7 WETLAND 47

Wetland 47 (Figure 3-4; Figure 3-17) is 189.1 ha in size, and located approximately 100 m southeast of EMPA D27(4)-E (Map 2-1). Marsh habitat comprised 140.1 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Project clearing or disturbance in this wetland was not observed during the 2015 aerial survey.

In 2016, a small amount of clearing within the possibly disturbed Project footprint (0.02 ha in total) extended into the northwestern and northeastern edges of Wetland 47 (Map 3-1), all of which was in the marsh habitat buffer. Approximately half of this clearing was for an EMPA, and the other half was for a cutline, both of which were within the possibly disturbed Project footprint.

As of August 2017, a total of 1.03 ha of Wetland 47 was cleared, 1.01 of which was in the planned Project footprint (Table 3-2). No further clearing had occurred within the possibly disturbed Project footprint. At the northwestern edge, south dyke clearing occurred within 50 m of the shoreline (Figure 3-18). Part of a runnel, draining water through the wetland into the lake, was cleared where it was within the planned Project footprint, and woody debris had accumulated in the channel, but this did not appear to block water flow into the uncleared wetland. There were no apparent Project-related impacts from the clearing in the marsh habitat buffer. It was noted that water levels appeared relatively low in the marsh habitat (Figure 3-17).

Figure 3-17: View along the Wetland 47 shore in August 31, 2017

Figure 3-18: Aerial view showing the proximity of south dyke clearing to Wetland 47, September 19, 2017

3.8 WETLAND 51

Wetland 51 is 25.7 ha in size and located immediately northwest of EMPA D16 (Map 2-1). Marsh habitat comprised 10.5 ha of the wetland's total area. Approximately 20% of the marsh habitat buffer burned in the 2013 wildfire.

Ground surveys in August 2015 identified clearing for an EMPA within 25 m of the edge of Wetland 51 (Map 3-1), all of which was within the planned Project footprint.

Project disturbances noted in 2015 included heavy machinery rutting around the western edge of the EMPA. Other Project impacts included erosion and sedimentation at the base of the EMPA slope on the northern and northwestern edges. Mitigation measures in place at the time of the survey included a soil berm and a silt fence to prevent runoff into the adjacent marsh habitat. Portions of the silt fence, which was installed along the western edge of the EMPA, had fallen over. Erosion and sedimentation into a creek flowing into Wetland 51 was observed.

Some dead and dying vegetation was observed adjacent to the creek near the base of the EMPA slope during the 2015 survey. It was unclear if construction activity or sedimentation had

caused this. Mineral soil had begun to cover the creek bed in areas where marsh plants were growing (this was outside of Wetland 51 boundaries).

No Project clearing, disturbance or other impacts were observed within Wetland 51 in 2016. By the time of the 2016 ground survey, some EMPA D16 banks had been graded, creating gentler slopes on the northwestern edges. These slopes were within the licensed Project footprint and came within approximately 2 m of the Wetland 51 boundaries. There was no sedimentation into the wetland at the time. Also, the heavy machinery rutting, soil berm, fallen silt fence locations, dying vegetation and erosion and sedimentation into waterways connected to Wetland 51 that had been observed in 2015 were no longer present. In the previous annual report (ECOSTEM 2017b), it was recommended that sediment control measures be placed at strategic locations along the northwestern, northern and eastern EMPA banks to prevent further spread towards Wetland 51 or towards the Stephens Lake/Nelson river channel.

As of late summer 2017, the only additional Project impact within Wetland 51 was sediment deposition into the buffer portion of the wetland. While the EMPA D16 slopes adjacent to the buffer in Wetland 51 had not been altered since the 2016 surveys (Figure 3-20), two larger erosion channels had developed in the slope. These channels were now depositing sediment into the water adjacent to the wetland (Figure 3-21), although none of the wetland vegetation within the marsh buffer had been covered. While sediment may have entered the buffer under water, mapping of submerged sediment was not attempted (an arbitrary area of 0.005 ha was used to record the impact). There was no apparent vegetation mortality within Wetland 51 between the EMPA slope and shoreline.

Recent slumping of peat banks was observed around a small peat plateau bog between the wetland and EMPA slope (Figure 3-21). It was unclear if potential water regime changes due to the EMPA caused or accelerated this slumping, or if the slumping was due to massive ground ice melting that is occurring throughout the Keeyask region as a delayed response to past climate warming (ECOSTEM 2011).

Figure 3-19: Wetland 51 in 2017 satellite imagery showing adjacent EMPA, stream to Stephens Lake channel and boundaries of licensed Project footprint

Figure 3-20: Aerial photo of Wetland 51 and adjacent EMPA on August 31, 2017

Aerial view of EMPA slope near the east shore of Wetland 51, showing erosion channels and sediment entering marsh habitat buffer

Slumping peat bank within Wetland 51 buffer

Figure 3-21: Aerial and ground photos of Wetland 51 in August 2017

Sediment from EMPA entering the buffer of Wetland 51

Figure 3-19: Continued...

3.9 WETLAND 52

Wetland 52 (Figure 3-5) is 28.4 ha in size and located south of Gull Rapids (Map 2-1). Marsh habitat comprised 9.1 ha of the wetland's total area. None of this wetland's buffer was burned in the 2013 wildfire.

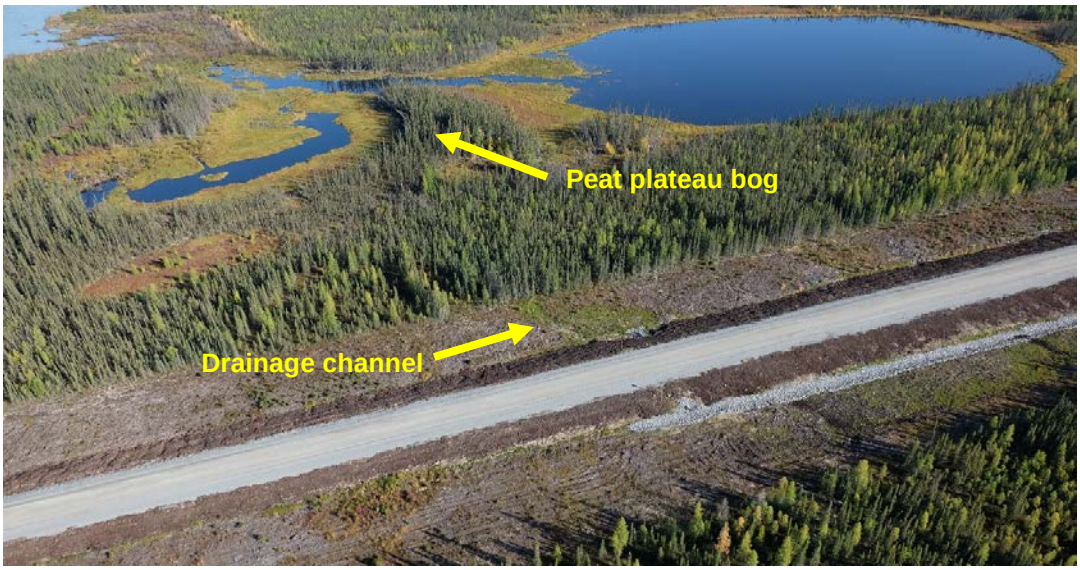
There was no observed clearing or disturbance in or near Wetland 52 at the time of the 2015 aerial survey. The south access road (SAR) right-of-way (ROW) had been cleared, but road construction had not entered the marsh habitat buffer.

Project clearing or disturbance was not observed within Wetland 52 during the 2016 or 2017 surveys (Map 3-1).

For other potential Project impacts, one instance of a potential hydrological effect was found in 2016. A culvert on the north side of the SAR was draining water into a woodland south of the marsh, creating pooling water at and into the woodland edge (Figure 3-22). Closer to the marsh, the water table was at or above ground level in a natural depression between the SAR and Wetland 52. It was unknown at the time of the survey whether runoff from the SAR was contributing to an elevated water table in this area. However, it appeared that a high peat plateau bog (which contains ground ice) between the actual marsh area and the natural depression (Figure 3-22) was likely raising the water table by impeding drainage. In any event, if there had been additional flow into the marsh habitat from the SAR, it appeared that the drainage outlet for this wetland was passing such flows downstream into a bay on the Nelson River.

Ground surveys in 2017 did not find any evidence of sediment runoff from the SAR extending beyond the cleared ROW. Aerial surveys observed that the vegetation appeared to be healthy, there was no noticeable evidence of Project-related disturbance, and there were no obvious signs that water levels were being affected by the access road.

Monitoring of water levels and the condition of the marsh's drainage outlet for Project effects will continue.



Aerial view of Wetland 52 showing peat plateau bog between the SAR and the wetland (September 19)

Drainage channel between SAR and treeline of peat plateau bog (August 23)

Figure 3-22: Aerial and ground photos of Wetland 52 in 2017

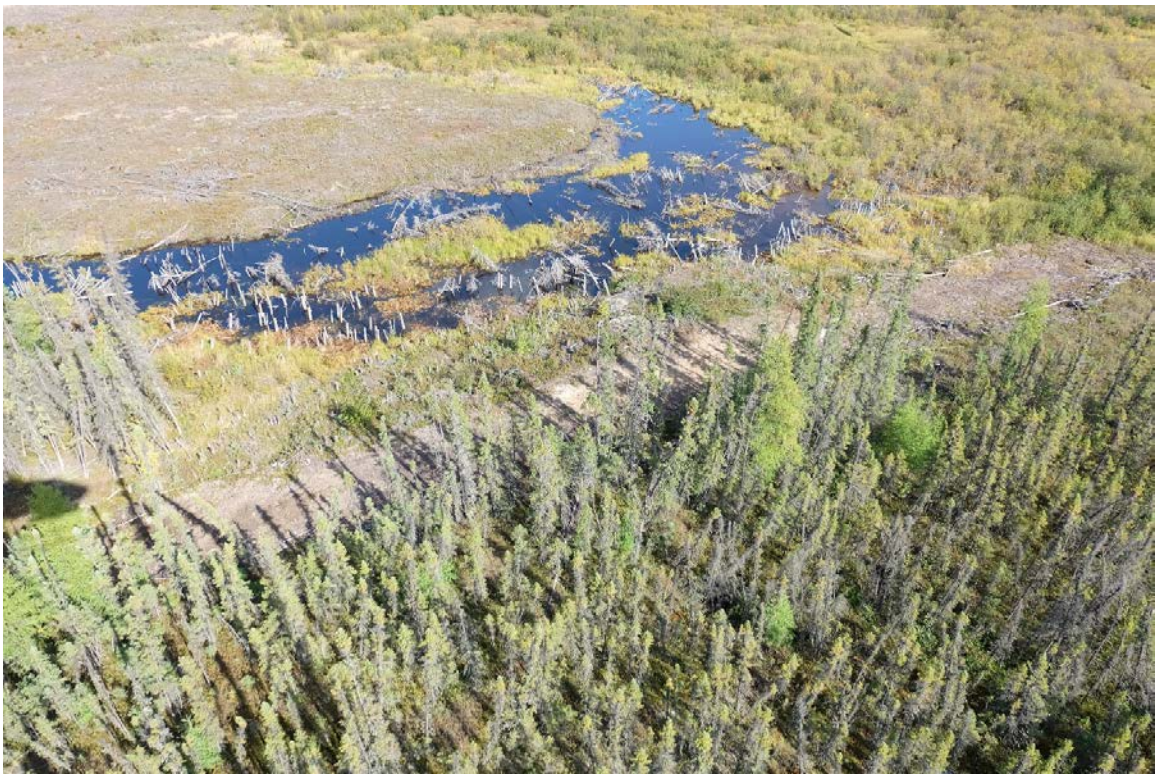
3.10 WETLAND 53

Wetland 53 (Figure 3-5) is 5.5 ha in size. It is located on the south side of the Nelson River, just downstream of the future generating station (Map 2-1). Marsh habitat comprised 0.3 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

The clearing in the marsh habitat buffer that was visible in the 2015 aerial survey photos and DOIs (*e.g.*, cut trees, an access trail though the east side of the marsh habitat buffer) was for the Keeyask Transmission Project ROW. This was the only clearing or disturbance found in the marsh habitat buffer during the 2015 ground survey (Figure 3-23).

Some flooded vegetation at the cleared transition zone between the creek/marsh and the degrading peat plateau bog, just outside of the marsh habitat buffer, was also found in 2015. This was attributed to peat plateau bog disintegration, which was unrelated to the Project (ECOSTEM 2011).

Ground surveys in 2016 and 2017 found no expansion of the impacts that were present in 2015. No new clearing, disturbance or other impacts were observed in 2017.



View of trail cut through the Wetland 53 buffer (wetland is off bottom of photo)

Figure 3-23: Aerial photo of Wetland 53 on September 19, 2017

3.11 WETLAND 54

Wetland 54 (Figure 3-6) is 113.1 ha in size, and located along the north side of the SAR, north of Borrow Area S-2b (Map 2-1). Marsh habitat comprised 70.1 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

The clearing visible in the 2015 DOIs and aerial survey photos was for the Keeyask Transmission Project ROW. This clearing, which only impacted the marsh habitat buffer, had come as close as 20 m to the marsh habitat in some locations (Figure 3-24). No evidence of erosion or sedimentation into the marsh habitat was observed during the 2015 ground survey.

Ground surveys in 2016 found no expansion of the impacts recorded in 2015. New impacts were limited to clearing and disturbance for two Keeyask Transmission Project towers south of the marsh, which came right up to the marsh habitat buffer boundary (Figure 3-25). No new Project clearing or disturbance to Wetland 54 or its buffer was found during 2017 surveys.

The relatively dense existing low vegetation in the cleared areas within 100 m of the marsh should be adequate to stabilize soils and facilitate revegetation.

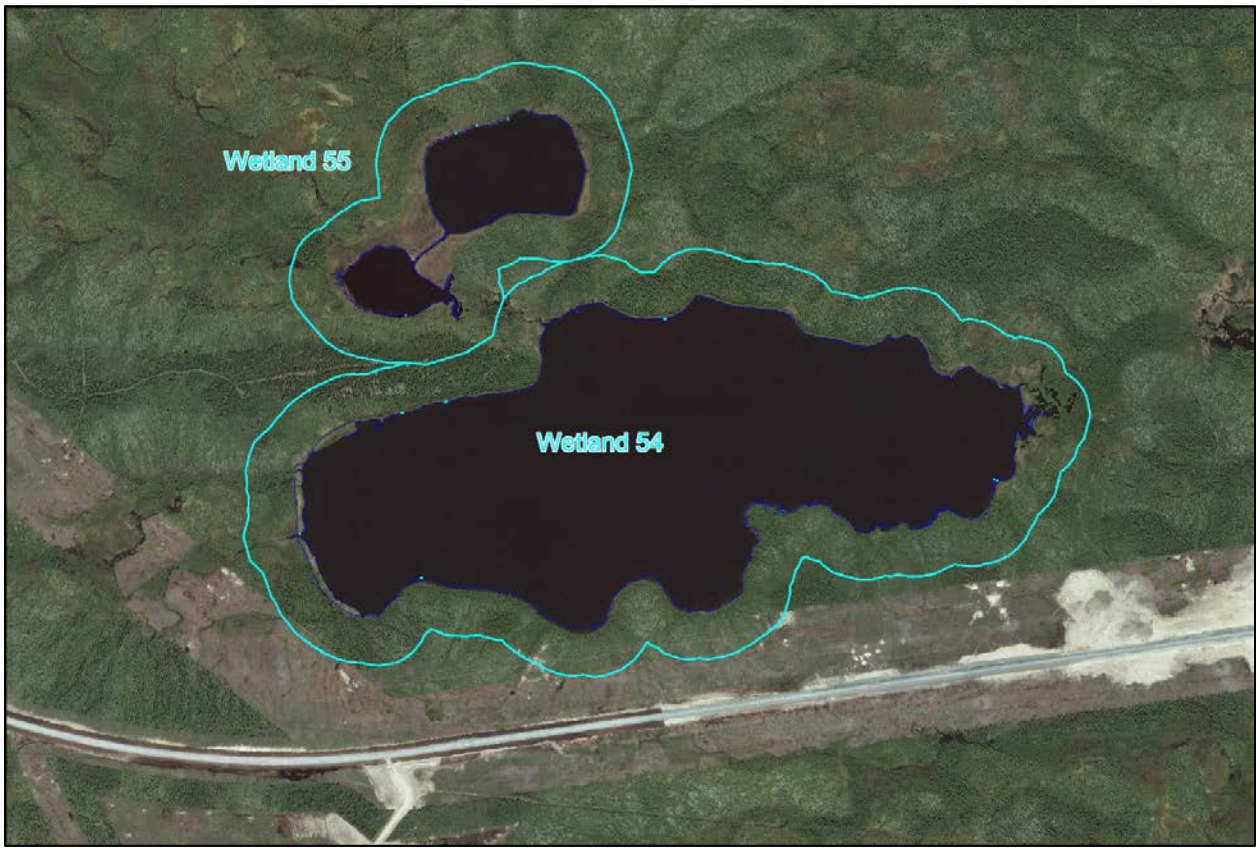
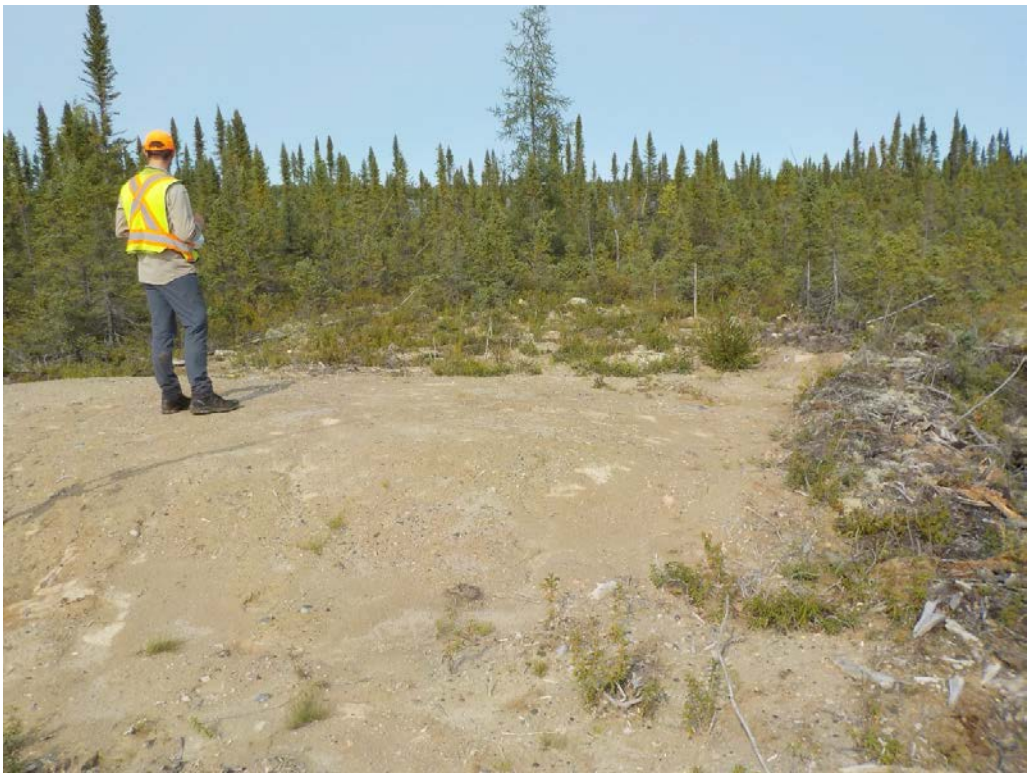


Figure 3-24: View of Wetland 54 in July, 2017 satellite imagery

View along the Wetland 54 shore (August 23)

Transmission towers adjacent to Wetland 54 buffer (September 19)

Figure 3-25: Ground and aerial photos of Wetland 54 in 2017



Ground view of transmission tower clearing and disturbance adjacent to Wetland 54 buffer (August 23)

Figure 3-23: Continued...

3.12 WETLAND 57

Wetland 57 is 64.6 ha in size, and nestled between the Butnau Road and Stephens Lake, with its buffer overlapping the road to the south and a dyke to the north (Map 2-1). Marsh habitat comprised 37.6 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Ground surveys in 2015 found that construction of the SAR had cleared 0.21 ha in the southern edge of the buffer, and all of this was within the planned Project footprint. No clearing or disturbance was found in the marsh habitat. Ground surveys in 2016 found that clearing in the marsh habitat buffer had increased to 0.79 ha (Table 3-2), which was 0.58 ha higher than in 2015. All of the clearing was still within the planned Project footprint and no clearing or disturbance was found in the marsh habitat.

In 2017, ground surveys found no additional clearing or disturbance in the marsh habitat buffer or marsh habitat.

In terms of other potential Project impacts, a ditch from the SAR drains into the marsh habitat. The observed water levels in the waterbody in 2016 and 2017 were very low compared to those observed in 2015. For 2016, some of the possible causes were lower water levels on Stephens

Lake (marsh habitat is within 75 m of Stephens Lake; see Section 4.1) or altered hydrology due to road construction. Surveys of the drainage ditch from the SAR and the surrounding area did not find an obvious Project-related cause for the low water levels observed in 2016 and 2017.

Aerial view of Wetland 57 (September 19)

Low water levels in marsh habitat (August 31)

Figure 3-26: Aerial and ground photos of Wetland 57 in 2017

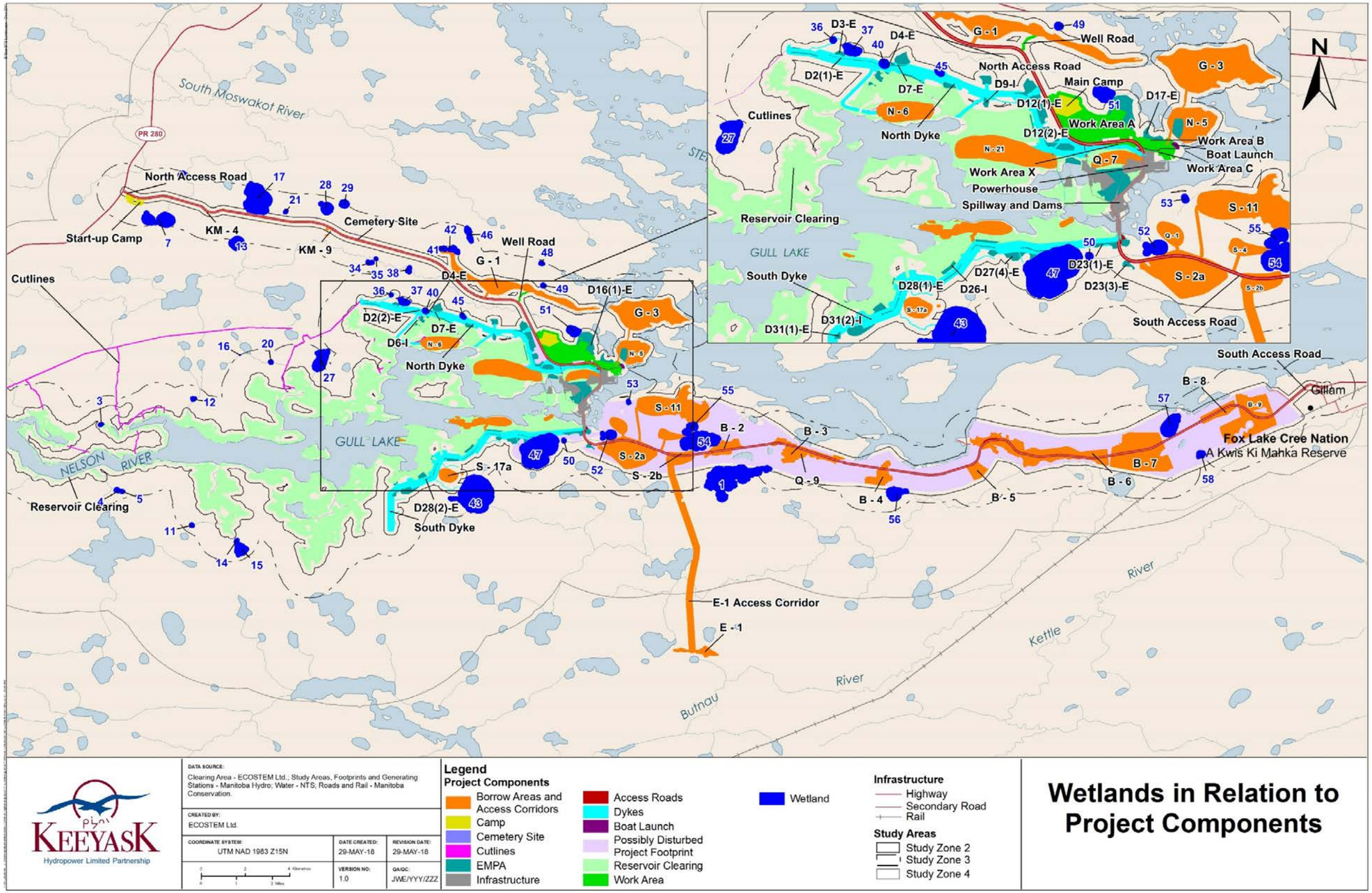
3.13 REMAINING WETLANDS

Figure 3-27 shows the state of two of the remaining 30 wetlands visited during the aerial surveys. They were not closely surveyed because there were more than 100 m from existing Project clearing or disturbance. Monitoring in 2018 will determine if any of these or any of the other 30 wetlands have been impacted by the Project since the 2017 surveys.

Wetland 7

Wetland 36

Figure 3-27: Aerial photos of Wetlands 7 and 36 on August 31, 2017



Map 3-1: Wetlands in relation to the Project components

4.0 DISCUSSION

4.1 POTENTIAL INFLUENCES ON WATERBODIES

Natural variations in water levels in off-system waterbodies (which are unrelated to Project) were of interest for the wetland monitoring because they can lead to changes to marshes and their habitat. During the aerial surveys conducted in 2016 and 2017, it was noted that water levels in off-system waterbodies appeared to be lower than typical throughout Study Zone 3 (Map 2-1) at the time of the survey. This observation was based on exposed lake bottom areas, where different plant species were appearing relative to water levels, visible water lines on banks and vegetation, and on DOIs from various years.

Typically submerged portions of vegetation exposed in Wetland 40

Exposed lake bottom at Wetland 47

Figure 4-1: Photos illustrating evidence of lower than typical water levels in summer 2017

It was theoretically possible that water levels on Stephens Lake or the Gull reach of the Nelson River (i.e., the regulated system) indirectly contributed to lower water levels in nearby off-system waterbodies. Lower than typical water levels could lower the groundwater water table between the regulated system and an off-system waterbody, which could then contribute to lower water levels in the off-system waterbody.

It was unlikely that water levels on Stephens Lake and the Gull reach of the Nelson River indirectly contributed to lower water levels in nearby off-system waterbodies since they were relatively high rather than low during 2016 and 2017. Similarly, any construction effects on Nelson River water levels would have been in the context of high water levels, and would have been localized. The construction synthesis report will examine potential indirect effects of the

regulated system or Project construction on water levels in the off-system waterbodies monitored by this study.

Vegetation clearing has potential indirect effects on water levels in nearby waterbodies. Vegetation clearing has been shown to raise the groundwater water table, which can indirectly affect nearby surface water levels. While reservoir clearing is the best example of a Project activity in this regard, it would not help explain why off-system waterbody water levels were lower than typical throughout Study Zone 3 in 2016 and 2017. However, if water levels in cleared areas did not decline as much as in the remaining waterbodies, this pathway could be contributing. The construction synthesis report will examine potential indirect effects of Project clearing on water levels in the off-system waterbodies monitored by this study.

4.2 WETLAND IMPACTS AND MITIGATION

The following paragraphs summarize observed Project impacts on each of the off-system marsh wetlands, and potential future impacts that merit mitigation or a particular focus during ongoing monitoring. Mitigation recommendations are summarized in Appendix 1.

Wetland 3 was the only wetland where clearing or disturbance extended into the marsh habitat as well as the marsh habitat buffer. Here, a band of taller vegetation on collapsed or collapsing peatlands was removed along the shoreline during clearing for the future reservoir in the winter of 2015/16. The clearing impacted 0.25 ha of Wetland 3 area overlapping the possibly disturbed Project footprint, including 0.05 ha of marsh habitat and 0.20 ha in the marsh habitat buffer. In this case, the clearing only impacted vegetation taller than 1 m, and not the ground surface as it was done in the winter. Of the Project clearing overlapping this wetland, 0.12 ha was within the planned Project footprint and 0.25 ha was within the possibly disturbed Project footprint.

Project clearing extended only into the marsh habitat buffer at four wetlands (Wetlands 3, 37, 47, and 57). All of these impacts were within the licensed Project footprint, with the majority of them being in the planned Project footprint. Clearing or disturbance extended into the possibly disturbed Project footprint at Wetlands 3, 37 and 47.

At Wetlands 37 and 47, a very small amount of clearing from an adjacent EMPA extended into the marsh habitat buffer but not into the marsh habitat. The total clearing was less than 0.01 ha for Wetland 37 and approximately 0.02 ha for Wetland 47. It is recommended that an extension of the existing EMPA clearing be avoided, to the extent possible, to minimize additional impacts on these wetlands. For Wetland 47, it is also recommended that the drainage channels passing through the clearing into the wetland be monitored for sediment runoff by site staff during dyke construction.

At Wetland 57, a small amount of the SAR clearing extended into the marsh habitat buffer but not into the marsh habitat. In terms of other potential Project impacts, a ditch from the SAR drains into the marsh habitat. The observed water levels in the marsh habitat were very low in 2016 and 2017 in comparison with 2015. Some of the possible causes were lower precipitation

and/or higher evapotranspiration in Study Zone 3, lower water levels on Stephens Lake (this wetland is within 75 m of Stephens Lake) or altered hydrology due to road construction. Further investigations in 2017 did not find an obvious local reason for the low levels in 2016. As described in Section 4.1, water levels were generally low in off-system waterbodies throughout the Project area in 2016 and 2017. Additionally, water levels on Stephens Lake were relatively high in these years.

At Wetland 51, sediment was observed entering the water adjacent to the Wetland 51 buffer from the west slopes of the EMPA. As the situation between this EMPA and the marsh area is somewhat complex, several mitigation measures were recommended for strategic locations in 2016 (see Section 3.8 for details).

In light of the above-noted sediment deposition situation, it is recommended that sediment control measures be placed along the northwestern, northern and eastern banks of EMPA D16 to prevent further deposition towards the northwest. The recommended sediment control measures would be in addition to those recommended for the northeast side of this EMPA in the Habitat Loss and Disturbance report (ECOSTEM 2018). It is also recommended that, if this EMPA receives further excavated material, then it should be placed to the southwest of the existing material or on existing areas well back from the top of the bank. Since August 2017, material in EMPA D16 has been re-sloped and additional sediment fencing has been installed.

Project disturbance or clearing was not observed at the remaining eight wetlands within 100 m of actual Project clearing or disturbance at the time of the 2017 surveys. However, most of these eight wetlands had potential future impacts that merited either a mitigation recommendation or a particular focus during ongoing monitoring.

At Wetland 17, the marsh habitat is downslope and within 100 m of the NAR, so there is potential for road-related surface runoff or hydrological alterations. A small amount of vegetation mortality was observed along the south shore. It was thought that this was not due to the NAR, but rather to ground collapse from permafrost melting that is naturally occurring in response to past climate warming (TE SV Section 2.9). Monitoring in 2017 found no additional Project-related effects in this wetland. Monitoring in 2018 will revisit sites with vegetation mortality to determine whether anything has changed.

Wetlands 40, 42 and 45 were all near cleared mineral slopes. Wetland 45 had additional mineral material exposed by the 2013 wildfire. The exposed mineral slopes create the potential for runoff and sediment deposition from existing Project clearing into the marsh habitat. Continuing care should be taken by construction crews when working near all three of these wetlands. It is also recommended that extensions of the existing dyke clearing be minimized to the extent feasible to limit additional impacts on these wetlands.

A sediment control recommendation was not made for Wetland 42 given the amount of undisturbed ground cover and vegetation between the exposed mineral area and the marsh habitat.

This report makes three recommendations for Wetlands 40 and 45. A silt fence should be added between the dyke clearing and these wetlands at the base of the slope. Also, site staff should continue to observe and implement sediment control measures where needed to prevent sediment and other runoff from entering the marsh habitat. Finally, it is recommended that an extension of the existing clearing (see Figure 3-2 and Figure 3-15) be avoided to minimize additional impacts on these wetlands.

To date, Wetland 52 has not been impacted by Project clearing or disturbance. Water flowing from a culvert in the SAR was pooling in a natural depression between the SAR and the marsh habitat. Water input from the SAR had the potential to alter wetland hydrology. If there has been additional flow into the marsh area from the SAR, it appeared that the drainage outlet from this wetland was passing it downstream into a bay on the Nelson River. Continued monitoring of this site will be done to help determine if runoff from the SAR is affecting this wetland.

Wetlands 53 and 54 had not been impacted by Project clearing or disturbance at the time of the 2017 surveys. The impacts visible in the September 2017 satellite imagery were from ROW clearing for the Keeyask Transmission Project, which is a separately licensed project with an associated terrestrial monitoring program. The transmission ROW clearing in the marsh habitat buffer may interact with Project effects in the future. Monitoring in 2018 will include revisiting the cleared area to further evaluate the potential for interactions with Project effects. For Wetland 54, the relatively dense existing low vegetation in the cleared areas within 100 m of the marsh should be adequate to stabilize soils and facilitate the growth of additional vegetation.

5.0 SUMMARY AND CONCLUSIONS

During the construction phase, the wetland function monitoring is focusing on direct Project effects, which primarily consist of clearing, disturbance or potential hydrological alterations. In the terrestrial habitat, ecosystems and plant studies, clearing refers to complete vegetation removal in a patch that was at least 400 m^2 in size. Disturbance refers to either physical disturbance in intact vegetation (e.g., machinery trail, test pits, sediment deposition), use of a pre-existing trail or a clearing smaller than 400 m^2. These areas refer to the entire patch regardless of how much overlaps a particular wetland.

Off-system marsh and its habitat occur within a waterbody. The area surrounding these waterbodies is important for the off-system marsh and its habitat because these areas naturally affect each other, and in most cases the surrounding area is peatland, which is another type of wetland. For these reasons, each monitored wetland includes the entire waterbody, plus a 100 m buffer of the waterbody. In total, 42 off-system marsh wetlands are being monitored by this study for potential Project effects.

Thirty-nine of the 42 monitored wetlands were surveyed from a helicopter on August 31, 2017 because they were within 1 km of Project clearing or disturbance. These aerial surveys confirmed that additional wetlands had not been recently impacted.

Eleven of the monitored wetlands were within 100 m of the existing Project clearing or disturbance and were not separated from these impacts by a wide band of natural ground cover and vegetation. Ground surveys in 2017 were conducted at these 11 wetlands.

Areas burned in the 2013 wildfire (which was unrelated to the Project) were of interest for the wetland monitoring because runoff from Project areas could be carried over burned bare mineral areas rather than being trapped by mosses and other ground plants. Seven of the 11 ground surveyed wetlands either overlapped recently burned areas or the burned areas were between a monitored wetland and Project clearing.

Surveys in 2017 found that there had been no new Project clearing in any of the monitored wetlands since the 2016 surveys. In one of the monitored wetlands, disturbance in the form of sediment deposition into standing water adjacent to the marsh habitat buffer was continuing.

Of the 4.19 ha of Project clearing or disturbance within wetlands, 0.11 ha was in marsh habitat while the rest was in the marsh habitat buffer.

Clearing or disturbance was present in marsh habitat in only one of the monitored wetlands, which was located in the cleared future reservoir area. The total marsh habitat area impacted was only 0.11 ha and was entirely within the licensed Project footprint.

Clearing or disturbance up to September 2017 was observed in the buffer portion of four of the monitored wetlands. Of the total impacted area (4.19 ha), 3.91 ha was in the planned Project footprint and 0.28 ha was in the possibly disturbed Project footprint.

To date, there have been no unanticipated effects on the off-system marsh wetlands being monitored by this study. While there has been some clearing or disturbance within four of the wetlands, this was expected as they overlapped the licensed Project footprint.

5.1 NEXT STEPS

Monitoring fieldwork for the off-system marsh wetlands will continue in 2018. No major changes to field methods are anticipated.

6.0 LITERATURE CITED

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APPENDIX 1:
MITIGATION RECOMMENDATIONS

This appendix collates and summarizes (Table 6-1) the off-system marsh wetland mitigation recommendations made during the TEMP monitoring.

At Wetlands 37 and 47, it is recommended that an extension of the existing EMPA clearing be avoided, to the extent possible, to minimize additional impacts on these wetlands (Figure 6-1 and Figure 6-2). For Wetland 47, it is also recommended that the drainage channels passing through the clearing into the wetland be monitored for sediment runoff by site staff during dyke construction.

At Wetland 51, it is recommended that sediment control measures be placed or reinforced along the northwestern, northern and eastern EMPA banks to prevent further deposition towards the northwest, and that the bulk of the sediment deposited on the uncleared peat north of the EMPA be removed if possible (Figure 6-3). It is also recommended that, if this EMPA receives further excavated material, then it should be placed to the southwest of the existing material or on existing areas well back from the top of the bank.

At Wetlands 40, 42 and 45, continuing care should be taken by construction crews when working in these areas. It is also recommended that extensions of the existing dyke clearing be avoided, if possible, to limit additional impacts on these wetlands (Figure 6-1, Figure 6-4 and Figure 6-5).

This report makes two additional recommendations for Wetlands 40 and 45. A silt fence should be added between the dyke clearing and these wetlands at the base of the slope. Also, site staff should continue to observe and implement sediment control measures where needed to prevent sediment and other runoff from entering the marsh habitat.

Table 6-1: Summary of Mitigation Recommendations

Wetland	Recommendation[1]	Mitigation Implemented
Wetland 37	2015: Evaluate and implement sediment control measures where needed to prevent sediment from entering the site along the north dyke. 2016 and 2017: Limit further clearing along northeastern edge of EMPA (D3-E) that overlaps buffer. Monitor for potential effects from slope runoff. See Figure 6-1.	No additional clearing has occurred along the northeastern edge of the EMPA.
Wetland 40	2015: Silt fence be added between the north dyke clearing and marsh at the base of the slope. Evaluate and implement sediment control measures where needed. 2016 and 2017: Evaluate and implement sediment control measures such as silt fence where needed. Avoid northward extension of the existing dyke clearing, if possible. See Figure 6-1.	No additional northward clearing has occurred near the wetland buffer. Monitoring in 2018 will document if any sediment control measures were installed.
Wetland 42	2017: Monitor intact vegetation between Borrow Area G-1 and wetland for any erosion or surface runoff from the slope into the marsh. See Figure 6-4.	
Wetland 45	2015: Silt fence be added between the north dyke clearing and marsh at the base of the slope. Evaluate and implement sediment control measures where needed. 2016 and 2017: Evaluate and implement sediment control measures such as silt fence where needed. Avoid northward extension of the existing clearing, if possible. See Figure 6-5.	No additional northward clearing has occurred near the wetland buffer. Monitoring in 2018 will document if any sediment control measures were installed.
Wetland 47	2016 and 2017: Avoid a southeastern extension of the existing south dyke clearing, if possible. 2017: Monitor the drainage channels passing through the clearing into the wetland during south dyke construction. See Figure 6-2.	No additional southward clearing has occurred near the wetland buffer.
Wetland 51	2015: Inspect and enhance sediment control measures along the northern edges of the EMPA (D16). Erect a silt fence around the north and northwest side of the EMPA. 2016 and 2017: Silt fence be placed between the EMPA and marsh and water channel along the northwest, north and northeast edges of the EMPA at strategic locations. Place any additional excavated materials to the southwest of the placement area, or well back from the top of the bank. See Figure 6-3.	In fall 2017, material in EMPA D16 was re-sloped and additional sediment fencing was installed.
Wetland 52	2016: Monitor water levels and condition of marsh outlet for runoff effects from SAR.	

Wetland	Recommendation[1]	Mitigation Implemented
Wetland 57	2016: Investigate possible causes for low water levels during 2017 surveys.	

Notes: [1] Recommendations in addition to continued monitoring. The number at the beginning of a line indicates the year that the recommendation was made. See ECOSTEM (2016) and ECOSTEM (2017b) for the 2015 and 2016 recommendations, respectively.

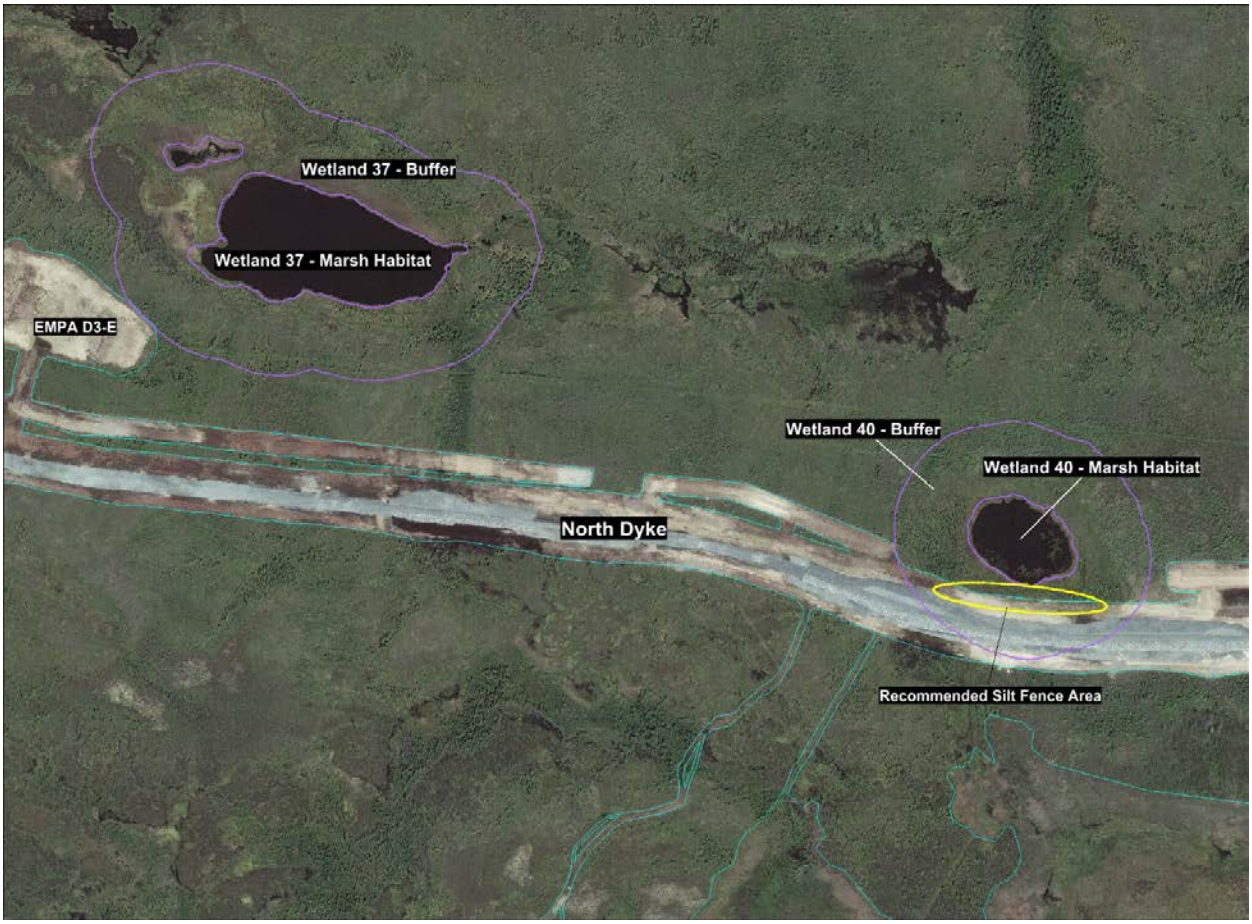

Figure 6-1: Mitigation areas and recommendations for Wetlands 37 and 40

Figure 6-2: Mitigation areas and recommendations for Wetland 47

Figure 6-3: Mitigation areas and recommendations for Wetland 51

Figure 6-4: Mitigation areas and recommendations for Wetland 42

Figure 6-5: Mitigation areas and recommendations for Wetland 45