Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Wetland Loss and Disturbance Monitoring Report

TEMP-2022-03

KEEYASK

Manitoba Environment, Climate and Parks Client File 5550.00
Manitoba Environment Act Licence No. 3107

2021 -2022

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2022-03

WETLAND LOSS AND DISTURBANCE MONITORING

Prepared for

Manitoba Hydro

By

ECOSTEM Ltd.

June 2022

This report should be cited as follows:

ECOSTEM Ltd. 2022. Keeyask Generation Project Terrestrial Effects Monitoring Plan Report #TEMP-2022-03: Wetland Loss and Disturbance Monitoring. A report prepared for Manitoba Hydro by ECOSTEM Ltd., June 2022.

SUMMARY

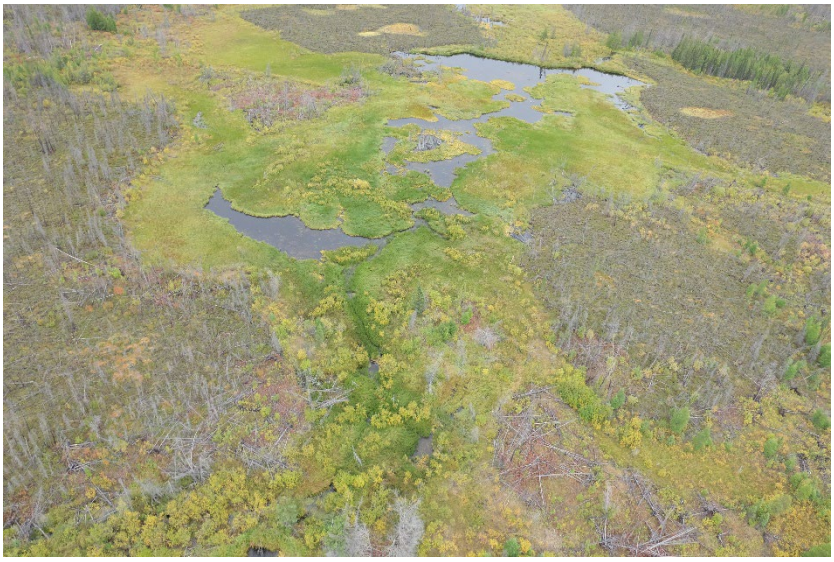
Background

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014. The vast majority of construction activities had been completed by fall 2021.

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 the wetland loss and disturbance monitoring conducted during summer 2021, the eighth summer of Project construction. It also summarizes overall effects on wetlands and wetland function during the construction phase.

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 in areas 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.



Off-system marsh wetland in the Keeyask region in 2021

Why is the study being done?

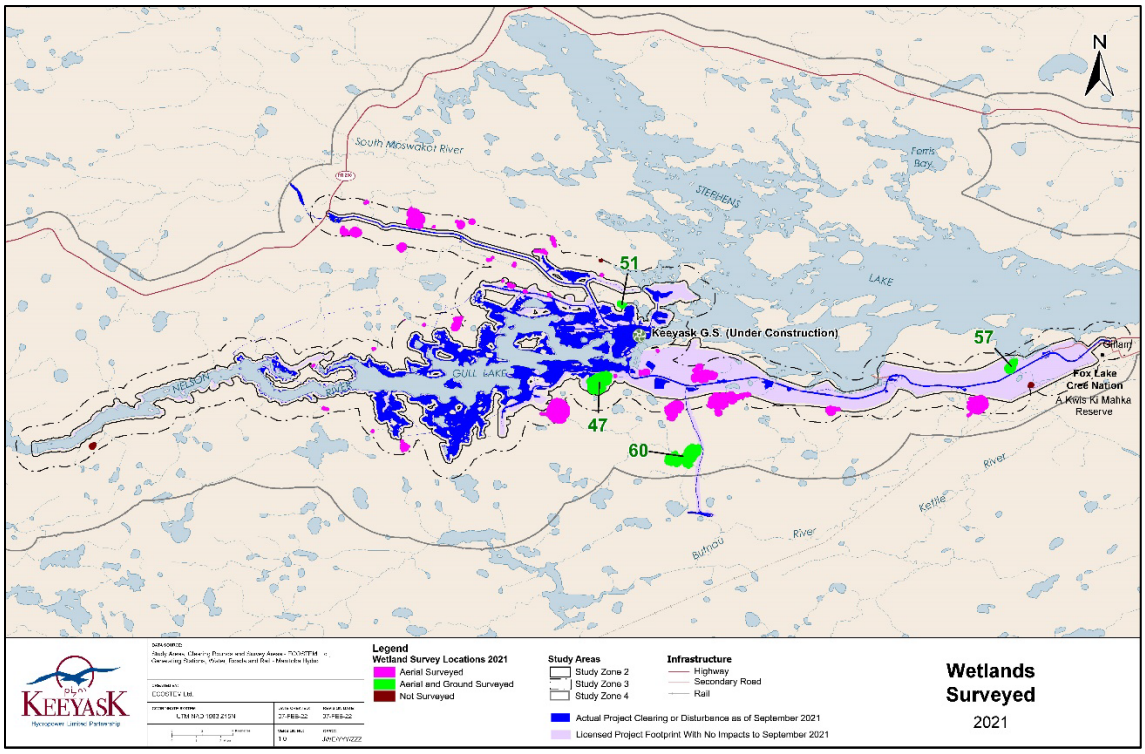
Wetland mapping for the environmental assessment showed that the Project would affect wetland areas. Since it is impossible to avoid all wetlands in the Project footprint given its size and that wetlands are widespread within it (i.e., peatlands are common throughout the Keeyask region), mitigation (replacement of 12 ha of off-system marsh wetland) is planned to help reduce Project effects.

This monitoring study documents Project impacts on, and mitigation related to, the very important marsh wetland type. This is to make sure the Project effects predictions are accurate and that no additional unexpected impacts are occurring. As the construction phase is complete, this report evaluates Project effects on all wetland types.

What was done?

Off-system marsh was the only very important wetland type identified by the environmental assessment. 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 common in the Keeyask region. For these reasons, each monitored wetland includes the entire waterbody, plus a 100 m buffer of the waterbody. A total of 44 off-system marsh wetlands are being monitored by this study.

In each year of construction, aerial and ground surveys are done at wetlands that are close to the Project construction areas. In September 2021, 42 wetlands were surveyed from a helicopter (see map below), and four of these wetlands were also surveyed on the ground.



What was found?

Up to 2021, Project clearing or disturbance in the monitored marsh wetlands (including their buffers) totalled 4.2 ha. All of this area was within seven of the 44 monitored wetlands. Clearing accounted for the vast majority (99.5%) of this total area. New clearing has not been recorded in the monitored wetlands since the 2016 surveys.

The vast majority (3.9 ha; 93%) of the clearing or disturbance was within the planned Project footprint. As outlined in the environmental assessment, this was expected since a portion of these wetlands overlapped a permanent Project feature such as a dike, a road or the future reservoir area.

In six of the seven impacted wetlands, Project clearing only occurred in the marsh habitat buffer. In the seventh wetland, clearing extended into a very small amount (0.1 ha) of marsh habitat where taller vegetation had been cleared for the future reservoir area.

A very small area (<0.1 ha) at one marsh wetland had been disturbed by sediment deposition from a nearby construction area. All of this sediment deposition was in the marsh habitat buffer.

Potential future Project impacts were noted for four of the off-system marsh wetlands located within 100 m of actual Project clearing or disturbance. For two of these four wetlands, altered water flows outside of the wetland buffer could potentially affect the amounts of marsh and its habitat. At another wetland, impacts from adjacent ATV usage had potential to disturb wetland habitat. At the remaining wetland, water drainage from the Main Camp had potential to disturb wetland habitat.

The total amount of wetland area directly affected by the Project during construction was 21% lower than assumed for the EIS. Additionally, effects on every wetland type were lower than assumed for the EIS predictions with one exception for which there was no difference. Effects on all of the wetland function indicators were lower than predicted.

What does it mean?

To date, there have been no unexpected Project impacts on the off-system marsh wetlands being monitored by this study. Some Project clearing or disturbance occurred in a small portion of seven wetland areas, however this was expected because these areas overlapped the planned Project footprint or were close to active construction areas. The vast majority (97.5%) of these impacts were in the buffer around the marsh habitat. Mitigation measures (e.g., erosion barriers) have been recommended where there are potential future risks to an off-system marsh or its surrounding habitat.

Construction monitoring has shown that the EIS predictions for Project effects on wetlands and wetland function were consistent with what was observed and were cautious. Actual Project effects were lower than predicted in the EIS, partially because the mitigation measures outlined in the EIS were generally implemented as prescribed and were effective.

What will be done next?

Construction monitoring for off-system marsh wetland monitoring has now concluded. Off-system marsh wetland monitoring, including the effectiveness of mitigation measures, will continue during Project operation in 2022. Where needed, additional mitigation measures will be recommended after the 2022 surveys.

ACKNOWLEDGEMENTS

ECOSTEM Ltd. would like to thank Rachel Boone, Sherrie Mason and the on-site Manitoba Hydro staff, including Marney Ritchot for their support and assistance in planning field activities and providing access to the sites. Rachel Boone and Sherrie Mason are also gratefully acknowledged for coordinating the terrestrial monitoring studies.

Chiefs and Councils of Tataskweyak Cree Nation (TCN), War Lake First Nation (WLFN), York Factory First Nation (YFFN) and Fox Lake Cree Nation (FLCN) are gratefully acknowledged for their support of this program.

We would also like to thank North/South Consultants Inc., in particular Ron Bretecher and Shari Fournier, for their guidance, logistical support and other resources that made these studies possible.

Custom Helicopters is thanked for providing transportation during fieldwork and Aaron Johnson for coordinating the logistics.

STUDY TEAM

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

Fieldwork in 2021 was conducted by Alex Snitowski.

Data analysis and report writing in 2021 were completed by Alex Snitowski and James Ehnes. GIS analysis and cartography were completed by Alex Snitowski.

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GLOSSARY

Term	Definition
approved Project footprint areas	All areas that were either initially licenced or subsequently approved for use by the Government of Manitoba.
buffer zone	A 100 metre buffer of marsh habitat.
DOI	A spatial dataset produced from satellite images or digital stereo photos that have been stitched together and processed so that all pixels are positioned in an accurate ground position. Such processing is necessary because the earth's surface is round and has topography.
Habitat	The place where a plant or animal lives.
habitat disturbance	Physical disturbance in an area of intact vegetation or use of pre-existing trails or borrow areas.
habitat loss	Permanent physical removal or alteration of previously undisturbed habitat.
licensed Project footprint	Footprint licensed for Project use under the Project's *Environment Act* Licence.
Marsh	A class in the Canadian Wetland Classification System which includes non-peat wetlands having at least 25% emergent vegetation cover in the water fluctuation zone.
planned Project footprint	A subdivision of the licensed Project footprint where clearing or disturbance was expected and is largely comprised of permanent Project features.
possibly disturbed Project footprint	A subdivision of the licensed Project footprint where clearing or disturbance could potentially occur.
off-system	Water body or waterway outside of the Nelson River hydraulic zone of influence.

Term	Definition
Project clearing	Project areas with complete removal of trees and tall shrubs. Includes terrestrial areas that were flooded, or formerly aquatic areas that were dewatered.
Project footprint	Boundary of all areas affected by Project activities.
Wetland	A land ecosystem where periodic or prolonged water saturation at or near the soil surface is the dominant driving factor shaping soil attributes and vegetation composition and distribution.
wetland function	Natural properties or processes that are associated with wetlands, stated in ways that describe what they do for the ecosystem.

ACRONYMS

Acronym	Name
DOI	Digital orthorectified imagery
EIS	Environmental Impact Statement
EMPA	Excavated material placement area
EnvPP	Environmental Protection Plan
GIS	Geographic Information System
GS	Generating Station
KHLP	Keeyask Hydropower Limited Partnership
KIP	Keeyask Infrastructure Project
KM	Kilometre
KTP	Keeyask Transmission Project
NAR	North Access Road
RoW	Right-of-Way
SAR	South Access Road
TEMP	Terrestrial Effects Monitoring Plan

1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt hydroelectric generating station (GS) and the associated facilities. 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. Project construction began in July 2014. The vast majority of construction activities were completed by fall 2021. The reservoir was first brought to full supply level in September 2020. The final generating unit went into service on March 9, 2022.

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; KHLP 2015) was developed as part of the licensing process for the Project. 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 concluded 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 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).

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.

Wetland Loss and Disturbance has been conducted during each year from 2015 to 2021. ECOSTEM (2016, 2017, 2018, 2019, 2020 and 2021) provide evaluations regarding the implementation and effectiveness of off-system marsh protection measures from 2015 to 2020

This report presents the Wetland Loss and Disturbance monitoring conducted in 2021, which includes addressing both of the study objectives. As was the case for previous annual reports, it provides a detailed evaluation of the implementation and effectiveness of off-system marsh protection measures as of September 2021. This report also evaluates direct Project effects on wetland function during the construction phase, which is considered to have ended in September 2021.

2.0 METHODS

2.1 APPROACH

To verify the implementation and effectiveness of off-system marsh protection measures (i.e., the first study objective), the Wetland Loss and Disturbance study included annual surveys during Project construction. Mapping and analysis to locate and quantify direct Project effects on wetland function during construction (i.e., the second study objective) was completed using the Project footprint at the end of the construction phase (i.e., the Construction Footprint) to identify directly affected wetlands and evaluate effects on wetland function.

Section 2.5.2 of the TEMP details the methods for the Wetland Loss and Disturbance study, which began in 2015. The same monitoring methods were used during each year from 2015 to 2021. The following summarizes the activities conducted in 2021.

The wetland function monitoring used the same five nested terrestrial study zones as were used for the environmental assessment (Map 2-1).

As noted above, the sole focus of this monitoring prior to 2021 was on how the Project is affecting off-system marsh wetlands. Even under natural conditions, the amounts and locations of off-system marsh change from year to year in response to a number of factors. Such changes are possible because only a portion of the area that is able to support marsh (i.e., marsh habitat) actually has vegetation in it at a given time. For this reason, the off-system marsh monitoring extends beyond the patches of off-system marsh that were mapped for the EIS studies to include all marsh habitat. This approach is analogous to monitoring both the number of beavers and the amount of beaver habitat to understand Project effects on beaver.

The locations of marsh habitat were predominantly determined by water depths and water level variations (TE SV; KHLP 2012b; see ECOSTEM (2013) for the detailed pathways of potential Project effects.). In Study Zone 4 (Map 2-1), which is where detailed marsh mapping was completed, off-system marsh was not found in water known or thought to be deeper than 2 m (ECOSTEM 2012; unpublished raw data). Bathymetry data was not available to identify which portions of waterbodies were shallower than 2 m, to identify marsh habitat. However, the available information indicated that the waterbodies that could potentially be affected by the Project were either predominantly or entirely shallower than 2 m. To err on the side of caution, the entire waterbody was included as off-system marsh habitat.

Marsh and its habitat can be strongly influenced and altered by human impacts such as physical disturbance or hydrological alterations, both within its habitat and in surrounding areas. For this reason, in addition to monitoring selected waterbodies (i.e., the marshes and their habitat), this study also monitored changes within a 100 m buffer of the waterbody. For this same reason, the Project's Environmental Protection Plans (EnvPPs) had already designated the portions of the

marsh habitat buffers outside of the planned Project footprint as environmentally sensitive sites, which were to be avoided whenever possible.

In this report, a waterbody and its buffer are referred to as a monitored wetland. In other words, references to a specific wetland in the Wetland Loss and Disturbance study include a waterbody and its 100 m buffer zone.

Prior to describing the monitoring activities, some terminology is introduced to assist the reader. The following definitions are used in all of the terrestrial habitat, ecosystems and plant monitoring studies.

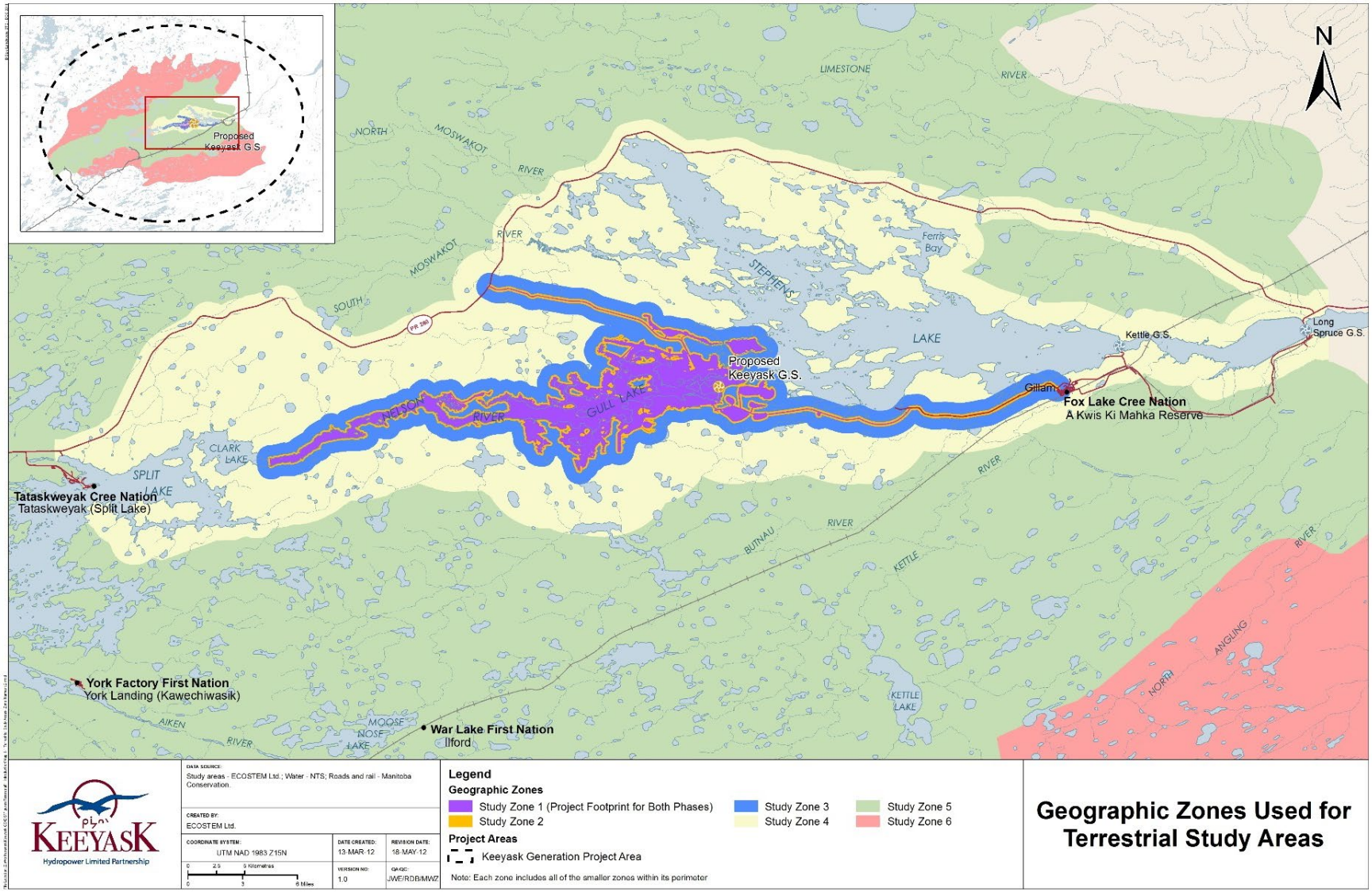
“Impact” refers to what the Project does in terms of the question of interest (e.g., lowering water levels in a lake, vegetation clearing), while “effect” refers to the consequence relative to the question of interest (e.g., marsh habitat loss, reduced wetland function).

“Clearing” refers to complete vegetation removal of trees and tall shrubs (e.g., the herbaceous and moss cover can be intact) in an area that is at least 400 m^2 in size. In the results, “clearing” also includes areas where excavated material was piled on uncleared vegetation since the vegetation was no longer visible. Many of the cleared areas also included excavation of topsoil and overburden (e.g., in a borrow area).

“Disturbance” refers to either physical disturbance in an area of intact vegetation (e.g., machinery trail, test pits), use of a pre-existing trail or an area of clearing smaller than 400 m^2.

It is noted that, while the definition of clearing means that every cleared patch being referred to in this report is at least 400 m^2, the portion of a clearing that overlaps a wetland or its buffer can be much smaller than 400 m^2. In other words, all uses of “clearing” in this report are referring to the entire area cleared (including areas outside the wetland and its buffer).

Bringing the reservoir to full supply level in fall 2020 introduced reservoir flooding as a Project impact type for the first time. In situations where this report identifies which wetland areas were inundated for the reservoir, such impacts are referred to as initial flooding.



Map 2-1: Terrestrial study zones used for the environmental assessment and monitoring

2.2 PROJECT AREAS

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

The first two areas were 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 (Map 2-2). The planned Project footprint was largely comprised of permanent Project features. There was 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 was 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 disturbed 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 the Government of Manitoba (Environment, Climate and Parks). This was the third type of Project area. These subsequently approved areas primarily included the former Keeyask Infrastructure Project (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.

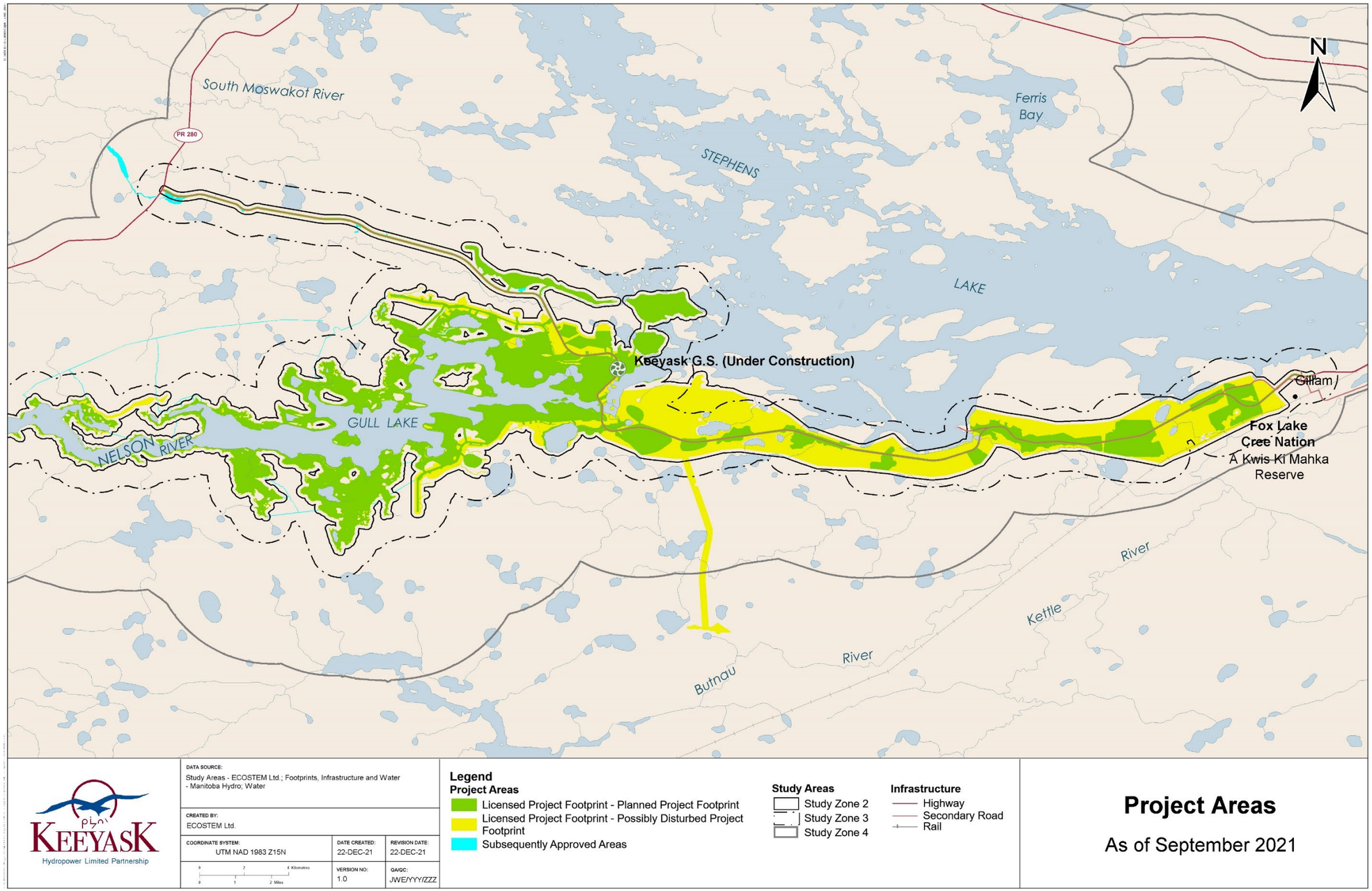
The subsequently approved areas were evaluated for potential effects by terrestrial specialists prior to their submission to the Government of Manitoba, and their locations were modified to alleviate any ecological concerns that were identified at that time. Given the modifications recommended by terrestrial specialists, the subsequently approved areas were not a concern from the terrestrial ecosystem health perspective.

An important consideration for the evaluation of areas that were subsequently submitted for approval was how these potential additions would alter predicted cumulative effects. This evaluation primarily focused on the characteristics of the potentially affected areas and the amount of the licensed Project footprint that was expected to remain undisturbed at the end of construction. For the latter factor, 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 2021, the majority (56%) of the originally licensed Project footprint had not been impacted by the Project (ECOSTEM 2022).

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

The fourth, and final, type of Project area used in this report included any areas cleared or disturbed outside the approved Project footprint. This included all areas that were not part of 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 monitored the area actually impacted by the Project in comparison to the amount assessed for the Project in the EIS. The operations Long-Term Effects on Wetlands study will monitor long-term direct and indirect Project effects on wetland function.



Map 2-2: Project areas as of September 2021

2.3 WETLANDS TO MONITOR

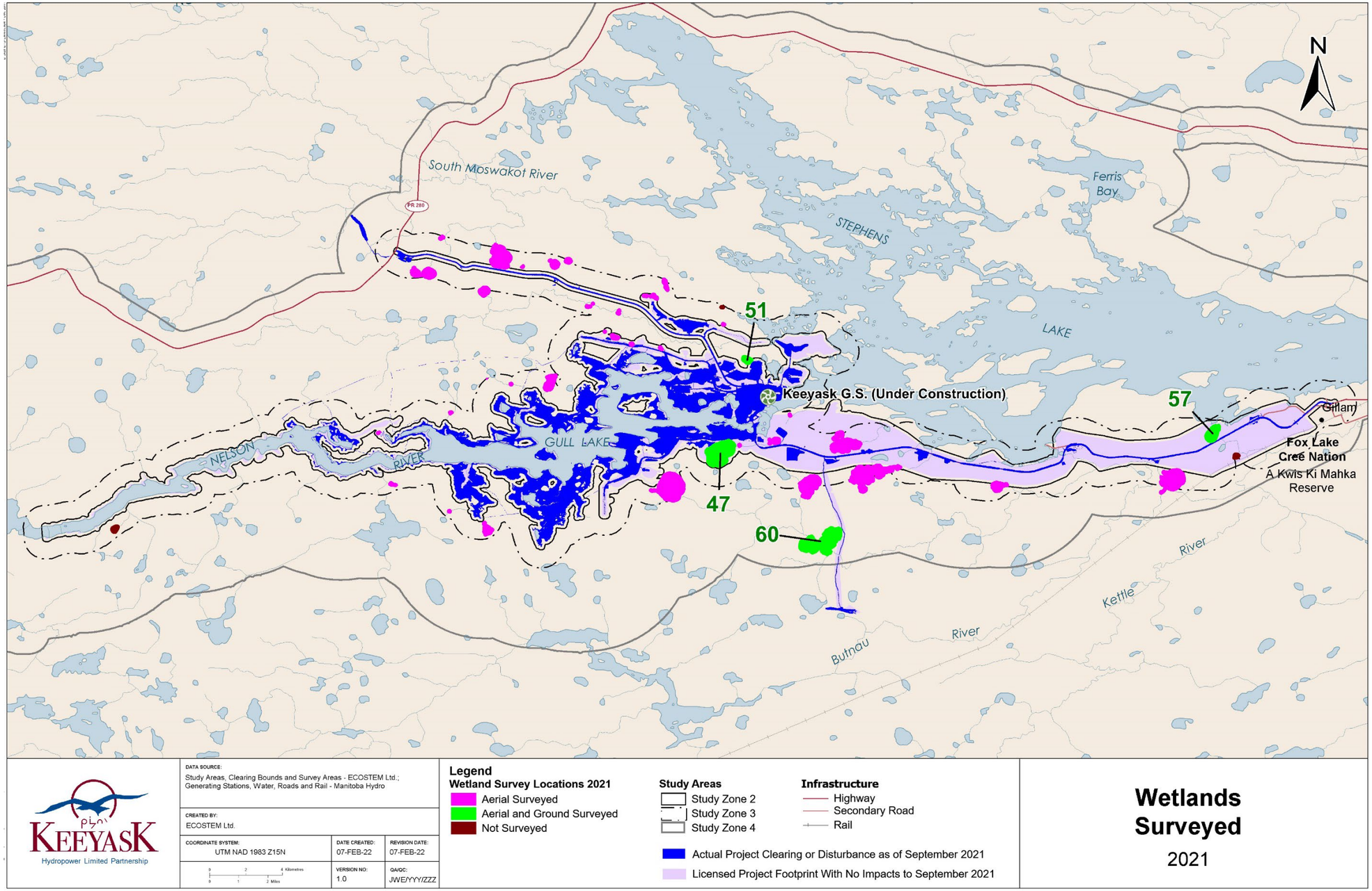
For the first study objective (Section 1.0), the wetlands selected for monitoring were all off-system marsh wetlands located in Study Zone 3 and not entirely within the planned Project footprint (Map 2-3). Wetlands entirely in the planned Project footprint were excluded because we expected they would be lost to Project construction, and this is reflected in the Project's Environmental Protection Plans (EnvPPs). Wetlands in Study Zone 2 were included as this zone captures the areas that could potentially experience direct and indirect Project effects on terrestrial habitat, which included off-system marsh wetlands. Wetlands in Study Zone 3 were also included because, while unlikely, it was possible for some hydrological effects to extend for a considerable distance beyond the licensed Project footprint. Although not a focus for the first objective of this study (Section 1.0), it was important to document when potential hydrological effects occur as they will be evaluated when addressing the second objective.

Studies completed for the environmental impact statement (EIS) had mapped the off-system marshes that were present in Study Zone 4 (Map 2-3) in 2012. This mapping was used to select the waterbodies (Section 2.1) in Study Zone 3 to be included in this monitoring.

Map 2-3 shows the 44 wetlands in Study Zone 3 that were being monitored to verify the implementation and effectiveness of off-system marsh protection measures, and to quantify direct Project effects on wetland function. Each of the 44 monitored wetlands was assigned a unique wetland identification number for the monitoring (e.g., Wetland 17).

Once each year during construction, surveys were conducted in the monitored wetlands that were sufficiently close to actual Project impacts to be potentially affected. Potentially affected wetlands were identified in two stages. The first stage selected all of the wetlands that were within approximately 1 km of the Project clearing or disturbance as seen in the most recent digital orthorectified imagery (DOI; a DOI is a digital dataset produced from satellite images or digital stereo photos that have been stitched together and processed so that all pixels are positioned in an accurate ground position). A 1 km distance was used because it is possible for hydrological effects to extend well beyond the immediate vicinity of a Project impact in continuous peatlands (Section 2.1).

In the second stage of wetland selection, an aerial survey was conducted to identify and add any other of the monitored wetlands within 1 km of Project clearing or disturbance that occurred after the DOI was acquired.



KEEYASK Hydropower Limited Partnership	DATA SOURCE: Study Areas, Clearing Bounds and Survey Areas - ECOSTEM Ltd.; Generating Stations, Water, Roads and Rail - Manitoba Hydro CREATED BY: ECOSTEM Ltd. COORDINATE SYSTEM: UTM NAD 1983 Z15N DATE CREATED: 07-FEB-22 REVISION DATE: 07-FEB-22 VERSION NO: 1.0 QA/QC: JWE/YYY/ZZZ	**Legend** **Wetland Survey Locations 2021** Aerial Surveyed Aerial and Ground Surveyed Not Surveyed **Study Areas** Study Zone 2 Study Zone 3 Study Zone 4 **Infrastructure** Highway Secondary Road Rail Actual Project Clearing or Disturbance as of September 2021 Licensed Project Footprint With No Impacts to September 2021	**Wetlands Surveyed** 2021

Map 2-3: Monitored off-system marsh wetlands, and those that were surveyed in 2021

2.4 DATA COLLECTION

Aerial surveys were conducted for every wetland that had been selected for monitoring in that year. Ground surveys were also conducted at a subset of these wetlands that are within 100 m of the actual Project footprint if impacts have changed within the past three years. Ground surveys searched for effects not visible from the air, documented implemented mitigation measures, and documented possible future Project effects.

In 2021, the first stage of wetland selection used a DOI created from Worldview 2 imagery (30 cm resolution) acquired on August 3 through September 10, 2020 because a DOI from summer 2021 was not available prior to the September 2021 aerial surveys. A total of 42 wetlands were identified for inclusion in the aerial surveys.

Aerial surveys conducted on September 12, 2021 did not identify any additional wetlands for inclusion in the 2021 monitoring.

Of the 42 wetlands surveyed in 2021, 13 were within 100 m of existing clearing or disturbance. Ground surveys were conducted at four of the 13 wetlands within 100 m of existing clearing or disturbance (Map 2-3) on September 14, 2021. The remaining 9 wetlands (wetlands 3, 17, 37, 40, 42, 45, 52, 53 and 54) were not ground-surveyed because there had been no new clearing or other Project impacts near them for several years, and there were no documented Project effects at these wetlands in the previously surveyed years.

Conditions in the surveyed wetlands were recorded with geo-referenced photographs, marked-up maps and/or notes. Any erosion, sedimentation, or surface hydrological alteration observed was recorded, as well as any mitigation implemented to address these issues.

2.5 MAPPING

The spatial extent of impacts on the surveyed wetlands were mapped in a Geographic Information System (GIS) from remote sensing. Remote sensing refers to data obtained from above the ground from sources such as satellite imagery, digital stereo photos or photos taken from a helicopter). In this monitoring, remote sensing includes a combination of photos acquired from a helicopter and DOIs. The most recent growing season DOI was also generally used as the base map. Exceptions occurred where the spatial extents of the most recent DOI did not overlap a wetland, in which case the next most recent DOI was used.

Areas burned in the 2013 wildfire (which was prior to and unrelated to development of the Project) are 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 also used to map the percentage of the wetland's buffer that was burned in the 2013 wildfire.

2.6 WATER LEVEL INDICATORS

Water levels and water level variability in the off-system waterbodies were of interest for the wetland monitoring because these factors are the primary determinants for the distribution and abundance of off-system marsh and its habitat.

During the annual aerial surveys, the apparent deviation of water levels relative to their median was visually evaluated for each waterbody. Indicators of relatively low water levels were the degrees of exposed aquatic vegetation and lake-bottoms. Indicators of relatively high-water levels were inundation of the upper beach or surface water presence within inland edge vegetation. No actual measured water levels were collected in the off-system waterbodies.

3.0 RESULTS

3.1 OVERVIEW

The 2021 surveys did not detect any new clearing since 2020 in the marsh habitat or marsh habitat buffers for any of the 42 surveyed wetlands (Map 2-3).

Of the 4.2 ha of Project clearing or disturbance within wetlands since 2014, 0.1 ha was in marsh habitat while 4.1 ha was in the marsh habitat buffer. With one minor exception (Marsh 51), the total area impacted at each wetland has remained unchanged since 2017.

Water levels were observed to be below the median levels in all wetlands during 2021 surveys. Water levels in the Project footprint were also generally observed to be lower in 2021 during the surveys.

To date, all recorded impacts in wetlands have been within the licensed Project footprint, and the vast majority were within the planned Project footprint (Map 2-2). Of the 4.2 ha of total wetland area impacted to date by the Project, 3.9 ha was within the planned Project footprint while 0.3 ha was within the possibly disturbed Project footprint.

Table 3-1 summarizes the main findings for the 13 wetlands within 100 m of Project impacts as of September 2021. Table 3-2 provides the distribution of these impacts by Project area. Map 3-1 shows the locations of the monitored wetlands in relation to the Project components.

As of September 2021, Project clearing or disturbance had only affected 0.5% of off-system marsh wetlands (Table 3-1). The vast majority (97%) of these impacts were in the marsh habitat buffer, and not in actual marsh habitat. The impacts in marsh habitat were confined to a single wetland, and were necessary to clear trees that would be within future reservoir flooding.

The following sub-sections present results for each of the monitored wetlands.

Table 3-1: Impacts and potential future effects in the off-system marsh wetlands within 100 m of Project clearing or disturbance, as of September, 2021

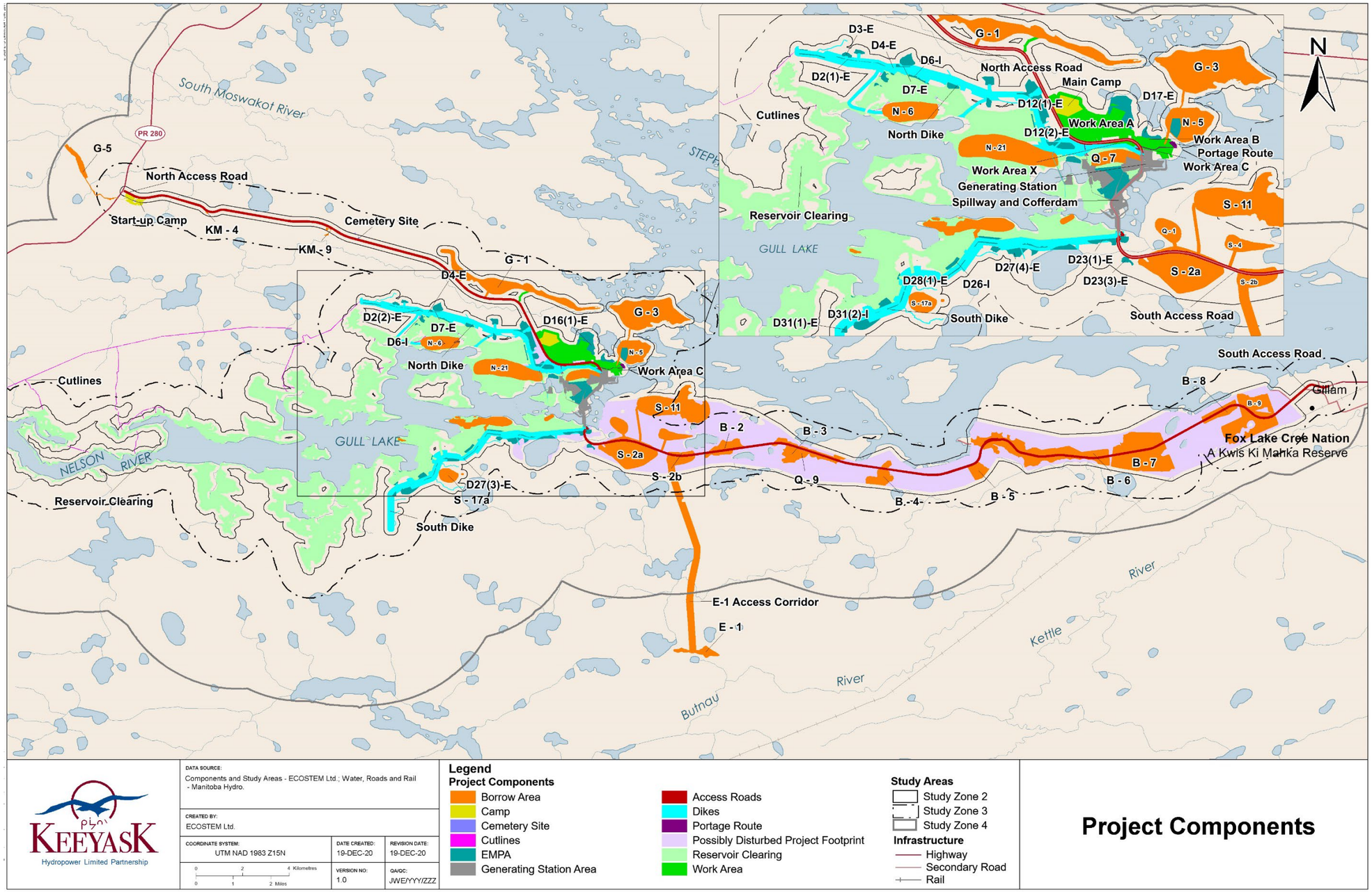
Wet-land ID[1]	Wetland Area (ha)			Area (ha) Impacted[2] by Project Clearing and Disturbance			Other Project Impacts up to 2021	2013 Burn in Buffer (%)[3]	Potential Additional Future Effects or Effects Outside of the Monitored Wetlands
	Total	Marsh Habitat	Buffer	Total	Marsh Habitat	Buffer			
3	5.0	1.0	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	Likely none[4]
40	7.9	1.2	6.7	1.754	-	1.754	None	10	Likely none[4]
42	15.7	2.9	12.8	-	-	-	None	50	Likely none[4]
45	7.3	0.8	6.5	0.236	-	0.236	None	50	Likely none[4]
47	189.7	140.7	49.0	1.033	-	1.033	None	0	Runoff from dike through drainage channels into marsh
51	25.7	10.5	15.2	0.023	-	0.023	Sediment from EMPA D16(1)-E into the buffer zone	20	Deposition of sediment or other materials into the marsh habitat buffer from EMPA. Increase in water levels due to runoff from culvert at Main Camp
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	Hydrological effects from a road culvert
60	232.4	150.0	82.5	-	-	-	None	0	Additional vegetation clearing and disturbance from adjacent ATV usage
All	847.6	525.7	322.0	4.208	0.105	4.104			

Notes:
[1] Bold font identifies wetlands that were ground sampled in 2021.
[2] All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2022) for the mapping.
[3] Percentage of total buffer area that burned in the 2013 wildfire (which was unrelated to the Project).
[4] The potential runoff from EMPA or dike slope is declining. Evidence of runoff has not been recorded for past few years and colonizing vegetation may eventually prevent it.

Table 3-2: Project clearing or disturbance in the off-system marsh wetlands within 100 m of Project clearing or disturbance as of September, 2021, by Project area

Wetland ID	Total Wetland Area (ha)	Area (ha) Impacted by Project Clearing and Disturbance[1]			Percent of Total Wetland Area Impacted
		Total	Planned Project Footprint	Possibly Disturbed Project Footprint	
3	5.0	0.364	0.117	0.247	7.2
17	135.1	-	-	-	-
37	17.0	0.006	-	0.006	0.0
40	7.9	1.754	1.754	-	22.2
42	15.7	-	-	-	-
45	7.3	0.236	0.236	-	3.2
47	189.7	1.033	1.015	0.018	0.5
51	25.7	0.023	-	0.023	0.1
52	28.4	-	-	-	-
53	5.5	-	-	-	-
54	113.1	-	-	-	-
57	64.6	0.793	0.793	0.00	1.2
60	232.4	-	-	-	-
All	847.6	4.208	3.914	0.294	0.5

Notes:
1 All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2022) for the mapping.



KEEYASK Hydropower Limited Partnership

DATA SOURCE:
Components and Study Areas - ECOSTEM Ltd.; Water, Roads and Rail - Manitoba Hydro.

CREATED BY: ECOSTEM Ltd.

COORDINATE SYSTEM: UTM NAD 1983 Z15N

DATE CREATED: 19-DEC-20

REVISION DATE: 19-DEC-20

0 2 4 Kilometres
0 1 2 Miles

VERSION NO: 1.0

QA/QC: JWE/YYY/ZZZ

Legend

Project Components
- Borrow Area
- Camp
- Cemetery Site
- Cutlines
- EMPA
- Generating Station Area
- Access Roads
- Dikes
- Portage Route
- Possibly Disturbed Project Footprint
- Reservoir Clearing
- Work Area

Study Areas
- Study Zone 2
- Study Zone 3
- Study Zone 4

Infrastructure
- Highway
- Secondary Road
- Rail

Project Components

Map 3-1: Monitored off-system marsh wetlands in relation to the Project components as understood at the start of construction

3.2 WETLAND 3

Wetland 3 (Photo 3-1) is 5.0 ha in size (Table 3-1), and is located about 1 km from the Nelson River. It is approximately 21 km west of the generating station site (Map 2-3). This wetland is directly connected to the Nelson River through a lake and then a short stream. Marsh habitat comprised 1.0 ha of the wetland's total area. The 2013 wildfire (see Section 2.4) burned approximately 90% of the marsh habitat buffer (*i.e.*, a 100 m buffer of the marsh habitat) included in Wetland 3.

Photo 3-1: Aerial view of Wetland 3 on September 12, 2021

No Project clearing or disturbance was observed in Wetland 3 during the 2015 survey but 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 3-1). 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.

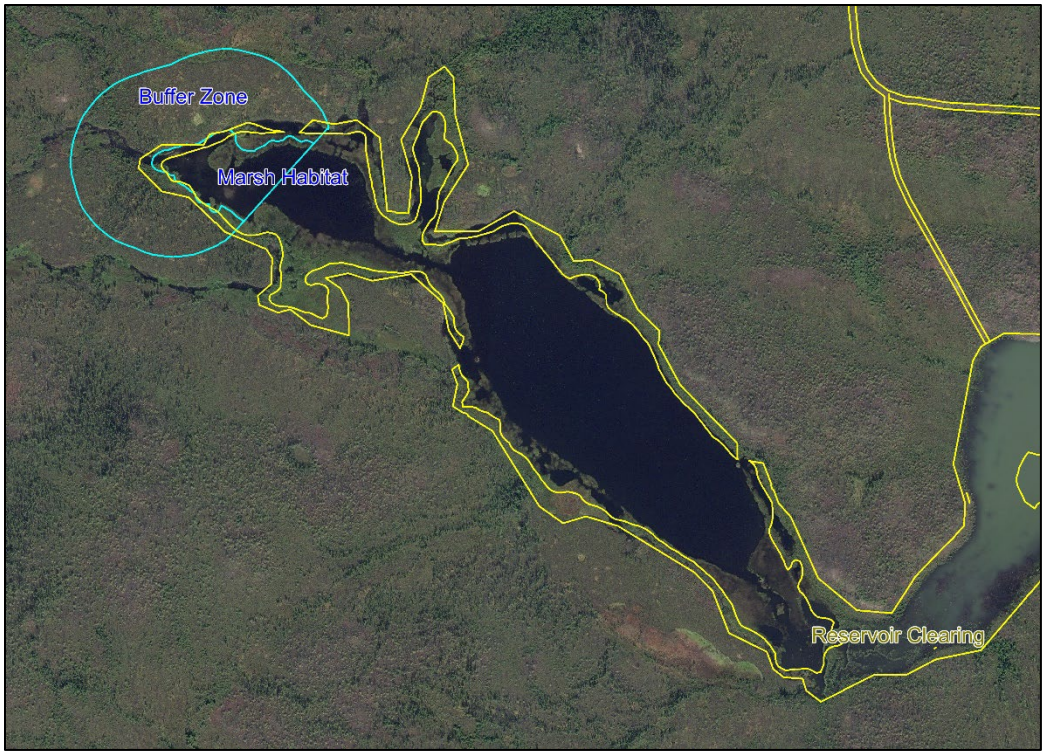


Figure 3-1: Satellite imagery showing reservoir clearing (in yellow) at Wetland 3 (in blue) in 2021

Approximately 0.26 ha of the cleared area was in the marsh habitat buffer and 0.11 ha was in the marsh habitat (Table 3-1). Cleared trees were visible where collapsed or collapsing peatlands outside of the planned Project footprint had become part of the marsh habitat (Photo 3-2).

Photo 3-2: Cleared trees in Wetland 3 on August 31, 2017

No further clearing or disturbance was observed in this wetland during the 2017 to 2021 surveys. Water levels in 2017 were noted to be lower than in previous years and near the median from 2018 to 2020, however water levels appeared to be lower than the median in 2021.

3.3 WETLAND 17

Wetland 17 (Photo 3-3) is 135.1 ha in size and located on the southwest shore of a small lake located near the kilometre 6 point of the north access road (NAR) (Map 3-1). Marsh habitat comprised 97.4 ha of the wetland's total area. Approximately 85% of the marsh habitat buffer burned in the 2013 wildfire.

Photo 3-3: Aerial view of southern portion of Wetland 17 on September 12, 2021

Project disturbance or clearing had not been observed within Wetland 17 up to the time of the 2021 surveys (Figure 3-2). Ground surveys conducted from 2015 to 2017 found no incremental changes in the condition of the wetland (Photo 3-4).

Ground surveys were not conducted in 2018 through 2021 as the aerial surveys found no new clearing or activity nearby. Details about conditions observed in Wetland 17 in previous survey years are provided in ECOSTEM (2018).

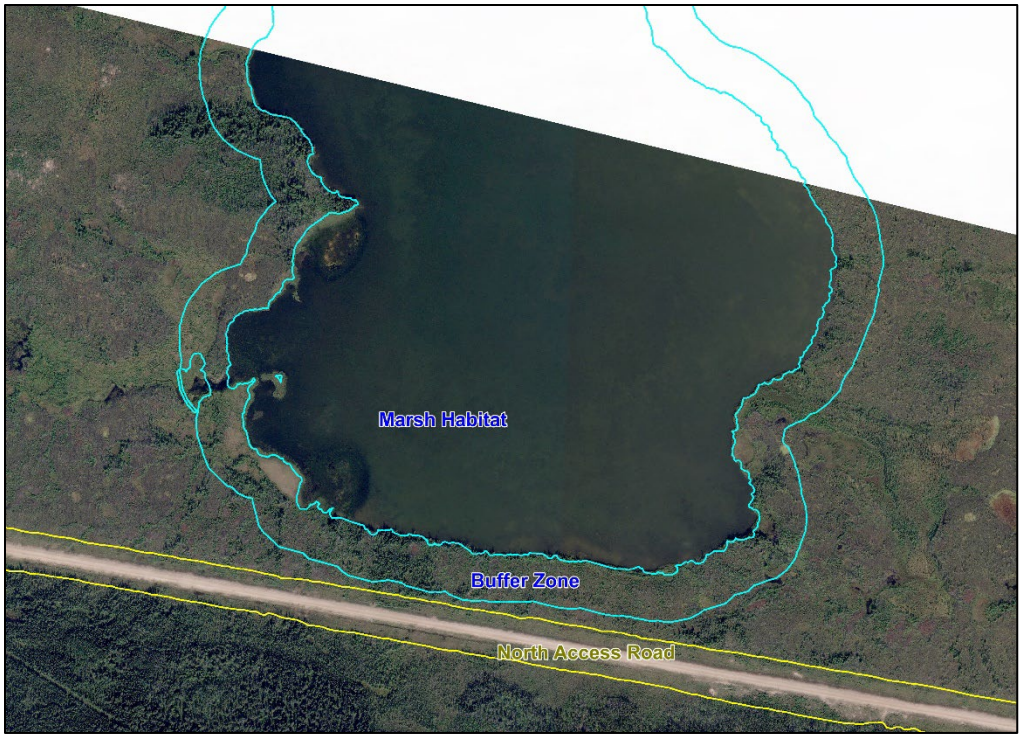


Figure 3-2: Satellite imagery showing Wetland 17 (in blue) in relation to the North Access Road (in yellow) in 2021

Photo 3-4: Ground photo of Wetland 17 on August 23, 2017

3.4 WETLAND 37

Wetland 37 (Photo 3-5, Photo 3-6) is 17.0 ha in size, and located near the north dike, 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.

Photo 3-5: Ground photo of Wetland 37 in 2019

Photo 3-6: Aerial photo of Wetland 37 in September 2021, looking south

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; Figure 3-3) extended into the buffer portion of the wetland. Surveys from 2017 to 2021 found no further changes to the EMPA and no new impacts on the wetland were observed.

The potential for sediment runoff from EMPA D3-E into the wetland buffer is likely decreasing as the EMPA is becoming increasingly vegetated, which will help stabilize the soil (Photo 3-6). Evidence of runoff has not been recorded since 2016.

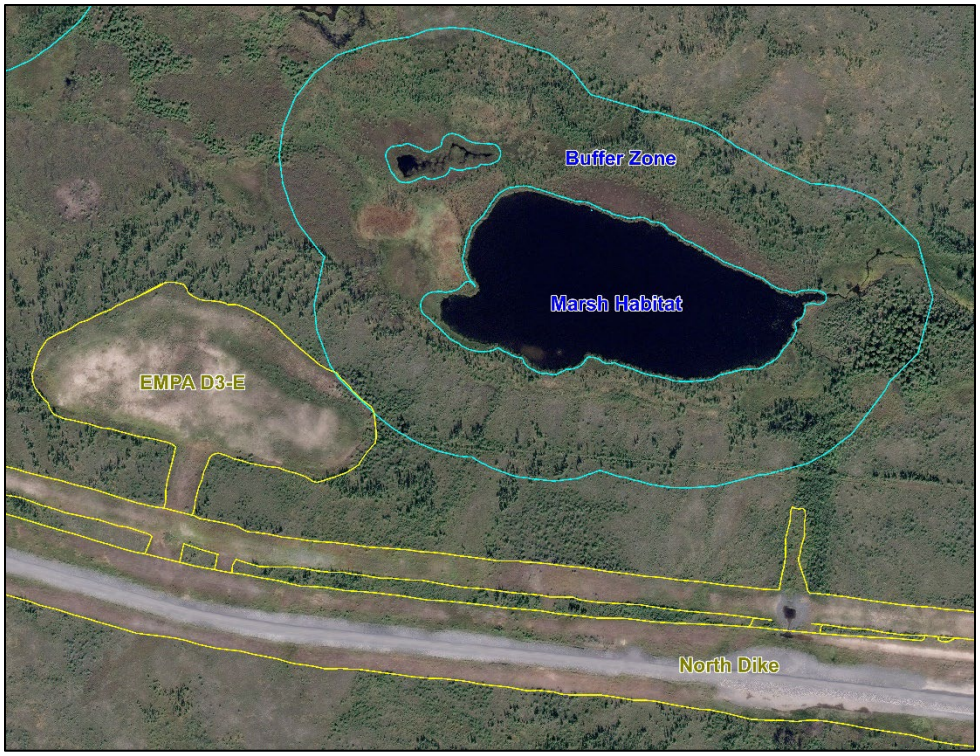


Figure 3-3: Satellite image showing EMPA D3-E (in yellow) adjacent to Wetland 37 (in blue) buffer in 2021

3.5 WETLAND 40

Wetland 40 (Photo 3-7) is 7.9 ha in size, and located along the north dike, approximately 750 m east of Wetland 37 (Map 2-3). Marsh habitat comprised 1.2 ha of the wetland's total area. Approximately 10% of the marsh habitat buffer burned in the 2013 wildfire.

Photo 3-7: Aerial view of Wetland 40 on September 12, 2021

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 dike (Map 3-1) had extended through the buffer to approximately 3 m away from the southern portion of the marsh habitat (Figure 3-4). This 1.75 ha of clearing was within the planned Project footprint (Table 3-2). Water levels in 2017 appeared to be lower than the median level based on exposed underwater portions of marsh vegetation. Surveys from 2018 to 2020 found that water levels appeared to be approximately at the median level (Figure 3-5). Water levels were observed to be lower than the median in 2021.

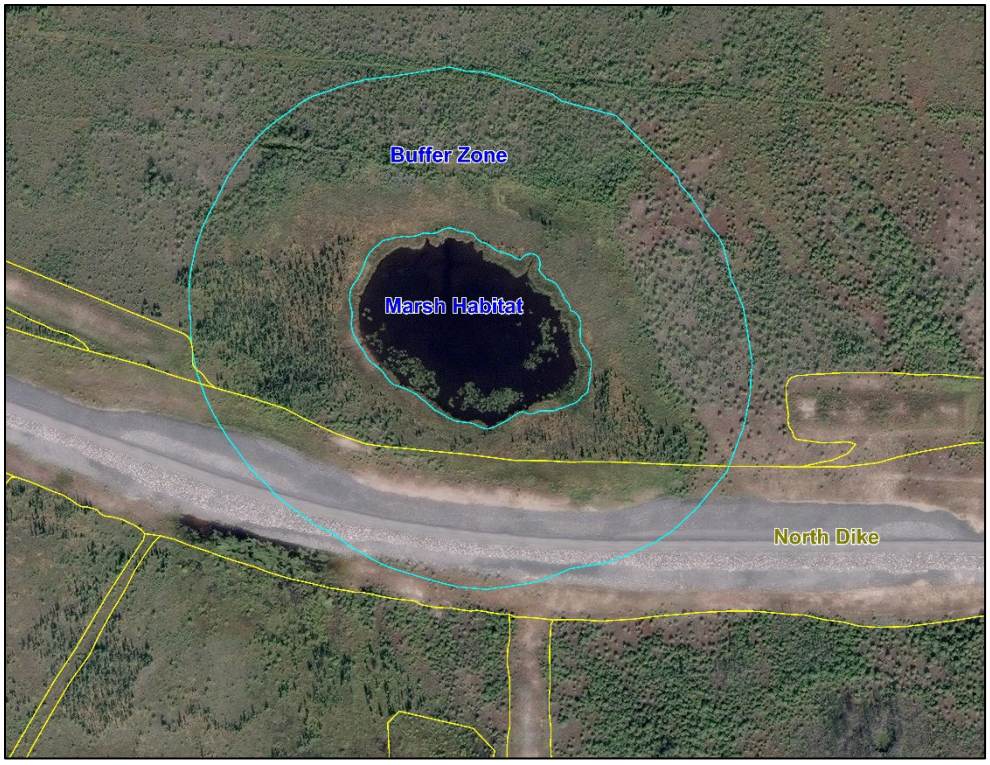


Figure 3-4: Satellite imagery showing dike clearing (in yellow) at Wetland 40 (in blue) in 2021

View along the shores of Wetland 40

Regenerating peatland between marsh and dike clearing

Figure 3-5: Ground photos of Wetland 40 on September 9, 2019

The 2016 surveys noted that a shallow slope leading from the dike clearing to the water's edge should be monitored for the potential to transport sediment from the exposed mineral of the dike into the marsh. In 2017, it was recommended that a sediment fence be installed between the dike clearing and the wetland at the base of the slope. No sediment fencing had been installed as of September 2021, however no clearing, sedimentation or runoff from the dike was observed during surveys.

A peatland with black spruce (*Picea mariana*) seedlings and saplings was continuing to regenerate between the dike clearing and the marsh (Figure 3-5). As regeneration progresses, this peatland is expected to become an increasing barrier to potential runoff. These areas will be monitored for any future runoff effects.

3.6 WETLAND 42

Wetland 42 (Photo 3-8) is 15.7 ha in size, and located approximately 750 m north of the NAR at kilometre 14, at the northwestern end of Borrow Area G-1 (Map 2-3). Marsh habitat comprised 2.9 ha of the wetland's total area. Approximately 50% of the marsh habitat buffer burned in the 2013 wildfire.

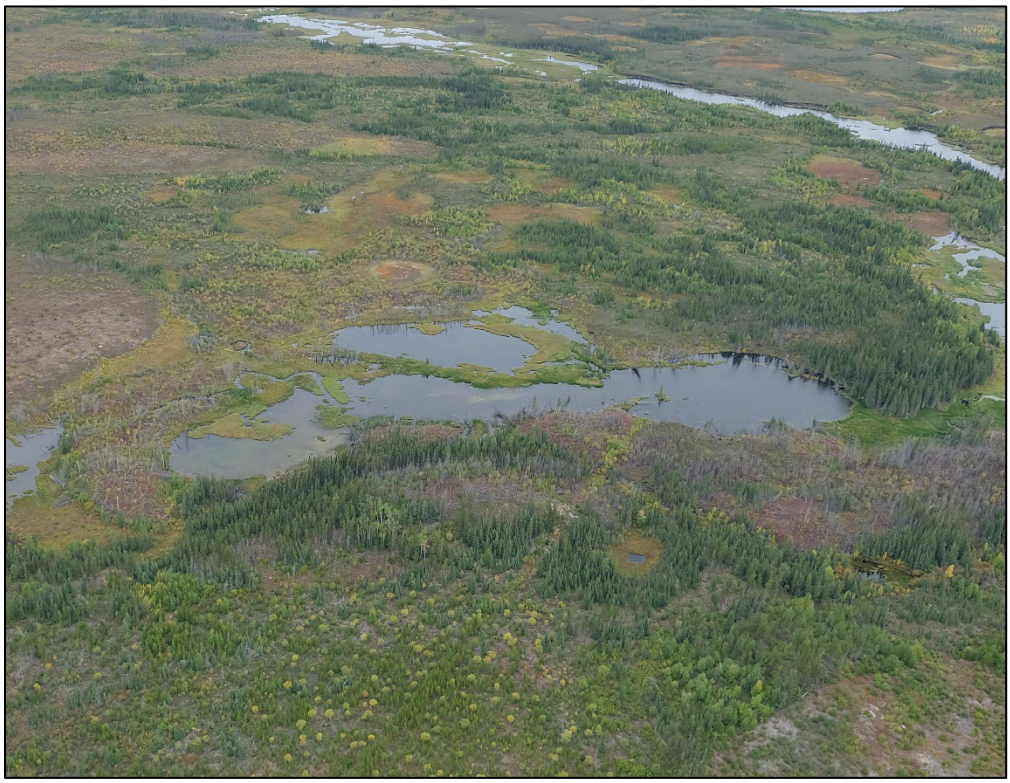


Photo 3-8: Aerial view of Wetland 42 on September 12, 2021

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

Aerial surveys in 2016 found that clearing for Borrow Area G-1 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 (Figure 3-6). Project disturbance within the wetland was not visible in the DOIs or aerial photos.

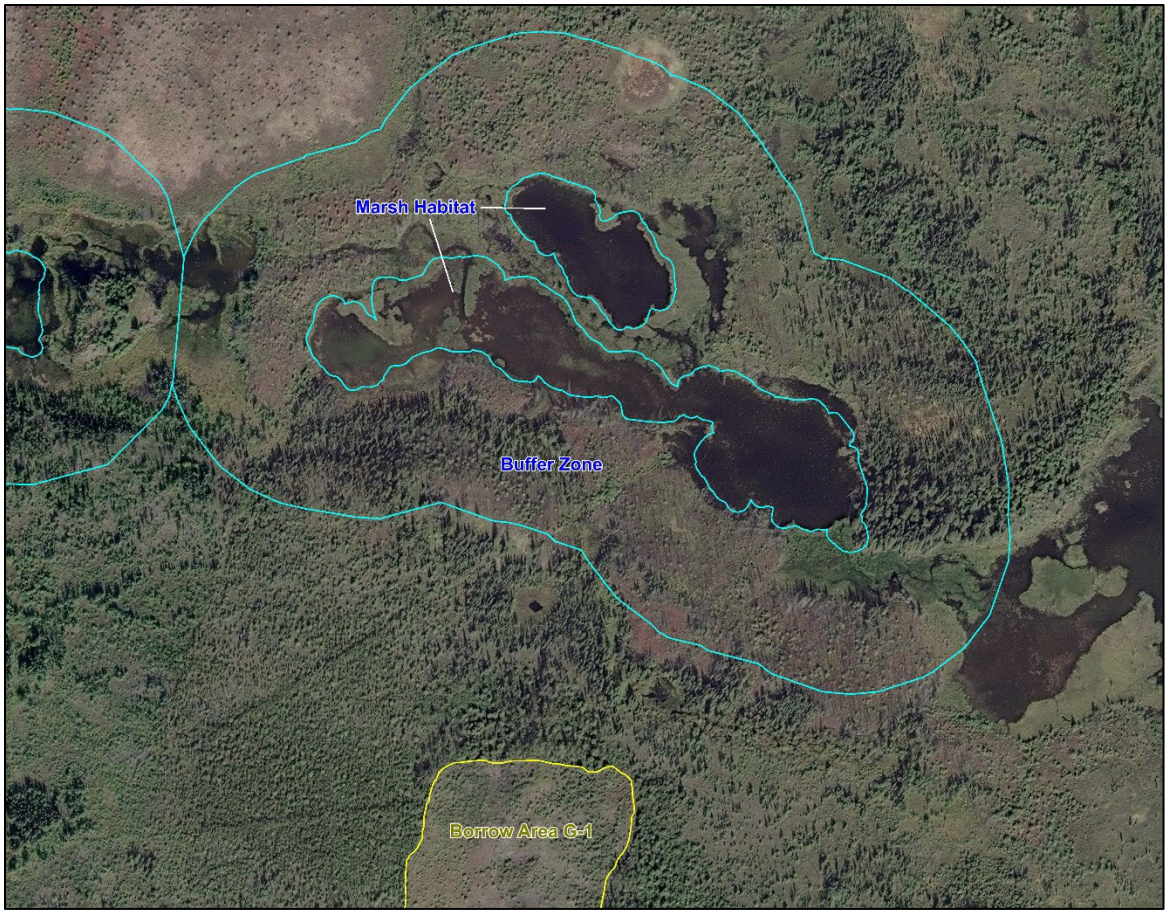


Figure 3-6: Satellite imagery showing proximity of Borrow Area G-1 clearing (in yellow) to Wetland 42 (in blue) in 2021

During the 2016 aerial survey, it was noted that there was a significant slope extending downwards from the Borrow Area G-1 clearing to the southern edge of the wetland. 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 2021 surveys, there was no clearing or excavation in the adjacent borrow area and there were no signs of erosion along the slope to the wetland. Ground surveys in 2018 found that the peat bank at the base of the slope adjacent to the wetland was beginning to slump and break apart (Photo 3-9). This slumping was attributed to melting permafrost in the peat related to having been recently burned in the wildfire.

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, but the risk for this continues to decline due to the vegetation regeneration occurring in Borrow Area G-1.

Photo 3-9: Slumping peat bank adjacent to Wetland 42 on September 16, 2018

3.7 WETLAND 45

Wetland 45 (Photo 3-10) is 7.3 ha in size, and located along the north dike, approximately 1.5 km east of Wetland 40 (Map 2-3). 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 dike and the marsh habitat, and some sites within this area had either a thin layer of organic matter or exposed mineral substrate.

Photo 3-10: Aerial view of Wetland 45 on September 12, 2021

At the time of the 2015 ground survey, north dike clearing extended approximately 3 m into the buffer on the south side of Wetland 45 for about 60 m. By the time of the 2016 ground survey, north dike clearing had extended approximately 25 m into the marsh habitat buffer (Figure 3-7; Map 3-1). This 0.24 ha of clearing was completely within the planned Project footprint (Table 3-2) and no other Project impacts were noted at that time. All of the dike clearing within Wetland 45 was also within the above noted burned area.

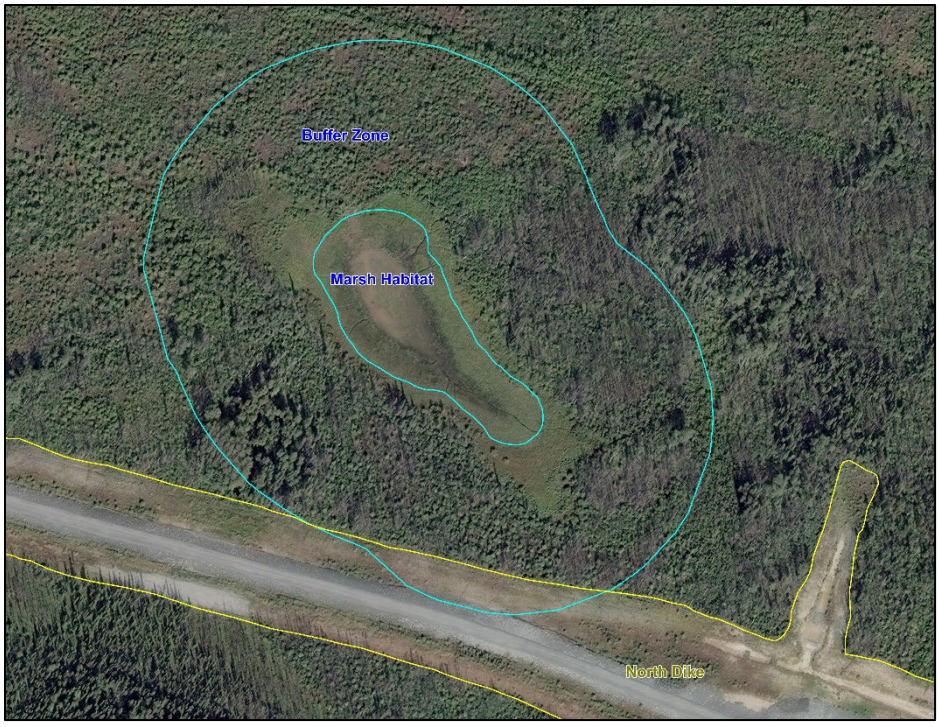


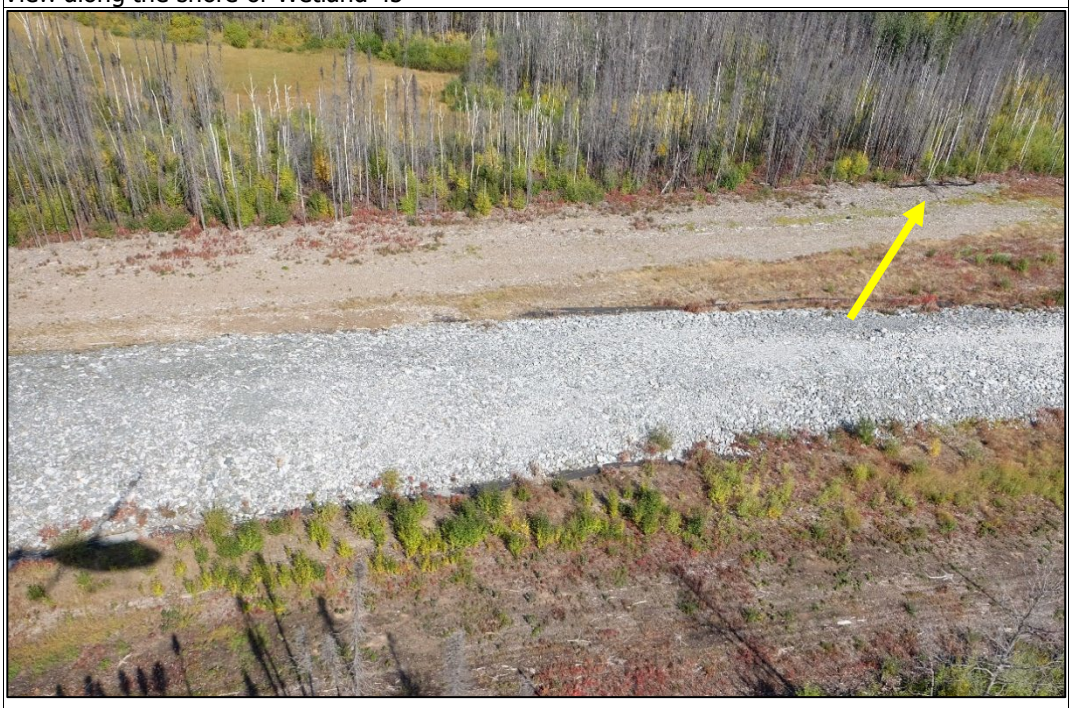
Figure 3-7: Satellite imagery showing North Dike clearing (in yellow) at Wetland 45 (in blue) in 2021

No further clearing was recorded within the marsh habitat buffer between 2016 and 2021.

An approximately 15% slope running through the dike clearing area to the marsh habitat creates the potential for surface runoff to carry material into the marsh habitat. In addition to the slope containing exposed mineral material in the cleared area (Figure 3-8), the entire slope had been burned with some areas having virtually all vegetation removed. In 2017, it was recommended that staff evaluate and implement sediment control measures such as sediment fence where needed as a preventative measure (e.g., a sediment fence at the base of the dike). A short sediment fence was installed at one location (Figure 3-8).

At the time of the 2021 surveys, no runoff or sedimentation was seen entering the marsh habitat. In addition to the existing sediment fences, a small ridge between the wetland and the dike may be serving as a natural barrier to sediment transport further downslope. Additional sediment fences appear to be unnecessary at this time. These areas will be monitored for any future runoff effects.

View along the shore of Wetland 45



Sediment fence installed at bottom of North Dike slope near Wetland 45 (yellow arrow)

Figure 3-8: Ground and aerial photos of Wetland 45 on September 9, 2019

3.8 WETLAND 47

Wetland 47 (Figure 3-9; Photo 3-11) is 189.1 ha in size, and located approximately 100 m southeast of EMPA D27(4)-E (Map 2-3). Marsh habitat comprised 140.7 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Figure 3-9: Satellite imagery showing the North Dike, EMPA D27(4)-E (in yellow) and Wetland 47 (in blue - center) in 2021

Photo 3-11: Aerial view of Wetland 47 on September 12, 2021

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.

As of August 2017, a total of 1.03 ha of Wetland 47 was cleared, 1.01 ha 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 Dike clearing occurred within 50 m of the shoreline (Figure 3-9). A runnel, draining water through the wetland north of the dike into the lake, was cleared and blocked by the dike where it was within the planned Project footprint.

No further clearing had occurred between the 2017 and 2021 surveys.

Water levels in Wetland 47 have fluctuated considerably since 2017, possibly because the newly constructed South Dike was altering water inputs. Based on the degrees of exposed lake-bottom and aquatic vegetation, water levels in relation to the median observed in 2018 appeared to be lower in 2017 and 2019, at median in 2020, and lower once again in 2021.

3.9 WETLAND 51

Wetland 51 is 25.7 ha in size and located immediately northwest of EMPA D16(1)-E (Map 2-3, Figure 3-10). Marsh habitat comprised 10.5 ha of the wetland's total area. Approximately 20% of the marsh habitat buffer burned in the 2013 wildfire.

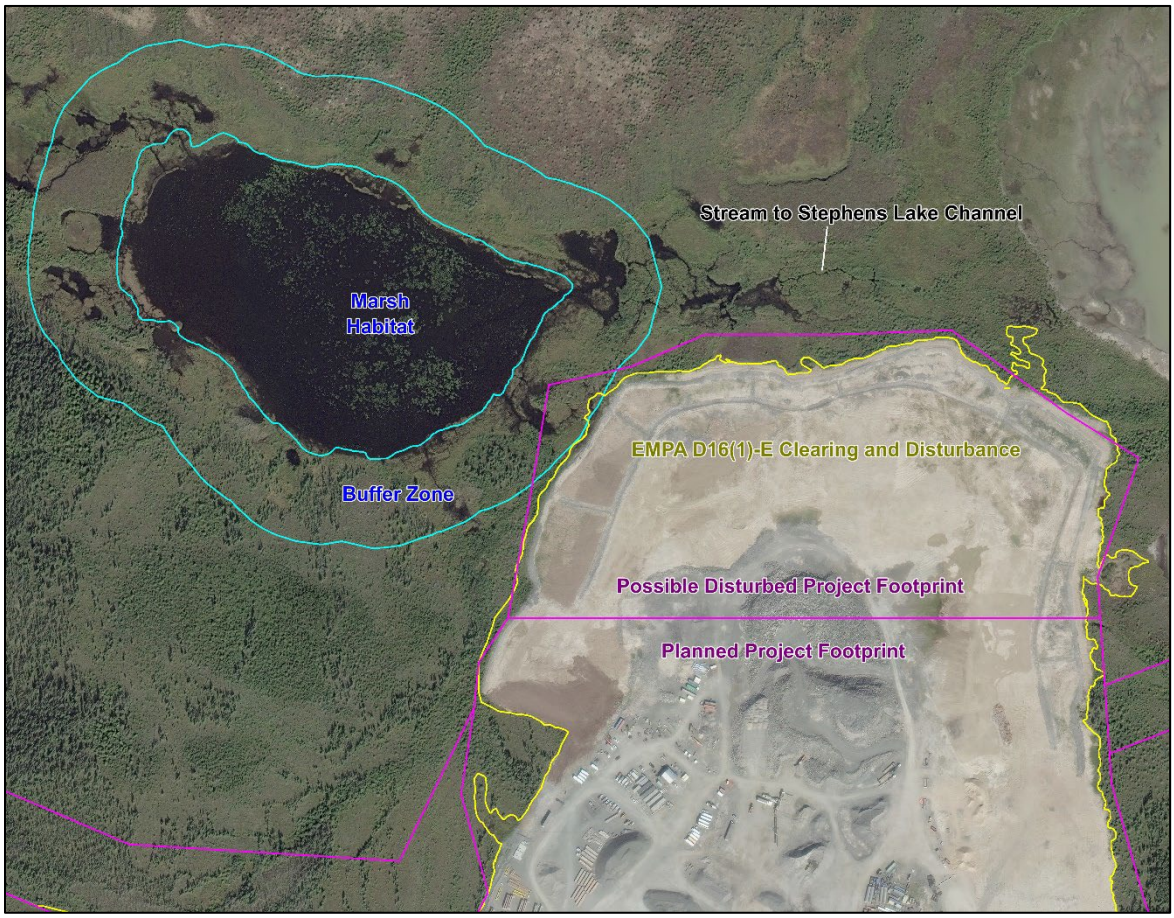
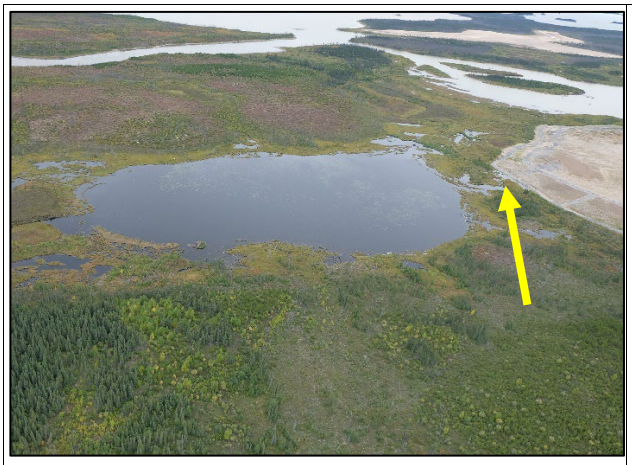


Figure 3-10: Wetland 51 (in blue) in 2021 satellite imagery showing adjacent EMPA, stream to Stephens Lake channel, 2021 Project clearing and disturbance (yellow line), and the boundaries of licensed Project footprint (purple line)

Ground surveys in August 2015 identified EMPA clearing within 25 m of the edge of Wetland 51. Various disturbances have been observed in the area between EMPA D16(1)-E and Wetland 51 since 2015 (e.g. machinery rutting, sediment deposition). Several measures were implemented to mitigate erosion and sediment deposition in this area such as slope grading, installation of soil berms and sediment fences as well as the placement of straw wattles within erosion channels.

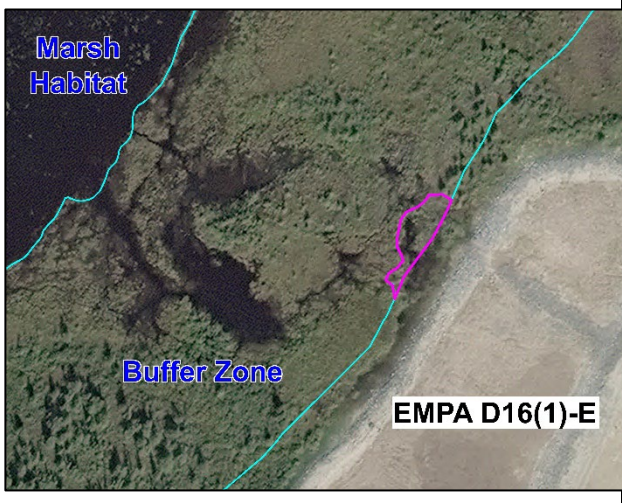
Up to the time of the 2019 survey, the installation of straw wattles within the channels had slowed but not stopped sediment deposition into the water adjacent to the wetland. This resulted in sediment reaching into the wetland buffer in an area of 0.005 ha.

By late summer of 2020, the rock barrier that had been constructed on the northern edge of EMPA D16(1)-E was extended along the western edge to form a sediment barrier between the EMPA and Wetland 51. A gap in this barrier allowed sediment to continue flowing past the straw wattles and be deposited into the wetland buffer zone (see ECOSTEM (2022) for further details). The area of sediment deposition within the wetland buffer zone increased by approximately 0.02 ha by September 2020 (Figure 3-11). Sediment deposition was still occurring at this location at the time of the 2021 surveys however the area affected had not increased in size since 2020.



Aerial view of Wetland 51 and location of sediment deposition in the wetland buffer zone (yellow arrow)

Gap in rock barrier surrounding EMPA D16(1)-E (yellow arrow) and adjacent sediment deposition in flooded portion of Wetland 51 buffer (background)



Extent of sediment deposition in the buffer zone of Wetland 51 (in blue) to 2021 (in pink)

Figure 3-11: Sediment deposition in buffer zone of Wetland 51 in 2021

By late 2020, a secondary rock-lined drainage channel to divert water runoff had been constructed parallel to the rock barrier further upslope around the edges of EMPA D16(1)-E (Figure 3-12). Several rock-lined turnouts were constructed along the secondary channel to strategically direct material downslope towards the rock barrier. The straw wattles lining the erosion channels on the western edge of the EMPA were removed and the erosion channels were replaced by rock-lined turnouts. Sediment deposition was still occurring at the base of the drainage turnout adjacent to the gap in the rock barrier in September 2021, but it was not clear whether this sediment was coming from the turnout or if it was present prior to its construction. Surveys in 2022 will monitor this area for incremental changes.

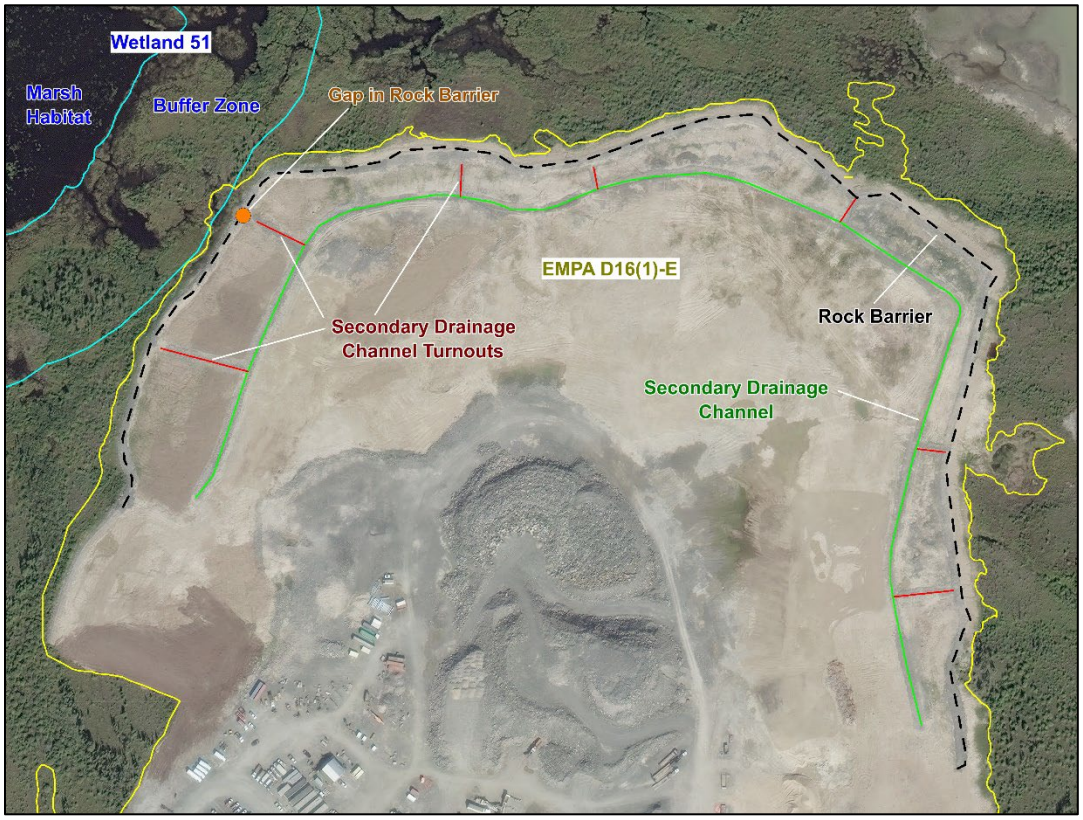


Figure 3-12: Rock barrier (in black), secondary drainage channel (in green), drainage turnouts (in red) and gap in rock barrier (in orange) in EMPA D16(1)-E as of September, 2021

Significant output from a drainage culvert at the northeastern corner of the Main Camp created a channel of running water through the previously undisturbed adjacent forest by September 2020. This channel of water flowed northeast towards a low area directly adjacent to Wetland 51 (Figure 3-13; see ECOSTEM (2022) for further details). At the time of the 2020 survey, this disturbance was approximately 185 m away from entering the low-lying area adjacent to the wetland and by September 2021, the disturbance was approximately 165 m away. Although no effects were observed in the low-lying area during aerial surveys, this disturbance has the potential to affect

water levels in the marsh. Air and ground surveys in 2022 will continue to monitor for adverse effects in the area.

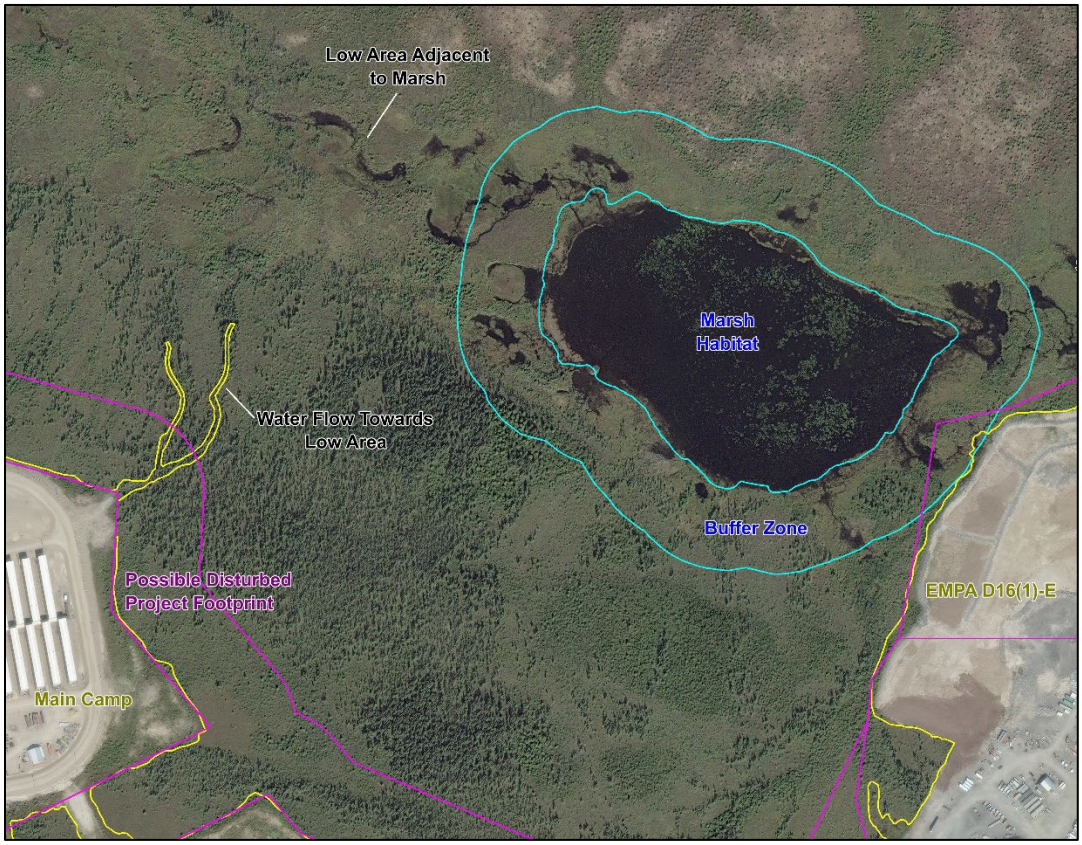


Figure 3-13: Extent of water flow from culvert (in yellow to the west) with potential to affect Wetland 51 (in blue) as of September, 2021

Peat bank slumping was observed around a small peat plateau bog between the wetland and EMPA slope in 2017. There did not appear to be any incremental change to the bog between 2017 and 2021. 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).

The substantial amount of floating-leaved vegetation in the waterbody in 2015 was absent at the time of surveys from 2016 to 2019. This vegetation was apparent again in 2020 and 2021. It is uncertain whether these changes are the result of indirect Project effects, herbivory from muskrats and/or beavers, or a combination of both. The construction synthesis report will evaluate the causes, using all relevant data available.

3.10 WETLAND 52

Wetland 52 (Figure 3-14) is 28.4 ha in size and located south of Gull Rapids (Map 2-3). Marsh habitat comprised 9.1 ha of the wetland's total area. None of this wetland's buffer was burned in the 2013 wildfire.

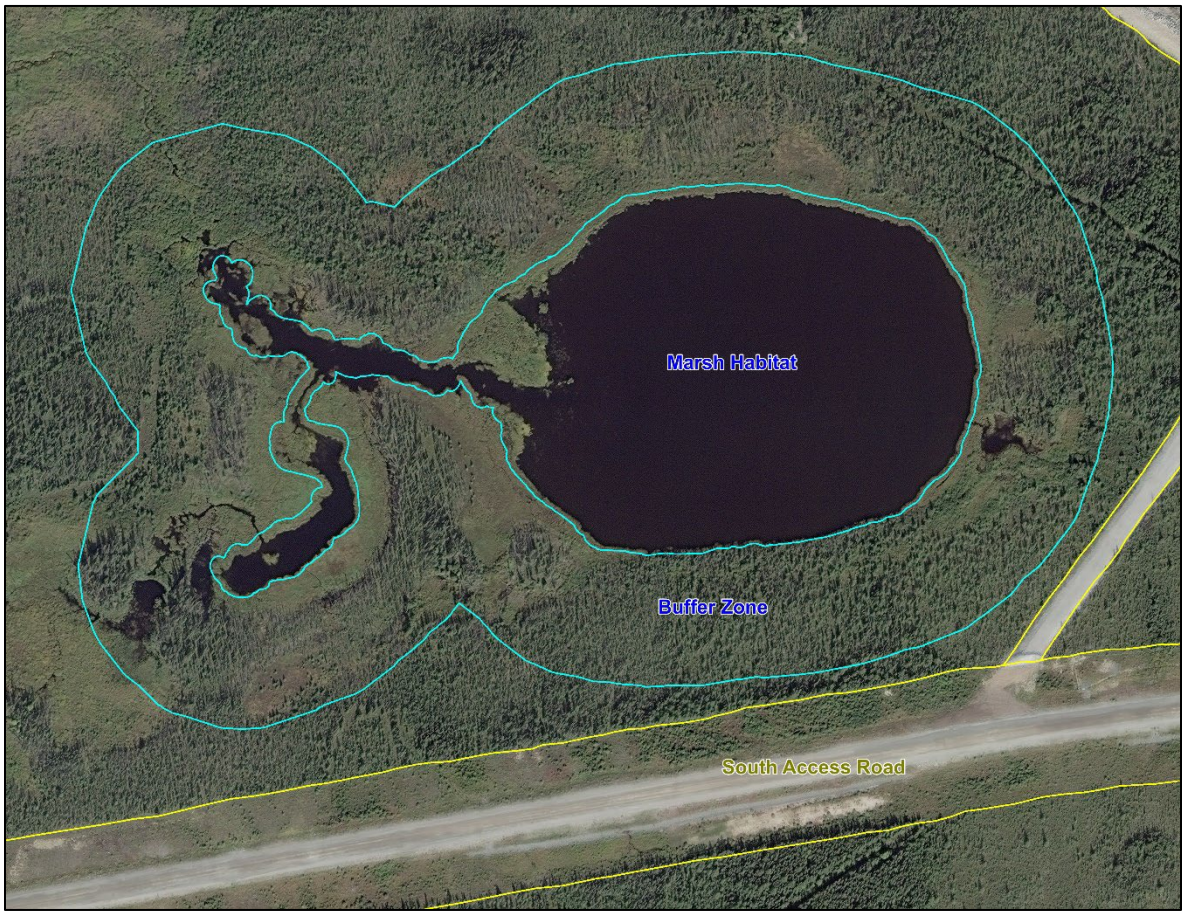


Figure 3-14: Satellite imagery showing proximity of Project clearing (in yellow) to Wetland 52 (in blue)

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 within Wetland 52 has not been observed during the surveys from 2016 to 2021 (Map 3-1). Potential hydrological impacts from the SAR were being monitored, but to date none have been observed. Consequently, ground surveys were not conducted at Wetland 52 in 2021. See ECOSTEM (2018) for specific observations made in previous survey years.

3.11 WETLAND 53

Wetland 53 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 2-3). Marsh habitat comprised 0.3 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Clearing in the marsh habitat buffer was observed during the 2015 aerial surveys. This clearing was for the Keeyask Transmission Project right-of-way (RoW), which is a separate project (Figure 3-15; Photo 3-12). See ECOSTEM (2018) for details.

Surveys from 2016 to 2021 found no new impacts or indirect expansion of the impacts that were present in 2015.

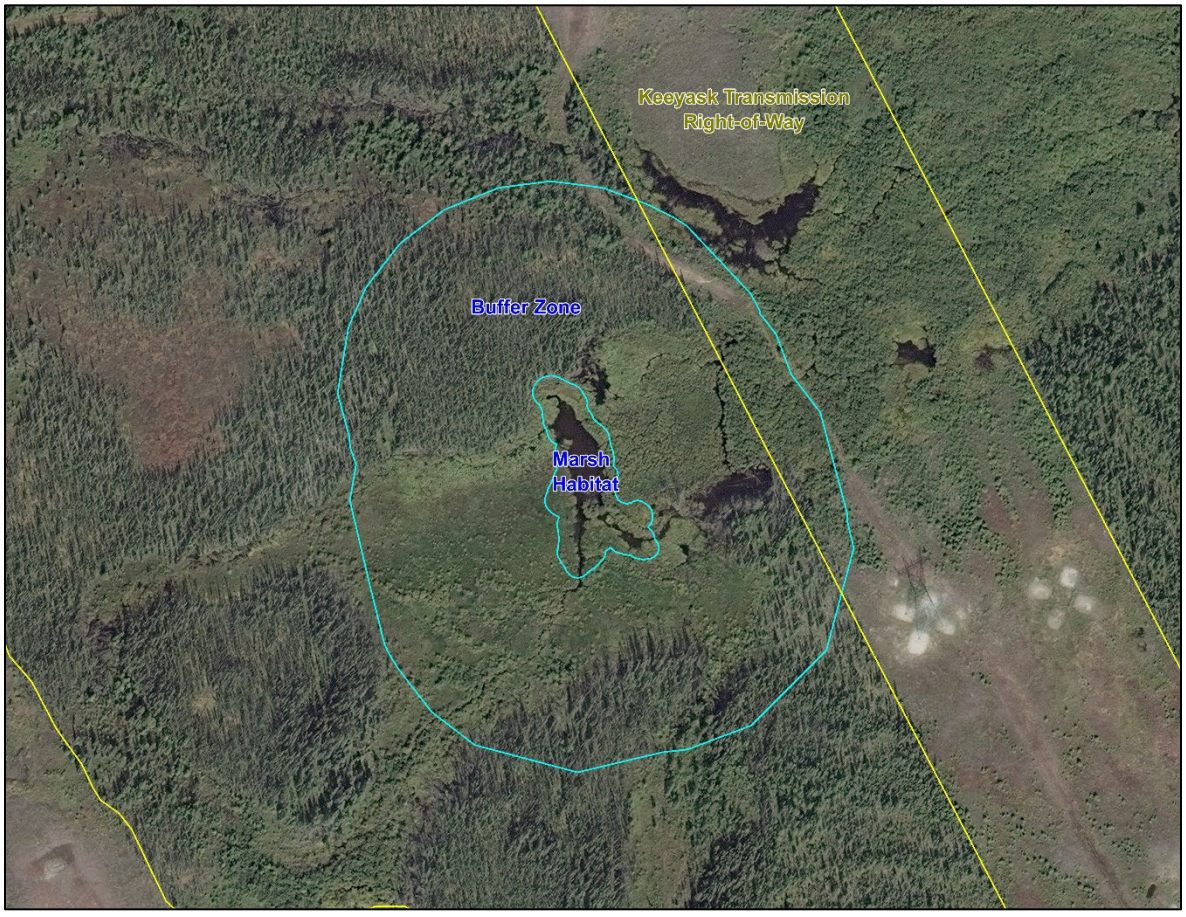


Figure 3-15: Satellite imagery showing Keeyask Transmission Project clearing (in yellow) in the Wetland 53 (in blue) buffer zone

Photo 3-12: Aerial photo of Wetland 53 on September 12, 2021

3.12 WETLAND 54

Wetland 54 (Photo 3-13) is 113.1 ha in size, and located along the north side of the SAR, north of Borrow Area S-2b (Map 2-3). Marsh habitat comprised 70.1 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

Surveys in 2015 and 2016 found clearing and disturbance in the marsh habitat buffer, but this was for the Keeyask Transmission Project RoW (Figure 3-16). Ground surveys in 2016 and 2017, and aerial surveys from 2018 to 2020 found no expansion of the impacts recorded in 2015 and 2016. 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. Specific observations regarding the impacts observed in 2015 and 2016 are provided in ECOSTEM (2018).

Photo 3-13: Aerial view of Wetland 54 (western end) on September 12, 2021

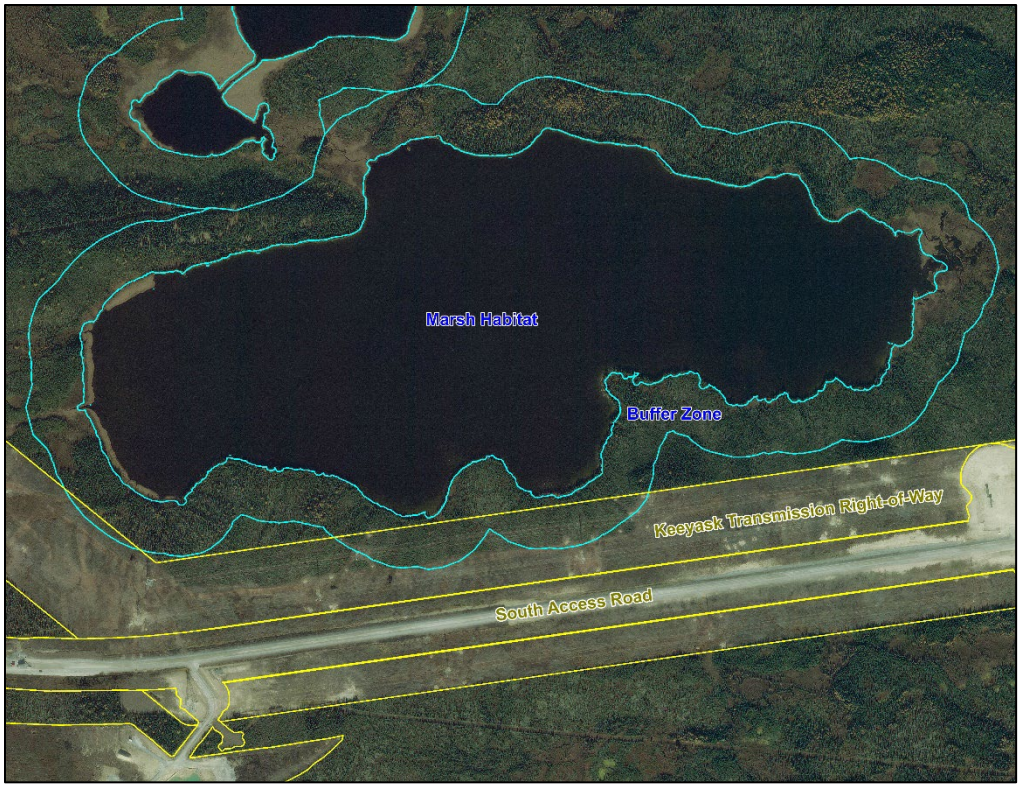


Figure 3-16: Satellite imagery showing Keeyask Transmission Project clearing (in yellow) in the Wetland 54 (in blue) buffer zone

3.13 WETLAND 57

Wetland 57 is 64.6 ha in size and nestled between the Butnau Road and Stephens Lake. Its buffer overlaps the road to the south and a dike to the north (Map 2-3). 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 SAR construction had cleared 0.21 ha in the southern edge of the buffer, and all of this was within the planned Project footprint (Figure 3-17). 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.

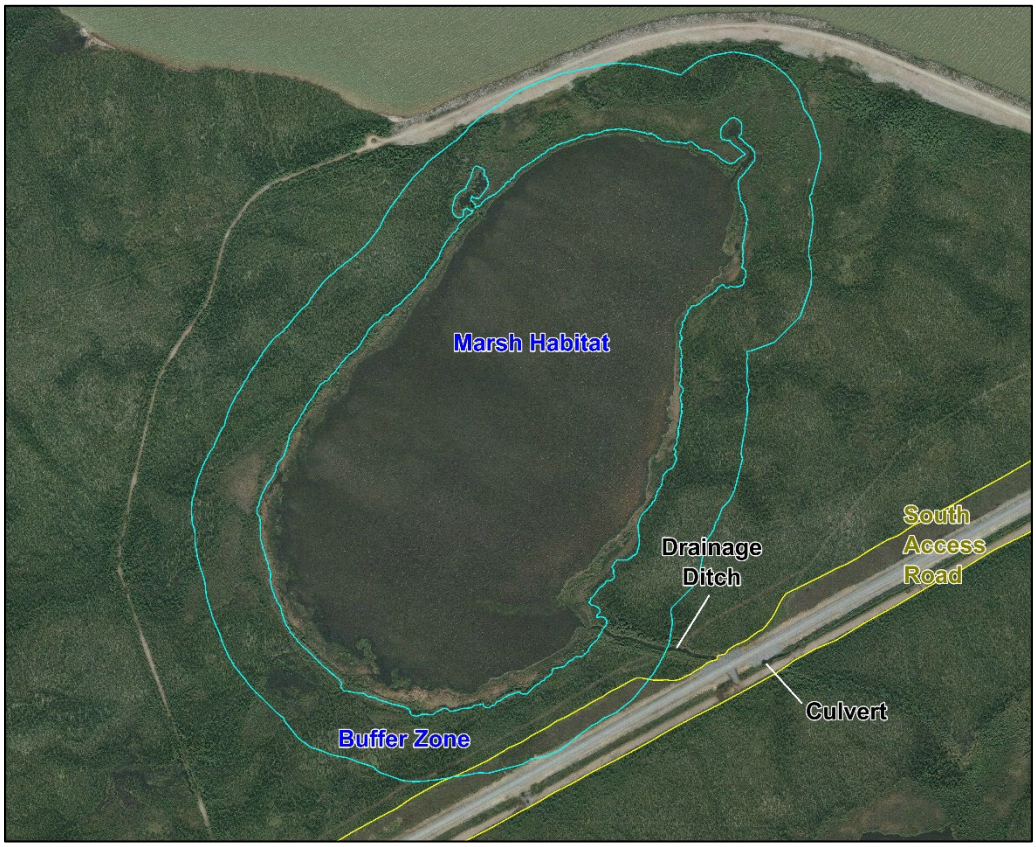
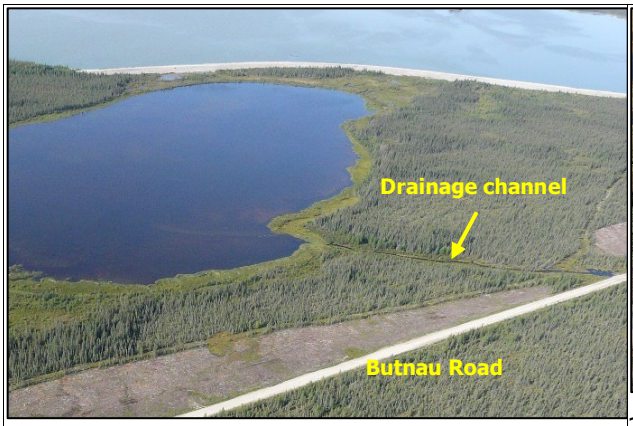


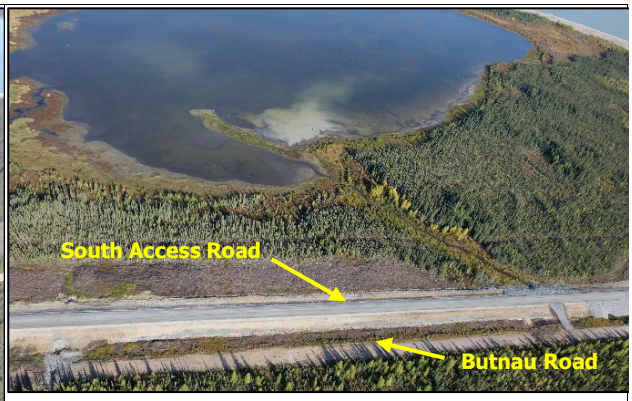
Figure 3-17: Satellite imagery showing South Access Road clearing (in yellow) in the Wetland 57 (in blue) buffer zone

Surveys from 2017 to 2021 found no additional clearing or disturbance in the marsh habitat buffer or marsh habitat.

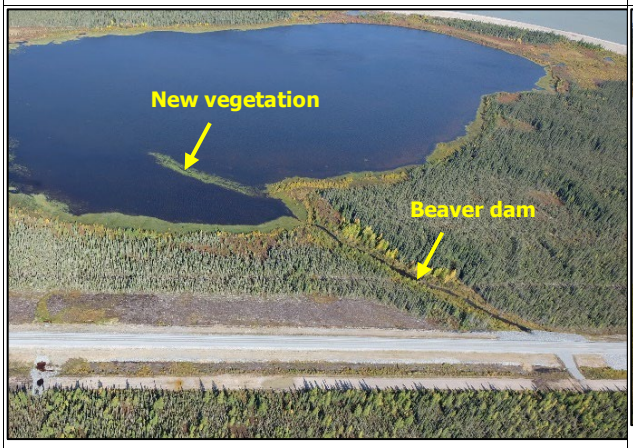
At the time of the 2016 and 2017 surveys, the water levels in the Wetland 57 waterbody were very low compared to those observed in 2015 (Figure 3-18). This wetland drains through a natural channel into a ditch along the SAR (Figure 3-18).



2015



2017 (and 2016)



2018

2019

2020

2021

Figure 3-18: Aerial view of Wetland 57 showing varying water levels from 2015 to 2021

At the time of the 2018 surveys, water levels increased to levels similar to those observed in 2015, while in 2019 they were slightly lower than observed in 2018. At the time of the 2019 surveys, the beaver dam had been breached and water was flowing freely from the wetland towards the SAR.

Water levels in 2020 were slightly lower than in 2019 (Photo 3-14) and the beaver dam within the drainage channel had not been rebuilt. Surveys in 2021 found that water levels were still lower than the median and although the beaver dam had been rebuilt, it had recently been broken up by local hunters. A full ground survey of the main body of the wetland was not done in 2021 as hunters were actively using the area at the time.

An expansion of shore zone wetland vegetation was observed during the 2017 monitoring. New vegetation was establishing on the lake bottom exposed by low water levels, and in the shallow water. The extent of shore zone vegetation has remained approximately the same or perhaps increased from 2018 to 2021.

Photo 3-14: Marsh habitat upstream of beaver dam in Wetland 57 on September 10, 2020

3.14 WETLAND 60

Wetland 60 is 232.4 ha in size. It is located approximately 6.6 km south of Stephens Lake, just west of the access road corridor for the Ellis Esker borrow area (E-1) (Figure 3-19; Map 2-3). Marsh habitat comprised 150 ha of the wetland's total area. None of the marsh habitat buffer burned in the 2013 wildfire.

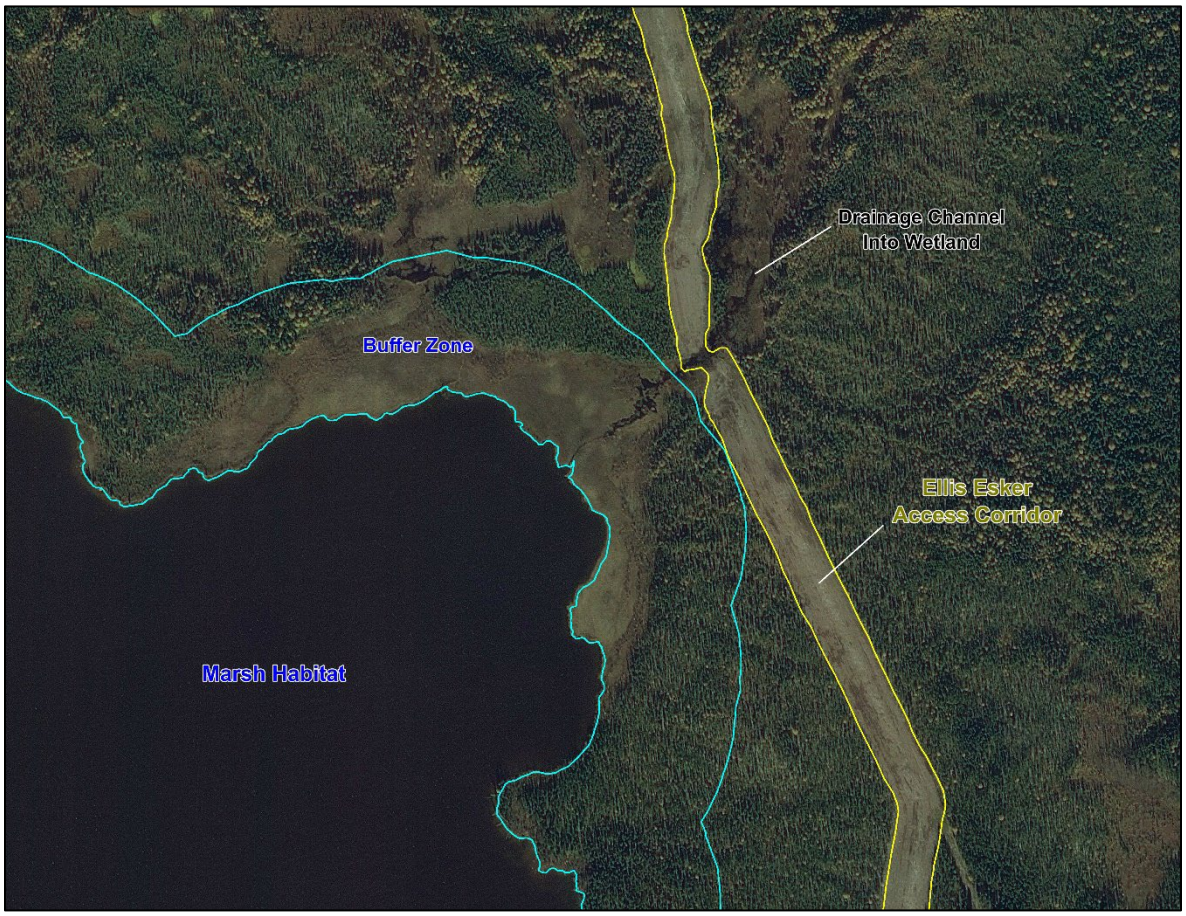


Figure 3-19: Satellite imagery showing proximity of Project clearing (in yellow) to Wetland 60 (in blue)

Wetland 60 was monitored for the first time in 2018. The wetland is situated well outside of Study Zone 3 because this study zone was a buffer of the planned and possibly disturbed areas at the time the EIS was completed. At that time, it was thought the use of the Ellis Esker borrow area was highly unlikely (even so, its potential effects were assessed in the EIS).

Surveys from 2018 to 2021 did not find any apparent effects of Project clearing on the marsh vegetation or hydrology (Photo 3-15).

Photo 3-15: Ground view of marsh habitat (background), marsh buffer (center) and drainage channel (foreground) at Wetland 60 on September 12, 2021

In terms of other potential Project impacts, a natural drainage channel into the wetland ran through the clearing (Figure 3-20). There is a possibility that the vegetation clearing, past construction activity or future revegetation activity could alter water flow into the wetland through localized changes to the moisture regime or soil compaction. Although surveys in 2020 and 2021 found that the access road corridor was being actively used by ATVs, the channel itself did not appear to be substantially disturbed and the adjacent vegetation appeared to be unaffected (Figure 3-20). This may have been due to the fact that the ATVs appeared to only be using one path in the center of the right-of-way. If usage continues, there is the potential for alternate paths through the channel to be made, creating a disturbance outside of previously cleared bounds.

Surveys in 2022 will monitor for any adverse effects in this area and within the wetland habitat.

Ellis Esker access road and channel to wetland in 2019

Ellis Esker access road and channel to wetland in 2020

Ellis Esker access road and channel to wetland in 2021

Figure 3-20: Aerial views of the Wetland 60 channel from 2019 to 2021

3.15 REMAINING WETLANDS

Figure 3-21 shows the state of two of the remaining 28 wetlands visited during the aerial surveys. These wetlands were not closely surveyed because they were more than 100 m from existing Project clearing or disturbance, and there were no visible Project effects in them.

Wetland 34

Wetland 49

Figure 3-21: Aerial photos of Wetlands 34 and 49 on September 12, 2021

4.0 DISCUSSION

4.1 WATER LEVELS IN OFF-SYSTEM WATERBODIES

Water levels and water level variability in the off-system waterbodies are the primary determinants of the distribution and abundance of off-system marsh and its habitat. In the Project area, the two predominant potential drivers for changes to water levels were precipitation and Project-related effects on hydrology.

Total precipitation over the preceding months and years has a major influence on water level variations in waterbodies. The pathways and nature of precipitation effects can be quite complex as they are also controlled by subsurface topography, surficial material stratigraphy and ground ice in broad areas dominated by peatlands, such as Study Zone 4. ECOSTEM (2013) provides an overview of key pathways and processes for the Project region.

Based on water level indicators (Section 2.6), water levels at the time of the monitoring surveys appeared to be relatively low in 2016 and 2017, and then around median levels from 2018 to 2020. Levels appeared to be below median again in 2021.

Initial attempts to relate the annual differences in water levels to precipitation were unsuccessful due to serious limitations to the available weather data. For example, the closest weather station, which is at Gillam, is missing total precipitation data for 48% of the days in 2015 (including entire consecutive summer months) and 18% of the days in 2016. A similar, but less pronounced, situation was the case for the next closest weather station, which is at the Kelsey generating station site.

The widespread distribution of relatively low water levels in off-system waterbodies in September 2016, 2017 and 2021, including those that were far from the Project footprint, suggested they were likely due to natural factors (i.e., precipitation) rather than related to Project development. The construction synthesis report will explore possible approaches to developing precipitation data for the Project area (e.g., estimating missing data or using a more distant weather station) as this report is produced when all relevant data will be available.

4.2 WETLAND IMPACTS AND MITIGATION

This section focuses on wetlands where new or ongoing Project impacts were found during the 2021 monitoring, and on wetlands with potential future impacts that merit mitigation or a particular focus during ongoing monitoring. Appendix 1 summarizes the mitigation recommendations provided to date for all wetlands.

There is a possibility that construction may have altered water flows and water levels at Wetlands 47 and 57. Over time, altered water flows and levels may change the amounts of marsh and its

habitat in these wetlands. Both wetlands will continue to be monitored for changes to marsh habitat.

The year-to-year pattern of water levels at Wetland 57 was different from the overall pattern across all of the monitored wetlands (Section 4.1). Construction of the SAR was a possible cause for the low water levels observed in Wetland 57 in 2016 and 2017. As this wetland drains through a channel into a ditch along the SAR (Figure 3-18), it is possible that the SAR ditch increased drainage from the lake. The higher water levels in Wetland 57 in 2018 were attributed to a beaver dam that was constructed in the drainage channel between 2018 and 2019. Although in 2019, the beaver dam had been breached and water was flowing freely from the wetland towards the SAR, the dam showed signs of being rebuilt and successively torn down in 2021. Other notable potential contributors to the inter-annual water level variations included variations in precipitation and variations in groundwater flow under the dike that prevents Stephens Lake from inundating the areas surrounding this wetland. The construction synthesis report will evaluate whether, and to what degree, the water level changes were related to the Project, using all relevant data available.

Surface water drainage flowing from the Main Camp had the potential to transport sediment or nutrient-enriched water into Wetland 51. Surveys in 2022 will monitor for these potential impacts, and also the effectiveness of mitigation recommended by other monitoring (ECOSTEM 2022).

At Wetland 51, sediment continued to run off the west slopes of the nearby EMPA (D16) into the wetland buffer zone. Despite the implementation of several mitigation measures from 2016 to 2020 (see Appendix 1 for details), the sediment deposition was still occurring in 2021. It is recommended that sediment containment structures be reinforced or repaired to prevent further sediment deposition into the wetland buffer. It is also recommended that revegetation of EMPA D16 slopes adjacent to the wetland be set as a high priority area for rehabilitation. Slope revegetation would stabilize the soil, and should reduce sediment transport.

Wetland 60 had not been impacted by use of the Ellis Esker corridor by the time of the survey in 2021.

New project disturbance or clearing was not observed at the remaining 11 wetlands that were within 100 m of actual Project clearing or disturbance at the time of the 2020 surveys. However, potential future impacts that merit a particular focus during future monitoring were noted for wetlands 47, 51, 57 and 60.

While ground surveys at Wetlands 37, 40, 42 and 45 were discontinued in 2019, future aerial surveys may detect impacts that merit subsequent ground surveys.

5.0 COMPARISON WITH PREDICTED EFFECTS

5.1 PREDICTED EFFECTS

The *Keeyask Generation Project Response to EIS Guidelines* (EIS; KHLP 2012b) included predictions as to how the Project was expected to affect wetlands and wetland function. The EIS predicted that Project construction would:

1. Create a temporary loss of most of the Nelson River shoreline wetlands in the Local Study Area;
2. Create no net area loss for off-system marsh;
3. Have no effects on five wetland types; and,
4. For the remaining wetland types, remove or alter between 0.2% and 1.3% of estimated historical area, depending on the wetland type.

The EIS also indicated that the effect of Project construction on Nelson River (on-system) shoreline wetlands was uncertain. Prolonged high-water levels prior to the submission of the EIS had apparently removed all shoreline wetlands in the Local Study Area. It was thought that if water levels tended to remain above historical median levels, then construction effects on Nelson River shoreline wetlands may be negligible. Additionally, even though possible on-system wetland area would still be affected during construction, this could be offset by wetland development along the reservoir shoreline during operation.

It was the case that water levels during construction were generally at or above historical median levels (Manitoba Hydro 2017, 2018, 2019, 2020, 2021). For this reason, and because there was no plan to map pre-impoundment reservoir wetlands, results in this Section 5.0 exclude wetlands on the regulated system.

Taking a cautious approach (i.e., using the higher end of the anticipated range of adverse effects), the EIS predicted that the Project could affect up to 5,780 ha of the off-system vegetated wetland area in the Construction Footprint as it was known at the time, or up to 5,826 ha if the Ellis Esker borrow area (Borrow Area E-1) was also used. These were overestimates for inland wetland habitat loss in the Construction Footprint because it was expected that portions of the Project footprint would not be used, and because measures to minimize clearing and disturbance outside of the footprint components would be employed.

A moderately low level of uncertainty was associated with these predictions because: (i) existing wetlands were mapped with relatively high accuracy; and, (ii) the spatial extent of Project-related physical wetland loss as a percentage of the Regional Study Area could be predicted with relatively high accuracy.

5.2 MITIGATION

The EIS predictions were based on the following mitigation measures being implemented during the construction period:

1. Measures to protect against erosion, siltation and hydrological alteration will be implemented in utilized construction areas that are within 50 m of any off-system marsh that is outside of the Project Footprint; and,
2. 12 ha of the off-system marsh wetland type will be developed within or near the Local Study Area.

As documented in Section 3.1, measures to protect against erosion, siltation and hydrological alteration (mitigation item 1) were predominantly implemented as prescribed, and were highly effective. As of September, 2021, Project clearing or disturbance had only affected 0.5% of off-system marsh wetlands. The vast majority (97%) of these impacts were in the marsh habitat buffer, and not in marsh habitat. The 0.1 ha of impacts in marsh habitat were confined to a single wetland where it was necessary to clear trees that would be within future reservoir flooding.

Development of the 12 ha off-system marsh (mitigation item 2) has been delayed as the proposed work is still under review in the Project's Fisheries Act Authorization amendment process. As of the date of this report, it is still expected that there will be no net area loss for off-system marsh.

5.3 ACTUAL RESIDUAL EFFECTS

The focus of monitoring for the entire construction phase was direct effects on wetlands and wetland function. These effects were evaluated by enhancing the wetland map for Study Zone 4 to identify which wetlands areas were within the actual Project footprint during construction (i.e., the Construction Footprint). The resulting map was then used to locate and quantify actual direct Project effects on wetlands and wetland function, which were then compared with the EIS predictions.

ECOSTEM (2022) provides the Construction Footprint and the methods used to produce it. In brief, the Construction Footprint includes all Project clearing and physical disturbance that occurred up to September, 2021.

Monitoring has shown that direct Project effects on wetlands and wetland function during the construction phase were consistent with the EIS predictions. As expected, actual residual Project effects on the various off-system wetland types during construction were much lower than predicted. The Construction Footprint included approximately 4,609 ha of vegetated wetland area, which was 21% (1,217 ha) less than assumed for the EIS predictions. Direct effects on all wetland types were lower than assumed for the EIS predictions with one exception for which there was no difference (Table 5-1). In descending order, the largest area differences between predicted and actual direct effects were for Strongly sloped Veneer Bog and Blanket Bog wetland types.

Table 5-1. Predicted and actual area (ha) of vegetated wetlands in the Construction Footprint

Wetland Type	EIS Predicted	Actual	Difference
Strongly sloped Veneer Bog	2,801.5	2,061.2	-740.3
Blanket Bog	1,437.5	1,184.4	-253.1
Peat plateau/CS mixture Bog	625.2	533.6	-91.7
Peat plateau Bog	357.8	306.1	-51.7
Shore and floating Riparian Fen	208.6	180.7	-27.9
Veneer Bog	107.9	86.1	-21.8
Horizontal Fen	149.1	138.3	-10.8
Slope Bog	28.7	18.5	-10.1
Bay Lacustrine Marsh	6.4	2.3	-4.2
Flat Bog	47.0	44.2	-2.8
Collapse scar Fen	9.3	8.0	-1.3
Slope Fen	11.6	10.7	-0.9
Collapse scar (CS) Bog	22.5	22.0	-0.5
Shore and floating Riparian Bog	10.8	10.5	-0.3
Stream Riparian Marsh	2.0	2.0	0.0
All	5,826.0	4,608.7	-1,217.3

Wetland quality is the indicator used to quantify effects on wetland function. Section 2.8.2.4.2 of the TE SV describes how wetland quality classes were assigned (KHLP 2012b). The area directly affected during construction was lower for every one of the wetland quality classes. The reduction in direct Project effects on wetland function during construction were predominantly concentrated in the lowest quality wetlands, which were also the most common types. In descending order, the largest area differences between predicted and actual construction effects were for the 11 to 20 and 21 to 30 wetland quality classes (Table 5-2).

Table 5-2. Predicted and actual area (ha) of construction phase effects on wetlands by wetland quality class

Wetland Quality Class	EIS Predicted	Actual	Difference
20	4,239.0	3,245.6	-993.4
30	1,189.0	1,010.5	-178.5
50	217.9	188.7	-29.2
40	171.6	159.5	-12.1
60	8.5	4.3	-4.2
All	5,826.0	4,608.7	-1,217.3

6.0 SUMMARY AND CONCLUSIONS

The Wetland Loss and Disturbance study monitored the implementation and effectiveness of off-system marsh protection measures each year during Project construction, and evaluated construction phase effects on wetlands and wetland function.

As has been the case since 2017, the 2021 monitoring found that there has been no new Project clearing in any of the 44 monitored wetlands.

As of 2021, Project clearing or disturbance within the monitored wetlands totalled 4.2 ha. Clearing accounted for the vast majority (99.5%) of this total. All of the recorded clearing or disturbance was at seven of the 44 wetlands being monitored.

Of the 4.2 ha of total Project clearing or disturbance, 0.1 ha (2.5% of the impacted area) was in marsh habitat, and this area was all at one wetland within the future reservoir area. The remaining 4.1 ha of impacts were within the marsh habitat buffers of seven of the wetlands.

All of the Project clearing or disturbance was within the licensed Project footprint, including 3.91 ha (93%) in the planned Project footprint, and 0.29 ha in the possibly disturbed Project footprint.

Monitoring in 2021 found ongoing disturbance in one wetland. In Wetland 51, previously recorded sediment deposition from EMPA D16 into standing water adjacent to the marsh habitat buffer was continuing, and was spreading into the wetland buffer zone.

Potential future Project impacts were identified for four of the monitored wetlands. At Wetland 47 and 57, construction may have altered water flows into the wetland, affecting water levels. New ATV usage adjacent to Wetland 60 (not related to the Project) may have potential to affect this wetland in the future. Water flow from a culvert at the northwest corner of the Main Camp has the potential to reach a small stream that flows into Wetland 51.

To date, there have been no unexpected effects on the off-system marsh wetlands being monitored by this study. While there has been some clearing or disturbance within seven of the monitored wetlands, these impacts were expected as the wetlands overlapped the licensed Project footprint.

This report includes mitigation recommendations to avoid or minimize potential future Project effects on the monitored wetlands.

Monitoring has shown that the EIS predictions for construction phase effects on wetlands and the indicators for wetland functions were consistent with what was observed, and were cautious. As expected, actual residual Project effects on the various off-system wetland types during construction were much lower (21%) than predicted. Additionally, effects on all but one of these wetland types were lower than assumed for the EIS predictions (the exception had no difference). The magnitude of actual construction effects on all of the wetland function indicators was lower than predicted.

Monitoring fieldwork for the off-system marsh wetlands will continue in 2022. No major changes to field methods are anticipated.

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APPENDIX 1:
MITIGATION RECOMMENDATIONS

This appendix collates and summarizes the off-system marsh wetland mitigation recommendations made during the TEMP construction monitoring (2015 to 2021).

Table 7-1: Summary of Mitigation Recommendations

Wetland	Recommendation[1]	Mitigation or Follow-up Implemented
Wetland 37	2015: Evaluate and implement sediment control measures where needed to prevent sediment from entering the site along the north dike. 2016, 2017 and 2018: Limit further clearing along northeastern edge of EMPA (D3-E) that overlaps buffer. Monitor for potential effects from slope runoff. 2019, 2020 and 2021: The potential for runoff from EMPA is declining. Monitor only if new construction activity or disturbance occurs nearby.	No additional clearing has occurred along the northeastern edge of the EMPA. No mitigation recommended. In 2022, ground survey only if air surveys detect new construction activity or disturbance.
Wetland 40	2015: Add sediment fence between the north dike clearing and marsh at the base of the dike. Evaluate and implement sediment control measures where needed. 2016, 2017 and 2018: Evaluate and implement sediment control measures such as sediment fence where needed. Avoid northward extension of the existing dike clearing, if possible. 2019, 2020 and 2021: The potential for runoff from the dike is declining. Monitor only if new construction activity or disturbance occurs nearby.	No additional northward clearing has occurred near the wetland buffer. No mitigation recommended. In 2022, ground survey only if air surveys detect new construction activity or disturbance.
Wetland 42	2017 and 2018: Monitor intact vegetation between Borrow Area G-1 and wetland for any erosion or surface runoff from the slope into the marsh. 2019, 2020 and 2021: The potential for runoff from the borrow area is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. In 2022, ground survey only if air surveys detect new construction activity or disturbance.
Wetland 45	2015: Sediment fence be added between the north dike clearing and marsh at the base of the slope. Evaluate and implement sediment control measures where needed. 2016, 2017 and 2018: Evaluate and implement sediment control measures such as sediment fence where needed. Avoid northward extension of the existing clearing, if possible. 2019, 2020 and 2021: The potential for runoff from the dike is declining. Monitor only if new construction activity or disturbance occurs nearby.	No additional northward clearing has occurred near the wetland buffer. Between 2017 and 2018, sediment fencing was installed at the base of the dike bank adjacent to the wetland. Mitigation no longer recommended. In 2022, ground survey only if air surveys detect new construction activity or disturbance.

Wetland	Recommendation[1]	Mitigation or Follow-up Implemented
Wetland 47	2016 and 2017: Avoid a southeastern extension of the existing south dike clearing, if possible. 2017 and 2018: Monitor the drainage channels passing through the clearing into the wetland during south dike construction. 2019, 2020 and 2021: Monitor water levels in wetland and for potential effects from altered water flows.	No additional southward clearing has occurred near the wetland buffer. No additional mitigation recommended at this time.
Wetland 51	2015: Inspect and enhance sediment control measures along the northern edges of the EMPA (D16). Erect a sediment fence around the north and northwest side of the EMPA. 2016 and 2017: Sediment 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. 2018 and 2019: Consider additional sediment control measures along the northwestern banks of the EMPA to prevent continued sediment deposition into wetland. 2020 and 2021: Reinforce or repair sediment containment structures to prevent further sediment deposition into the wetland buffer. Revegetate EMPA D16 slopes adjacent to the wetland to stabilize soil. See Figure 3-12 2020 and 2021: Potential for disturbances from drainage at Main Camp to reach wetland. Monitor for adverse effects from Main Camp area reaching wetland. See Figure 3-13.	In fall 2017, material in EMPA D16 was re-sloped and additional sediment fencing was installed. Between 2017 and 2018, additional sediment fencing was installed at the base of the slope adjacent to the wetland. Rock barriers and woody debris armouring placed around northern and eastern edges of EMPA D16 in spring, 2018. Sediment fences on western edge of EMPA D16 removed and straw wattles placed into erosion channels in April 2019. Rock barriers extended along western edge of EMPA D16 in 2020. Secondary drainage channel with rock-lined drainage turnouts installed parallel to rock barrier, upslope, in 2021. Gap left in rock barrier at wetland edge.
Wetland 52	2016, 2017, 2018, 2019, 2020 and 2021: Monitor water levels and condition of marsh outlet for runoff effects from SAR.	No mitigation recommended at this time.
Wetland 57	2016: Investigate possible causes for low water levels during 2017 surveys. 2019, 2020 and 2021: Continue to monitor for water level changes and wetland development.	Field surveys in 2018 suggested that the low water levels may have been one of, or a combination of, natural water level variability and altered drainage due to construction of the SAR. A beaver dam increased water levels in the wetland in 2018. Breaching of the beaver dam in 2019 (not Project

Wetland	Recommendation[1]	Mitigation or Follow-up Implemented
		related) lowered water levels slightly since 2018.
Wetland 60	2018 and 2019: Monitor wetland for runoff effects from the Ellis Esker access corridor. Avoid additional clearing or disturbance near this wetland. 2020 and 2021: Potential for disturbance in wetland from adjacent local ATV use (not Project related). See Figure 7-1. Monitor for adverse effects to wetland habitat.	No mitigation recommended at this time.

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; 2017; 2018; 2019; 2020) for the 2015, 2016, 2017, 2018 and 2019 recommendations, respectively.

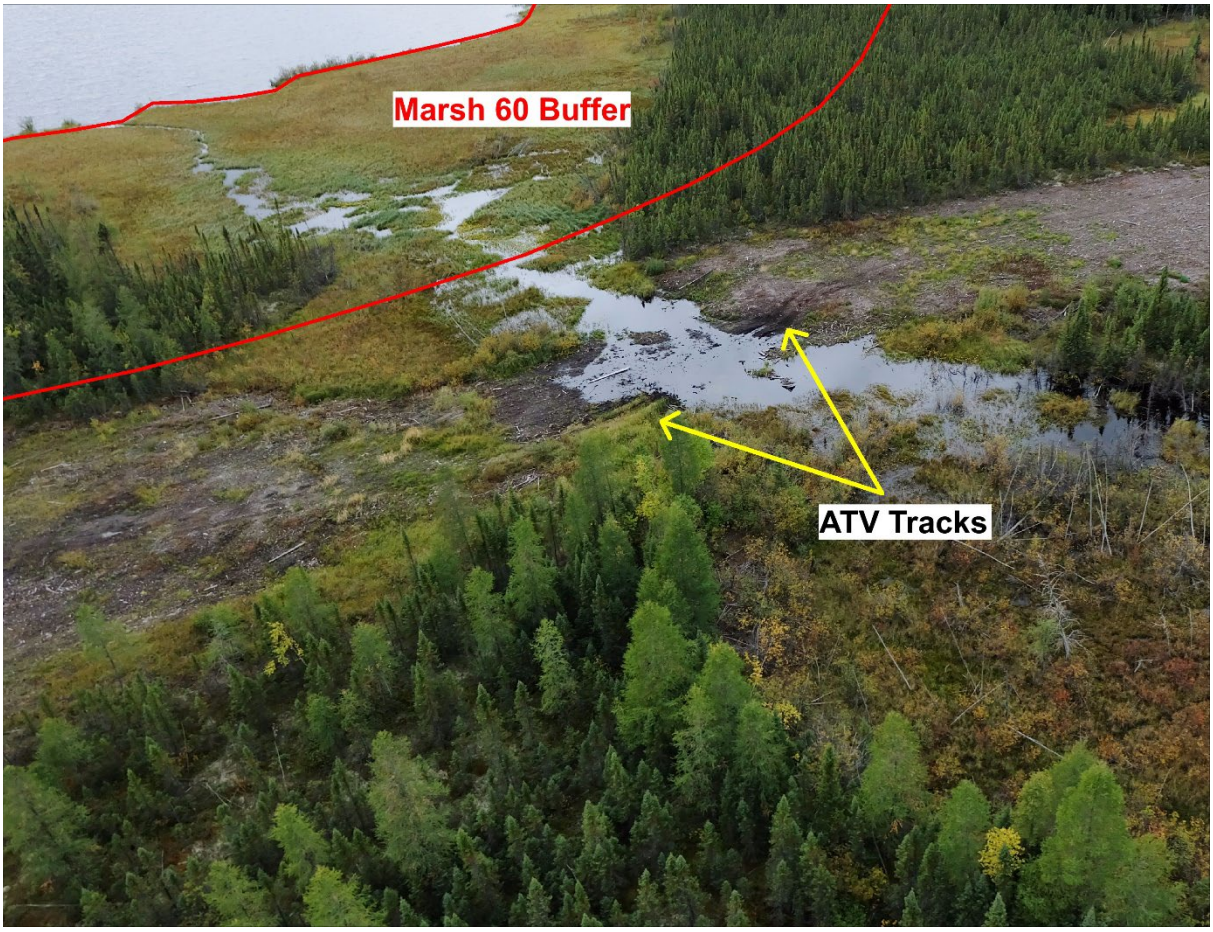

Figure 7-1: Evidence of ATV use (not Project related) in Ellis Esker access corridor near Wetland 60 in September, 2021