Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Wetland Loss and Disturbance Monitoring Report

TEMP-2023-04

KEEYASK

Manitoba Environment and Climate Client File 5550.00
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2022 - 2023

KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2023-04

WETLAND LOSS AND DISTURBANCE MONITORING
YEAR 1 OPERATION
2022

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 vast majority of construction activities had been completed by fall 2021 and all generating units were in service by March 2022.

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 in 2022, the first summer of operation monitoring for the terrestrial monitoring studies.

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 away from 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 2022

Why is the study being done?

It is not possible for the Project to avoid all wetlands in the area given its size and that wetlands (mostly peatlands) cover most of the Keeyask region. Therefore, mitigation to help reduce Project effects includes avoiding off-system marsh wetlands as much as possible and replacing 12 ha of off-system marsh wetland.

The wetland loss and disturbance monitoring documents Project impacts on, and mitigation related to, the very important off-system marsh wetland type. It also evaluated direct Project effects on wetland function during construction. This monitoring confirms that the Project effects predictions are accurate, and that no additional unexpected impacts are occurring.

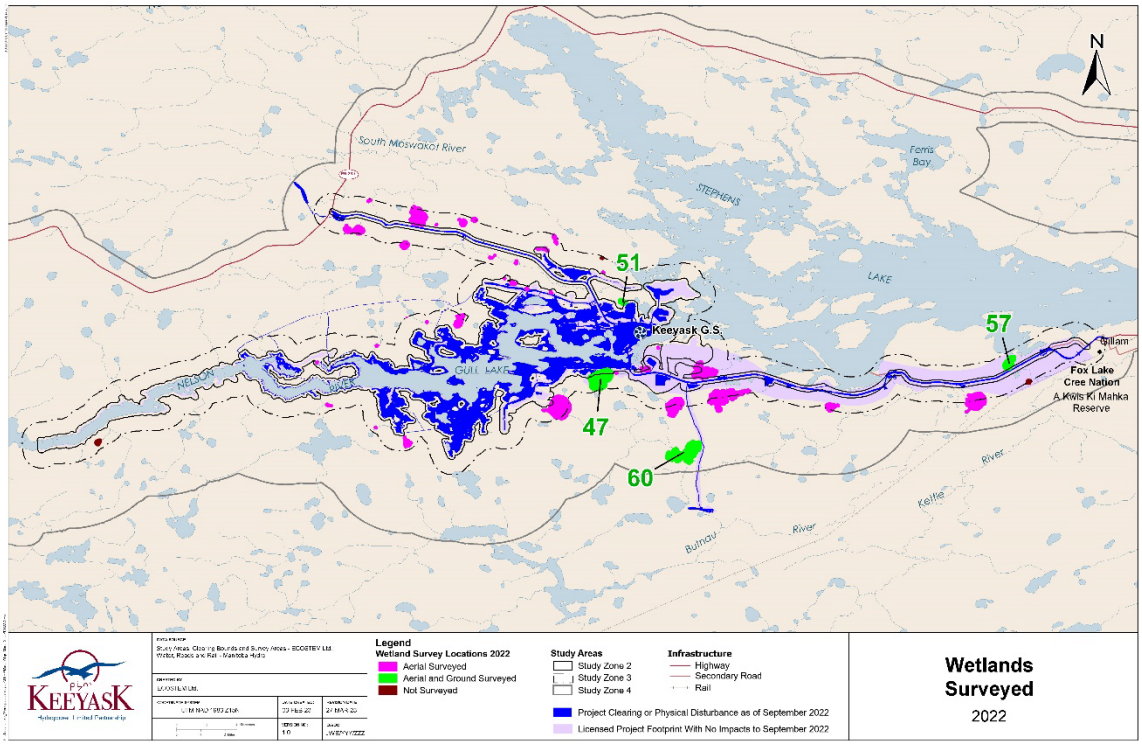
What was done?

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 next to a waterbody is important for the off-system marsh and its habitat because impacts within this area can lead to adverse changes in the marsh habitat (e.g., sediment deposition, altering flows that maintain water levels). For these reasons, each monitored wetland includes the entire waterbody, plus a 100 m buffer of the waterbody.

A total of 45 off-system marsh wetlands are being monitored by this study. Aerial and ground surveys are done at wetlands that are close to the Project construction areas.

In 2022, 42 wetlands were surveyed from a helicopter (see map below), and four of these wetlands were also surveyed on the ground.

Project effects on wetland function are periodically evaluated using results from several monitoring studies. The first such evaluation was done at the end of the construction phase.



What was found?

Monitoring found that a very small area of sediment deposition at one marsh wetland had been lessened by nearby earthwork.

Water levels in Wetland 57 were higher than recorded during previous surveys, and relatively higher than changes in other wetlands. It was unclear if this was due to the Project or to other factors (e.g., a beaver dam, Stephens Lake water levels).

A wildfire in summer 2022 burned a portion of one marsh wetland buffer that was more than 100 m from the Construction Footprint.

The 2022 monitoring results showed that existing Project impacts had the potential to indirectly alter three marsh wetlands. For one of these wetlands, altered water flows outside of the wetland buffer could potentially change the amount of marsh and its habitat. At another wetland, ATV use nearby had the potential to disturb wetland habitat. At the remaining wetland, water drainage from the Main Camp could potentially change wetland habitat.

What does it mean?

To date, there have been no unexpected Project impacts on the off-system marsh wetlands being monitored by this study. Total impacts remain substantially lower than assumed for the Project's environmental assessment.

What will be done next?

Based on the schedule in the TEMP, this was the last year of monitoring for the Wetland Loss and Disturbance study. Given that there have been no unexpected effects, monitoring for this study is now complete.

ACKNOWLEDGEMENTS

ECOSTEM Ltd. would like to thank Rachel Boone, Sherrie Mason and the on-site Manitoba Hydro staff, including Martial Lemoine, James Teskey and Jodi Ross 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 Claire Brueckner for coordinating the logistics.

STUDY TEAM

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

Fieldwork in 2022 was conducted by Alex Snitowski.

Data analysis and report writing in 2022 were completed by Alex Snitowski, with assistance from 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 the former 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 and the vast majority of construction activities were completed by fall 2021. The reservoir was first brought to full supply level in September 2020 and 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. The 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 the 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 based on wetland quality scores.

Monitoring for this study has been conducted in each year from 2015 to 2022. Previous ECOSTEM reports (ECOSTEM 2016, 2017, 2018, 2019, 2020, 2021 and 2022b) provide the findings regarding the implementation and effectiveness of off-system marsh protection measures from 2015 to 2021.

As set out in the TEMP (Section 2.1.2.3.3), the *Keeyask Generation Project Terrestrial Footprint Map for Construction* (i.e., the Construction Footprint) was mapped within one year of construction phase completion. ECOSTEM (2022a) provides the Construction Footprint, which was mapped based on Project impacts as of September, 2022. The 2021 monitoring report (ECOSTEM 2022b) also details how the Project progressively affected off-system marsh during construction.

This report presents the monitoring conducted in 2022 for the Wetland Loss and Disturbance study. The results from the first year of monitoring for the Long-term Effects on Wetlands study are presented in a separate report (ECOSTEM 2023).

The Wetland Loss and Disturbance monitoring conducted in 2022 addresses the first study objective. This monitoring focused on changes that occurred between September 2021 and 2022 (i.e., the date of the Construction Footprint).

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, and periodic surveys during operation.

Mapping and analysis to evaluate direct Project effects on wetland function during construction (i.e., the second study objective) was completed at the end of the construction phase using the Construction Footprint (ECOSTEM 2022a).

Section 2.5.2 of the TEMP details the methods for the Wetland Loss and Disturbance study. The same monitoring methods were used as in previous years (ECOSTEM 2022b). The following summarizes the activities conducted in 2022.

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 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 emergent 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.

Detailed off-system marsh mapping had been completed for Study Zone 4 (Map 2-1). This mapping was used to select the patches of off-system marsh and its habitat that were included in this monitoring. ECOSTEM 2022b details how these patches were selected.

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.

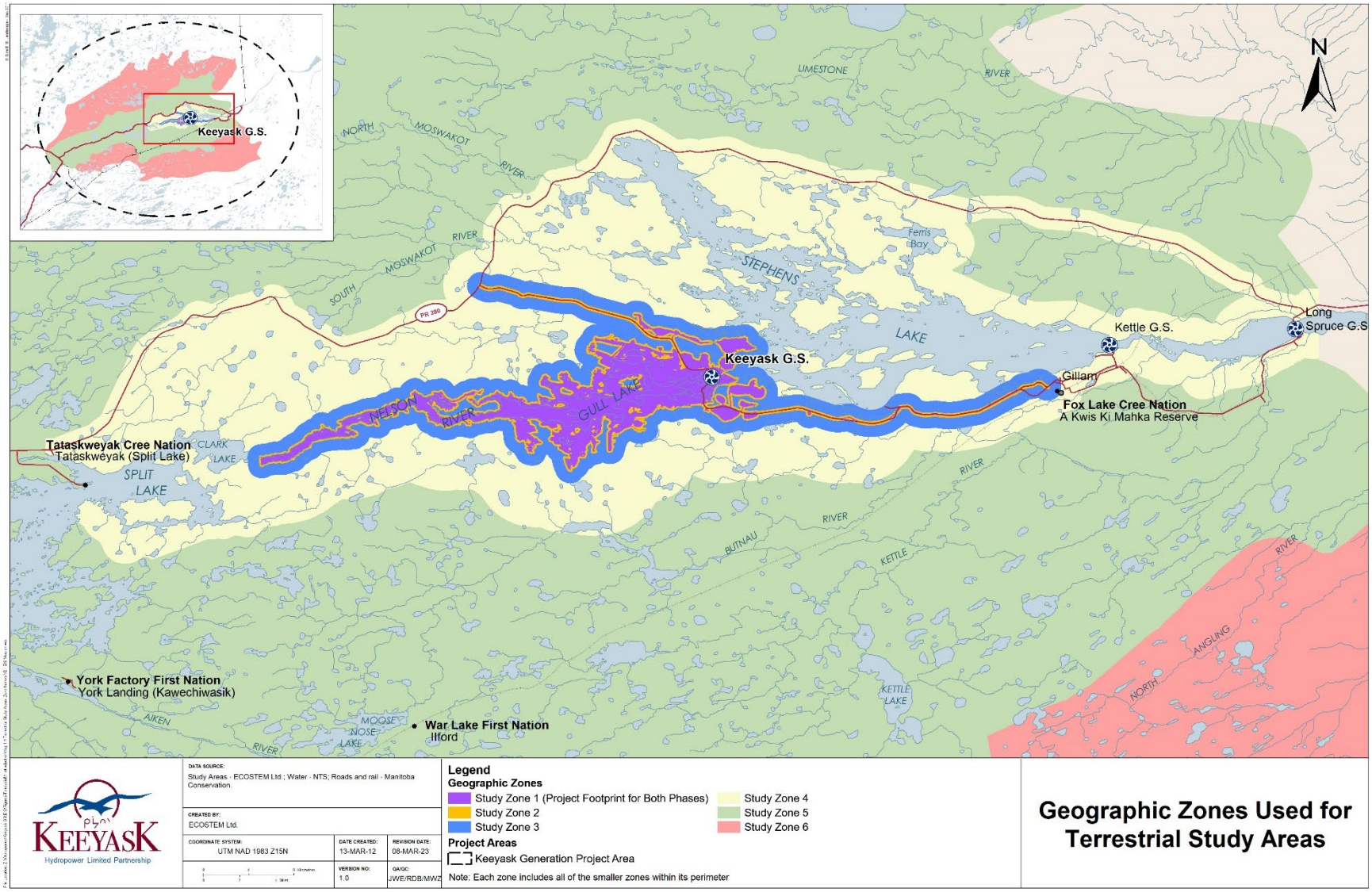
Prior to describing the monitoring activities, some terminology is introduced to assist the reader. The following definitions are used in all of the terrestrial habitat, ecosystems and plant monitoring studies.

“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).



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

2.2 PROJECT AREAS

Four distinct Project areas (Map 2-2) are used when reporting on where Project clearing or disturbance occurred. This is being done to facilitate comparisons with EIS predictions. See ECOSTEM 2022b for a detailed description of what is included in each Project area.

The first two Project areas are a subdivision of the Footprint licensed for Project use under the Project's *Environment Act* Licence (i.e., licensed Project Footprint) into: the planned Project Footprint; and, the possibly disturbed Project Footprint (Map 2-2). The planned Project Footprint is largely comprised of permanent Project components. The possibly disturbed Project Footprint provided for some of the unknown components of the Project design at the time the Project was being licensed.

Subsequently approved Project areas include areas approved for Project use by the Government of Manitoba after the Project was licensed.

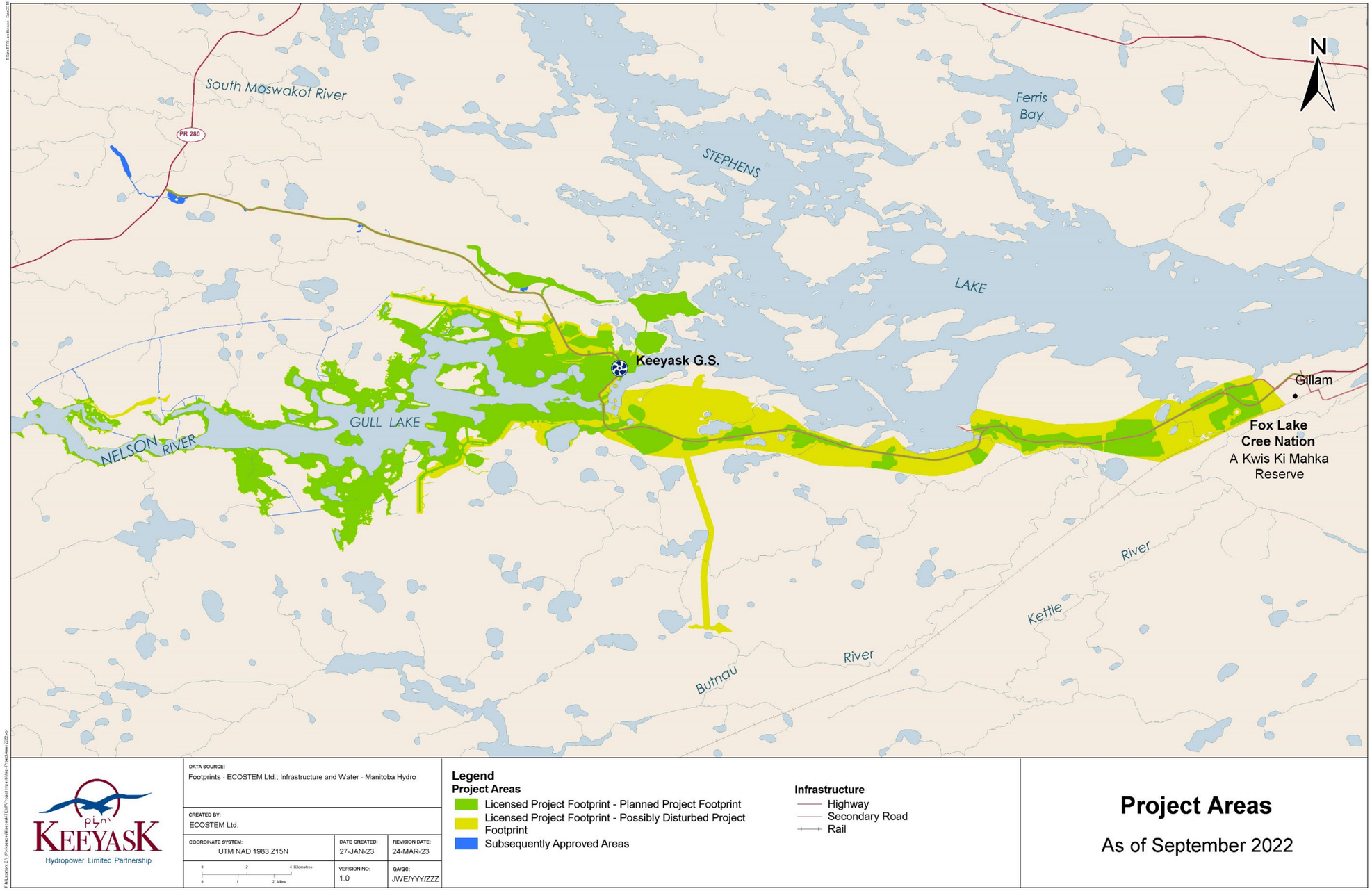
The preceding three Project areas are collectively referred to as the "approved Project Footprint".

The fourth type of Project area includes all cleared or disturbed areas that are outside of the approved Project Footprint.

In summary, the Project areas are the:

- Approved Project Footprint
    - Planned Project Footprint;
    - Possibly disturbed Project Footprint;
    - Subsequently approved Project areas; and,
- Areas outside 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 2022

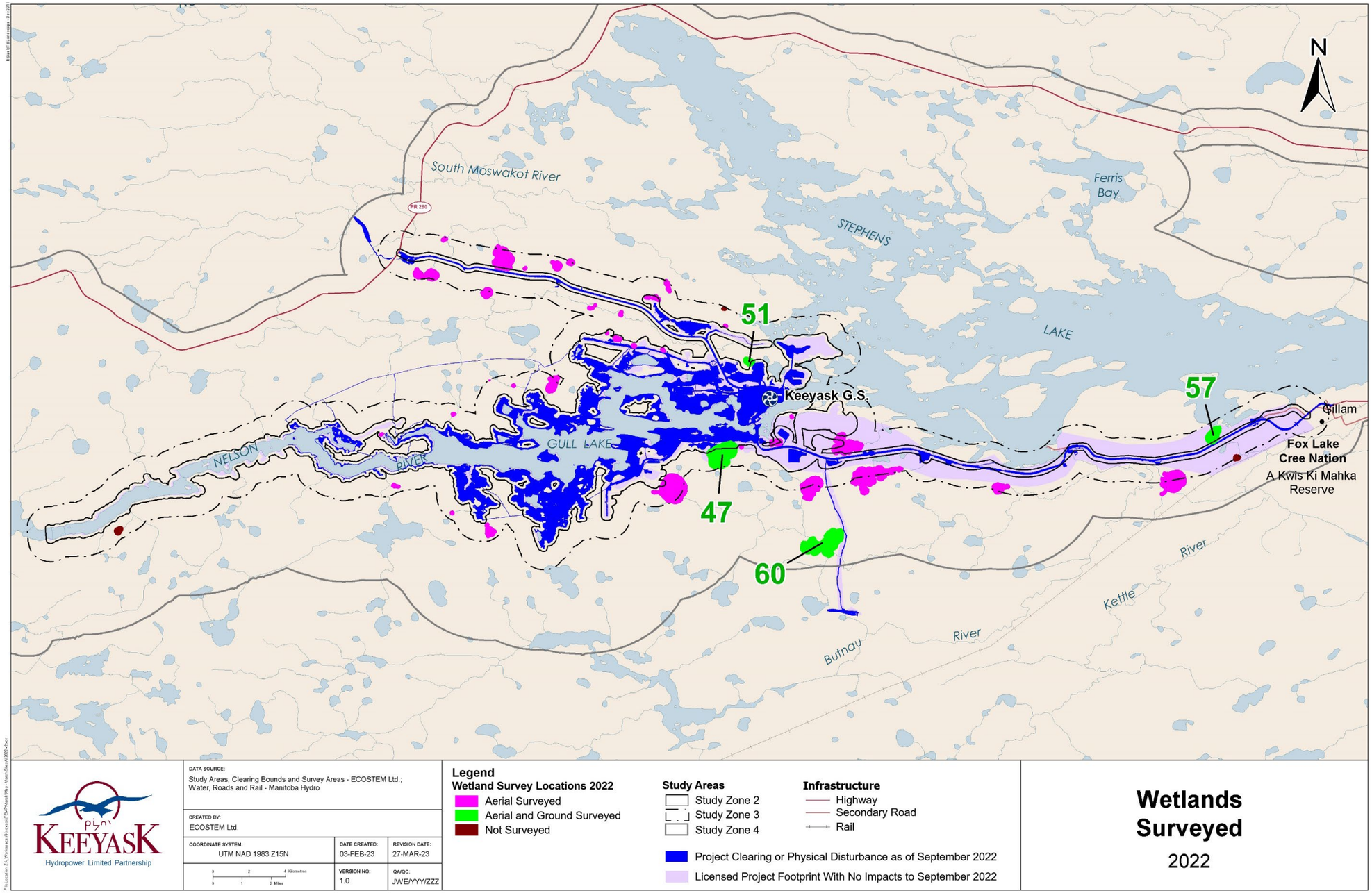
2.3 WETLANDS TO MONITOR

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.

Map 2-3 shows the 45 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 45 monitored wetlands was assigned a unique wetland identification number for the monitoring (e.g., Wetland 17).

Surveys in 2022 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.



Map 2-3: Monitored off-system marsh wetlands, and those that were surveyed in 2022

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 2022, the first stage of wetland selection used DOIs created from Worldview 2 imagery (30 cm resolution) acquired on August 30, 2021 and from stereo photos collected by air on October 2, 2021 because a DOI from summer 2022 was not available prior to the September 2022 aerial surveys. A total of 42 wetlands were identified for inclusion in the aerial surveys.

Aerial surveys conducted on August 31 and September 1, 2022 did not identify any additional wetlands for inclusion in the 2022 monitoring.

Of the 42 wetlands surveyed in 2022, 13 were within 100 m of the Construction Footprint. Ground surveys were conducted at four of these 13 wetlands (Map 2-3) on August 23 and 29, 2022. 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, and surveys in previous years had not documented any Project effects at these wetlands.

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.

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.

Water levels were not measured in the off-system waterbodies during the annual aerial surveys as this would have been somewhat complicated and time consuming, and visual indicators were deemed to be adequate to meet the study objectives.

Water levels for a waterbody were visually evaluated as the apparent deviation from their median level. Indicators of relatively low water levels were the degrees of exposed aquatic vegetation and lake-bottom. Indicators of relatively high-water levels were inundation of the upper beach or the presence of surface water within inland edge vegetation.

3.0 RESULTS

3.1 OVERVIEW

As of September 2022, cumulative Project clearing or disturbance had only affected 0.5% of off-system marsh wetlands (Table 3-1). The previous wetland monitoring report (ECOSTEM 2022b) provides details regarding how the Project progressively affected the monitored wetlands during construction.

Table 3-1 summarizes the main findings for the 13 wetlands within 100 m of the Construction Footprint as of September 2022. 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.

Photo 3-1 to Photo 3-3 provide an aerial view of conditions in a few of the surveyed wetlands that were more than 100 m from the Construction Footprint.

Monitoring in 2022 identified no new physical disturbance in any of the 42 surveyed wetlands (Map 2-3).

The potential for future disturbance was identified in three of the surveyed wetlands - Wetlands 51, 57 and 60 (Map 2-3; Table 3-1).

Outflow of water from the Main Camp culvert had potential to affect water levels in Wetland 51 as it had reached the low area adjacent to the marsh habitat at the time of the 2022 Surveys.

Water levels were observed to be above the median levels in all wetlands during the 2022 surveys. Wetland 57 was observed to have higher water levels than previously recorded, and were also relatively higher than the other monitored wetlands.

The Ellis Esker access corridor crosses a drainage channel into Wetland 60. The corridor is actively used by ATVs and there is a potential to create new disturbance outside of the current corridor if alternate channel crossings were used.

A wildfire in 2022 adjacent to Wetland 61 burned about 6.8 ha (15%) of area within the marsh habitat buffer. The wildfire was not caused by the Project, and Wetland 61 was not within 100 m of the Construction Footprint.

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

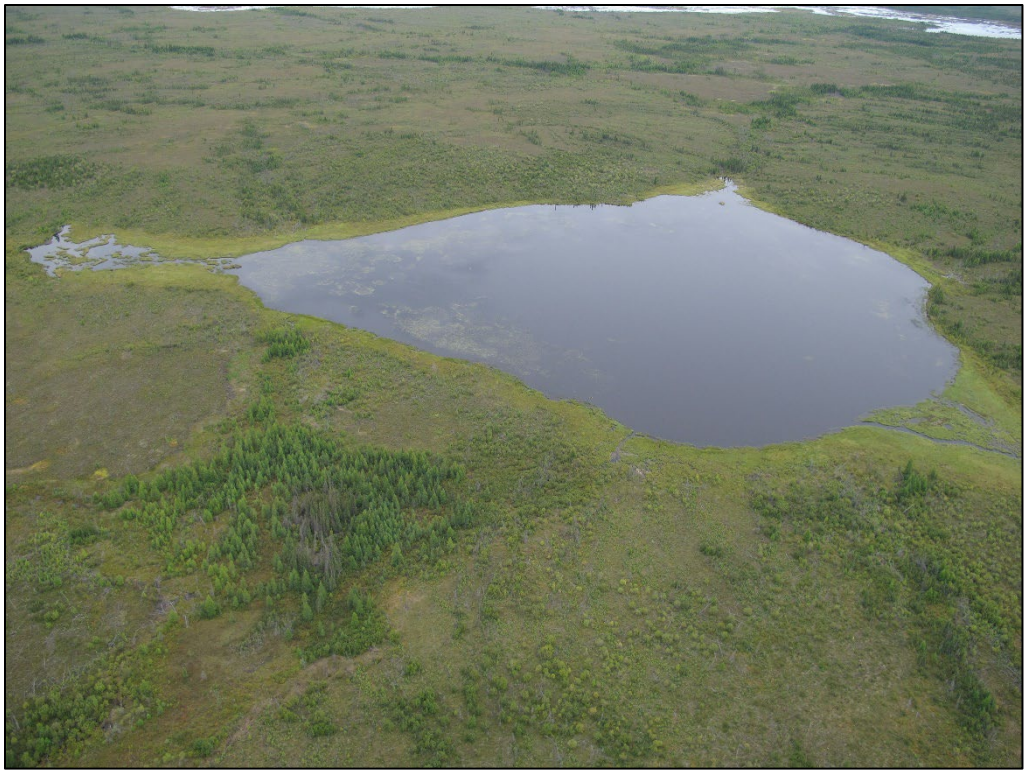


Photo 3-1: Wetland 15 marsh habitat on August 31, 2022

Photo 3-2: Wetland 20 marsh habitat on August 31, 2022

Photo 3-3: Wetland 28 marsh habitat on August 31, 2022

Table 3-1: Impacts and potential future effects in the off-system marsh wetlands within 100 m of the Construction Footprint as of September, 2022

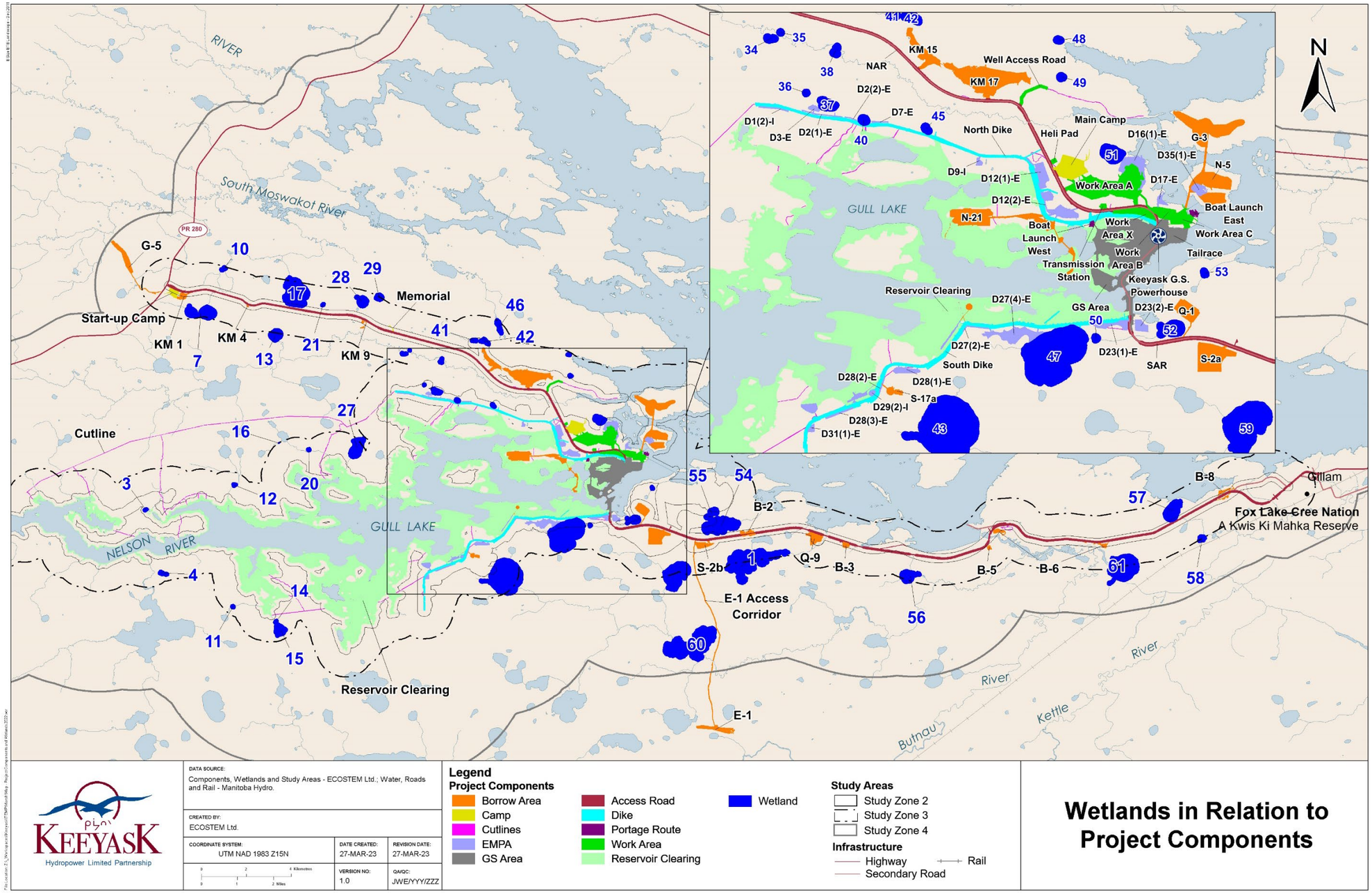
Wetland ID[1]	Wetland Area (ha)	Area (ha) Impacted[2] by Construction Footprint		Other Project Impacts from 2021 to 2022	2013 Burn in Buffer (%)[3]	Potential Additional Future Effects or Effects Outside of the Monitored Wetlands
		Up to 2021	2021 to 2022			
3	5	0.364	-	None	90	None
17	135.1	-	-	None	85	None
37	17	0.006	-	None	5	Likely none[4]
40	7.9	1.754	-	None	10	Likely none[4]
42	15.7	-	-	None	50	Likely none[4]
45	7.3	0.236	-	None	50	Likely none[4]
47	189.7	1.033	-	None	0	Likely none[4]
51	25.7	0.023	-	None	20	Increase in water levels due to runoff from culvert at Main Camp
52	28.4	-	-	None	0	None
53	5.5	-	-	None	0	None
54	113.1	-	-	None	0	None
57	64.6	0.793	-	None	0	Hydrological effects from a road culvert
60	232.4	-	-	None	0	Additional vegetation disturbance from adjacent ATV usage
All	847.6	4.208	-			

Notes:
A "0.0" value indicates an area less than 0.05 ha; a "-" value indicates no area.
[1] Bold font identifies wetlands that were ground sampled in 2022.
[2] All mapped Project clearing or physical disturbance in monitored wetlands. See ECOSTEM (2022a) 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, 2022, by Project area

Wetland ID	Area (ha) Impacted by Project Clearing and Disturbance 2021[1]		Area (ha) Impacted by Project Clearing and Disturbance 2022		Change	
	Planned Project Footprint	Possibly Disturbed Project Footprint	Planned Project Footprint	Possibly Disturbed Project Footprint	Planned Project Footprint	Possibly Disturbed Project Footprint
3	0.117	0.247	0.117	0.247	-	-
17	-	-	-	-	-	-
37	-	0.006	-	0.006	-	-
40	1.754	-	1.754	-	-	-
42	-	-	-	-	-	-
45	0.236	-	0.236	-	-	-
47	1.015	0.018	1.015	0.018	-	-
51	-	0.023	-	0.023	-	-
52	-	-	-	-	-	-
53	-	-	-	-	-	-
54	-	-	-	-	-	-
57	0.793	0	0.793	0	-	-
60	-	-	-	-	-	-
All	3.914	0.294	3.914	0.294	-	-

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



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

3.2 WETLAND 51

No additional Project effects were identified at Wetland 51 at the time of the 2022 surveys (Map 2-3; Table 3-1).

A gap in the rock berm surrounding the adjacent excavated material placement area (EMPA) in 2021 had been filled at the time of the 2022 surveys (Photo 3-4). The erosion and sediment deposition into the wetland buffer had stopped, and the ponding water in the disturbed area had less visibly suspended particulate matter within it than observed in previous surveys (Photo 3-4).

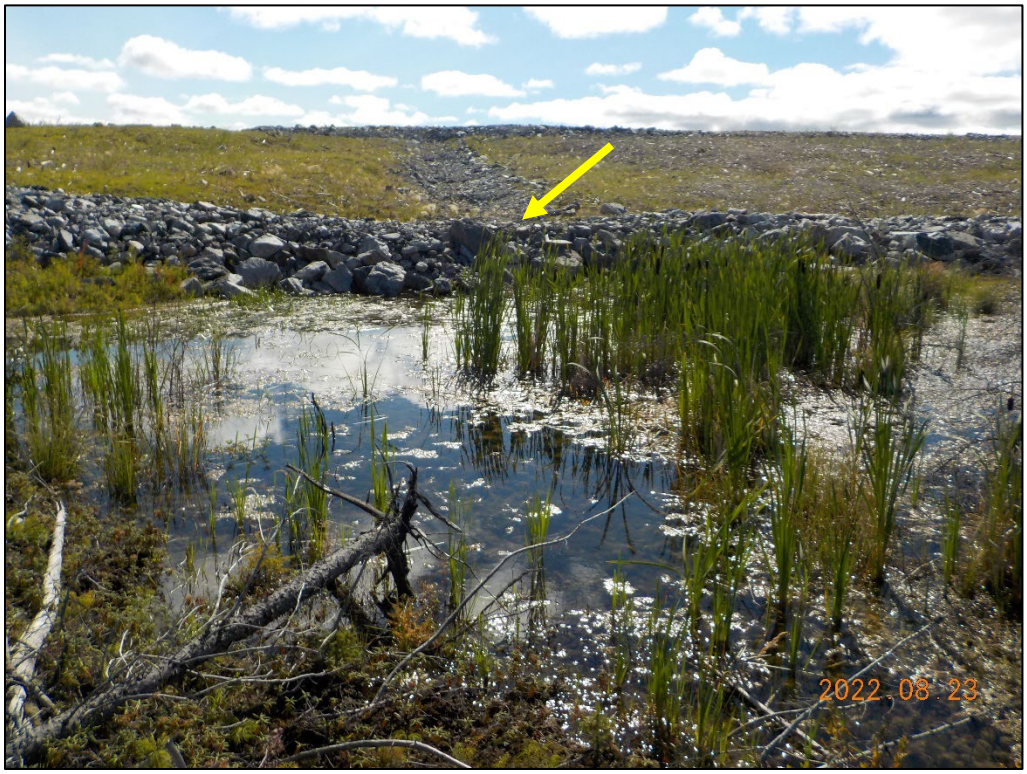


Photo 3-4: Filled gap in rock berm (yellow arrow) and ponding water in the Wetland 51 buffer zone.

A channel of flowing water from a drainage culvert at the northeastern corner of the Main Camp had reached a low area adjacent to Wetland 51 at the time of the 2022 survey (Figure 3-1). The amount of water flowing through the channel, which was up to two metres in width in some spots (Photo 3-5), was enough to raise concerns that the altered water flows through the adjacent riparian fen into Wetland 51 could negatively impact the marsh habitat. Although no effects were observed in the low-lying area during ground surveys, this disturbance has the potential to affect water levels in the marsh. This area will continue to be monitored for future effects.

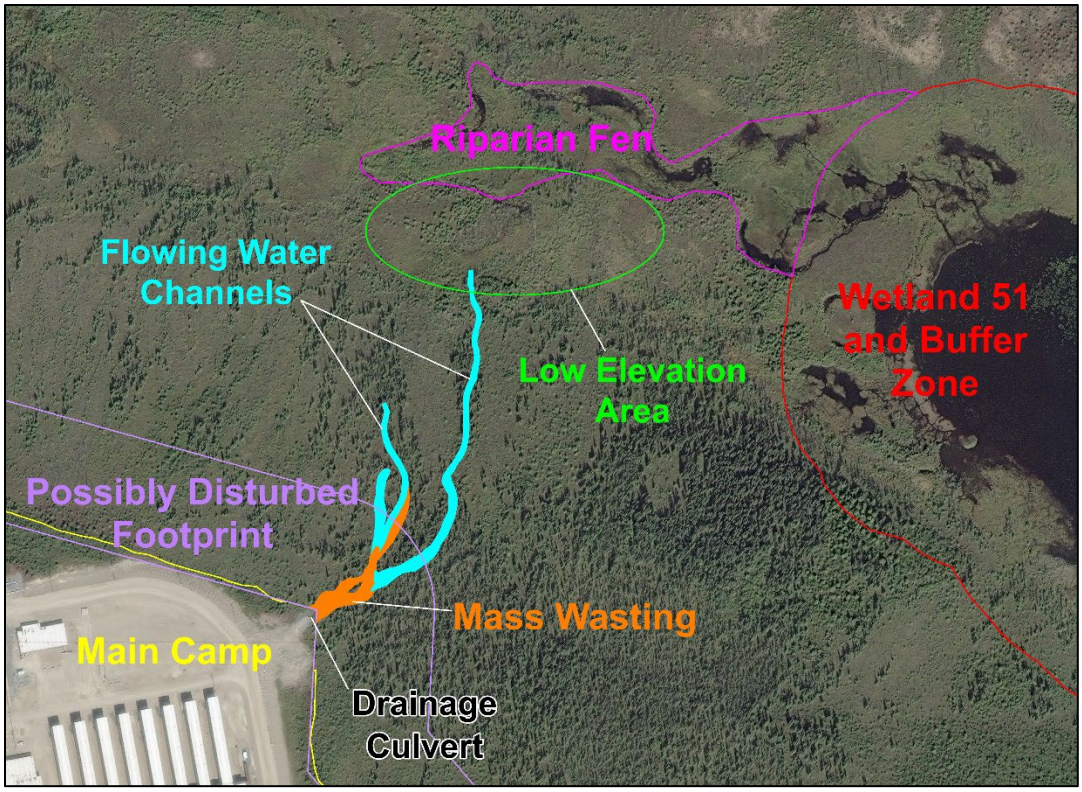


Figure 3-1: Extent of water flow from Main Camp culvert with potential to affect Wetland 51 (in red) as of September, 2022

Photo 3-5: Flowing water through previously undisturbed forest (yellow arrow) adjacent to Wetland 51.

3.3 WETLAND 57

No additional Project effects were identified at Wetland 57 at the time of the 2022 surveys (Map 2-3; Table 3-1).

At the time of the 2022 survey, water levels at Wetland 57 were at the highest level observed since Project construction began (Figure 3-2). They were also higher relative to the differences observed in the other surveyed wetlands. The water levels in the drainage channel were relatively high as well, however the level at the South Access Road (SAR) culvert was not higher than observed in previous years (Photo 3-6). The beaver dam within the drainage channel was partially intact as of August 29, 2022 and a small flow of water was spilling over the top (Photo 3-7).

2021

2022

Figure 3-2: Aerial view of a portion of Wetland 57 showing increased water levels from 2021 to 2022.

Photo 3-6: Culvert at the SAR in drainage channel at Wetland 57.

Photo 3-7: Flowing water over top partial beaver dam (yellow arrow) in drainage channel at Wetland 57.

The reason for the increase in water levels could not be fully determined during ground surveys. It is believed that the high water was due to the beaver dam that may have been recently breached by local duck hunters, just prior to the 2022 survey, as had been done in previous years (see ECOSTEM 2022b).

3.4 WETLAND 60

No additional Project effects were identified at Wetland 60 at the time of the 2022 surveys (Map 2-3; Table 3-1).

In terms of other potential impacts, surveys in 2022 found that the adjacent Ellis Esker access corridor was being actively used by ATVs (Photo 3-8). If the usage of the ATV trails that spanned across the natural drainage channel into the wetland were to continue, there could be potential for alternate paths through the channel to be made, creating a disturbance outside of previously cleared bounds. The channel itself did not appear to be substantially disturbed and the adjacent vegetation appeared to be unaffected as of September, 2022 (Photo 3-9). This may have been due to the fact that the ATVs appeared to only be using one path near the center of the right-of-way.

Photo 3-8: Aerial view of channel into Wetland 60 and ATV trail (yellow arrow) on August 26, 2022.

Photo 3-9: Ground view of marsh habitat (background), and drainage channel (foreground - left) at Wetland 60 on September 1, 2022.

3.5 WETLAND 61

Wetland 61 was not within 100 m of the Construction Footprint, however a wildfire in 2022 burned approximately 6.8 ha (15%) within the buffer zone (Photo 3-10).

Photo 3-10: Fire in and around Wetland 61 as of September 1, 2022.

4.0 DISCUSSION

4.1.1 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. Project alterations could change the amounts of 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.

Water levels in most surveyed wetlands in 2022 were observed to be higher than the median. In Wetland 57, water levels were higher than in any previous survey.

4.1.2 WETLAND IMPACTS AND MITIGATION

This section focuses on wetlands where new or ongoing Project impacts were found during the 2022 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 for all wetlands.

New project disturbance or clearing was not observed at Wetlands 3, 17, 37, 40, 42, 45, 47, 52, 53 and 54 at the time of the 2022 surveys. However, potential future impacts that merit a particular focus during future monitoring were noted for wetlands 51, 57 and 60.

Surface water drainage flowing from the Main Camp had the potential to alter water flows into Wetland 51. Given that the terrain surrounding the camp currently slopes towards the culvert location, it is not possible to redirect a portion of the flow elsewhere. While the area impacted to date is small and in a common habitat type, it is progressing towards Wetland 51. The Main Camp closed permanently in December, 2022, and decommissioning is underway. It is recommended that measures be implemented to slow or redirect the water flow and contain sediment within the approved Project Footprint.

At Wetland 51, the sediment deposition off the west slopes of the nearby EMPA (D16-E) into the wetland buffer zone was abated by filling the gap within the adjacent rock berm surrounding the EMPA.

There is a possibility that the SAR was a either a contributor to or the cause of higher water levels observed at Wetland 57 in 2022. This wetland drains through a channel into a ditch along the SAR (Figure 3-2). Photos taken during aerial surveys over several years show standing water in the ditches on both sides of the SAR, which suggests that the road has raised water levels in this wetland. While this would explain higher water levels since that start of SAR construction, it does not fully explain why levels were higher in 2022 than in previous years.

Generally higher than typical water levels across the region are likely to have contributed to the levels observed at Wetland 57. Other potential causes for the high-water levels in 2022 were beaver damming and Stephens Lake water levels. While it was clear that the beaver dam within the drainage channel was impeding flows to some degree, it was uncertain if this was occurring to a higher degree than in previous years.

As Stephens Lake is at a higher elevation than Wetland 57, a dike between these two waterbodies prevents Stephens Lake from draining into Wetland 57. However, the dike may not be entirely preventing groundwater flow from Stephens Lake into this wetland. Higher water levels on Stephens Lake in 2022 would create higher hydrostatic pressure at the dike, which could increase groundwater flows into Wetland 57, and then raise water levels in the wetland.

Wetland 60 had not been impacted by local ATV use of the Ellis Esker corridor by the time of the survey in 2022, however there was potential for the ATV trails running across the drainage channel to affect previously unaffected habitat if alternate paths were to be made.

Wetland 61 was not within 100m of the Construction Footprint, however it had a small portion (15%) of the marsh buffer burned as of September 2022 due to a wildlife in summer 2022.

5.0 SUMMARY AND CONCLUSIONS

The Wetland Loss and Disturbance study monitored the implementation and effectiveness of off-system marsh protection measures.

The 2022 monitoring found that there has been no new Project clearing or disturbance within any of the 45 monitored wetlands.

Surveys in 2022 identified the potential for future Project effects on three of the monitored wetlands. Water flow from a culvert at the northwest corner of the Main Camp has the potential to increase water levels into Wetland 51. Increased water levels could change the amount of habitat available to wildlife and alter the composition of marsh vegetation. It was uncertain if the higher water levels in Wetland 57 were due to the Project or other factors. Local ATV usage adjacent to Wetland 60 (not related to the Project) may have potential to affect this wetland in the future.

Wetland 61 had a portion of the buffer zone burnt by a wildfire in 2022, however this wetland was not within 100 m of the Construction Footprint and had not been affected by the Project.

This report includes mitigation recommendations to avoid or minimize potential future Project effects on the monitored wetlands (see Appendix 1).

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.

Based on the schedule in TEMP, this was the last year of monitoring for the Wetland Loss and Disturbance study. Given that there have been no unexpected effects, monitoring for this study is now complete.

6.0 LITERATURE CITED

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APPENDIX 1:
MITIGATION RECOMMENDATIONS

This appendix collates and summarizes the off-system marsh wetland mitigation recommendations made during the 2022 surveys.

Table 6-1: Summary of Mitigation Recommendations

Wetland	Recommendation[1]	Mitigation or Follow-up Implemented
Wetland 37	2021: The potential for runoff from adjacent EMPA is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
	2022: The potential for runoff from adjacent EMPA is very low. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended at this time.
Wetland 40	2021: The potential for runoff from the dike is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
	2022: The potential for runoff from the dike is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
Wetland 42	2021: The potential for runoff from the borrow area is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
	2022: The potential for runoff from the borrow area is very low. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended at this time.
Wetland 45	2021: The potential for runoff from the dike is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
	2022: The potential for runoff from the dike is declining. Monitor only if new construction activity or disturbance occurs nearby.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
Wetland 47	2021: Monitor water levels in wetland and for potential effects from altered water flows.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
	2022: Monitor water levels in wetland and for potential effects from altered water flows.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.

Wetland	Recommendation[1]	Mitigation or Follow-up Implemented
Wetland 51	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.	2021: Secondary drainage channel with rock-lined drainage turnouts installed parallel to rock barrier, upslope. Gap in rock barrier at wetland edge. Gap in rock berm filled in 2022.
	2021: Potential for disturbances from drainage at Main Camp to reach wetland. Continue to monitor for adverse effects from Main Camp area reaching wetland.	None to date. Continue ground surveys.
	2022: Potential for disturbances from drainage at Main Camp to reach wetland. Implement measures to slow the water flow and contain within the approved Project Footprint.	None to date. Main Camp closed permanently in December 2022 and is currently being decommissioned.
Wetland 52	2021: Monitor water levels and condition of marsh outlet for runoff effects from SAR.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
	2022: Monitor water levels and condition of marsh outlet for runoff effects from SAR.	No mitigation recommended. Ground survey only if air surveys detect new construction activity or disturbance.
Wetland 57	2021: Continue to monitor for water level changes and wetland development.	No mitigation recommended at this time.
	2022: Continue to monitor for water level changes and wetland development.	No mitigation recommended at this time. Continue ground surveys.
Wetland 60	2021: Potential for disturbance in wetland from adjacent local ATV use (not Project related). Monitor for adverse effects to wetland habitat.	No mitigation recommended at this time.
	2022: Potential for disturbance in wetland from adjacent local ATV use (not Project related). 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 previous ECOSTEM reports (ECOSTEM 2016; 2017; 2018; 2019; 2020; 2021) for the 2015, 2016, 2017, 2018, 2019 and 2020 recommendations, respectively.