Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Invasive Plant Spread and Control Monitoring Report

TEMP-2021-05

KEEYASK

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2021-05

INVASIVE PLANT SPREAD AND CONTROL MONITORING

A Report Prepared for

Manitoba Hydro

By

ECOSTEM Ltd.

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SUMMARY

Background

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

Non-native plants are those plant species that are not naturally found in the Keeyask region. Invasive plants are the non-native plant species that can out-compete or even replace native plants.

Non-native plants can be introduced or spread in the Keeyask area by seeds that are brought into the Project site on vehicles, construction equipment, and footwear. There are measures in place under the Project's Environmental Protection Plan to help minimize this from happening. For example, washing any construction equipment that is coming to the Project site from areas outside the Keeyask region is a preventative measure.

This report describes the results of invasive and other non-native plant monitoring conducted during 2020, the seventh summer of Project construction.

Common tansy, an invasive plant found at the Keeyask site during construction

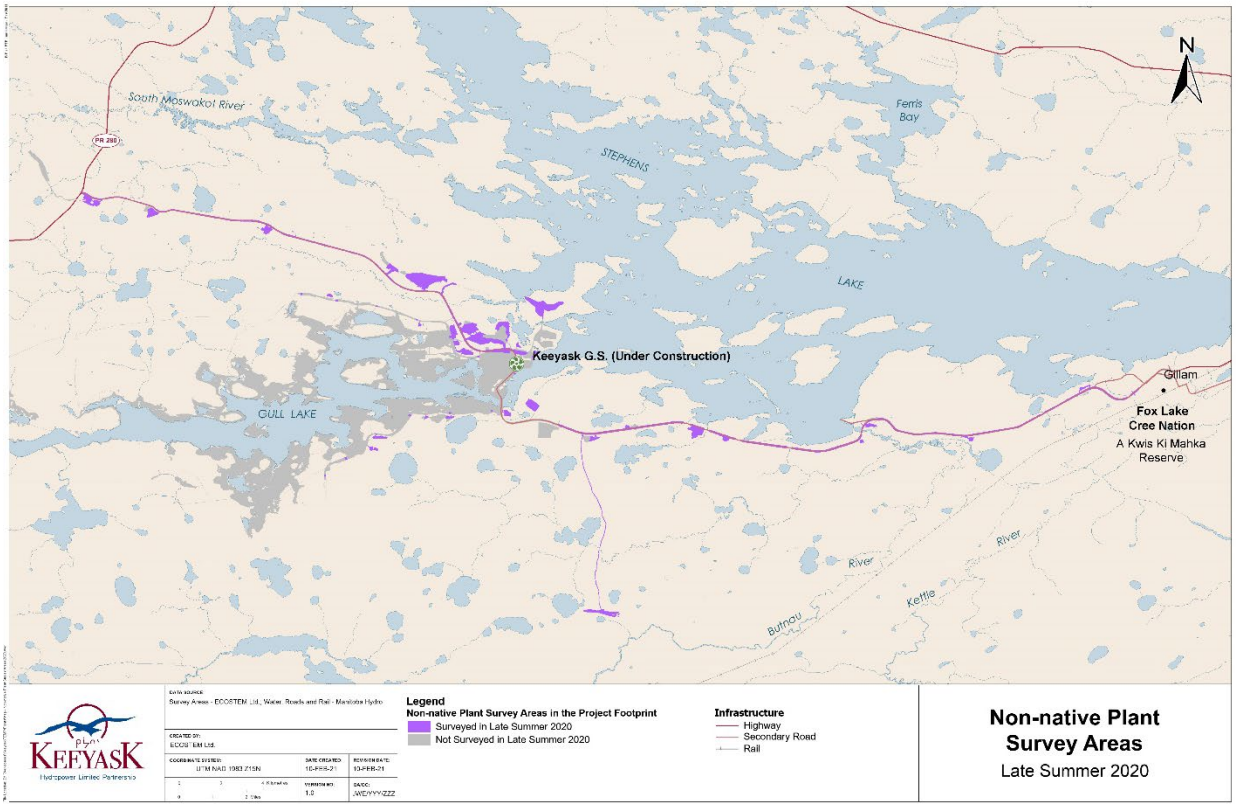
Why is the study being done?

Invasive and other non-native plants are of concern because they can crowd out native plants or prevent native plants from growing where they are normally found. In extreme cases, invasive plants can change the kind of vegetation, soils or other natural conditions. Non-native plants are also a concern because they could interfere with restoring native habitat in sites that are no longer being used by the Project.

Surveys are being done to determine how Project development is affecting how many non-native plants are present, where these plants are found, and to help decide where to carry out measures to control the plants that can become an issue at the Project site.

What was done?

In 2020, non-native plant surveys were carried out within most of the cleared Project areas between August 14 and 26 (see map below). Some cleared areas were not surveyed because the people doing the surveys could not safely access them due to construction activity.



What was found?

Total non-native plant extent (the general area where plants were present) and cover (the area covered by the plants) increased slightly between the 2019 and 2020 late summer surveys. Total non-native plant cover remained less than 1% of the surveyed area. As was the case in 2019, most of the non-native plant cover was within cleared areas that were either there before the Project (e.g., cutlines, borrow areas and ditches along the Butnau Road portion of the South

Access Road) or that were developed as part of the Keeyask Infrastructure Project, and are now being used by the Project.

A total of 27 non-native plant species were found during the 2020 surveys, which was two more than recorded in 2019. The new species recorded in 2020 included flixweed and canola. Neither of these species were of high invasive concern.

Common dandelion was the most abundant non-native plant species found in 2020, followed by narrow-leaved hawksbeard.

Five of the seven most abundant species increased in cover between 2019 and 2020 (common dandelion, white and yellow sweet clover, alsike clover and narrow-leaved hawks-beard). Lamb's-quarters and field sow-thistle, the other two abundant species, decreased in cover since 2019.

Of the 27 non-native plant species found in 2020, scentless chamomile and common tansy are the ones of highest invasive concern for the Project site. There was a large increase in the number of sites where common tansy was found, from single sites in the previous two years to 20 sites in 2020.

Species of highest invasive concern are being controlled by manual removal of these plants as soon as they are found during the surveys. This has worked well. Scentless chamomile was not found in 2020 at the sites where they had been removed in previous years, nor was common tansy, with the exception of one site. Ox-eye daisy, which was another species of high invasive concern found in previous years and manually removed, was not found in 2020.

Five of the 27 non-native plant species found in 2020 are of moderate invasive concern for the Project site. To minimize further spread of invasive plants, herbicides were applied in a few key Project areas in mid-July 2020, followed by targeted mowing in early September 2020. Living non-native plant cover was reduced by at least 72% in the areas treated with herbicides. Surveys in 2021 will assess the effectiveness of both treatments in continuing to reduce non-native plant cover.

What does it mean?

As expected, further spreading of some non-native plant species is happening during Project construction. However, all species combined still cover less than 1% of the Project footprint. Monitoring results suggest that non-native plant cover may be declining or expanding more slowly in some portions of the Project footprint since 2018.

Given their potential to spread rapidly, evaluations continued as to whether or not there are practical ways to reduce invasive and other non-native plant species in the Project footprint, or to prevent them from spreading further. Many of these species are commonly found in disturbed areas in the Keeyask region, particularly along roadsides, making it difficult to prevent vehicles and people from accidentally spreading these species into the Project site.

Monitoring results from 2020 showed that immediate manual removal was generally effective for species that do not have the ability to produce many new plants from pieces of roots left in the

ground. Staff conducting the monitoring surveys will continue to manually remove plants at sites where there are one to a few plants.

The herbicide treatment in late July 2020 appeared to be effective in reducing the overall cover of some species of high concern. Results from monitoring conducted in 2021 will determine if the herbicide treatment and subsequent mowing is expected to continue to reduce or slow the spread of invasive plant cover in these sites.

What will be done next?

Additional invasive plant control recommendations will be developed for the 2021 growing season based on the monitoring results to date. Monitoring fieldwork for invasive and other non-native plants will continue in 2021. Where appropriate, additional control measures will be recommended based on what is found during the monitoring.

ACKNOWLEDGEMENTS

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STUDY TEAM

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

Fieldwork in 2020 was conducted by Brock Epp and Karine Grotte of ECOSTEM Ltd..

Data analysis and report writing in 2020 were completed by Brock Epp and James Ehnes. GIS analysis and cartography was completed by Brock Epp and Alex Snitowski.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF MAPS

LIST OF APPENDICES

1.0 INTRODUCTION

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

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

Non-native plants are those plants that are growing outside of their country or region of origin. Invasive plants are non-native plants that can out-compete or even replace native plants. Invasive plants are of concern because they can crowd out other plant species and, in extreme cases, change vegetation composition or other ecosystem attributes. Invasive plants have been described as one of the greatest threats to natural areas in Canada (Canadian Food Inspection Agency 2008).

Non-native plant species that are not generally invasive may be problematic for some local conditions or may become so in the future with changing climate (Hellman *et al.* 2008). For example, well-established patches of non-native plants will be a consideration for areas where native habitat will be regenerated.

Since all invasive plants are non-native, this report generally uses “non-native” except when discussing species that are of higher invasive concern for the Project area.

The goals of the Invasive Plant Spread and Control study are to determine the degree to which the Project contributes to introducing and spreading invasive and other non-native plants, and to evaluate the effectiveness of mitigation measures. The overall objectives of the Invasive Plant Spread and Control study are to:

- Verify that appropriate seed mixtures were used where seeding is implemented as a rehabilitation or erosion control measure;
- Document the degree of invasive and other non-native plant introduction and spread;
- Recommend appropriate control and eradication programs; and,
- Verify the efficacy of any programs implemented to control or eradicate invasive plants.

The Invasive Plant Spread and Control study includes two components. The first component monitors non-native plant distribution and abundance in Project areas. In the event that control or eradication programs are needed, the second study component provides recommendations and monitors their effectiveness.

A previous monitoring study and report (ECOSTEM 2015) evaluated non-native plant spread during construction of the Keeyask Infrastructure Project (KIP), which ended in June 2014. This study is monitoring non-native plant distribution during Project construction and operation. To date, surveys have been conducted in each year from 2015 to 2020. Results for the monitoring conducted annually from 2015 to 2019 are provided in previous reports by ECOSTEM (2016, 2017, 2018a, 2019b and 2020 respectively). The following presents the monitoring conducted during 2020.

2.0 METHODS

Section 3.3.2 of the TEMP details the methods for this study. The following summarizes the activities conducted in 2020.

2.1 PROJECT COMPONENTS

There were far too many individual Project footprint components to evaluate each one separately for patterns of non-native plant spread. Therefore, the Project footprint was subdivided and grouped into general components (Table 2-1) based on the general type of activity occurring there. Activity type may be an important influence on non-native plant spread or establishment. For example, the “Camp and Work Areas” Project component is dominated by foot and light vehicle traffic, with minimal to no ongoing excavation, while the “Borrow Areas” component is often characterized by ongoing excavation and heavy equipment traffic. For reservoir clearing areas, the ground vegetation and soils are generally undisturbed, which means there is a poor seedbed for non-native plant colonization.

It should be noted that because the subdivision of the Project footprint into activity types is generalized, there may be small areas within a specific footprint that are from a different activity type. Nevertheless, this categorization aids in the interpretation of broad patterns and trends across the Project site. Map 2-2 shows the locations of the Project components as well as some of their constituent features.

A second level of analysis was based on the length of time since an area was first cleared, the current level of construction activity, and the projects it was used for (e.g., portions of areas cleared for the Keeyask Infrastructure Project (KIP) are also being used for the Project). All of these factors can influence non-native plant distribution and abundance. The categories used for the second level of analysis included:

- Areas used either for the KIP only or minimally affected by the Project;
- Areas used by both the KIP and the Project; and
- Areas used only by the Project.

Areas used for the KIP only are included because they were developed prior to the Project and may be an important seed source for the spreading of non-native plants into other nearby areas.

Table 2-1: General Project components and their associated activity prior to 2020 surveys

Project Component	Description	Activity
North Access Road	Road and right of way	Light and heavy vehicle traffic
South Access Road	Road and right of way	Light and heavy vehicle traffic
Camp and Work Areas	All camps, work areas and attached excavated material placement areas	Foot and light vehicle traffic, or heavy vehicle traffic for a short period or limited area
Borrow Areas	All borrow areas accessible by road, cleared or excavated, and attached excavated material placement areas	**Active:** Clearing, excavation and heavy equipment traffic **Inactive:** Regenerating vegetation
North Dyke	North dyke clearing, associated excavated material placement and borrow areas, and north channel rock groin	Clearing, excavation, light and heavy vehicle traffic
South Dyke	South dyke clearing and associated excavated material placement and borrow areas	Clearing, excavation, light and heavy vehicle traffic
Generating Station Areas	Generating station, spillway, dam and coffer dam infrastructure, and associated excavated material placement areas	Excavation, construction, heavy and light vehicle traffic
Reservoir Clearing Area	Vegetation clearing in the reservoir areas that are close to Project areas that will be outside of the reservoir	Clearing only

2.2 DATA COLLECTION

2.2.1 FIELD METHODS

Late summer (typically mid to late August) non-native plant surveys have been conducted annually from 2014 to 2020. Early summer (typically late June to early July) surveys were also conducted annually from 2014 to 2019. To date, surveys in the shore zone areas were conducted in 2019 only.

The information collected for the 2020 surveys differed from previous years because an early summer survey was not conducted. From 2014 to 2016, a full non-native plant survey of all accessible cleared areas was completed twice annually, in the early summer and in late summer. Surveys were conducted twice in order to collect information that would help characterize seasonal patterns in the distribution of non-native plants.

Starting in 2017, the early summer survey was less detailed than the late summer survey. After three consecutive years of data, the seasonal patterns in the distribution of non-native plants was established. The purpose of the early summer survey shifted to provide a rapid, spatially focused survey that still allowed for early detection and response to non-native plants that had spread into new areas. For this reason, the 2017 to 2019 early summer surveys were spatially focused on two types of areas: (i) the areas that were newly cleared since the previous year; and, (ii) the areas that were cleared as of August the previous year, and that had few to no non-native plants. Further details on methods and rationale are provided in the 2018 report (ECOSTEM 2018a). The results from the early summer surveys were not expected to be representative of non-native plant distribution and abundance for the entire Project footprint.

By 2018, Project clearing was nearly complete (ECOSTEM 2019a), and by August 2019 non-native plants had become established in nearly all the previously cleared areas that were accessible for surveys (ECOSTEM 2020). In each year since 2018, results from the previous late summer survey had already provided the bulk of the information needed to select sites for treatment in the current summer. For these reasons, it was determined that an early summer survey was not required for 2020.

Results from the late summer surveys were expected to overestimate non-native plant distribution and abundance for the entire Project footprint. With the exception of the North and South Access roads and Dykes, surveys of the Project footprint were not conducted in areas where non-native plants were expected to be completely or virtually absent based on results from similar types of areas and in previous years. The two predominant types of areas that were not surveyed were the portions of the Project footprint that were not safe to access due to construction or wildlife activity, and the cleared future reservoir area. Inclusion of the zero or very low values from these areas would have reduced the non-native plant percentages for the entire Project footprint.

Late summer surveys were conducted from August 14 to 26, 2020 at the locations shown in Map 2-1.

In 2020, most of the non-native plant cover was recorded and mapped in the field using electronic tablets which were introduced to the fieldwork methods during the 2019 late summer surveys. The information recorded using this method was the same as the information recorded prior to 2019 to maintain comparability with results from previous years. Advantages to utilizing the electronic data collection method over the previous method included:

1. Reduction in recording error;
2. Improvements in field data gathering efficiency (i.e. reduced time); and
3. Reduced data entry and GIS processing time.

Despite the advantages, there were a few general limitations to using tablets to gather field data. First, the tablets could not be used in heavy rain as this interfered with the touch-screen inputs. Second, the GPS positional accuracy decreased in denser tall vegetation cover or structures to a much higher degree than the handheld GPS receivers. Third, they were inefficient for rapidly recording data when conducting surveys from a vehicle.

In situations where weather conditions or the survey method (e.g. helicopter surveys) did not support effective use of the tablets, the surveyor reverted to the same data recording method used for late-summer surveys in 2018. As a result, non-native plant cover was recorded in two different ways for the 2020 surveys; however, the data collected was the same, and was combined for the resulting cover maps. Both data collection methods are detailed below.

Late summer non-native plant surveys were conducted in the portions of the Project footprint that had been cleared or disturbed prior to the surveys and were safe to access. A botanist and trained environmental technician conducted surveys on foot and by truck within the cleared areas that were both safe to survey and were not undergoing clearing at the time of the surveys. Due to safety-related access restrictions, some active construction areas, or portions thereof, could not be surveyed in 2020.

Three approaches to selecting survey locations were employed, depending on the nature of the footprint.

For the North and South Access roads, a combination of systematic sampling on foot and mobile truck-based surveys were employed. This method was also used for the North and South Dykes for the first time in 2020 because their construction was complete, and their entire lengths were truck accessible at the time of the surveys (see ECOSTEM (2020) for methods previously used for the dykes). Permanent sample locations were established every 2 km along each road and dyke. Non-native plants were sampled at every stop except where construction or haul truck activity made stopping unsafe. At each stop, a 100 m transect on each side of the road or dyke (*i.e.*, two 100 m transects at each stop) was surveyed by foot. Additionally, the sides were scanned while driving approximately 40-50 km/h between each stop and observations of species of high concern or unusual conditions were recorded. It was expected that smaller patches and individual plants would not be recorded.

The Ellis Esker access corridor was surveyed by a combination of helicopter and foot surveys due to its length, and inaccessibility by non-construction vehicles. The helicopter was flown at a low altitude above the centre of the corridor, and the surveyor recorded locations of non-native plants. Foot surveys were conducted where needed to confirm plant identification, or to map more complicated patches of plants.

For the remaining areas (which accounted for the majority of the surveyed area), field surveys traversed all cleared areas using a combination of perimeter and meandering walks. The perimeter of each cleared area was generally surveyed because the non-native plants tended to be clustered in these locations. For the remainder of a cleared area, the surveyor walked to all remaining vegetation patches that had the potential to include non-native plants. The exception to this was areas that posed safety concerns (primarily related to the presence of heavy construction activity).

Data recorded at each location included spatial coordinates, species spatial extent and species abundance. Additional notes were also recorded and photos were taken.

Non-native plant spatial extent at a location was recorded either as a point with an associated number of individuals or as a patch of plants with an associated percent foliage cover. The “point

with number of individuals" method was typically used in locations where there less than 20 individual plants covering a very small area, while a patch (typically 20 or more plants) was used where there was a large number of plants, and/or the plants covered a large area. Regardless of the data collection tools used (see below), patches are recorded in one of two general methods: (1) as a point with an estimated radius (in meters), which typically applied to small, roughly circular patches in open areas where the boundaries were visible from a single location. These points were later converted to polygons in the GIS. (2) As a patch, spatially defined by a polygon in the field. This method was used for large patches where the boundaries could not be discerned from a single location. The method by which the polygons are defined varied depending on the data collection tools used (see Sections 2.2.2 and 2.2.3).

Once a non-native species patch was defined, the percent plant cover was estimated for each species present and recorded into one of the six classes listed in Table 2-2.

Table 2-2: Cover class and associated percent cover ranges used for non-native plant surveys

Cover Class	Percent Cover Range
Very sparse	>0 - 2%
Sparse	3 - 10%
Low	11 - 25%
Moderate	26 - 50%
High	51 - 75%
Very high	76 - 100%

2.2.2 TABLET-BASED DATA COLLECTION

Non-native plant cover data was collected electronically using Samsung Galaxy Tab A tablets during foot-based surveys, when weather conditions allowed the tablets to operate. These tablets have a built-in GPS receiver, which facilitated mapping non-native plant cover directly in the field using Collector for ArcGIS. To help digitize the boundaries of the plant patches, the most recently available remote sensing imagery was uploaded as a base-map on the tablet prior to the surveys.

Two layers were prepared for field data collection, one for point type features (plant individuals) and "point with radius" patch types, and another for defined polygons. When individuals or patches with a radius were encountered, a new point feature was added in Collector as close to the centre of the patch as possible for the species. When a larger patch was encountered, a polygon was digitized in Collector, either by using the streaming function, and walking around the patch boundary, or by manually drawing the patch polygon using the base imagery as a reference. After either feature was created, the point or patch attributes were filled in using the form that had been set up for use in Collector. If more than one non-native plant species occurred at the same point, or within the same patch, the feature was copied, and the species and cover attributes were updated.

2.2.3 PAPER-BASED DATA COLLECTION

Paper-based data collection methods in 2020 were the same as those used in 2019. These methods were used when rainfall was too heavy for the tablet's touch-screen input to work, or during higher-speed truck, helicopter, or boat-based data recording.

Non-native plant spatial extent at a site was recorded using field notes in conjunction with waypoints and tracks acquired using a GPS (Garmin Map 62 or Map 78). The notes included the same point and patch attributes that were recorded when the tablets were used.

For non-native plant individuals and small patches (less than 20 plants), a GPS waypoint was recorded as close to centre of the patch as possible. For larger patches, defined polygons were recorded in one of three ways:

1. **Point:** Used for small patches (20 or more plants) that had a relatively regular shape. Typically applied to small patches in open areas where the boundaries were visible from a single point. In these situations, a GPS waypoint was taken at the patch center whenever possible, with an associated ocular estimate of patch radius (in meters) for circular patches or the dimensional length (e.g. 2m x 4m) for rectangular patches.
2. **Band:** Used for patches too large to be recorded as a point and that were linear with a relatively constant width. In these situations, the length of the band of the non-native species (e.g. along a ditch) was walked while a GPS recorded a track log for the species. An estimate of the average bandwidth in meters was recorded. For some wider bands, the bandwidth was recorded using distinct features such as a specific impact area (e.g. width of the transmission line right-of-way).
3. **Defined Area:** Used if the patch could not be recorded as a point or a band. In these situations, the surveyor generally walked around the perimeter of a large homogeneous patch with non-native species cover while recording a GPS track log for the patch. Alternately, the surveyor walked through the area in a zig-zag transect so that the points generally corresponded to the boundaries of the patch. The former method was used when the non-native species could be observed throughout the patch from the outer boundaries, which typically occurred in open barren, or low vegetation areas. The latter method was used in heavily vegetated areas where non-native plants were not visible over a long distance. In this method, waypoints were added while recording the species tracklog to indicate if there was a change in cover.

2.3 TOTAL AREA SURVEYED

In 2020, ground searches were not possible in several locations for safety reasons. Locations not surveyed due to construction activity included all of Borrow Areas N-5, N-21 and S-2a, portions of Work Area A (particularly around the rock crusher), the two westernmost SAR survey stops and the easternmost NAR survey stop. Based on previous results (ECOSTEM 2017; WRCS and ECOSTEM 2017), it is unlikely that many non-native plants would have established in areas with

a high volume of construction activity, including ongoing excavation, material stockpiling and vehicle traffic. Finally, portions of the generating station area and north channel rock groin upstream of the dam that were surveyed in previous years were not surveyed because they were inundated at the time of the 2020 surveys.

Late summer non-native plant surveys in 2020 covered approximately 618 ha (11%) of the cleared or disturbed Project footprint (Table 2-3; Table 2-4). The percentage of the Project footprint surveyed increased to 48% when recently cleared or very large footprint components utilizing different sampling methods footprint components were excluded (i.e., the future reservoir area and the North and South Access roads and dykes). The future reservoir area accounted for 65% of the Project footprint in 2020, including all Project and KIP areas.

Compared with 2019, the total area surveyed in 2020 was 86 ha lower, primarily because the construction activity at the time prevented access to portions of some Project components. The largest of these Project components included Borrow Areas N-21 and N-5.

Overall, the locations included in the 2020 and 2019 surveys were similar for most of the Project components (Table 2-3). As noted above, most of the exceptions were due to high levels of construction activity, or a change in survey methods in the case of the dykes. Portions of Borrow Area G-1 were not surveyed for reasons similar to those of the reservoir clearing area. Only the aboveground vegetation had been cleared in the unsurveyed portions of this borrow area, and previous surveys found very few non-native plants, with little to no change in cover over time (ECOSTEM 2017; 2018a).

Table 2-3: Total area (ha) surveyed for non-native plants by year and Project component

Project Component	Early Summer Survey							Late Summer Survey						
	2014	2015	2016	2017	2018	2019	2020	2014	2015	2016	2017	2018	2019	2020
North Access Road[1]	9	9	9	-	-	-	-	10	9	8	10	9	8	9
South Access Road[1]	-	-	9	306	268	127	-	-	-	10	16	13	14	13
Camp and Work Areas	126	109	163	19	6	16	-	138	111	186	182	185	173	179
Borrow Areas	112	119	323	79	131	200	-	120	131	329	334	329	369	330
North Dyke[1]	-	-	52	88	108	12	-	1	-	56	120	124	138	51
South Dyke[1]	-	-	38	7	3	2	-	-	-	21	4	8	2	35
Generating Station Area	-	-	20	10	0	10	-	-	-	10	6	-	-	1
Reservoir Clearing Area	-	-	56	0	-	-	-	-	-	-	0	-	-	-
Total surveyed area	*247*	*237*	*669*	*509*	*516*	*367*	-	*269*	*251*	*620*	*671*	*668*	*703*	*618*
Total footprint area [2]	*540*	*1,438*	*3,643*	*5,372*	*5,716*	*5,759*	*5,798*	*540*	*1,438*	*3,643*	*5,372*	*5,716*	*5,759*	*5,798*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Sampled area consists of a systematic sample of the road (Section 2.1). In addition, cleared areas were scanned for large patches while driving between stops.
[2] Approximately 75 ha of KIP borrow areas not used by the Project are included in these totals.

Table 2-4: Percentage of Project footprint area included in the non-native plant surveys by year and Project component

Project Component	Early Summer Survey							Late Summer Survey						
	2014	2015	2016	2017	2018	2019	2020	2014	2015	2016	2017	2018	2019	2020
North Access Road[1]	5	5	5	-	-	-	-	5	5	4	5	5	4	5
South Access Road[1]	-	-	3	94	82	39	-	-	-	3	5	4	4	4
Camp and Work Areas	68	48	71	8	3	7	-	75	49	81	78	78	73	75
Borrow Areas	90	35	74	16	24	36	-	96	38	76	68	60	66	55
North Dyke[1]	-	-	28	45	54	6	-	3	-	30	61	62	69	26
South Dyke[1]	-	-	31	4	2	1	-	-	-	17	2	4	1	17
Generating Station Area	-	-	9	4	0	4	-	-	-	4	3	-	-	0
Reservoir Clearing Area	-	-	3	0	-	-	-	-	-	-	0	-	-	-
All surveyed areas[2]	*46*	*17*	*18*	*9*	*9*	*6*	-	*50*	*17*	*17*	*12*	*12*	*12*	*11*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Sampled area consists of a systematic sample of the road (Section 2.1). In addition, cleared areas were scanned for large patches while driving between stops.
[2] Approximately 75 ha of KIP borrow areas not used by the Project are included in these totals.

2.4 MAPPING

This report includes detailed non-native plant distribution and abundance mapping derived from the non-native plant cover estimates. These maps show plant patches, by cover class, in the surveyed portions of the Project footprint. The mapping detail is the same as that in the 2019 annual report (ECOSTEM 2020). Mapping methods are the same for both the inland and shore zone data.

The analysis evaluated non-native plant distribution and abundance in the context of precise clearing and disturbance mapping produced for 2020 (see ECOSTEM 2021). The primary focus of this report is on the patterns and changes observed in 2020. A detailed comparison of non-native plant spread over all construction years will be provided at the end of Project construction in the monitoring synthesis report.

Species spatial extent and cover data collected using the note-based method was converted into GIS polygons. Where the patch extent method (Section 2.2) was used to record non-native species in the field, patch polygons were created from the GPS tracklogs. After polygons were created from the note-based method data, they, along with the point data, were merged with the point and polygon features produced in the field using the tablets.

Polygons for sites where plants were recorded as individuals in the field were created by applying a fixed radius buffer around the site coordinate. The radius applied for each species at each point was a fixed value for the species multiplied by the number of plants recorded. The radius for one plant of a particular species was the estimated typical area covered by an individual plant (Appendix 1, Table 7-1). Since there were situations where plants were close enough to each other to have overlapping buffers, this method slightly overestimates total non-native plant cover.

The non-native plant mapping provided two measures of plant cover in the footprint components. One measure was the overall spatial extent of one or more non-native plant species, which also indicated species distribution. The other measure was the area covered by each species (approximate plant cover), which was used to indicate abundance. Non-native plant cover will usually be lower than plant extent due to less than complete canopy closure within most of the mapped patches.

Non-native plant cover was derived from the patch cover class (Table 2-2) for sites recorded using the “patch method” or from multiples of individual plant area (Appendix 1, Table 7-1) for sites recorded using the “number of individuals” method. The area covered by a species in a mapped patch was calculated by multiplying the patch area by the midpoint of the percent cover class (Table 2-2). For example, a 10 m^2 non-native plant patch with sparse cover for Species A would have a derived area of: 10 m^2 x 6.5% = 0.65 m^2 for Species A.

Factors that affected how the data generated from the mapping were interpreted included GPS accuracy, interpreter bias and variability, total plant cover and access. For GPS accuracy, non-native patch mapping relied on GPS waypoints and track logs for positioning. Depending on the

terrain and satellite signal, accuracy of the GPS could vary by several meters during and between surveys. The same patch, mapped during different surveys, may show different positions or extents from track logs and waypoints even if its boundaries remained unchanged. Such year-to-year differences were expected to be small relative to the size of the footprint surveyed.

While efforts were made to calibrate plant cover estimates between the different individuals conducting the surveys, some individual bias is always inherent in this measurement method. Furthermore, even for the same individual, there may have been differences in the approach taken to map a particular patch of non-native plants in one year compared with the previous year. For example, an area with very sparse cover of a particular species may have been recorded as a series of individual points during one survey and as a single patch with very sparse cover during another survey (generally because the number and extent of individual points changed). While the actual cover and number of plants may have been the same between surveys (when limiting the comparison to the same spatial extent as the previous year), the current year patch limits and plant cover class could be different. Consequently, results for the area covered by a species could reflect the mapping approach, and not actually a change in non-native plant extents. To minimize this effect, whenever possible, the same individuals were used to conduct the surveys over the monitoring period, and an effort was made to subdivide the areas surveyed by each individual in the same way each time. This element of the field methods was not expected to create a large bias in the overall results even though there could be relatively large differences at specific sites.

As cleared areas regenerate, native vegetation cover may obscure non-native plants, confounding estimates of cover. This could result in a bias toward underestimating non-native plant cover in areas with dense or taller native plants. This could also result in a seasonal bias in which non-native plant cover for some species was underestimated during spring surveys because the plants were small and obscured by other vegetation.

During construction, some areas could not be safely accessed at the time when surveys were conducted due to construction activity (e.g., Borrow Areas N-21 and N-5). While effort was made to observe these areas from a distance, it is possible that non-native plants were present but not recorded (note that this does not refer to sites where non-native plants definitely could not be seen if present; such areas are not included as part of the surveyed area). This could result in total cover being underestimated for certain areas in some years. However, any bias was expected to be small as the areas surveyed from a distance were typically in active borrow areas (i.e., the new substrate was recently exposed). Because the total area surveyed varies due to these reasons, the results are related to total area surveyed, rather than total footprint area, increasing comparability of results from different surveys.

Due to the above factors (particularly the first two), derived species cover, rather than polygon extents, were considered to be a more meaningful measure for interpreting changes in non-native plant abundance between years. Non-native species polygon extents should only be considered as an indication of overall distribution as well as a very broad measure of area covered.

2.5 NON-NATIVE PLANT CONTROL

Several areas were recommended for herbicide application and mowing based on the 2019 findings (see Section 4.2 for details). The areas were those which contained invasive species of high concern that had high potential to spread into other areas. Manitoba Hydro treated these areas with herbicides on July 23 and 24, 2020 (see Section 4.0 for details).

Surveys were conducted in the herbicide-treated areas during the late summer survey to document the treatment efficacy. Non-native plants in the treatment areas were recorded according to the standard survey methods. In addition to the standard data, the percent of dead foliage for each non-native species in the patch was also recorded. Photos of the treated patches of plants were taken. A patch was considered to be treated with herbicide if there was evidence of herbicide damage on any of the vegetation in the patch. This may be different than the actual area sprayed because the effects of the herbicide can be systemic, and may extend beyond the application area for rhizomatous species.

A follow-up mowing in the same areas was carried out, where needed, on September 10, 2020, after the 2020 field surveys were completed.

2.6 INVASIVENESS RANKINGS AND MANAGEMENT STRATEGIES

2.6.1 BACKGROUND

The EIS and EnvPPs include standard control or eradication measures for invasive and other non-native plants, including:

- Contractors that will be using equipment and machinery that was recently used more than 150 km from the Project area will wash that equipment and machinery prior to transport to the Project area.
- Areas that are rehabilitated using a seed mixture will be seeded with a mixture that only contains native and/or non-invasive introduced plant species.
- Areas where there are patches of noxious weeds will be flagged for avoidance if they are not contained in active construction areas.
- Exposed areas shall be revegetated as quickly as possible following construction to prevent soil erosion and the establishment of noxious weeds.

This monitoring study provides additional control or eradication recommendations during construction monitoring. The following summarizes the approach taken to make

recommendations regarding which non-native species to prioritize for management, and the types of locations that management efforts will focus on. Appendix 2 details the approach.

It is widely recognized that it is not practical to attempt to eradicate or even control all non-native plant species (e.g., White *et al.* 1993; Morse *et al.* 2004; Ministry of Transportation and Infrastructure *et al.* 2011). For example, some species are already too widespread and well-established to implement an approach that removes plants at a faster rate than they reappear in the same sites and establish in new sites. Many of the non-native species recorded during Project monitoring are commonly found in disturbed areas throughout the Province (e.g., field sow-thistle, white clover), particularly along roadsides, making it difficult to prevent them from being spread by human or natural sources.

To prioritize and develop management recommendations for non-native plants in the Project area, the focus is on the plant species of highest invasive concern and the situations where there are practical ways to reduce these species or prevent further spreading. The primary sources used to classify the potential for a non-native plant species to have substantial adverse effects on ecosystems or biodiversity in the Project area were the ISCM (2020), White *et al.* (1993), the Provincial *Noxious Weeds Act* (Government of Manitoba 2017a) and the Federal Weed Seeds Order (Government of Canada 2016). While the federal *Plant Protection Act* was also relevant from the regulatory perspective, few of the species currently on its list occur in Manitoba, and those that do are limited to a few locations in the southern portion of the province.

The primary additional sources of information that assisted with evaluating potential invasiveness in the Project area, and with developing management recommendations, included the Biology of Canadian Weeds Series (Canadian Weed Science Society 2019a), the Biology of Invasive Alien Plants in Canada (Canadian Weed Science Society. 2019b), Manitoba Agriculture (2019) and results from EIS or monitoring studies for this and other projects in northern Manitoba. The last of these sources also provided some information regarding patterns of distribution and abundance in the Project region.

A limitation for some of the sources used to determine a plant's degree of invasiveness was that they did not include data from the Keeyask region. The observed degree of invasiveness for the species included in these sources was generally obtained in regions subject to much different climates than that occurring in the Project region. Local invasiveness can differ greatly from that observed in other regions (Carlson *et al.* 2008).

Of the sources used for ranking a species' degree of invasiveness listed above, ISCM (2020) and White *et al.* (1993) were considered the most relevant ones because their focus is on impacts to ecosystems and biodiversity. The Provincial *Noxious Weeds Act* and the Federal Weed Seeds Order were developed to address impacts on the agricultural economy or the viability of the agricultural operations. An upshot of this agricultural focus is that these regulations do not list some species known to be of concern for impacts on native ecosystems and biodiversity (e.g., purple loosestrife). Conversely, these regulations also list some native boreal plant species (e.g., foxtail barley) as weeds since they can be problematic for agriculture. Native boreal species appearing on these lists were not considered to be invasive for the Project area.

2.6.2 INVASIVE CONCERN CLASSIFICATION

The non-native plant species recorded during monitoring to date were classified into one of four levels of invasive concern for the Project area (Table 2-5). Level 1 was the highest level of invasive concern for the Project. Level 1 species included ISCM Category 1 and 2 species.

The second highest level of invasive concern for the Project (Level 2 species) included ISCM "other" species of concern and/or the non-native species that White *et al.* (1993) classify as being principal or moderate invasives in Canada. These species also have the potential to crowd out native species in many of the conditions where non-native plants are found.

The third highest level of invasive concern (Level 3 species) included non-native species that White *et al.* (1993) classify as minor invasives in Canada and/or the species that government sources classify as noxious weeds or weed seed species.

The fourth and lowest level of invasive concern (Level 4 species) included all of the non-native plant species not already included in another level. Species at the third and fourth levels may become problematic in some locations and/or conditions (*e.g.*, changed climate). They will also be a consideration when developing revegetation plans for areas being rehabilitated to native habitat types.

Table 2-6 shows how the invasive concern classification was applied to the non-native plant species recorded in the Project footprint to date.

Table 2-5: Levels of invasive concern for plants in the Project footprint

Invasive Concern Level	Plant Species Included
Level 1	Species the ISCM classifies as "Category 1" or "Category 2"
Level 2	Species the ISCM classifies as "other" or White et al. (1993) classify as "high" or "moderate" invasives
Level 3	Species that either White et al. (1993) classify as "minor" invasives, or government sources classify as noxious weeds or weed seed species[1]
Level 4	All remaining non-native plant species

Notes: [1] The government regulations list some native boreal plant species (e.g., foxtail barley) as weeds since they focus on species that are problematic for agriculture. Native boreal species appearing on these lists are not considered to be invasive for the Project area.

Table 2-6: Classification of non-native plant species recorded in the Project footprint into levels of invasive concern

Invasive Concern[1]	Common Name[2]	Scientific Name	ISCM Category[3]	White et al. Category[4]	Noxious Weed[5]	Weed Seed[6]
Level 1	Scentless chamomile	*Tripleurospermum inodorum*	Category 2		Tier 2	Secondary
	Ox-eye daisy	*Leucanthemum vulgare*	Category 2		Tier 2	Primary
	Common tansy	*Tanacetum vulgare*	Category 2		Tier 2	
Level 2	Canada thistle	*Cirsium arvense*	Other	Moderate	Tier 3	Primary
	Field sow-thistle	*Sonchus arvensis*	Other		Tier 3	Primary
	Common burdock	*Arctium minus*	Other		Tier 3	
	Tufted vetch	*Vicia cracca*	Other			
	White sweet clover	*Melilotus albus*		Moderate		
	Yellow sweet clover	*Melilotus officinalis*		Moderate		
Level 3	Wormwood	*Artemisia absinthium*		Minor	Tier 3	
	Alfalfa	*Medicago sativa*		Minor		
	Lamb's quarters	*Chenopodium album*			Tier 3	
	Common dandelion	*Taraxacum officinale*			Tier 3	
	Narrow-leaved hawks-beard	*Crepis tectorum*			Tier 3	
	Flixweed	*Descurainia sophia*			Tier 3	
	Curly dock	*Rumex crispus*				Secondary
Level 4	Canola	*Brassica napus*				
	Shepherd's-purse	*Capsella bursa-pastoris*				
	Wormseed mustard	*Erysimum cheiranthoides*				
	Pineapple-weed	*Matricaria discoidea*				
	Bird's-foot trefoil	*Lotus corniculatus*				
	Black medick	*Medicago lupulina*				
	Spotted lady's-thumb	*Persicaria maculosa*				
	Common plantain	*Plantago major*				
	Common timothy	*Phleum pratense*				
	Smooth catchfly	*Silene csereii*				
	Alsike clover	*Trifolium hybridum*				
	Red clover	*Trifolium pretense*				
	White clover	*Trifolium repens*				
	Wheat	*Triticum aestivum*				

Notes: [1] See Table 2-5 for the invasive concern classification. [2] In decreasing order of concern for the Project area. [3] Invasive Species Council of Manitoba (2020). [4] White *et al.* (1993). [5] Government of Manitoba (2017b). Number in column is the Tier in the Act (see text). [6] Government of Canada (2016).

2.6.3 GENERAL APPROACH TO MANAGEMENT

The generally preferred overall strategy for addressing invasive (called "weedy" in some publications) non-native plants is a combination of prevention, early detection and eradication because this is generally considered to be the most economical and effective way to manage invasive plants (e.g., Clark 2003; Coastal Invasive Species Committee 2016).

For application, the generally preferred approach for dealing with individual plants or small patches of Level 1 non-native species appearing in new areas is to eradicate them as soon as they are discovered. Ideally, this is accomplished by manually removing the plant(s) including roots, removing the soil from around the base of the plant, immediately placing all plant and soil material into a double layer of garbage bags, and, disposing of all of the collected material (preferably by burning it). The following describes how the application of this strategy evolved over time during Project monitoring.

When Level 1 plants were found within the Project footprint during the 2015 and 2016 surveys, their locations were reported to Manitoba Hydro environmental site staff, who carried out their removal and disposal using the preferred method described above.

Partway through the 2017 surveys, it was decided that, going forward, ECOSTEM survey staff would manually remove and dispose of the Level 1 plants using the preferred approach described above. Immediate removal was intended to minimize the possibility for these plants to disperse seed or become well-established. Since this decision was made during the 2017 field season, some sites were not treated in this manner during 2017. As the 2017 surveys progressed, Level 2 plants were also immediately removed and disposed of at some sites, provided that the number of plants was low enough that it was practical to do so. This final approach was followed during the 2018 to 2020 surveys.

For the remaining sites with Level 2 plants, key sites were identified for herbicide application. The key sites were selected based on where invasive plants were most prolific and had the highest potential for being spread to other Project areas due to vehicles or footwear picking up seeds and carrying them elsewhere.

To assess the efficacy of herbicide treatments, foliage damage and mortality was used as an indicator for the approximate boundaries for where herbicides were actually applied in the treated sites. When possible, surveys were conducted soon enough after application (less than one month) that the plant remains should still have been present and identifiable to species. This indicator assumed that some degree of mortality would occur on any plants that were contacted by the herbicides. Some treated plants may occur outside of the mapped treated area due to factors such as variability in application rates or a particular species' tolerance to the chemicals used. Section 4.2 provides details.

2.7 SPECIES TREATED SEPARATELY

Native and non-native populations of reed canarygrass (*Phalaris arundinacea*) exist in North America. According to genetic analysis of herbarium specimens, the native reed canarygrass population was widespread in North American as of the early 20th century, extending from Alaska to New Brunswick (Jakubowski *et al.* 2012).

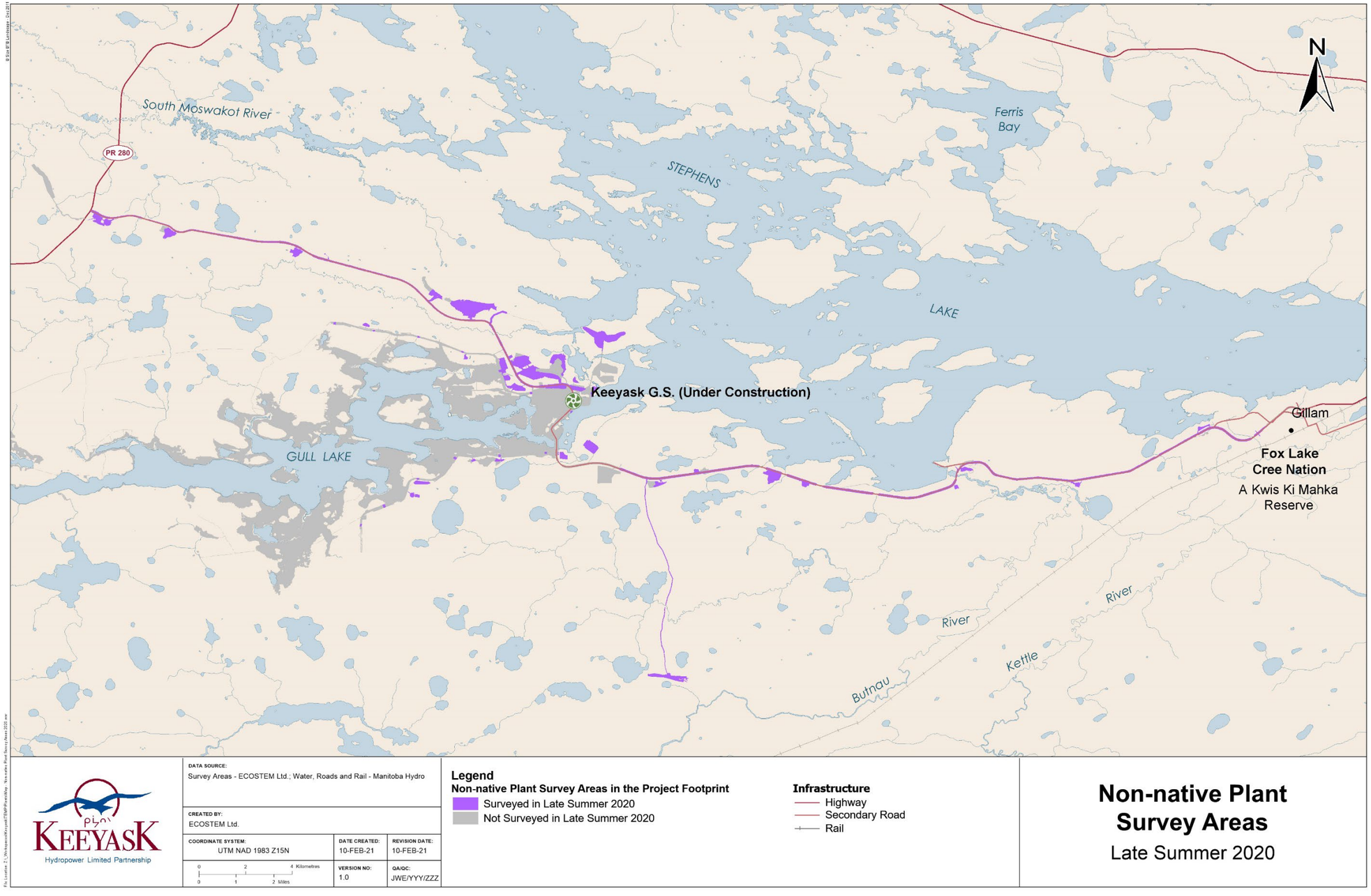
The non-native reed canarygrass population has been introduced from Eurasia on multiple occasions (Lavergne and Molofsky 2004; Lavergne and Molofsky 2007; Brodersen *et al.* 2008; Calsbeek *et al.* 2011). Genetic analysis concluded that the native and Eurasian populations are genetically distinct (Jakubowski *et al.* 2012). Additionally, non-native plants readily hybridize with native plants (Lavergne and Molofsky 2004).

Plants from the non-native or hybridized populations can be very aggressive, to the extent of crowding out native species. White *et al.* (1993) consider reed canarygrass to be a principal invasive plant in Canada.

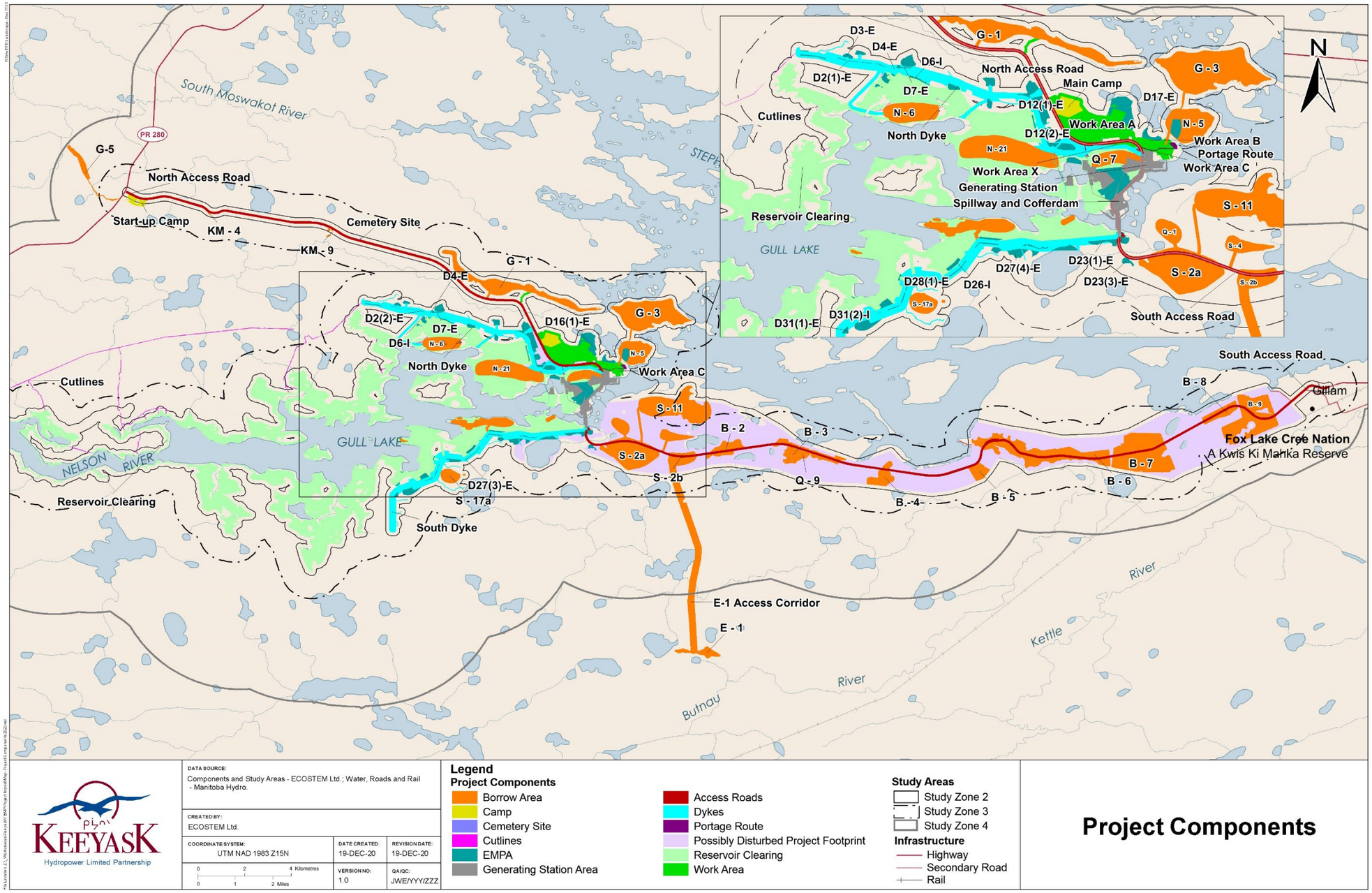
In the field, it is almost impossible to determine whether plants belong to the native, non-native or hybridized population (ISCM 2019). Some authors state that genetic analysis is the only reliable way to make this determination (Hayley 2012). As genetic analysis would be unduly onerous in many situations, some studies classify plants as native or non-native based on whether or not they are exhibiting invasive behavior (Maurer *et al.* 2003; Brodersen *et al.* 2008).

With regard to the Project footprint, evidence to date indicates that the recorded plants are likely from the native population. There is some evidence to suggest that the northern distribution limit of the non-native population in Manitoba is south of Thompson (Lavergne and Molofsky 2004; ISCM 2019). Also, more than a decade of data from the Wuskwatim Generation Project, which is also in northern Manitoba, have not demonstrated aggressive spread of the plants found there. Finally, the plants observed at Keeyask have not suggested aggressive spreading behaviour to date.

Based on the preceding information, the reed canarygrass plants recorded during Project monitoring to date are assumed to be from the native population. However, it is still possible that some or all plants occurring in the Project footprint are actually from the non-native or hybridized population but past conditions have limited invasive behavior. For this reason, field surveys still recorded reed canarygrass using the same methods as used for other non-native plants. Reed canarygrass observations and results are provided in Appendix 5 in the event that the recorded plants do become invasive in the Project area.



Map 2-1: Late summer non-native plant survey areas in 2020



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

KEEYASK Hydropower Limited Partnership

Legend

Project Components
- Borrow Area
- Camp
- Cemetery Site
- Cutlines
- EMPA
- Generating Station Area
- Access Roads
- Dykes
- 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 2-2: Project components

3.0 RESULTS

3.1 OVERALL CHANGES TO NON-NATIVE PLANT DISTRIBUTION AND ABUNDANCE

Section 2.1 describes the metrics used to document changes in distribution and abundance.

As of late summer, 2020, overall non-native plant extent had increased to 73.2 ha, or 11.9% of the total area surveyed (Table 3-1). This was an increase of 3.8 ha, which was the smallest increase in extent since the start of construction monitoring (in contrast, total extent increased by 35.0 ha between 2017 and 2018). A small degree of bias may have been introduced to the total extent due to some Project components that were sampled in 2019 but not in 2020 (Section 2.3). For example, Borrow Area N-21 was a large, recently excavated area with very few non-native plants, and was surveyed in 2019 but not in 2020. Inclusion of that area in 2020 would likely have had an effect on the overall percent of surveyed area with non-native plants depending on its non-native plant cover in 2020.

Non-native plant extent apparently decreased in several of the surveyed Project components, including the North Access Road and North Dyke. However, the North Dyke (and South Dyke) extents are not directly comparable to the 2019 extents because the survey method changed for that component (see Section 2.2.1). Increases occurred in the remaining components, with the largest being in the South Dyke followed by the Borrow Areas. Non-native plants were most widespread in the camp and work areas, borrow areas and both dykes, and were least widespread in the surveyed portion of the generating station area (Map 3-1 to Map 3-5). For the Project components, plants were distributed over 1.0% to 13.9% of the surveyed areas. When not considering Project components whose survey method changed, the largest increases in non-native plant extent since late-summer 2019 were in the Borrow Areas.

Table 3-1: Total late summer non-native plant extent as a percentage of total area surveyed, by year[1] and Project component

Project Component	2014	2015	2016	2017	2018	2019	2020	Change [2]
North Access Road	0.3	0.9	3.5	4.4	7.6	4.9	4.6	-0.3
South Access Road	-	-	0.2	2.8	7.9	7.7	7.9	0.2
Camp and Work Areas	3.2	4.7	4.0	5.9	12.8	13.1	13.9	0.8
Borrow Areas	0.3	3.1	2.1	5.1	8.9	8.0	11.5	3.5
North Dyke[3]	-	-	0.1	0.3	7.6	11.5	9.9	-1.6
South Dyke[3]	-	-	0.0	0.1	0.2	0.2	10.7	10.4
Generating Station Area	-	-	0.5	0.2	-	-	1.0	1.0
Reservoir Clearing Area	-	-	-	-	-	-	-	-
All Types	1.8	3.7	2.4	4.3	9.6	9.9	11.9	2.0
Total non-native plant extent (ha)	*4.9*	*9.3*	*14.8*	*28.9*	*64.0*	*69.4*	*73.2*	
Total area surveyed (ha)	*269*	*251*	*620*	*671*	*668*	*703*	*618*	

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Plant extent in some components are not directly comparable with other years because surveyed areas may change due to accessibility.
[2] Change from 2019 to 2020; A negative sign means that extent decreased.
[3] Due to change in survey methods, 2020 values not directly comparable to previous years.

Total non-native plant cover increased to 6.1 ha by late summer, 2020, or 0.99% of the total surveyed area (Table 3-2). This was only a 0.1 ha increase from 2019, and the total cover as a percentage of area surveyed increased by 0.14%. Cover increased in all surveyed Project components except the North Dyke.

Table 3-2: Total late summer non-native plant cover as a percentage of total area surveyed, by year[1] and Project component

Project Component	2014	2015	2016	2017	2018	2019	2020	Change [2]
North Access Road	0.01	0.07	0.25	0.38	0.62	0.45	0.50	0.06
South Access Road	-	-	0.01	0.36	1.21	2.17	3.96	1.79
Camp and Work Areas	0.34	0.77	0.58	0.73	1.20	1.05	1.54	0.49
Borrow Areas	0.05	0.48	0.24	0.46	0.74	0.64	0.66	0.02
North Dyke[3]	-	-	0.00	0.01	0.79	1.10	0.43	-0.67
South Dyke[3]	-	-	0.00	0.02	0.02	0.00	1.21	1.20
Generating Station Area	-	-	0.03	0.00	-	-	0.11	0.11
Reservoir Clearing Area	-	-	-	-	-	-	-	-
All surveyed area	0.20	0.59	0.31	0.44	0.88	0.86	0.99	0.14
Total non-native plant cover (ha)	*0.53*	*1.49*	*1.89*	*2.98*	*5.85*	*6.02*	*6.13*	
Total area surveyed (ha)	*269*	*251*	*620*	*671*	*668*	*703*	*618*	

Notes: Numbers that round to zero shown as "0"; absences shown as "-".
[1] Plant extent in some components are not directly comparable with other years because surveyed areas may change due to accessibility.
[2] Change from 2019 to 2020; A negative sign means that cover decreased.
[3] Due to change in survey methods, 2020 values not directly comparable to previous years.

As a percentage of surveyed area, non-native plant cover was highest (4%) along the surveyed segments of the SAR, followed by the camp and work areas and surveyed portions of the South Dyke.

Non-native plants continued to spread in the more recently cleared areas, but cover remained relatively low. The majority of the non-native species found in each year since 2015 were in the components used either for the KIP only or minimally affected by the Project, and components used by both the KIP and the Project (e.g., Start-up Camp, Borrow Area G-1).

In 2020, non-native plant extent was highest (20.0%) in areas used either for the KIP only or areas minimally affected by the Project (e.g., Borrow Area KM-4; Appendix 4, Table 7-7). Non-native plant cover was highest (1.5%) in areas utilized by both KIP and the Project, which was similar to what was found in 2019 (Appendix 4, Table 7-8). In areas that had not been used since the KIP or minimally affected by the Project, there was a decrease in both extent and cover of non-native plants each year from 2017 to 2020, with the exception of cover between 2019 and 2020, which remained unchanged. In areas used by both the KIP and the Project, non-native plant extent increased from 2018 to 2019, but cover remained essentially the same from 2018 to 2020.

Areas that were more recently cleared, and used only for the Project, had substantially lower non-native plant extent and cover compared to the other areas (5.2% and 0.6%, respectively). These areas had small increases for cover since 2019, while extent remained unchanged.

In 2020, the distribution of non-native plants on the north side of the Nelson River was broadly similar to that of 2019. The exception was EMPA D16 where recent erosion control measures had occurred (see ECOSTEM 2021). For the other components, non-native plants remained similar to 2019, albeit with higher plant cover, in those areas that have had minimal construction activity since 2017. These included EMPA D17, and the EMPAs along the North Dyke.

On the south side of the Nelson River, distribution had changed as plants became established in the more recently cleared areas (Map 3-1 to Map 3-5). Since 2019, non-native plants expanded along the South Dyke after construction completed, particularly in its attached EMPAs. Non-native plants were also establishing in some recently used borrow areas attached to the SAR (Borrow Areas Q-1, B-2 and E-1).

The largest increases in non-native plant extent and cover were observed in the EMPAs along the South Dyke and along the SAR (Table 3-1 and Table 3-2). Larger increases were also observed in Borrow Areas G-3 and B-2, and in the Cemetery Site.

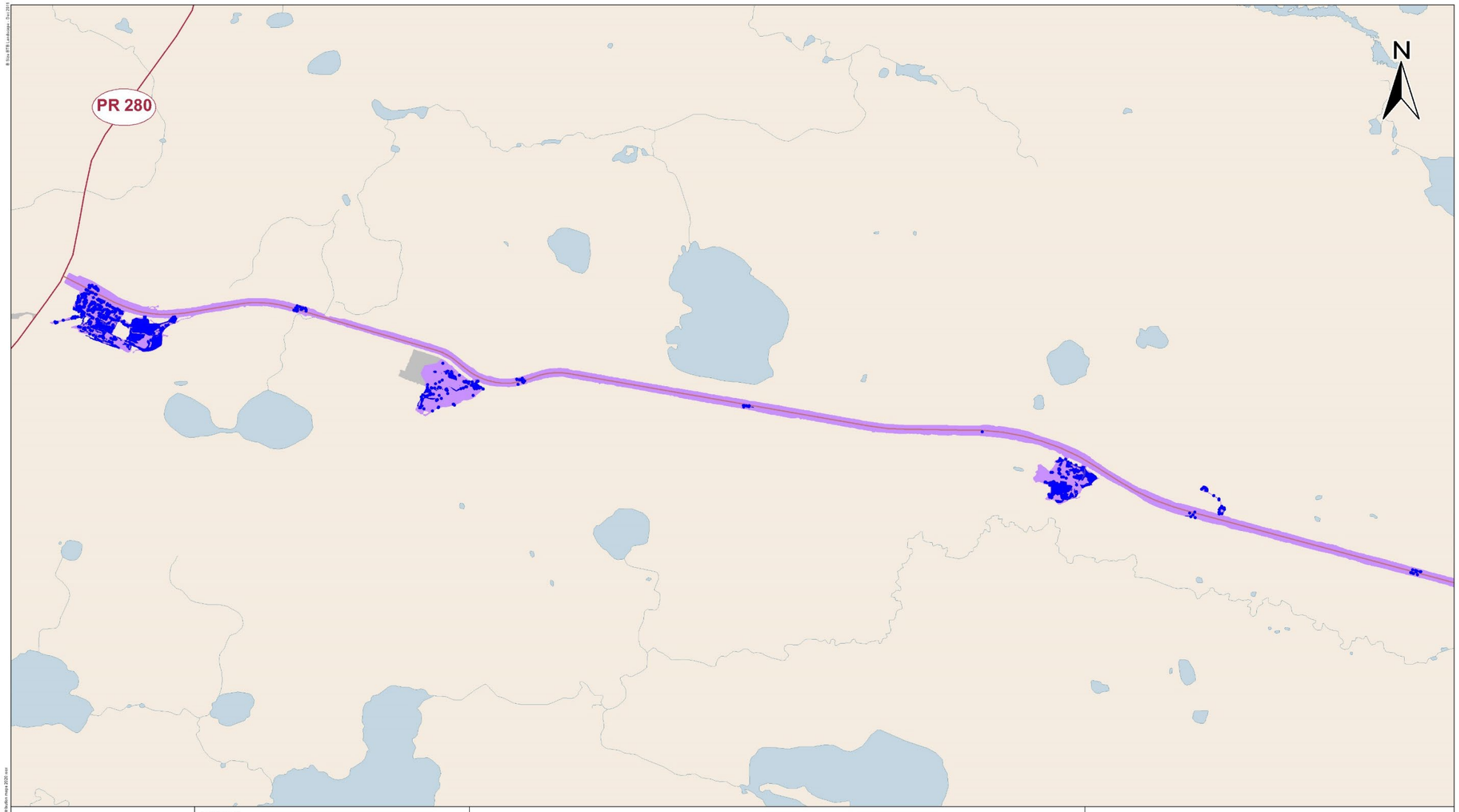
The westernmost 3 km of the SAR was not surveyed in 2018 through 2020 due to heavy construction traffic. For the remainder of the SAR, non-native plant cover had doubled from 2% to 4% of the area surveyed since 2019 (Table 3-2). The larger cover increases occurred west of the Butnau Marina (Map 3-4). In 2019, the larger increases in cover from the previous year were east of the marina. In 2019, decommissioning of the Sigfusson Northern/Voltage Camp and offices (formerly the SAR Camp) appeared to remove the non-native plant cover that was previously present in 2018. However, non-native plants had re-established there by August 2020. Plants continued to spread in Borrow Area Q-9 and Borrow Area S-2b.

While non-native plant cover was expanding along the western portions of the SAR, most of the non-native plant cover along the SAR occurred in the ditches east of the Butnau Marina, where the ROW was either in close proximity to or overlapped the old Butnau Road (Map 3-4). Non-native plant extent and cover had been expanding along this portion of the road since 2018, as well as in the west and east sections of Borrow Area B-6, and in Borrow Area B-8.

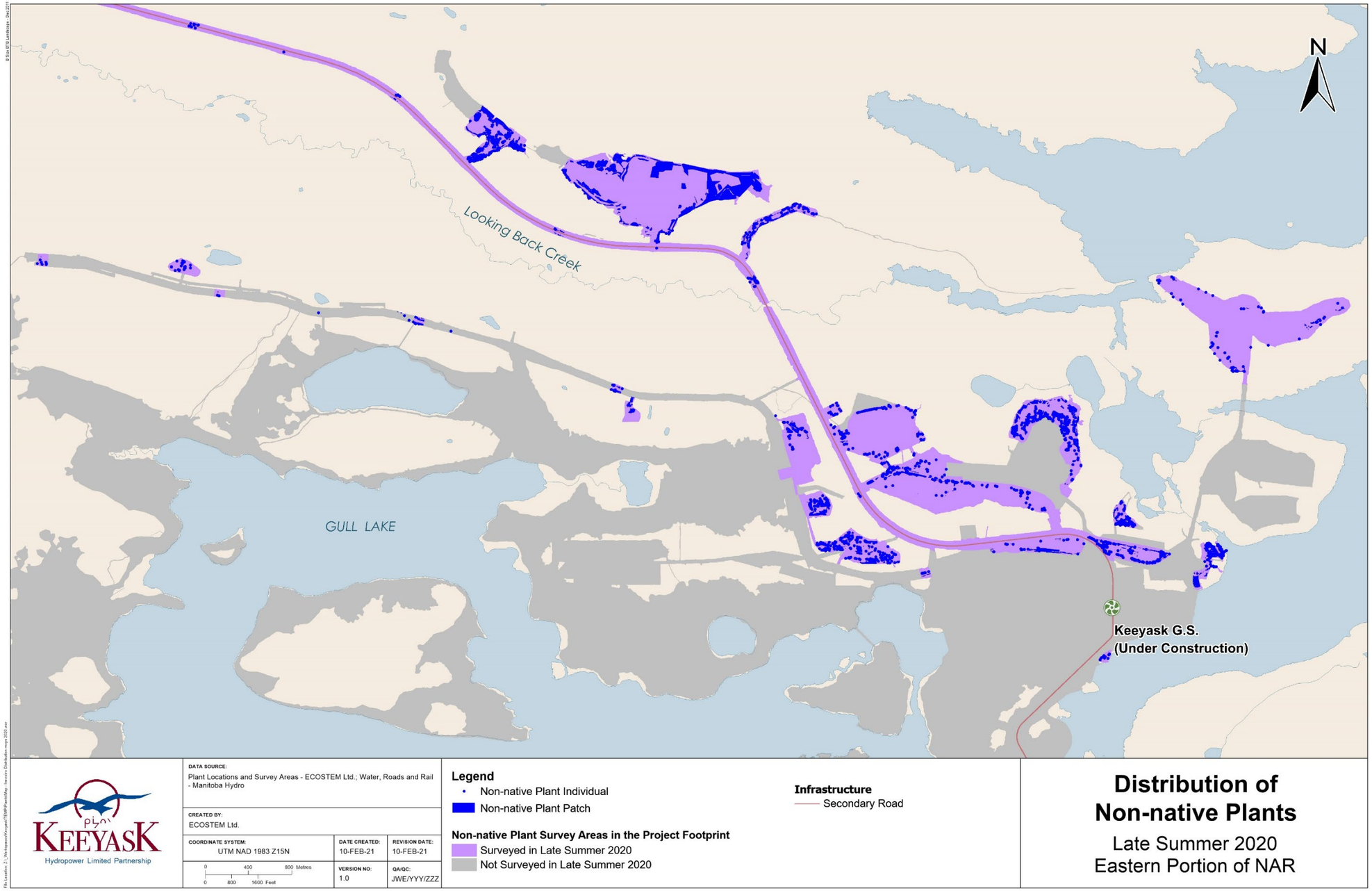
Total cover declined since 2019 in Borrow Area G-1 at KM17 and Borrow Area KM4, as well as in Borrow Area Q-9, although total extent increased there. Overall cover and extent also decreased in EMPA D16, and decreased slightly in Borrow Area S-2b. With the exception of the

dykes, where survey methods changed since 2019, non-native plant cover increased in all the remaining surveyed Project components.

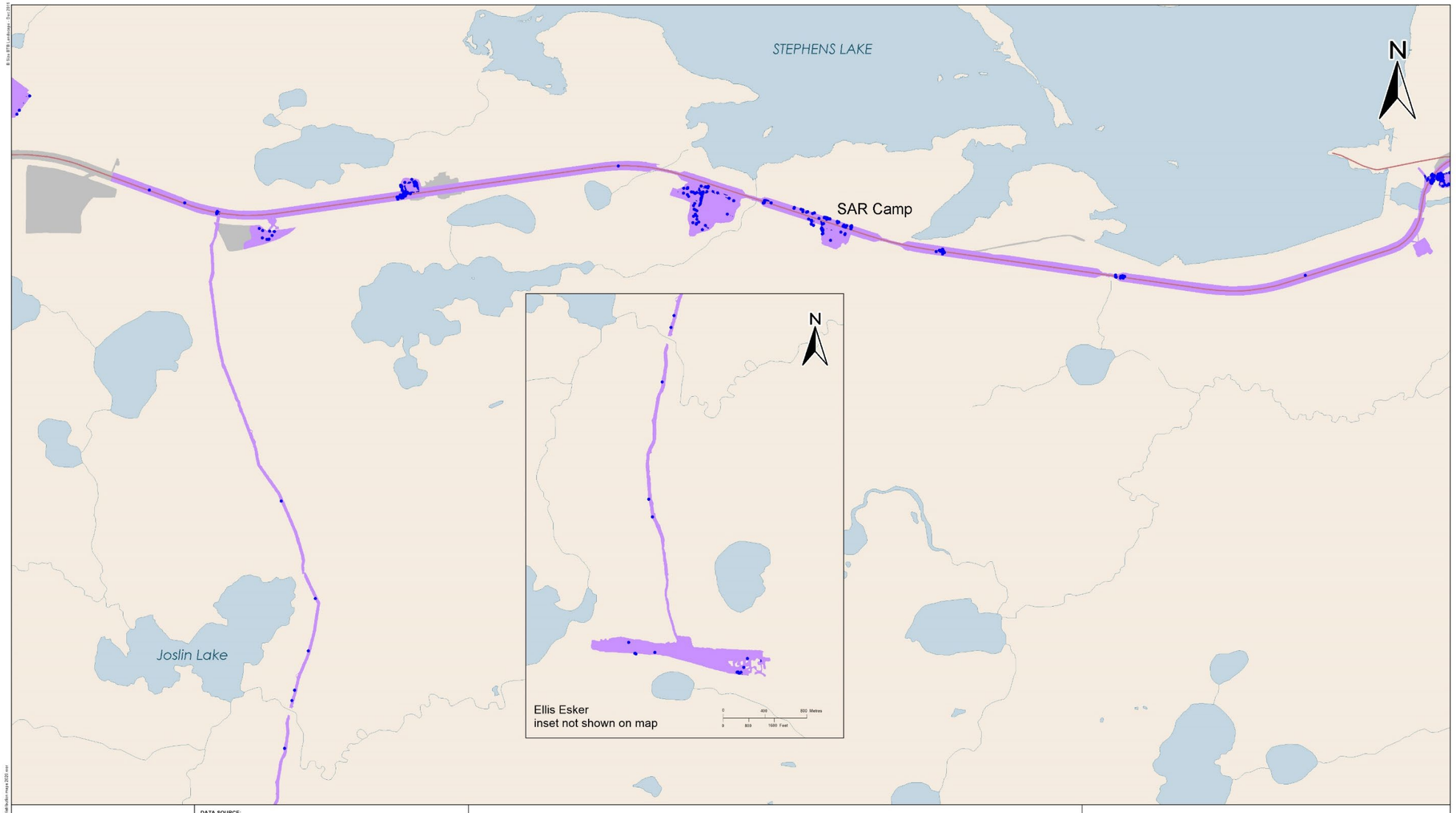
Clearing for the Ellis Esker borrow area (Borrow Area E-1) occurred during the winter of 2017/2018, was in use up to the winter of 2018/2019 after which excavation ceased there. Cleared areas included the winter access road corridor and the borrow area. By late summer 2020, a few individuals and small patches of non-native plants had established at several new sites in the borrow area, as well as at different sites along the entire length of the access corridor (Map 3-5).



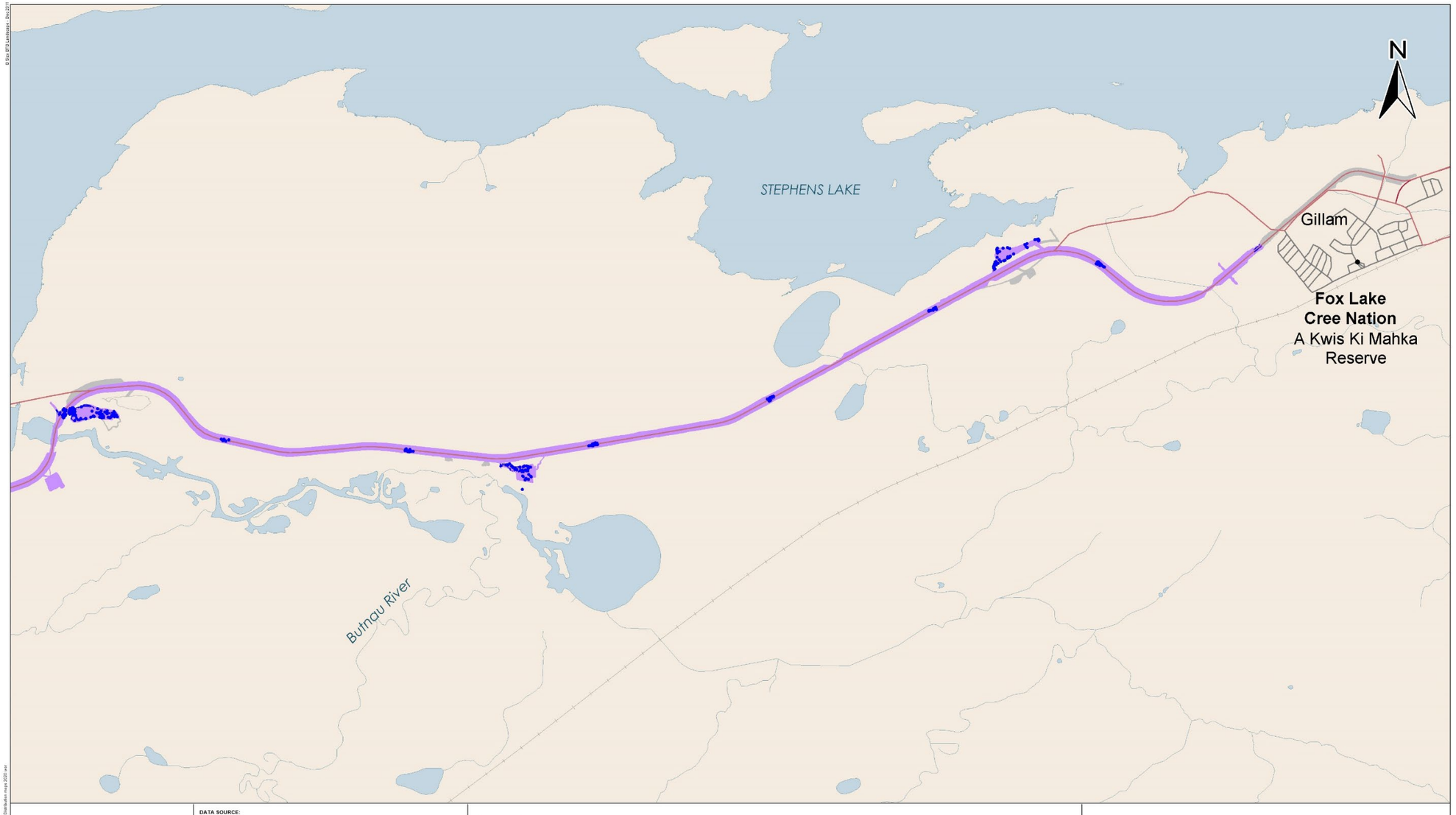
Map 3-1: Distribution of non-native plants during late summer 2020, in the Project footprint along the western portion of the North Access Road



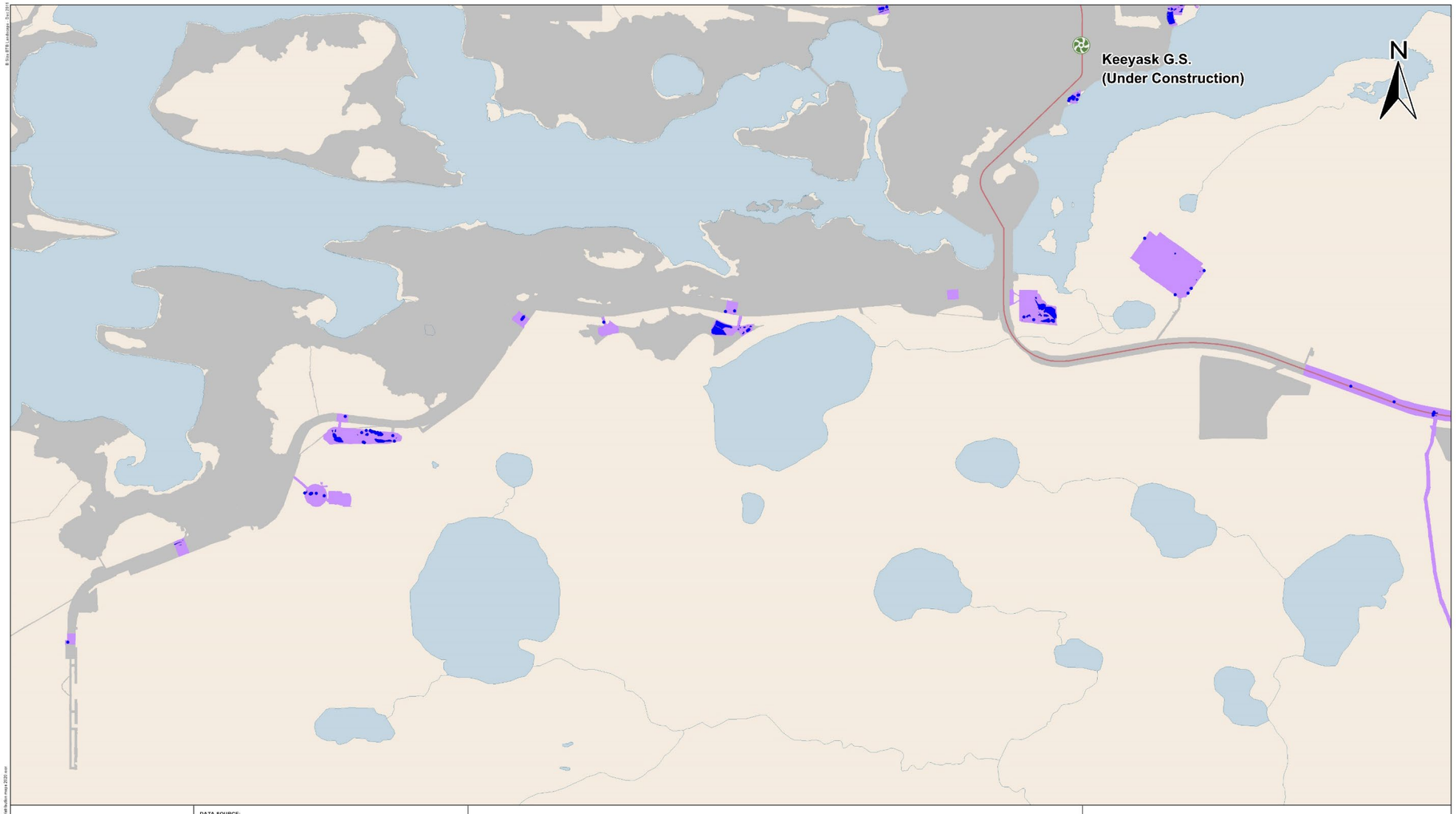
Map 3-2: Distribution of non-native plants during late summer 2020, in the Project footprint along the eastern portion of North Access Road



Map 3-3: Distribution of non-native plants during late summer 2020, in the Project footprint along the western portion of the South Access Road



Map 3-4: Distribution of non-native plants during late summer 2020, in the Project footprint along the eastern portion of the South Access Road



Map 3-5: Distribution of non-native plants during late summer 2020, in the Project footprint in the South Dyke area

3.2 CHANGES TO SPECIES DISTRIBUTION AND ABUNDANCE

A total of 27 non-native plant species were recorded in 2020 from the non-native plant monitoring and from incidental observations (Appendix 4, Table 7-3). This was two more than recorded in 2019. Map 7-1 to Map 7-25 (Appendix 3) show the distribution and abundance of the five most abundant non-native species recorded in 2020 in the Project footprint.

The four most abundant non-native species in 2020 (Table 3-3) accounted for 79% of all non-native plant cover (Table 3-4). These species were common dandelion (*Taraxacum officinale*), narrow-leaved hawks-beard (*Crepis tectorum*), lamb's quarters (*Chenopodium album*) and white sweet clover (*Melilotus albus*), each accounting for 24%, 22%, 18% and 15% of the total non-native cover in 2020, respectively (Table 3-4). The next most abundant species were field sow-thistle (*Sonchus arvensis*), yellow sweet clover (*Melilotus officinalis*) and alsike clover (*Trifolium hybridum*) with 4% of the total non-native cover each, followed by four species at between one and two percent cover.

Only five of the seven most abundant species increased in cover since 2019. As a percentage of the surveyed area, cover of common dandelion, yellow sweet clover and alsike clover more than doubled since 2019, and narrow-leaved hawks-beard and white sweet clover cover increased by 45% and 29%, respectively. Lamb's-quarters cover decreased by approximately 51%, and field sow-thistle by approximately 9% since late summer 2019.

Two non-native species were recorded for the first time in 2020. These included canola (*Brassica napus*) and flixweed (*Descurainia sophia*). Canola was found at a single site in the Borrow Area B-3, and six flixweed plants were found at another site in the same area. The flixweed plants were hand removed after they were recorded because it was the first time they were identified in the Project footprint. The canola was not removed because it was not positively identified until photos were closely examined in the lab. Species found during previous surveys but not recorded again in late summer 2020 (Table 3-3) included common burdock (*Arctium minus*), ox-eye daisy (*Leucanthemum vulgare*), rye (*Secale cereal*) and wheat (*Triticum aestivum*).

For rye, five individuals were found growing at three nearby sites beside the Start-up Camp in 2014. These plants were never found there again during subsequent surveys. Wheat was found growing from straw bales brought on site in 2016, but had disappeared by late summer 2019 and were not found again in 2020. Both common burdock and ox-eye daisy were species targeted for invasive plant control in 2019, and all the known plants were removed by the completion of the 2019 late summer surveys (see Section 4.0).

Table 3-3: Total approximate late summer non-native species cover (m^2) in the Project footprint, by year

Common Name[1,2]	Species	2014	2015	2016	2017	2018	2019	2020
Common Dandelion	*Taraxacum officinale*	1,291	2,422	5,268	5,521	10,302	6,792	14,638
Narrow-leaved Hawks-beard	*Crepis tectorum*	-	-	586	1,314	11,040	10,808	13,778
Lamb's-quarters	*Chenopodium album*	2,903	8,844	6,342	15,229	19,812	25,817	11,113
White Sweet Clover	*Melilotus albus*	532	2,252	3,015	4,949	11,591	7,839	8,907
Field Sow-thistle	*Sonchus arvensis*	252	972	1,111	1,656	2,562	3,338	2,674
Yellow Sweet Clover	*Melilotus officinalis*	0	2	109	254	543	1,235	2,652
Alsike Clover	*Trifolium hybridum*	25	242	190	91	833	1,021	2,250
Common Plantain	*Plantago major*	80	121	268	246	741	674	1,108
Smooth Catchfly	*Silene csereii*	-	5	26	32	294	338	855
Tufted Vetch	*Vicia cracca*	-	-	0	38	170	563	821
Spotted Lady's-thumb	*Persicaria maculosa*	-	-	-	-	-	77	752
Unidentified Sweet Clover	*Melilotus* spp.	72	-	1,838	67	307	851	567
Wormseed Mustard	*Erysimum cheiranthoides*	-	-	-	-	-	495	470
Curled Dock	*Rumex crispus*	-	-	100	19	148	204	465
Alfalfa	*Medicago sativa*	124	11	14	40	98	102	139
Pineapple-weed	*Matricaria discoidea*	-	18	29	325	74	32	78
Common Timothy	*Phleum pratense*	-	-	0	0	0	0	13
Red Clover	*Trifolium pratense*	0	0	-	1	0	0	6
Canada Thistle	*Cirsium arvense*	-	0	0	1	2	1	5
Black Medick	*Medicago lupulina*	0	1	-	0	-	-	3
Common Tansy	*Tanacetum vulgare*	-	-	-	-	0	0	2
Bird's-foot Trefoil	*Lotus corniculatus*	-	-	0	0	-	0	2
Wormwood	*Artemisia absinthium*	-	0	1	1	1	-	1
Flixweed	*Descurainia sophia*	-	-	-	-	-	-	0
White Clover	*Trifolium repens*	0	0	0	-	-	0	0
Unidentified Clover	*Trifolium* spp.	-	-	-	-	-	0	0
Shepherd's-Purse	*Capsella bursa-pastoris*	-	-	-	-	-	0	0
Canola	*Brassica napus*	-	-	-	-	-	-	0

Common Name[1,2]	Species	2014	2015	2016	2017	2018	2019	2020
Scentless chamomile	*Tripleurospermum inodorum*	-	0	0	0	1	0	0
Common Burdock	*Arctium minus*	-	-	0	-	5	5	-
Ox-eye Daisy	*Leucanthemum vulgare*	-	-	-	-	0	0	-
Rye	*Secale cereale*	0	-	-	-	-	-	-
Wheat	*Triticum aestivum*	-	-	30	21	-	-	-
All species		*5,280*	*14,890*	*18,927*	*29,805*	*58,524*	*60,191*	*61,300*

Notes: Numbers that round to zero shown as "0"; absences shown as "-". [1] Bolded species are Level 1 invasive concern (Table 2-6). Italicized species are Level 2 invasive concern. Underlined species are Level 3 invasive concern. Remaining species are non-native species that may become problematic in some sites and/or condition. [2] Species difficult to distinguish until they flower are combined into a broader taxon. *Melilotus* spp. includes *M. albus* and *M. officinalis*.

Table 3-4: Total approximate cover of non-native species as a percentage of total cover for all non-native species, by year

Common Name[1,2]	Species	2014	2015	2016	2017	2018	2019	2020
Common Dandelion	*Taraxacum officinale*	24	16	28	19	18	11	24
Narrow-leaved Hawks-beard	*Crepis tectorum*	-	-	3	4	19	18	22
Lamb's-quarters	*Chenopodium album*	55	59	34	51	34	43	18
White Sweet Clover	*Melilotus albus*	10	15	16	17	20	13	15
Field Sow-thistle	*Sonchus arvensis*	5	7	6	6	4	6	4
Yellow Sweet Clover	*Melilotus officinalis*	0	0	1	1	1	2	4
Alsike Clover	*Trifolium hybridum*	0	2	1	0	1	2	4
Common Plantain	*Plantago major*	2	1	1	1	1	1	2
Smooth Catchfly	*Silene csereii*	-	0	0	0	1	1	1
Tufted Vetch	*Vicia cracca*	-	-	0	0	0	1	1
Spotted Lady's-thumb	*Persicaria maculosa*	-	-	-	-	-	0	1
Unidentified Sweet Clover	*Melilotus* spp.	1	-	10	0	1	1	1
Wormseed Mustard	*Erysimum cheiranthoides*	-	-	-	-	-	1	1
Curled Dock	*Rumex crispus*	-	-	1	0	0	0	1
Alfalfa	*Medicago sativa*	2	0	0	0	0	0	0
Pineapple-weed	*Matricaria discoidea*	-	0	0	1	0	0	0
Common Timothy	*Phleum pratense*	-	-	0	0	0	0	0

Common Name[1,2]	Species	2014	2015	2016	2017	2018	2019	2020
Red Clover	*Trifolium pratense*	0	0	-	0	0	0	0
Canada Thistle	*Cirsium arvense*	-	0	0	0	0	0	0
Black Medick	*Medicago lupulina*	0	0	-	0	-	-	0
Common Tansy	*Tanacetum vulgare*	-	-	-	-	0	0	0
Bird's-foot Trefoil	*Lotus corniculatus*	-	-	0	0	-	0	0
Wormwood	*Artemisia absinthium*	-	0	0	0	0	-	0
Flixweed	*Descurainia sophia*	-	-	-	-	-	-	0
White Clover	*Trifolium repens*	0	0	0	-	-	0	0
Unidentified Clover	*Trifolium* spp.	-	-	-	-	-	0	0
Shepherd's-Purse	*Capsella bursa-pastoris*	-	-	-	-	-	0	0
Canola	*Brassica napus*	-	-	-	-	-	-	0
Scentless chamomile	*Tripleurospermum inodorum*	-	0	0	0	0	0	0
Common Burdock	*Arctium minus*	-	-	0	-	0	0	-
Ox-eye Daisy	*Leucanthemum vulgare*	-	-	-	-	0	0	-
Rye	*Secale cereale*	0	-	-	-	-	-	-
Wheat	*Triticum aestivum*	-	-	0	0	-	-	-
All species		*5,280*	100	100	100	100	100	100

Notes: Numbers that round to zero shown as "0"; absences shown as "-". [1] Bolded species are Level 1 invasive concern (Table 2-6). Italicized species are Level 2 invasive concern. Underlined species are Level 3 invasive concern. Remaining species are non-native species that may become problematic in some sites and/or condition. [2] Similar species that are difficult to distinguish until they flower are combined into a broader taxon. *Melilotus* spp. includes *M. albus* and *M. officinalis*.

4.0 EFFORTS TO MANAGE INVASIVE PLANTS

Non-native species that were considered for management measures included all of the Level 1 species (Section 2.6.2), which were the species of highest invasive concern for the Project footprint. Level 2 species were candidates for management measures if they were not already well-established in multiple locations. Level 3 and Level 4 species were opportunistically managed within locations where Level 1 or 2 species were treated.

Seven of the 27 non-native species recorded in 2020 (Appendix 4, Table 7-6) were classified as being Level 1 or 2 (Table 2-6). None of these were an ISCM Category 1 species, and none were a Tier 1 species in the *Noxious Weeds Act* of Manitoba.

The Level 1 species (Table 2-6) found in 2020 were scentless chamomile and common tansy. Level 2 species included Canada thistle, field sow-thistle, tufted vetch, and white and yellow sweet clover.

Strategies employed to date to manage non-native plants include prevention, eradication and control. Several prevention measures are included in the Environmental Protection Plans (e.g., washing equipment before transporting to site). Examples of prevention measures implemented in the monitoring are: staff conducting the surveys clean their footwear before they leave a surveyed area; and, providing site environmental staff with non-native plant identification training and resources.

The three primary eradication and control methods employed to date were rapid manual removal, herbicide treatments, and mowing at key sites. The following describes these measures.

4.1 RAPID MANUAL REMOVAL AND OTHER NON-CHEMICAL ACTIONS

The rapid manual removal strategy was applied to Level 1 plants at sites with one to a few plants (see Section 2.6.3 for the removal methods). Such plants were immediately removed when they were found.

4.1.1 LEVEL 1 NON-NATIVE SPECIES

The two Level 1 non-native species recorded in 2020 were scentless chamomile and common tansy. One additional species, ox-eye daisy, was found in previous years, but not in 2020. All three species are an ISCM Category 2 species or a Tier 2 species in the provincial *Noxious Weeds Act* (Table 2-6). Scentless chamomile is also a weed seed plant in the federal Weed Seeds Order.

To date, the rapid manual removal appears to have been effective for the Level 1 species (Section 2.6.3). The following describes the situations for individual species.

Scentless Chamomile

Scentless chamomile (Photo 4-1) is an annual to short-lived perennial. It is a fast-growing prolific seed producer that can form dense monocultures (LSSG 2010).

Field surveys identified one scentless chamomile plant in the Start-up Camp footprint (on the path to the well in 2015), in EMPA D17 in 2016, and in EMPA D16 in 2017, and several plants were found in the Start-up Camp, EMPA D16, Work Area B and the Main Camp in 2018 and 2019 (Appendix 3, Map 7-26). Shortly after the 2015 and 2016 plants were found, it was recommended that Manitoba Hydro site staff remove and dispose of these plants using the preferred method. Manitoba Hydro site staff carried out the scentless chamomile plant removal shortly thereafter. ECOSTEM staff removed all the plants found since 2017.

The sites where scentless chamomile plants had been removed in prior years were revisited in 2020. These sites had no scentless chamomile plants.

In August 2020, scentless chamomile was found growing at four new sites (Map 7-26): two in the ditch on the north side of the SAR, and two in EMPA D28(1)-E which is attached to the South Dyke (Photo 4-1). All of these plants were immediately removed and disposed of by ECOSTEM field staff.

Photo 4-1: Scentless chamomile growing in EMPA D28(1)-E on August 24, 2020

Common Tansy

Common tansy (Photo 4-2) is a perennial that spreads through seeds and its extensive root system. Seeds from this plant can germinate after being in the ground for up to 25 years (ISCM 2020).

Common tansy was found growing at a single site along the North Dyke in late summer, 2018, and at another site nearby in 2019 (Photo 4-2; Appendix 3, Map 7-27). The plants were immediately removed by ECOSTEM field staff.

Common tansy was found growing at eight sites in 2020. This included four sites in the ditch along the SAR, two in the ditch along the NAR, one site in Work Area A, and one site along the North Dyke. Single plants were found at each site, except for the North Dyke, where two plants were growing. The plants found at the North Dyke were growing at the same site that a single plant was found in 2018. All plants were immediately removed by ECOSTEM staff. No plants were found in 2020 growing at the site where a plant was removed in 2019.

Photo 4-2: Common tansy growing beside the South Access Road on August 24, 2020

Ox-eye Daisy

Ox-eye daisy (Photo 4-3) is an introduced ornamental perennial. It can quickly spread by both seed and rhizomes (ISCM 2020).

Single ox-eye daisy plants were found growing in Work Area B in 2017, in Borrow Area G-1 and the Sigfusson Northern/Voltage Camp in 2018, and in Borrow Area Q-9 in 2019. All plants were removed by ECOSTEM field staff.

Sites that had ox-eye daisy plants that were removed were revisited in 2020. No plants were found at any of these sites, and no new plants were found at any other sites during the 2020 surveys.

Photo 4-3: Ox-eye daisy growing in Borrow Area Q-9 on August 26, 2019

4.1.2 LEVEL 2 NON-NATIVE SPECIES

Five Level 2 non-native species were recorded in 2020. Of these, the ISCM "other" species included Canada thistle, field sow-thistle and tufted vetch. The first two of the preceding species are also Tier 3 species in the provincial *Noxious Weeds Act*. White *et al.* (1993) classify white sweet clover, yellow sweet clover and Canada thistle as moderately invasive in Canada. Canada thistle is also classified as a weed seed plant in the federal Weed Seeds Order (Table 2-6).

Manual removal has not been successful for Level 2 species in most cases. The following describes the situations for individual species.

Canada Thistle

Canada thistle is a perennial that has the capacity to proliferate from roots left in the ground after manual removal, and infestations can develop quickly (Saskatchewan Ministry of Agriculture 2008; Manitoba Agriculture 2019).

Canada thistle is the only Level 2 species that, in addition to meeting the criteria for inclusion in this level, is also a provincial Tier 3 noxious weed, a moderate invasive species in Canada, and a federal weed seed (Section 2.6.2).

Canada thistle was found at three sites during the 2015 and 2016 surveys (Appendix 3, Map 7-28). Plants were not observed again at one of the sites during surveys in subsequent years. The remaining two sites were included in the areas treated with herbicides (see Section 4.2).

Surveys in 2017 found two new sites with Canada thistle, one with two individuals near the south ditch surrounding the Start-up Camp, and one small patch at the eastern corner of Borrow Area KM-4. Because the patches were small, it was recommended that the plants be removed where feasible (Hutchinson 1992; Alberta Invasive Plant Council 2014). The preferred disposal method was the same as the one described above for scentless chamomile, with particular attention to removing the main root to the extent feasible. The plants at the latter site were removed and disposed of by ECOSTEM field staff in 2017. ECOSTEM field staff returned to the site at the Start-up Camp in 2017, and no new plants were found. However, plants at both sites had re-established in 2018, and were removed by ECOSTEM field staff in early and late summer. Surveys in September 2019 found that the plants had re-established in both the Start-up Camp and Borrow Area KM-4 in 2019. In 2020, the patch in Borrow Area KM-4 was still present, but did not appear to have expanded in size. The plant at the Start-up Camp site was not found in 2020.

Canada thistle was found at other sites in 2018. One site was a small patch growing next to the North Dyke. These plants were removed by ECOSTEM staff. The second site was a more extensive patch in the ditch along the NAR (Appendix 3, Map 7-28). This patch was too extensive and interspersed among other plants to be removed by hand. The plants at both of these sites were not found again in 2019. Canada thistle was found at four new sites in 2020. This included two new sites in the Start-up Camp parking lot ditch, one site in Borrow Area G-1 at KM 15, and one site in Borrow Area B-2.

Canada thistle is known to have the capacity to proliferate from roots left in the ground after manual removal, and infestations can develop quickly (Saskatchewan Ministry of Agriculture 2008; Manitoba Agriculture 2019). As plants have reappeared in Borrow Area KM-4 after more than one removal, it is apparent that root systems have become established.

The overall management strategy for Canada thistle was modified after 2018 because plants reappeared in the same site after several removals and manual removal can amplify vegetative spread. Canada thistle plants will no longer be removed at sites where the plants are mature or where they have reappeared after one removal of a plant. While manual removal will continue to include roots, there will be increased efforts to remove all of them at sites with one to a few plants.

The new sites in the Start-up Camp and Borrow Area G-1 were all in areas that were treated with herbicide (see Section 4.2). The plant at the site in Borrow Area B-2 was not removed. That site will be targeted for treatment with herbicide in 2021 and re-visited during the late-summer surveys.

Field Sow-Thistle

Field sow-thistle is a perennial that can spread both through seeds as well as through an extensive root system, and is capable of reducing the number of plant species in communities (ANHP 2011e; Manitoba Agriculture 2019).

Field sow-thistle was already present (sparsely but fairly widespread) in the Project footprint, and in disturbed areas throughout the Keeyask region, prior to the Project. By 2015, field sow-thistle was already becoming well established in Project footprint components that were previously utilized by the KIP, particularly at the Start-up Camp, and in Borrow Area G-1 at KM-15. To limit further spread, ECOSTEM field staff implemented the rapid manual removal protocol at sites where only a small number of plants were present during the 2017 through 2020 surveys.

Of the sites containing field sow-thistle in 2019, portions of Borrow Area G-1 at KM-15, the Start-up Camp, the Main Camp, and the North Dyke were treated with herbicide in late July, 2020. One area was also targeted for mowing (see Section 4.2).

Results from the 2020 late summer survey indicated that field sow-thistle cover continued to expand in all sites that it was already established in, and had expanded into new sites, particularly along the NAR and SAR and the North Dyke (Appendix 3, Map 7-16 to Map 7-20). However, total cover declined between 2019 and 2020, which was entirely due to large declines in cover in Borrow Area G-1 and the Start-up Camp.

The best form of control for field sow-thistle is removing or killing the plants before the extensive root system develops (Manitoba Agriculture 2019). Like Canada thistle, field sow-thistle infestations can develop quickly from roots left in the ground after manual removal. The overall management strategy for field sow-thistle is the same as described for Canada thistle.

Tufted Vetch

Tufted vetch is a trailing perennial that can spread by seed as well as rhizomes, and can overgrow surrounding vegetation and alter soil chemistry (ANHP 2011a; ISCM 2020).

Tufted vetch plants were most widespread along the SAR east of the Butnau Marina, where patches were recorded at 11 sites in the ditch in 2020 (Appendix 3, Map 7-29). Plants were also present at several sites in the west and east portions of Borrow Area B-6, adjacent to the SAR east of the marina. Previous surveys indicated that tufted vetch was already well established in this site and in nearby areas, particularly along the old Butnau Road and in the Town of Gillam.

Tufted vetch plants were found at five new sites west of the Butnau Marina and north of the Nelson River during the 2020 surveys (Appendix 3, Map 7-29). These included small patches in the Cemetery Site, Borrow Area G-1 at KM 15, Borrow Area KM-9, the Main Camp, and in Borrow Area B-3 south of the previous Sigfusson Northern/Voltage Camp site. One additional patch of tufted vetch in Borrow Area G-1 was at a site where a plant was present in 2019.

The patches found in 2020 were either too large to manually remove at the time of the surveys, or too interspersed with native vegetation in compacted soil to effectively remove. These sites will be targeted for herbicide treatment in 2021 (Section 4.2.1).

Rapid manual removal was not employed (and not recommended) at the remaining tufted vetch sites along the SAR and in an adjacent borrow areas east of the Butnau Marina. In these cases, the plants were well established at these sites and in areas adjacent to or near the Project footprint.

White and Yellow Sweet Clover

White and yellow sweet clover are biennial plants that spread prolifically by seed, and rapidly invade open areas, shading out other vegetation (ANHP 2011f).

Yellow sweet clover plants have expanded in both extent and cover annually since construction monitoring began in 2014 (Table 3-3). This was generally also the case for white sweet clover, except between August 2018 and August 2019 when total cover decreased by approximately 32%. However total cover increased again between August 2019 and August 2020, although not to the same level as in 2018. The year-to-year changes were not because the areas surveyed were somewhat different across the three years (the areas surveyed in 2018 but not 2019 or 2020 had very low or no sweet clover cover).

Sweet clover extent and cover continued to increase along the SAR, particularly west of the Butnau Marina. Sweet clover was also found at more sites along the NAR, although total cover there decreased slightly since 2019. Total sweet clover cover (particularly yellow) increased by nearly four times between 2019 and 2020 in EMPA D16 (Map 7-12). Sweet clover extent and cover also increased in the Cemetery Site and in Borrow Area KM-9. The plant was also establishing again in Work Area B around the Hydro and BBE offices, after it was absent in 2019 following herbicide treatments.

The rapid manual removal protocol was not applied for white and yellow sweet clover. White sweet clover was already fairly widespread in the Project footprint, and in disturbed areas throughout the Keeyask region, prior to the Project. This species had expanded considerably in extent and/or cover from 2014 to 2018, and in 2020 had returned to near 2018 cover levels after a decline in cover. As of August 2020, the two species were collectively the third most abundant non-native species. White and yellow sweet clover are commonly found in disturbed areas throughout the Province, particularly along roadsides, making it difficult to prevent them from spreading.

White and yellow sweet clover were present in some of the key sites treated with herbicides in 2020 (Section 4.2).

4.1.3 LEVEL 3 NON-NATIVE SPECIES

Seven of the non-native species recorded in the Project footprint were Level 3 invasive concern. All are considered to be noxious weeds, weed seed species and/or minor invasives in Canada (Table 2-6). Level 3 species recorded in 2020 included wormwood (*Artemisia absinthium*), lamb's quarters, narrow-leaved hawks-beard, flixweed, common dandelion, curly dock, and alfalfa (*Medicago sativa*).

Lamb's Quarters

Lamb's quarters is an annual that spreads by seeds. Its seeds can remain viable in the soil for up to 40 years (ANHP 2011c; Manitoba Agriculture 2019).

Lamb's quarters has been the most abundant of the Level 3 species in every year of Project monitoring until 2020, when it fell to the third-most abundant species (Table 3-4). Between 2019 and 2020, total lamb's quarters cover as a percentage of the surveyed area fell to just under half that recorded in 2019. Results from the 2016 surveys suggested that lamb's quarters cover was possibly beginning to decline (ECOSTEM 2017). However, by late summer 2017 lamb's-quarters extent and cover had increased substantially to its highest level since construction began (ECOSTEM 2018a). Plant cover continued to increase to late summer 2019 at a fairly consistent rate until decreasing sharply in 2020.

While there was an overall decline in total lamb's quarters cover, it continued to expand into new portions of the Project footprint. Large decreases in lamb's quarters cover occurred in Project components that were used by the KIP and the Project, or by the KIP only, as well as the older components used by the Project only (Map 7-1 to Map 7-5). These Project components included EMPAs D16 and D12(2)-E, and Borrow Areas G-1, KM-4 and KM-9. Increases in cover were observed in more recently used areas, including the EMPAs adjacent to the South Dyke and EMPA D12(1)-E, Borrow Area B-2 and G-3, and along the SAR.

Narrow-leaved Hawks-beard

Narrow-leaved hawks-beard is an annual that reproduces by seed, and can rapidly colonize areas delaying the establishment of other plants (ANHP 2011d; Manitoba Agriculture 2019).

By late summer 2020, narrow-leaved hawks-beard was the second-most abundant non-native species in the Project footprint. The plant has continued to spread into more recently cleared Project components, and total cover has increased throughout the footprint to its highest level to date. There was an apparent decrease in total cover between 2018 and 2019, but by August 2020, total cover had increased to above 2018 levels. The largest increases in cover were in Project components used by both the KIP and the Project (Appendix 3, Map 7-21 to Map 7-25).

Common Dandelion

Common dandelion is a perennial that spreads prolifically by seed, as well as by shoots from root crowns (ANHP 2011b; Manitoba Agriculture 2019). Common dandelion is an early colonizer, and can also establish in existing vegetation and compete for resources and pollinators (ANHP 2011b).

By late summer 2020, common dandelion was the most abundant non-native species in the Project footprint (Map 7-6 to Map 7-10). Common dandelion cover has rapidly expanded since 2017, nearly doubling by late summer 2018. By 2019, total common dandelion cover had decreased by about 34%, but it increased again by 2020 to its highest level to date. Increases occurred in all Project components, except for EMPA D16, where there was a small decrease in

total cover and extent. Cover remained very low or absent in the surveyed portions of the South Dyke and its attached EMPAs.

All Other Level 3 Species

Total cover for the remaining species at Level 3 invasive concern was relatively low in all survey years.

4.1.4 LEVEL 4 NON-NATIVE SPECIES

The remaining 13 non-native species recorded in the Project footprint were Level 4, or the lowest level of invasive concern, for the Project footprint.

While the Level 4 non-native species were fairly common in disturbed areas surrounding the Project, few of these species appeared to be spreading rapidly. Spotted lady's thumb, which was first recorded in in 2019, increased in total cover; but wormseed mustard, also recorded for the first time in 2019, did not increase in cover. The Level 4 non-native species with the highest cover overall were Alsike clover (*Trifolium hybridum*) and common plantain (*Plantago major*), both of which approximately doubled in cover between 2019 and 2018. These two species only made up 4% and 2% of the total non-native plant cover, respectively. These species will continue to be monitored.

4.2 HERBICIDE TREATMENTS AT KEY SITES

4.2.1 TREATMENTS

Herbicide application at key sites was the second management strategy employed to date to control invasive plants. The key sites were selected based on a combination of which invasive species were present, where these species were most prolific, accessibility, and which sites had the highest potential for providing seed that could be spread to other Project areas (i.e., due to vehicles or footwear picking up seeds and carrying them elsewhere).

Herbicide treatment programs were carried out in 2016, 2018 and 2019 in selected areas. Herbicide treatment programs continued in 2020 in the areas shown in Map 4-1. Table 4-1 summarizes the dates, locations and herbicide mixture used for the treatments.

In 2016 and 2018, the herbicide applicators were provided in generalized areas that contained the plants targeted for herbicide control. For the subsequent years, the herbicide applicators were provided with more specific locations that were patches of plants that included the target species, based on the previous year's mapping. The species targeted for treatment included common burdock, Canada thistle, ox-eye daisy, field sow-thistle, common tansy, scentless chamomile and tufted vetch. In 2020, Manitoba Hydro staff familiar with the target species visited the

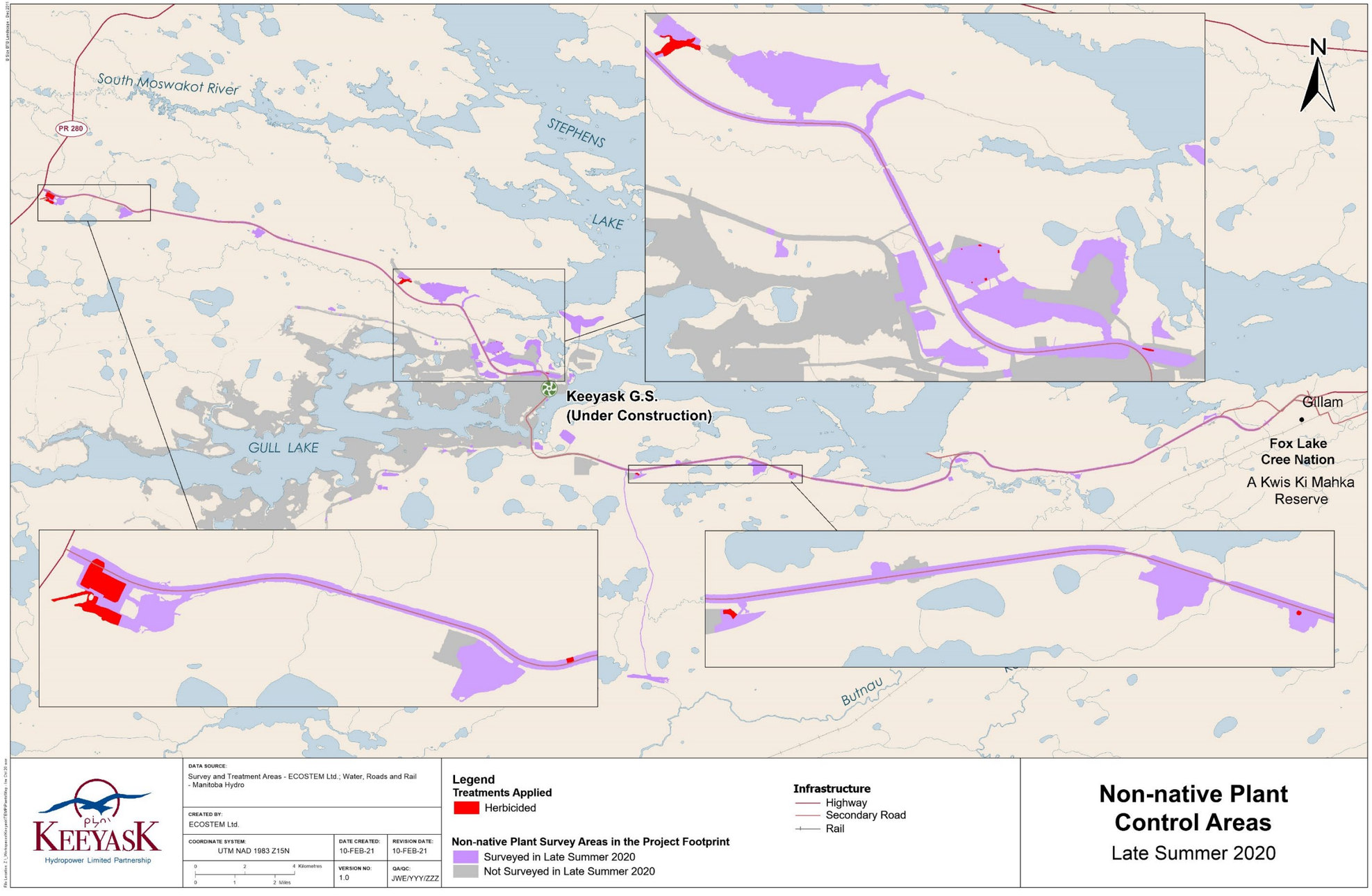
recommended treatment sites and marked the patches with flagging tape and spray paint prior to treatment.

Follow-up mowing treatments were also carried out in early October 2019, and on September 10, 2020. This treatment targeted the same species as the herbicide treatment, and focused on patches that were either missed by, or survived the herbicide treatment.

Table 4-1: Herbicide treatments carried out at key sites during Project construction to date

Treatment Dates	Areas Treated[1]	Herbicide Mixture[2]
August 25, 2016	Start-up Camp, Borrow Area KM-1, Borrow Area G-1 (KM 15), Work Area B	Vantage (5.0L)/ Milestone (0.5L)/ Esplanade (0.375L). Application rate = 700L/ha
Last week of July, 2018	Start-up Camp, Main Camp, Work Area B	Clearview (230g/ha)/ Esplanade (0.3L/ha)/ Roundup HC (5L/ha)
	Sigfusson Northern/Voltage Camp (SAR)	2,4-D Ester 700 (2L/ha)/ Blue Dye WSP40 (1 package/ha)/ Clearview (230g/ha)/ Esplanade (0.375L/ha)/ Roundup HC (5L/ha)
August 2 - 5, 2019	Start-up Camp, NAR gate staging area, Borrow Area G-1 (KM 15), Main Camp, Work Area B, Sigfusson Northern/Voltage Camp (SAR, decommissioned)	Navious (0.167g)/ VP480 (4L) treating 1.75ha; GalonXRT (8L)/ VP480 (8L) treating 4.5ha
July 23 - 24, 2020	Start-up Camp and NAR gate staging area, North Dyke, NAR, Borrow Area G-1 (KM 15), Main Camp, Work Area B, Borrow Area B-2, Borrow Area B-3	Navious (167g/ha)/ VP480 (2.5 L/ha)/ Arsenal (3 L/ha)/ Gateway (2.5 L/ha)

Notes: [1] Herbicide was applied to target patches within the indicated areas. [2] "L/ha" = Litres per hectare; "g" = Grams; "g/ha" = Grams per hectare.



Map 4-1: Key areas selected for invasive plant herbicide control and mowing in 2020

4.2.2 EFFICACY OF TREATMENTS

The overall effectiveness of the herbicide treatments is uncertain at this stage. Despite promising initial results, the 2016 treatment was later found to be ineffective. This was likely due to the late timing of the application. While initial results were good for the 2018 treatment, surveys in 2019 found that plant cover for the target species had recovered or exceeded the pre-treatment cover. ECOSTEM (2019b) provides details for the 2016 and 2018 herbicide treatment results.

The herbicide treatment in 2019 reduced non-native plant cover by approximately 42% overall within the treated areas, but heavy rainfall shortly after the treatments may have reduced their efficacy (see ECOSTEM 2020 for details).

For the 2020 treated sites, total non-native plant cover over all of the treated sites prior to treatment was approximately 1,341 m^2 in July, 2020 (Table 4-2; based on the total cover of live and deceased non-native plants). Total non-native plant cover was highest by far in the Borrow Area G-1. This is almost certainly an underestimate, because there were several treated areas in which no non-native plants could be discerned (Photo 4-4). It is likely that target species were present there because the patch was marked for treatment, but the treated plants had disintegrated and were not detectible at the time of the surveys.

Photo 4-4: Herbicide-treated site in the Start-up Camp with no discernable non-native plants

A total of 11 non-native species were identified within the sites that were treated. Narrow-leaved hawks-beard was the most abundant species in the treatment areas, making up 56% of the total non-native plant cover, followed by common dandelion (15%) and field sow-thistle (11%). Species at Levels 1 and 2 invasive concern included field sow-thistle, Canada thistle and sweet clover.

Combining all treated patches, individual species plant mortality ranged from 34% to 99%, with an overall average of 83% mortality. As indicated above, this is likely an underestimate because some treated patches had no detectible non-native plant cover. Living foliage among the treated patches was generally in poor condition regardless of the mortality rate for the entire patch. At the time of the surveys, which was approximately four weeks after the herbicide treatment, there appeared to be limited to no plant regrowth in the treated areas. Based on patches where plants could be identified, the species with the highest mortality were Canada thistle (99%), curled dock (96%) and narrow-leaved hawks-beard (83%). Canada thistle and field sow-thistle were the two target species confirmed to be present in the treated areas. Mortality for field sow-thistle was 58% overall.

When considering all identifiable non-native plant cover in the areas receiving herbicides, including foliage that survived treatment, overall live non-native plant cover in the treated sites was reduced by 72%, to 370 m^2 (Table 4-2). The largest overall cover reductions were in the treated patches of the North Dyke and Work Area B, where 100% of the non-native plant cover was killed, followed by the Start-up Camp and NAR gate staging area with 94% (Table 4-3). In Work Area B, herbicide was applied over a very small area, where a few plants were targeted with spot applications.

In one treated field sow-thistle patch in the Main Camp (Map 4-1), all the plants in the patch were damaged by the herbicide, but approximately 25% of the foliage was still living. This patch was recommended for a follow-up mowing, which was carried out on September 10, 2020. The effectiveness of the mowing will be evaluated by the 2021 monitoring.

Table 4-2: Non-native species cover in herbicide-treated sites[1] before and after treatment in 2020

Common Name	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change[2]
Canada Thistle	1	0	-99
Common Dandelion	204	76	-63
Common Plantain	5	4	-18
Field Sow-thistle	150	63	-58
Lamb's-quarters	15	10	-35
Narrow-leaved Hawks-beard	746	129	-83
Pineapple-weed	24	16	-34
Smooth Catchfly	65	23	-65
Curled Dock	29	1	-96
White and Yellow Sweet Clover	103	50	-52
All non-native species	*1,341*	*370*	*-72*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".[1] Only sites with identifiable non-native plants are included. [2] A negative sign means that cover decreased.

Table 4-3: Non-native species cover in herbicide-treated sites[1] before and after treatment in 2020, by treatment area

Treatment Area[2]	Pre-treatment cover (m^2)	Post-treatment cover (m^2)	Percent change[3]
Startup camp	55	4	-94
Borrow Area G-1	1,187	356	-70
Main Camp	24	6	-76
NAR	0	0	-84
North Dyke	62	0	-100
Work Area B	1	0	-100
B-2 Borrow Area	10	5	-50
B-3 Borrow Area	2	0	-90
All treated patches	*1,341*	*370*	*-72*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".[1] Only sites with identifiable non-native plants are included. [2] An area may include multiple treated sites. [3] A negative sign means that cover decreased.

5.0 DISCUSSION

5.1 OVERALL CHANGES TO NON-NATIVE PLANT DISTRIBUTION AND ABUNDANCE

Total non-native plant cover was still very low (1.0% of the total area surveyed) six years into construction. This was not surprising given that much of the Project footprint was only recently disturbed, construction activities such as excavation were still severely disturbing some areas, and targeted eradication and control efforts had been undertaken (Section 4.0).

Even though total non-native plant cover was still low in 2020, existing small patches of non-native plants were still a concern since they could quickly become broad infestations if not managed. Reinforcing this concern was the fact that non-native plants were recorded in almost 12% of the surveyed area (note that this is an overestimate of non-native plant distribution within the entire Project footprint for the reasons described in Section 2.2).

How much of a concern the existing patches of non-native plants were for the Project site was partly determined by the magnitude of recent increases in distribution and abundance. As a percentage of area surveyed, total non-native plant cover and extent both increased by about 100% between 2017 and 2018. In comparison, between 2018 and 2020, total non-native extent increased by only 23%, and total cover increased by 14%.

A possible explanation for a portion of the decreases in the rates of cover and extent expansion between 2018 and 2020 is that some of the areas were not surveyed in all years due to accessibility issues. However, the total non-native plant cover in the areas that were not surveyed in all years was too low to account for the differences.

When non-native plant cover was examined within different portions of the Project footprint based on their age and degree of construction activity, some potential trends emerged. Starting in 2018, total cover has been declining annually in areas that were used by the KIP that were minimally affected by the Project (e.g. Borrow Areas KM-4 and KM-9). Over the same period, annual increases in cover occurred in areas used by the Project only, and in areas used by both the KIP and the Project. The exception was a decline in total cover for areas used by both the KIP and the Project between 2018 and 2019.

The decreases seen in portions of the Project footprint components that were used by the KIP and minimally affected by the Project may have resulted from competition with regenerating native vegetation. The sources of native vegetation regeneration were rehabilitation efforts (tree planting) and natural regeneration. This native revegetation was becoming quite advanced in some areas (Photo 5-1). Construction traffic in these areas was minimal, which limited transport of non-native plant seeds into the areas.

Photo 5-1: Regeneration in Borrow Area KM-1 in August 2020

Total cover in the newer footprint components used only by the Project increased between 2018 and 2020, but not to the degree seen in previous years. While non-native plant cover may have been increasing in Project areas cleared earlier in construction, in other areas ongoing construction activity prevented vegetation from becoming established while the increase in Project area reduced the overall percentage cover of plants. Additionally, rehabilitation activities such as site preparation could periodically reduce non-native plant cover in areas used by both the KIP and Project, but that have not been disturbed since earlier in construction. Two examples of this are the NAR ditches, where in late summer 2019 regrading and spreading of organic material removed much of the non-native plant cover that had established there. In EMPA D16, there was a 27% reduction in non-native plant cover between 2019 and 2020 following erosion mitigation construction activity (e.g. re-grading slopes).

Other factors that possibly contributed to localized decreases in non-native plant cover were variability in growing conditions, natural life cycle patterns and/or natural population dynamics for different plant species. Lamb's quarters, which was one of the more abundant species, accounted for much of the decline in total non-native plant cover recorded between 2019 and 2020. Lamb's-quarters has been declining in cover in areas used for the KIP only since 2017, while increasing

in all other areas up until 2019. Non-native plant monitoring for another project in northern Manitoba found that there was an apparent decline in non-native plant cover beginning several years after construction activity ceased (ECOSTEM 2018b).

Between 2019 and 2020, the larger increases in total extent and cover were seen along the South Dyke and in its attached EMPAs. These areas experienced heavy construction activity in recent years, which slowed or ended prior to the 2020 growing season. The end of excavation and construction in these Project components, coupled with tree planting activity in portions of the EMPAs, provided an opportunity for non-native plants to establish. It is expected that cover will continue to increase in subsequent years.

Similarly, in Borrow Area G-3 non-native plant species cover was very low, and plants were slow to establish around the perimeters of the excavated area up to 2019 compared to other borrow areas of similar age. It was suggested that these borrow areas being somewhat isolated, and surrounded by taller trees, reduced wind dispersal of seed into these borrow areas. By late summer 2020, slope grading was carried out, and trees were planted in portions of the area before the access road was decommissioned. Between late summer 2019 and 2020, total non-native plant cover in Borrow Area G-3 increased from 24 to 275 m^2. It is possible that the increased foot traffic introduced seeds into the area. Much of the new non-native plant cover was concentrated in areas that were planted with trees.

Non-native plant cover and extent continued to expand along the SAR west of the Butnau Marina, and in attached borrow areas, notably Borrow Area B-2 where a temporary camp was previously established. As plants were already becoming established in these areas in 2018 and 2019, they likely became seed sources for more rapid increases in cover. Along the SAR, regular vehicle traffic from and to the Town of Gillam, where non-native plants are well-established, was likely a continual seed source for that footprint component. It is expected that non-native plant cover will continue to increase and expand westward in the SAR ditches. Similarly, there was evidence of non-Project related use of the Ellis Esker access corridor. ATV tracks and boats stored at a stream crossing were seen during 2020 surveys. Non-native plants had established at several locations along the access corridor between 2019 and 2020, and it is possible that the seeds were dispersed there by the recent vehicular use.

A potential trend emerging in 2018 was an apparent decrease in non-native plant cover in the footprint components that were primarily utilized for the KIP but not for the current Project (e.g., most of Borrow Areas KM-4 and KM-9). Results from the 2020 surveys continued to support this observation. Possible reasons for this trend are reduced traffic and increasing competition with regenerating native plants whose cover has been increasing in these areas. Conversely, in newly established areas where construction recently stopped it is expected that non-native plant cover will begin or continue to rapidly increase for a period of time, depending on the degree of competition from native vegetation. Monitoring in 2021 will help determine if these trends are ongoing.

5.2 CHANGES IN SPECIES DISTRIBUTION AND ABUNDANCE

There were some notable changes in the relative abundances of some species. Common dandelion more than doubled in cover between 2019 and 2020, changing from the fourth-most abundant species in 2019 to the most abundant species in 2020. This was after the species had declined in cover between 2018 and 2019. Narrow-leaved hawks-beard and white sweet clover also increased in abundance in 2020 after declining in 2019.

The increases in common dandelion cover were seen in all Project areas, but were the largest in areas used by both the KIP and the Project, particularly Borrow Areas KM-1, KM-9 and the Start-up Camp. Increases in common dandelion extent and cover were seen in areas where there was also abundant regenerating native vegetation. This observation did not support the expectation that increased competition from native vegetation will generally reduce non-native plant cover.

Possible explanations for this contrary observation include differences in individual species tolerance to competition, and/or detectability bias between survey years. Common dandelion is a perennial plant. It is possible that the extent and cover of the plants were underestimated in areas with denser regenerating vegetation in 2019. Plant development and/or different conditions (e.g. higher moisture availability) in 2020 may have resulted in the plants being more conspicuous, and were consequently given a higher cover estimate compared with the previous year that did not reflect an actual increase of that magnitude. Annual variability may also have affected seed germination differently in 2019 and 2020.

The explanation above may also apply to the apparent decrease, then increase in narrow-leaved hawks-beard cover, although differences in seed germination may play a larger role since this is an annual species. Survey timing may also play a role in estimated cover differences. Field observations have found that narrow-leaved hawks-beard is more conspicuous in the early summer, because it is a smaller plant, and tends to deteriorate as it senesces later in the season. The previous annual report (ECOSTEM 2020) found that the decline in cover was occurring in portions of the footprint used only by KIP, or by KIP and the Project, while cover continued to increase in components used for the Project only. It was indicated that this may be due to competition with regenerating native vegetation. In 2020, the reverse was true, with relatively large increases in cover for the older components, and a decrease in the newer components. However, the change for the newer components is likely an artifact of the change in methods for the dykes, because much of the mapped cover in 2019 was along the North Dyke, which wasn't fully surveyed for that species in 2020.

The increases in white sweet clover extent and cover were highest in Borrow Area G-1, and along the SAR west of the Butnau Marina. The species was also beginning to establish in new locations along the South Dyke and the Ellis Esker Access corridor. It is likely that the plant was spread into these new areas through vehicular use. Sweet clover is an abundant plant in the ditches along Highway 280 (KLHP 2012b). Over time, it is expected that traffic along the NAR and SAR will continue to introduce sweet clover, as well as other non-native plants that occur along the

highway. Evidence for ATV use along the Ellis Esker Access corridor was also observed during surveys in 2020. It is possible that ATVs played a role in introducing white sweet clover to the corridor.

At least part of the observed decline in cover for lamb's-quarters was due to the change in area surveyed for the North Dyke, which contained nearly a quarter of the total mapped lamb's-quarters cover in 2019. Large declines were also observed in EMPA D16 and in Borrow Area G-1. The declines in the former were at least partly caused by plants being removed due to recent construction activity (which included slope grading and berm construction) to mitigate for erosion issues in the EMPA (ECOSTEM 2021). The declines in Borrow Area G-1 may be due to natural population dynamics. Similar declines were observed in areas used by the KIP only, where lamb's-quarters cover peaked in 2017, then substantially dropped in 2018 and have generally been declining since then.

The other species with a notable decline in cover between 2019 and 2020 was field sow-thistle. Almost all of the decline in cover for this species was in Borrow Area G-1 and the Start-up Camp, which were two of the Project components with the highest proportion of total cover for this species in 2019. Cover in all other Project components increased between 2019 and 2020, with the exception of the SAR and NAR, where there were slight declines in cover. The decrease in cover was due to plant control efforts carried out in those areas, which are discussed further in Section 5.3.

The total number of non-native plant species recorded during the 2020 surveys (27) was higher than in 2019. Two non-native species were recorded for the first time in 2020. These included flixweed and canola. It is possible that a few individuals of these species were present in previous years, but were missed because they were very scarce. In 2020, cover and extent for both species was very low, and limited to a single site for each. Because both species were found only at single sites, it was possible they were only recently introduced. Since 2019, the sites in which they were found (i.e., a previous work area adjacent to Borrow Area B-3) have become accessible to the general public.

In 2020, there was a large increase in the number of sites where common tansy was found. This is concerning because the species is of the highest level for invasive concern. The number of sites increased from a single sites in 2018 and 2019 to eight sites in 2020, which were well separated from each other along the NAR and SAR roadsides. As well, two new plants were found at the original site in 2018, which had been removed. Aside from the latter, all were single plants that were removed when they were found. The dispersal of sites suggest that the seed has been spread, possibly during roadwork or by vehicles from an unknown source. Continued monitoring will determine if the plant continues to appear at new locations in the Project footprint.

5.3 EFFORTS TO MANAGE INVASIVE PLANTS

To date, the rapid manual removal control strategy for invasive plants appears to have been effective for Level 1 species but not for Level 2 species in most cases. The most plausible possible

explanations for the difference in success were plant root systems being already well-established, seeds from the seed bank germinating, and/or some plants in the area had already produced seed. One Level 1 species targeted for rapid manual removal in 2018 and 2019, ox-eye daisy, was not found at any previous or new sites in 2020.

While the overall effectiveness of the herbicide treatments varied by year, the years when effectiveness was low could largely be explained by application issues or weather. The 2016 treatment was completely ineffective likely because the herbicide applications occurred in late August, which was after the plants had already produced seed. While the 2018 herbicide applications considerably reduced total non-native plant cover over all of the treated areas (i.e., approximately 84%), the cover reduction for the target species was much lower (i.e., 1.6%) because the contractor missed treating the priority areas with largest amounts of the target species (in areas that were treated, it was possible that the roots of some of the herbicided plants were not killed). Herbicide treatments in 2019 addressed the areas that were missed in 2018, however, heavy rains shortly after the herbicide application likely reduced its effectiveness.

For the 2020 treatments, inspection of the patches where herbicide damage was present showed that the mortality rate of all contacted vegetation was very high (Photo 5-2). In some cases, the treated patches were much larger than the patches where plants were still identifiable at the time of the surveys. It was unclear if the effectiveness of the herbicide on field sow-thistle (one of the major target species) was poor in some of the treated patches. Many of the plants in these patches were no longer unidentifiable to species at the time of the surveys as it had been at least three weeks since the herbicide application.

Photo 5-2: General vegetation mortality in an herbicide-treated patch in Borrow Area G-1

Comparison of total cover for the target invasive species in the treated Project footprint components provides a more informative assessment of the overall effectiveness of the herbicide treatments. The treatments were generally effective.

Total cover of field sow-thistle, which was the most abundant target species in the treated footprint components, decreased by approximately 92%, from 1,265 m^2 in 2018, to 98 m^2 in 2020 following targeted herbicide treatments in Borrow Area G-1 at KM 15 (Table 5-1). This large reduction followed two consecutive years of treatments.

A single treatment in 2020 reduced cover over the same period by 46% in the Start-up Camp, 61% along the NAR and by 63% along the North Dyke.

Herbicide treatment of the single patch of common burdock in the Main Camp in 2019 appeared to be 100% effective (Table 5-1). No plants were found at that site, or elsewhere in the Project footprint in 2020. Continued monitoring of the site in subsequent years will determine if the plant has been eradicated from the site, or if viable seed remains in the soil.

The long-term effectiveness of the herbicide program will be analyzed in more detail in the synthesis report in 2022.

Table 5-1: Total live cover[1] of species targeted by herbicide treatment[2] as of late August in Project components that were treated from 2018 to 2020

Common Name	Year	KM15 Borrow Area	Startup camp & NAR Gate Staging	Main Camp	NAR	North Dyke	Work Area B	Sigfusson Northern/ Voltage Camp & Borrow Areas B-2 & B-3
Canada Thistle	2018	-	0	-	0	0	-	-
	2019	-	0	-	-	-	-	-
	2020	**0**	**0**	-	-	-	-	0
Common Tansy	2018	-	-	-	-	0	-	-
	2019	-	-	-	-	0	-	-
	2020	-	-	-	1	0	-	0
Field Sow-thistle	2018	1,265	**481**	**11**	172	-	**1**	**3**
	2019	**722**	**449**	**5**	104	95	**0**	**7**
	2020	**98**	**257**	**28**	**68**	**35**	**2**	**53**
Common Burdock	2018	-	-	7	-	-	-	-
	2019	-	-	**-**	-	-	-	-
	2020	-	-	-	-	-	-	-
Ox-eye Daisy	2018	0	-	-	-	-	-	0
	2019	-	-	-	-	-	-	0
	2020	-	-	-	-	-	-	-
Scentless chamomile	2018	-	1	-	-	-	0	-
	2019	-	-	0	-	-	-	-
	2020	-	-	-	-	-	-	0
Tufted Vetch	2018	3	0	-	-	-	-	-
	2019	0	-	-	-	-	-	5
	2020	1	-	0	-	-	-	**0**

Notes: [1] Live cover following herbicide treatment in that year. Not all patches of plants in the Project component were necessarily

treated. [2] Bold-face font indicates that plants were treated with herbicide that year. Underlined font indicates plants were hand-pulled.

5.3.1 PREVENTION

The following provides some general considerations for future efforts to control invasive plants in the Project footprint. Specific control recommendations will be developed for the 2021 growing season based on the monitoring results to date.

It is difficult to prevent vehicles and people from inadvertently spreading non-native plant species into the Project footprint (Section 2.6.1). This becomes more difficult as portions of the Project footprint (i.e. the SAR and attached borrow areas, Ellis Esker access corridor) become open to the public. Therefore, recommendations in addition to the standard measures included in the EIS and EnvPPs focus on the plant species of highest invasive concern and on the situations where there are practical ways to eradicate these species or to prevent them from spreading further.

Of the non-native plant species recorded during monitoring, several falling into Levels 1 and 2 invasive concern were known to be present prior to the Project (KHLP 2009; KHLP 2012b). At least two such species (white sweet clover, ox-eye daisy) were likely already established in the Start-up Camp and Main Camp areas even before KIP construction began (ECOSTEM 2014). Additionally, some Level 2 species (i.e., white and yellow sweet clover, Canada thistle, field sow-thistle) were found along PR 280 prior to development of the KIP (KHLP 2009; KHLP 2012b).

One strategy to prevent or reduce the spread of invasive plants beyond their current locations is for equipment, machinery, vehicles and people to avoid or minimize travel through infested areas. A related strategy is to restrict travel to those periods when the spreading of seed or propagules is least likely (e.g., prior to seed development). Possible implementation of these strategies has become more feasible because the number of new construction areas have declined as the Project is approaching completion, and substantial additional Project clearing is not anticipated (Manitoba Hydro pers. comm. 2020).

Promoting native plant regeneration is another strategy to control and eradicate invasive plants. This can be accomplished in two ways: by implementing the already planned site regeneration as soon as is feasible after a construction area will no longer be used; and, by limiting traffic and other activity on sites where desired vegetation has established or is establishing.

5.3.2 ERADICATION AND CONTROL

The only situation for which an eradication strategy for Level 1 and 2 plant species is both feasible and likely to succeed is within those footprint components where these species occur as small patches in one to a few sites.

For sites with only one to a few plants, rapid manual removal has been effective to date for the Level 1 species (Section 4.1.1). Monitoring surveys in 2021 will determine if rapid manual removal continues to be effective for controlling these species.

Rapid manual removal has only been partially effective where it was applied to small patches of Level 2 species in 2016 (efficacy of the 2018 manual removals to be determined after 2019 surveys). As described in Section 4.1.2, the manual removal method will only be implemented in certain situations.

Rapid manual removal by staff conducting the monitoring surveys will continue to be employed for newly found sites with Level 1 and 2 species. For previously recorded sites, rapid manual removal will not be implemented for species that reproduce prolifically by rhizomes and where either the plants are mature or it appears the plants have already developed a root system (see Section 4.1.2). Herbicide application is being considered for these sites.

Additional herbicide applications and/or mowing are recommended to control or eradicate invasive plants at key sites. Key sites will be identified for treatment in summer 2021 using the same criteria as in previous years.

A general strategy to eradicate or control invasive plants involves promoting native plant regeneration. This can be accomplished in the same ways as described for prevention (Section 5.3.1).

Continued high vigilance is needed for Level 1 species because they are difficult to control (ISCM 2020). In addition, continued introductions by Project vehicles entering from outside of the Project footprint are quite possible. ISCM (2020) states that scentless chamomile, ox-eye daisy and common tansy are common along fence lines, roadways and fields in Manitoba, so vehicles and equipment coming to the Project site could easily transport them there. It is recommended that Manitoba Hydro site staff continue to look for for the species of highest invasive concern (i.e., scentless chamomile, common tansy, ox-eye daisy) and manually remove plants from these species if and when they encounter them in the Project areas. It is also recommended that site staff receive an invasive plant identification training session each spring.

6.0 SUMMARY AND CONCLUSIONS

In August 2020, non-native plants covered slightly less than 1% of the surveyed portion of the Project footprint, which included 11% of the total footprint area. As was the case in 2019, most of the non-native plant cover was within those cleared areas that were either there before the Project (e.g., cutlines, borrow areas and ditches along Butnau Road portion of the South Access Road), or were created by the Keeyask Infrastructure Project (KIP) and have been subsequently used by the Project.

The combined extent and cover of all non-native plants increased between the late summers of 2019 to 2020, but by a small amount compared to previous years. Starting in 2018, it appeared non-native plant cover was decreasing in the older Project components that have been minimally used since earlier in construction.

A total of 27 non-native plant species were found during the 2020 surveys. Two new species (flixweed and canola) were recorded in 2020, and four previously recorded species (common burdock, ox-eye daisy, rye and wheat) were not observed.

Plants from two of the three species at the highest level of invasive concern for the Project area were found during the 2020 monitoring. These species were scentless chamomile and common tansy. Common tansy was previously found at only a single site in 2018 and 2019, but was found at eight sites in 2020. ECOSTEM field staff manually removed these plants immediately after discovery.

Monitoring to 2020 has indicated that manual removal of plants from the species of highest concern was generally effective, as new plants have not returned to those sites. The exception was for species that have the ability to proliferate from roots left in the ground. Manual removal will be continued in 2021 except for selected situations of plants from species that can proliferate from roots left in the ground. Other control measures, such has herbicide applications, will be considered for plants that are not manually removed.

Eight key sites with species of higher concern in the Project footprint were treated with herbicides in mid-July 2020, and then mowed in early September. Monitoring in August 2020 found that the herbicide applications reduced non-native plant cover in the treated areas by approximately 72%. Surveys in 2021 will determine if the herbicide treatment and subsequent mowing is expected to continue to reduce or slow the spread of invasive plant cover in these sites.

It is recommended that Manitoba Hydro site staff continue to look for the species of highest invasive concern (i.e., scentless chamomile, common tansy, ox-eye daisy) and manually remove plants from these species if and when they encounter them in the Project areas. It is also recommended that site staff receive an invasive plant identification training session each spring.

Additional invasive plant control recommendations are being developed for the 2021 growing season based on the monitoring results to date. Monitoring fieldwork for invasive and other non-native plants will continue in 2021.

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APPENDIX 1:
NON-NATIVE PLANT INDIVIDUAL AREAS

Table 7-1: Estimated radius and derived area for individual non-native plant species in 2020

Species	Estimated Radius (cm)	Derived Area (m^2)
Arctium minus	25	0.196
Artemisia absinthium	25	0.196
Avena sativa	4	0.005
Brassica napus	10	0.031
Capsella bursa-pastoris	5	0.008
Chenopodium album	10	0.031
Leucanthemum vulgare	10	0.031
Cirsium arvense	10	0.031
Cirsium vulgare	15	0.071
Crepis tectorum	8	0.020
Descurainia sophia	15	0.071
Erysimum cheiranthoides	20	0.126
Helianthus annuus	20	0.126
Hordeum jubatum	4	0.005
Lotus corniculatus	25	0.196
Matricaria discoidea	7.5	0.018
Medicago lupulina	10	0.031
Medicago sativa	25	0.196
Melilotus albus	25	0.196
Melilotus officinalis	25	0.196
Oenothera biennis	20	0.126
Persicaria maculosa	15	0.071
Phalaris arundinacea	15	0.071
Phleum pratense	3	0.003
Plantago major	10	0.031
Secale cereale	4	0.005
Silene csereii	10	0.031
Sonchus arvensis	10	0.031
Tanacetum vulgare	25	0.196
Taraxacum officinale	10	0.031
Trifolium hybridum	20	0.126
Trifolium pratense	20	0.126
Trifolium repens	20	0.126
Tripleurospermum inodorum	5	0.008
Triticum aestivum	4	0.005
Verbascum thapsus	20	0.126
Vicia cracca	20	0.126

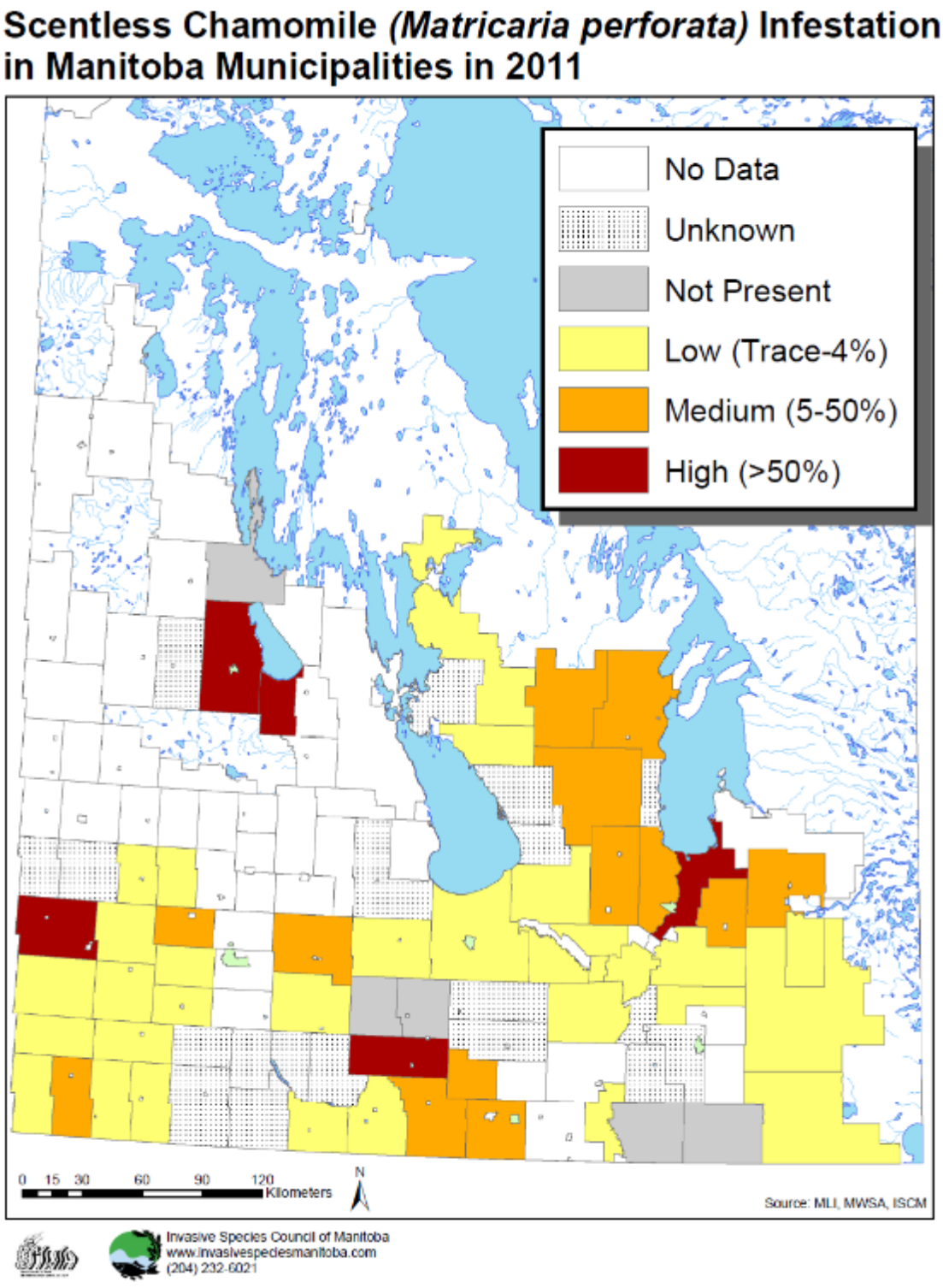
APPENDIX 2:
INVASIVENESS RANKINGS AND MANAGEMENT STRATEGIES

7.1.1 BACKGROUND

This monitoring study provides additional control or eradication recommendations during construction monitoring. The following describes the approach taken to make recommendations regarding which non-native species to prioritize for management, and the types of locations that management efforts will focus on.

It is widely recognized that it is not practical to attempt to eradicate or even control all non-native plant species (e.g., White *et al.* 1993; Morse *et al.* 2004; Ministry of Transportation and Infrastructure *et al.* 2011). For example, some species are already too widespread and well-established to implement an approach that removes plants at a faster rate than they reappear in the same locations and establish in new locations.

Many of the non-native species recorded during Project monitoring are commonly found in disturbed areas throughout the Province (e.g., field sow-thistle, white clover), particularly along roadsides, making it difficult to prevent them from being spread by human or natural sources. Maps produced by the Invasive Species Council of Manitoba (ISCM) demonstrate the widespread distribution of noxious weeds in southern Manitoba. For example, Figure 7-1 provides a general impression of how widespread scentless chamomile (a highly invasive species) was in southern Manitoba in 2011. However, this map considerably understates scentless chamomile distribution and abundance as data are missing for a high proportion of municipalities.



Source: Invasive Species Council of Manitoba.

Figure 7-1. Scentless Chamomile infestation in Manitoba municipalities in 2011

As noted above, it is not practical to eradicate or even control all non-native plant species. For this reason, numerous ranking systems have been developed to prioritize which non-native plant species to target, which types of locations should be focused on and/or the preferred management strategies. Examples of publications that review some of these systems include Williams and Newfield (2002), Wikeem (2007) and Carlson *et al.* (2008).

Three themes which frequently appear in systems that prioritize and/or determine which non-native plant species to actively manage (e.g., White *et al.* 1993; Morse *et al.* 2004; Ministry of Transportation and Infrastructure *et al.* 2011) are:

1. The potential for the species to cause major harm to ecosystems, conservation values or human health;
2. The species' current and expected future distribution and abundance; and,
3. The likelihood that management efforts can achieve their objectives over the long-term.

This monitoring study uses the preceding three themes to prioritize and develop management recommendations for non-native plants in the Project area. Management recommendations focus on the plant species of highest invasive concern (first and second themes) and the situations where there are practical ways to reduce these species or prevent further spreading (third theme).

For this monitoring, the primary sources used to classify the potential for a non-native plant species to have substantial adverse effects on ecosystems or biodiversity in the Project area were the ISCM (2020), White *et al.* (1993), the Provincial *Noxious Weeds Act* (Government of Manitoba 2017a) and the Federal Weed Seeds Order (Government of Canada 2016). While the federal *Plant Protection Act* was also relevant from the regulatory perspective, few of the species currently on its list occur in Manitoba, and those that do are limited to a few locations in the southern portion of the province.

The primary additional sources of information that assisted with evaluating potential invasiveness in the Project area, and with developing management recommendations, included the Biology of Canadian Weeds Series (Canadian Weed Science Society. 2019a), the Biology of Invasive Alien Plants in Canada (Canadian Weed Science Society. 2019b), Manitoba Agriculture (2019) and results from EIS or monitoring studies for this and other projects in northern Manitoba. The last of these sources also provided some information regarding patterns of distribution and abundance in the Project region.

A limitation for some of the sources used to determine a plant's degree of invasiveness was that they did not include data from the Keeyask region. The observed degree of invasiveness for the species included in these sources was generally obtained in regions subject to much different climates than that occurring in the Project region. Local invasiveness can differ greatly from that observed in other regions (Carlson *et al.* 2008).

Of the sources used for ranking a species' degree of invasiveness listed above, ISCM (2020) and White *et al.* (1993) were considered the most relevant ones because their focus is on impacts to ecosystems and biodiversity. The Provincial *Noxious Weeds Act* and the Federal Weed Seeds Order were developed to address impacts on the agricultural economy or the viability of the agricultural operations. An upshot of this agricultural focus is that these regulations do not list

some species known to be of concern for impacts on native ecosystems and biodiversity (e.g., purple loosestrife). Conversely, these regulations also list some native boreal plant species (e.g., foxtail barley) as weeds since they can be problematic for agriculture. Native boreal species appearing on these lists were not considered to be invasive for the Project area.

An additional reason for including the *Noxious Weeds Act* of Manitoba is that it includes some management obligations for species encountered during construction activities. This Act creates a general duty to destroy species it identifies as noxious weeds because they are a significant threat to Manitoba's agricultural economy or to the viability of the agricultural operations. The Act states that: “Each occupant of land, or, if the land is unoccupied, the owner thereof, or the agent of the owner, and each person, firm, or corporation who or which is in control of, or in possession of, or in charge of, land, shall destroy all noxious weeds and noxious weed seeds growing or located on the land as often as may be necessary to prevent the growth, ripening and scattering of weeds or weed seeds.”

The degree of management response required by the Act depends on the species’ threat to agricultural crops. Species are categorized into one of three degrees of threat, which are Tier 1, 2 or 3. The Act requires that a landowner, occupier or contractor:

a) destroy all tier 1 noxious weeds that are on land that the person owns or occupies;
b) destroy all tier 2 noxious weeds that are on land that the person owns or occupies if the area colonized by the weeds is less than five acres [2.023 ha];
c) control all tier 2 noxious weeds that are on land that the person owns or occupies if the area colonized by the weeds is five acres [2.023 ha] or more; and
d) control a tier 3 noxious weed that is on land that the person owns or occupies if the weed's uncontrolled growth or spread is likely to negatively affect an aspect of Manitoba's economy or environment in the area of the land or the well-being of residents in proximity to the land.

The Act defines control as curtailing the weed’s growth and preventing its spread beyond its current location.

It is noted that, as there are no agriculture crops near the Project, weeds in the Project site do not pose a local threat to agricultural operations. Equipment or vehicles moving from the site to other regions could transport weed propagules into agricultural areas.

7.1.2 INVASIVE CONCERN CLASSIFICATION

As noted above, ISCM and White *et al.* (1993) were the primary sources for ranking a species’ degree of invasiveness. To provide background for this study’s invasive concern classification, the criteria used in the ISCM and White *et al.* (1993) classifications are first presented.

Table 7-2 provides the ISCM invasive plant categories, criteria for inclusion in a category and the minimum management criteria. Category 1 and 2 species are the species considered to pose the greatest threats, and have a management response that includes eradication if feasible. The

essential differences between these categories is that Category 1 includes species not yet known to be present in natural areas and species declared to be noxious weeds. Species that ISCM lists as "other" are not on the early detection and rapid response list.

White *et al.* (1993) classify alien plants in Canada as being either a principal, moderate or minor invasive. Principal Invasive Aliens are the species considered to pose the greatest threat to natural areas. Moderate Invasive Aliens are the species considered to pose an intermediate level of threat to natural areas. Minor Invasive Aliens are the species considered to be only minor problems.

Table 7-2. ISCM invasive plant categories, criteria for inclusion and minimum management criteria

Categories and Criteria for Inclusion	Minimum Management Criteria
Category 1 Species	
• These invasive plants are not present in Manitoba, but may be present in cultivation[1] but not yet known to have escaped, and/or • If listed as a Manitoba Noxious Weed, and/or • If on the List of Pests Regulated in Canada and • Capable of establishing in Manitoba based upon climate variables • A pathway of introduction exists • Easily identifiable with available resources.	• Eradication is first option if detected and if feasible. • A lead agency should be identified and a management committee formed to develop an eradication strategy. • An education and awareness program is required. • Provincial ban on sale and trade. • Species may be moved to next category if found in Manitoba.
Category 2 Species	
• These invasive plants are present in Manitoba and • Capable of further spread and • Pathways for spread are present and • Easily identifiable with available resources.	• Eradication is first option, when feasible. • Containment and control programs are second option. • Education and awareness programs to foster prevention. • A response plan is available or under development.
Other Species	
• Other terrestrial invasive plants	• Not specified in the ISCM website.

Source: ISCM (2020).

Notes: [1] Cultivated as a garden plant, for ornamental horticulture, water ponds or gardens, for lawns; and is outside its natural range.

The non-native plant species recorded during monitoring to date were classified into one of four levels of invasive concern for the Project area (Table 2-5). Level 1 was the highest level of invasive concern for the Project. Level 1 species included ISCM Category 1 and 2 species.

The second highest level of invasive concern for the Project (Level 2 species) included ISCM "other" species of concern and/or the non-native species that White *et al.* (1993) classify as being principal or moderate invasives in Canada. These species also have the potential to crowd out native species in many of the conditions where non-native plants are found.

The third highest level of invasive concern (Level 3 species) included non-native species that White *et al.* (1993) classify as minor invasives in Canada and/or the species that government sources classify as noxious weeds or weed seed species.

The fourth and lowest level of invasive concern (Level 4 species) included all of the non-native plant species not already included in another level. Species at the third and fourth levels may become problematic in some locations and/or conditions (*e.g.*, changed climate). They will also be a consideration when developing revegetation plans for areas being rehabilitated to native habitat types.

Table 2-6 shows how the invasive concern classification was applied to the non-native plant species recorded in the Project footprint to date.

Table 7-3 classifies non-native species that have not been recorded to date but could potentially occur in the Project footprint. These included species that are known to be present in Manitoba, and are listed as Tier 2 or 3 noxious weeds in Manitoba (Government of Manitoba 2017b), or are listed as Category 2 or Other invasive plants by the ISCM (2020).

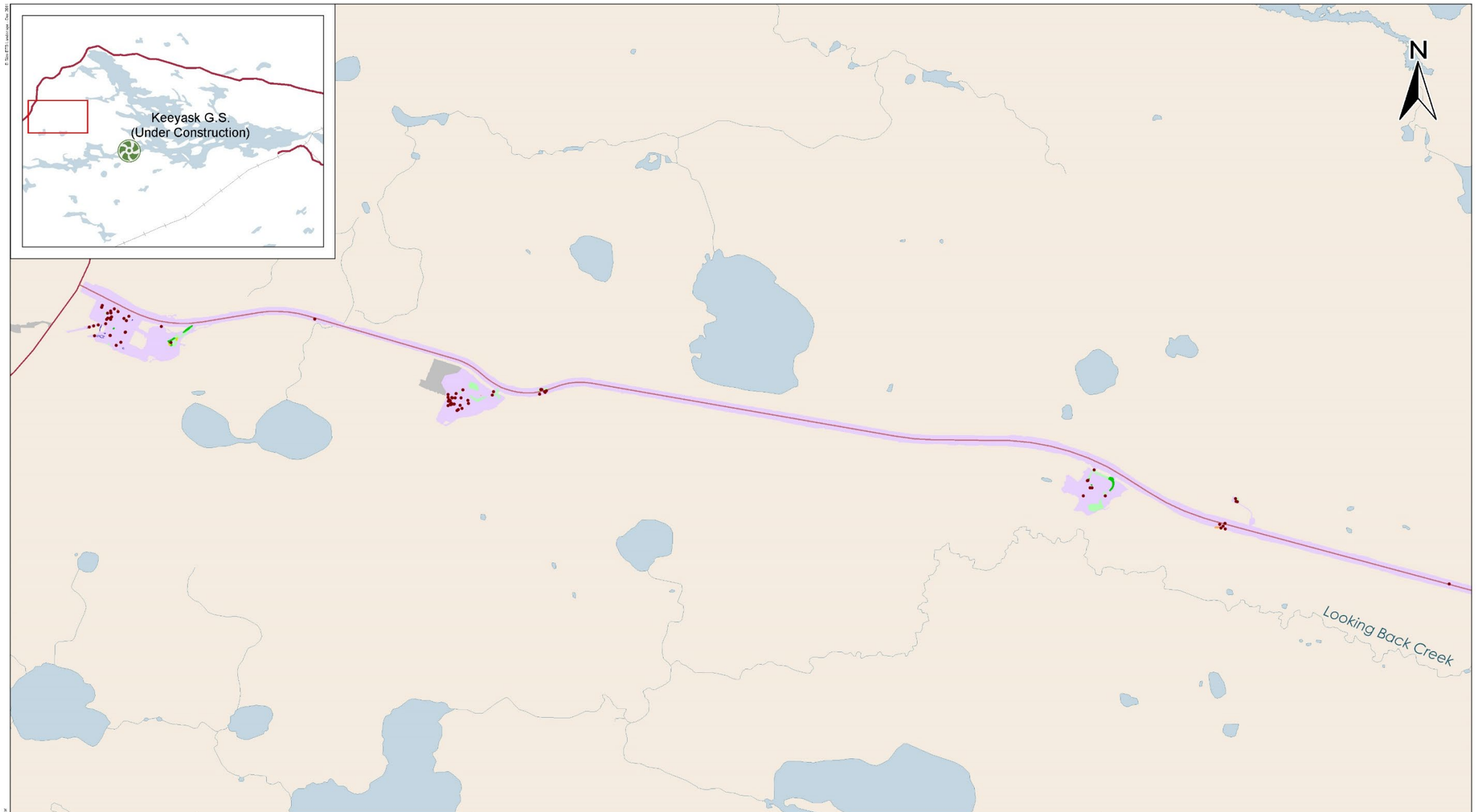
Table 7-3: Invasive concern classifications for non-native plant species that could potentially occur in the Project footprint

Invasive Concern[1]	Common Name[2]	Scientific Name	ISCM Category[3]	White *et al.* Category[4]	Noxious weed[5]	Weed Seed[6]
Level 1	Hoary alyssum	*Berteroa incana*	Other		Tier 2	
	Japanese brome	*Bromus japonicus*	Category 2		Tier 2	
	Downy brome	*Bromus tectorum*	Category 2		Tier 2	
	Flowering Rush	*Butomus umbellatus*	Category 2	Principal		
	Thistle, nodding	*Carduus nutans*	Category 2	Minor	Tier 2	Prohibited
	Blueweed	*Echium vulgare*	Category 2			
	Spurge, leafy	*Euphorbia virgata*	Category 2	Principal	Tier 2	Prohibited
	Baby's-breath	*Gypsophila paniculata*	Other		Tier 2	
	St. John's-wort	*Hypericum perforatum*	Category 2	Moderate	Tier 2	
	Large Touch-me-not	*Impatiens glandulifera*	Category 2			
	Scabious, field	*Knautia arvensis*	Category 2		Tier 2	
	Toadflax, Dalmatian	*Linaria dalmatica*	Category 2		Tier 2	Primary
	Toadflax, yellow	*Linaria vulgaris*	Category 2		Tier 3	Primary
	Purple Loosestrife	*Lythrum salicaria*	Category 2	Principal		Primary
	Bartsia, red	*Odontites vulgaris*	Category 2		Tier 2	Prohibited
	Common reed, invasive	*Phragmites australis* ssp. *australis*	Category 2		Tier 2	
	Buckthorn, European	*Rhamnus cathartica*	Category 2	Principal	Tier 3	
	Bouncingbet	*Saponaria officinalis*	Category 2		Tier 2	
Level 2	Garlic Mustard	*Alliaria petiolata*	Other	Principal		
	Bellflower, creeping	*Campanula rapunculoides*	Other		Tier 3	
	Thistle, bull	*Cirsium vulgare*	Other		Tier 3	
	Field Bindweed	*Convolvulus arvensis*	Other			Primary
	Common Hound's Tongue	*Cynoglossum officinale*	Other			

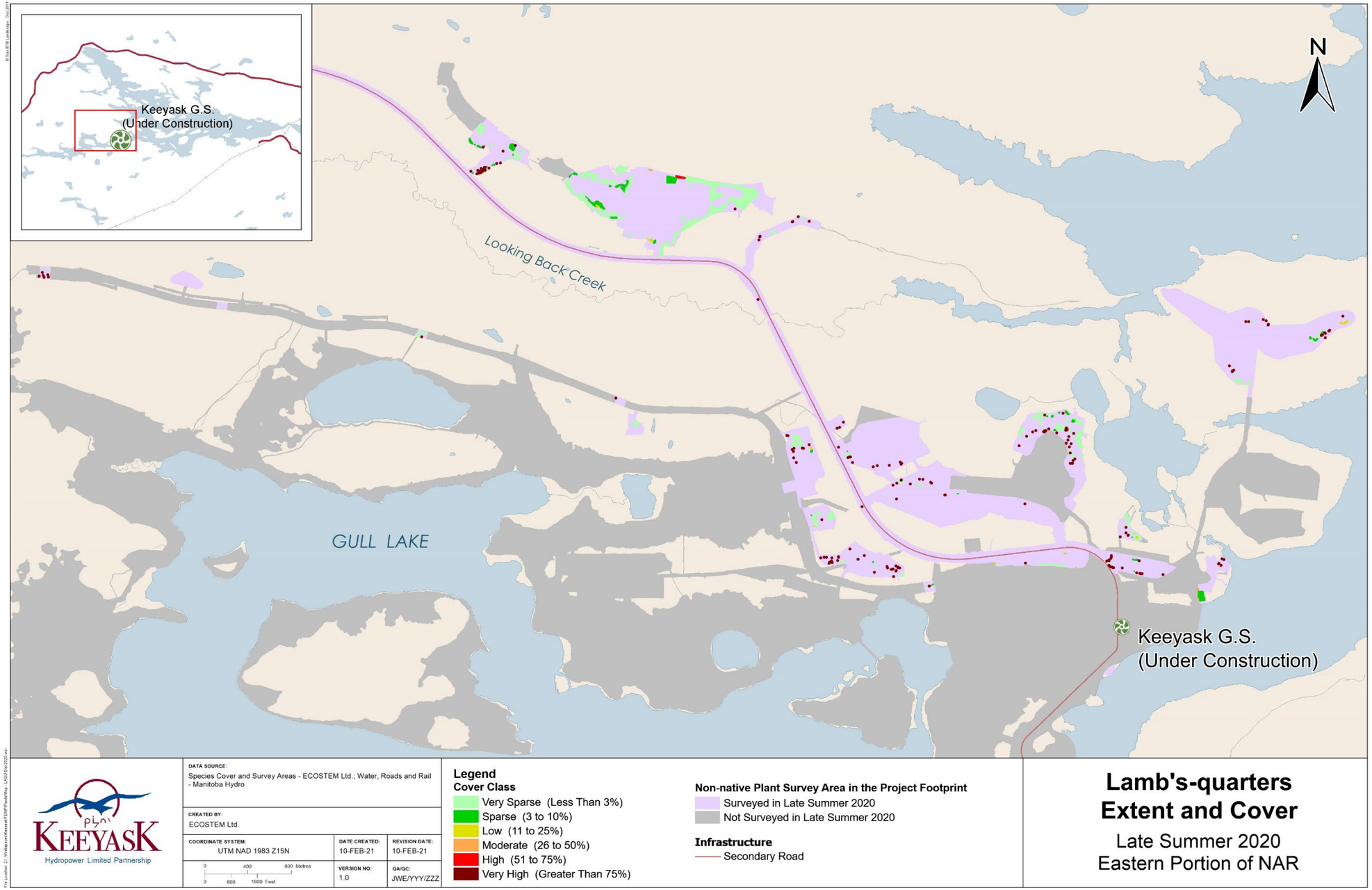
Invasive Concern[1]	Common Name[2]	Scientific Name	ISCM Category[3]	White *et al.* Category[4]	Noxious weed[5]	Weed Seed[6]
	Japanese Knotweed	*Fallopia japonica*	Other			
	Giant hogweed	*Heracleum mantegazzianam*	Other			
	Dame's-rocket	*Hesperis matronalis*	Other	Minor		
	Tansy Ragwort	*Jacobaea vulgaris*	Other			Primary
	Scotch Thistle	*Onopordum acanthium*	Other			
	Orange Hawkweed	*Pilosella aurantiaca*	Other			
	Common Buttercup	*Ranunculus acris*	Other			
	Cockle, white	*Silene latifolia*	Other		Tier 3	Primary
	Puncture Vine	*Tribulus terrestris*	Other			
	Cow-cockle	*Vaccaria hispanica*	Other			Secondary

Notes: [1] See Table 2-5 for the invasive concern classification. [2] In decreasing order of concern for the Project area. [3] Invasive Species Council of Manitoba (2020). [4] White *et al.* (1993). [5] Government of Manitoba (2017b). Number in column is the Tier in the Act (see text). [6] Government of Canada (2016).

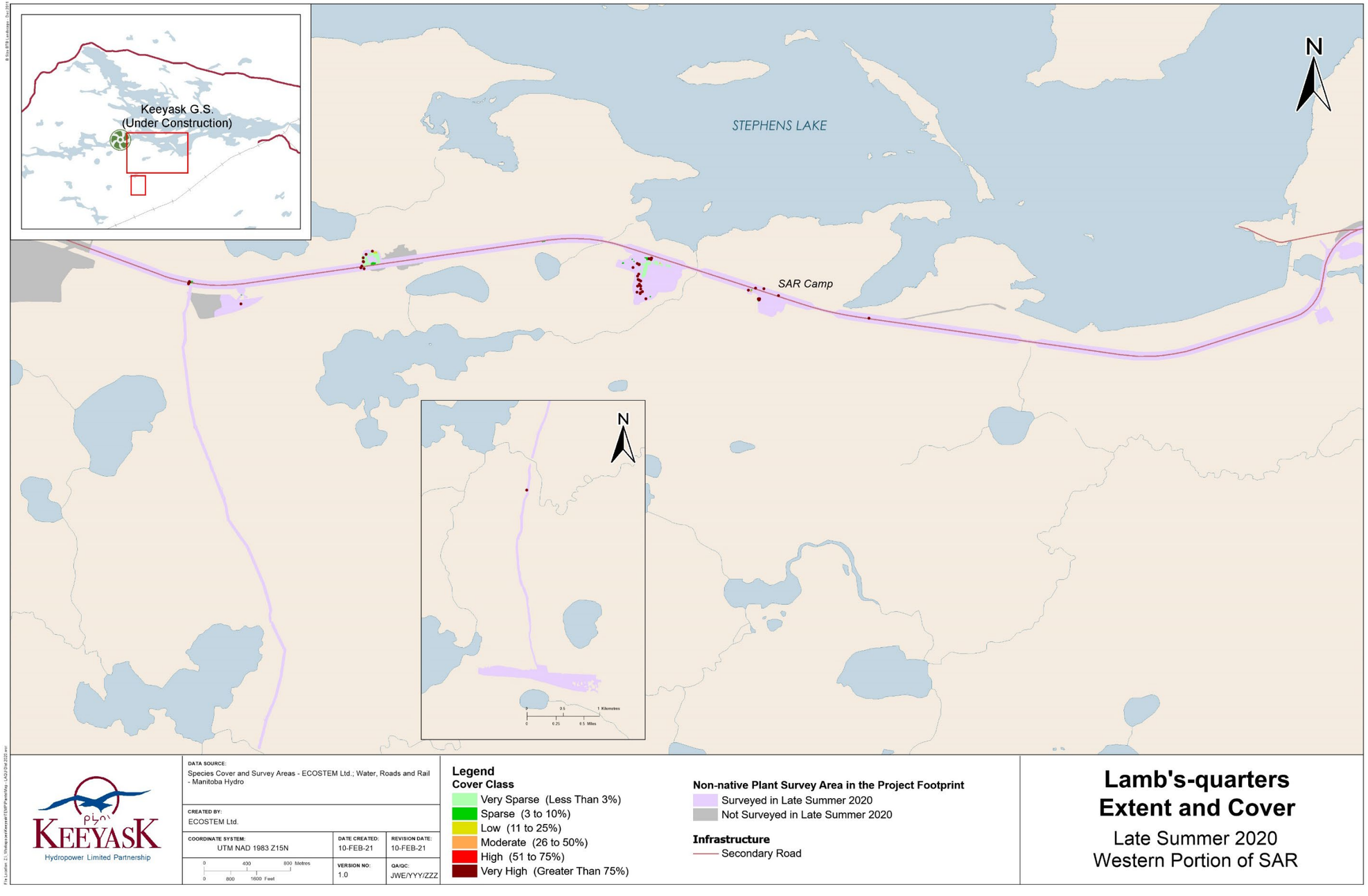
APPENDIX 3:
NON-NATIVE PLANT DISTRIBUTION MAPS



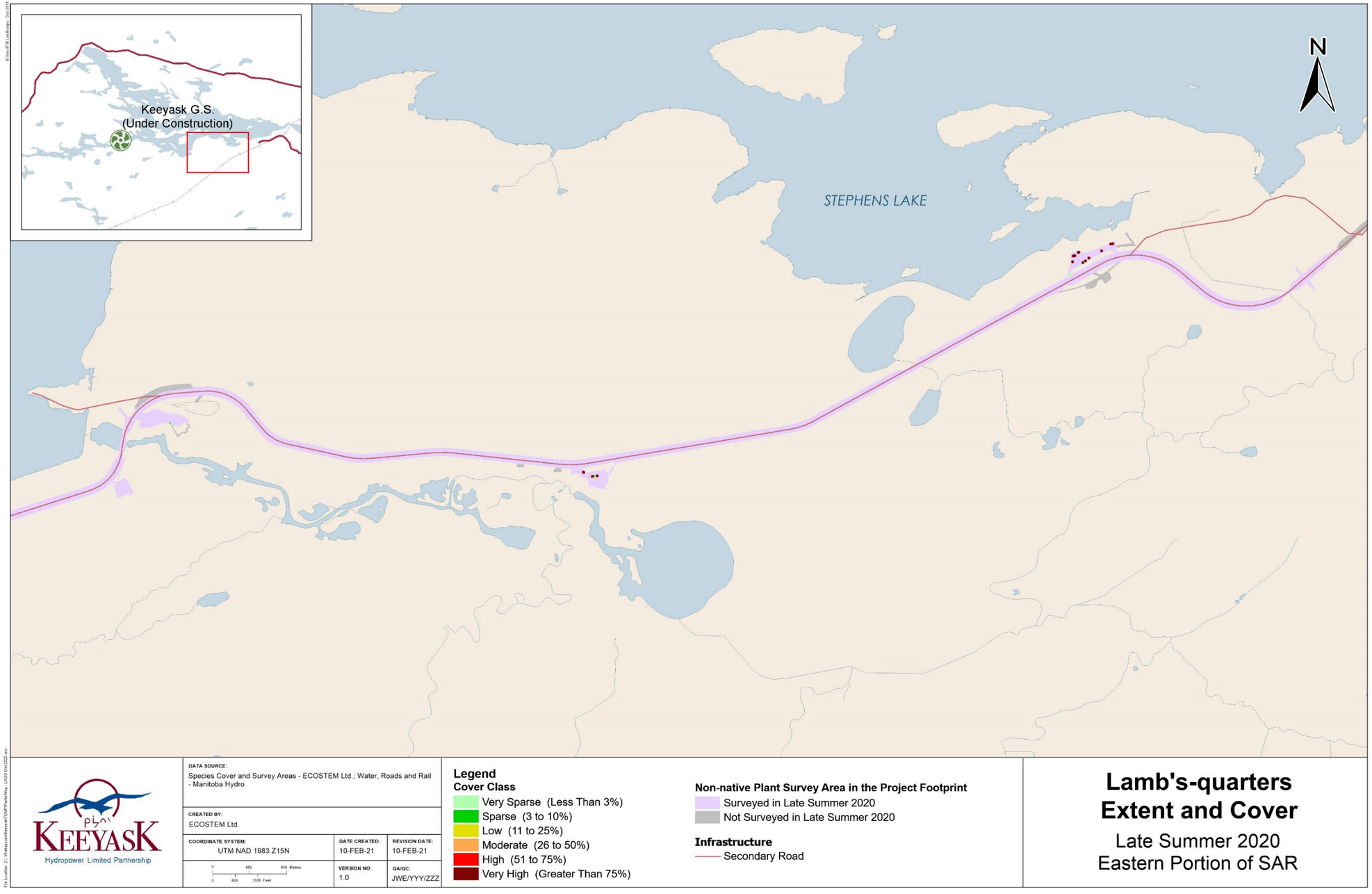
Map 7-1: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the western portion of the North Access Road in late summer, 2020



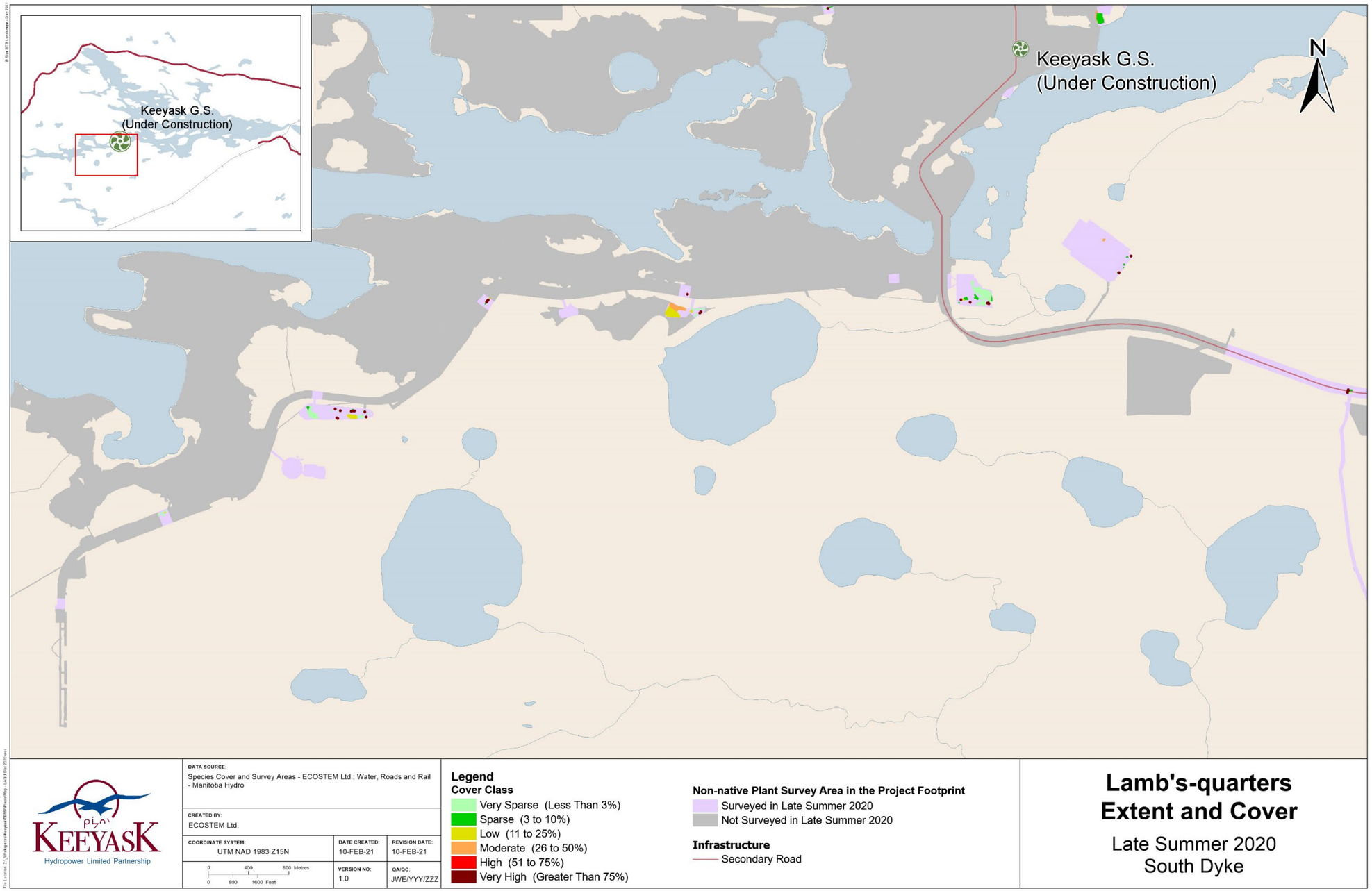
Map 7-2: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the eastern portion of the North Access Road in late summer, 2020



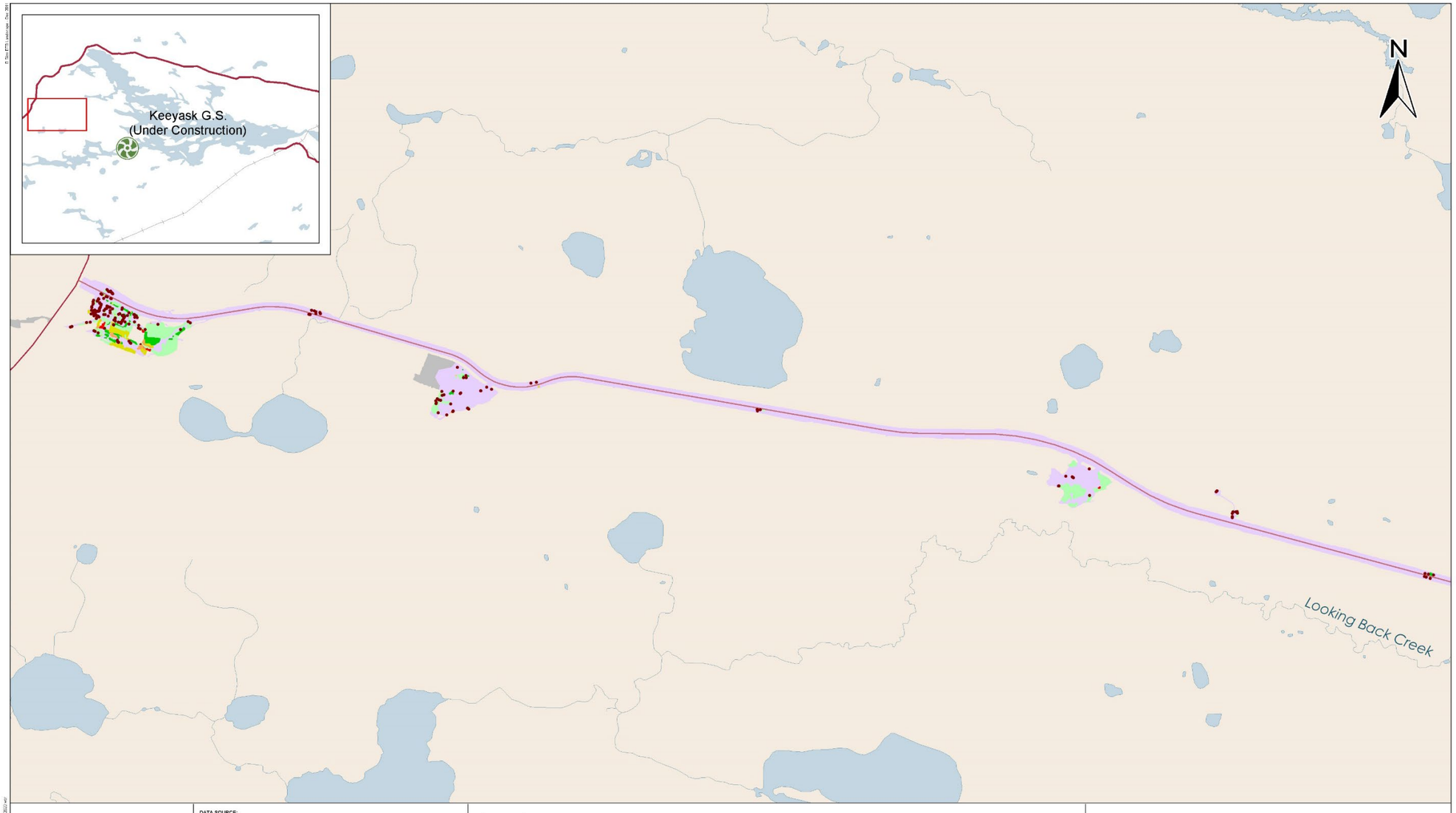
Map 7-3: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the western portion of the South Access Road in late summer, 2020



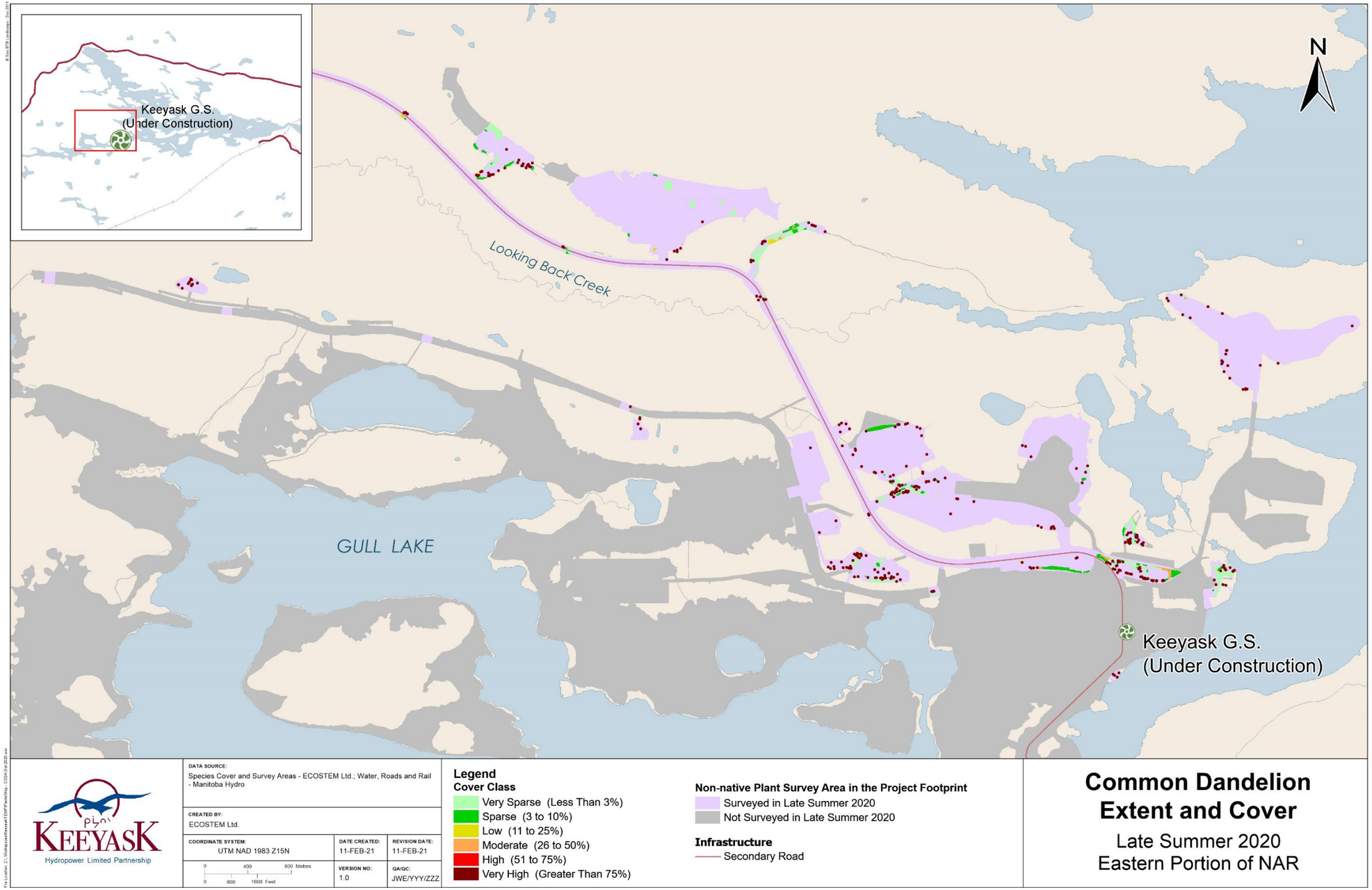
Map 7-4: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the eastern portion of the South Access Road in late summer, 2020



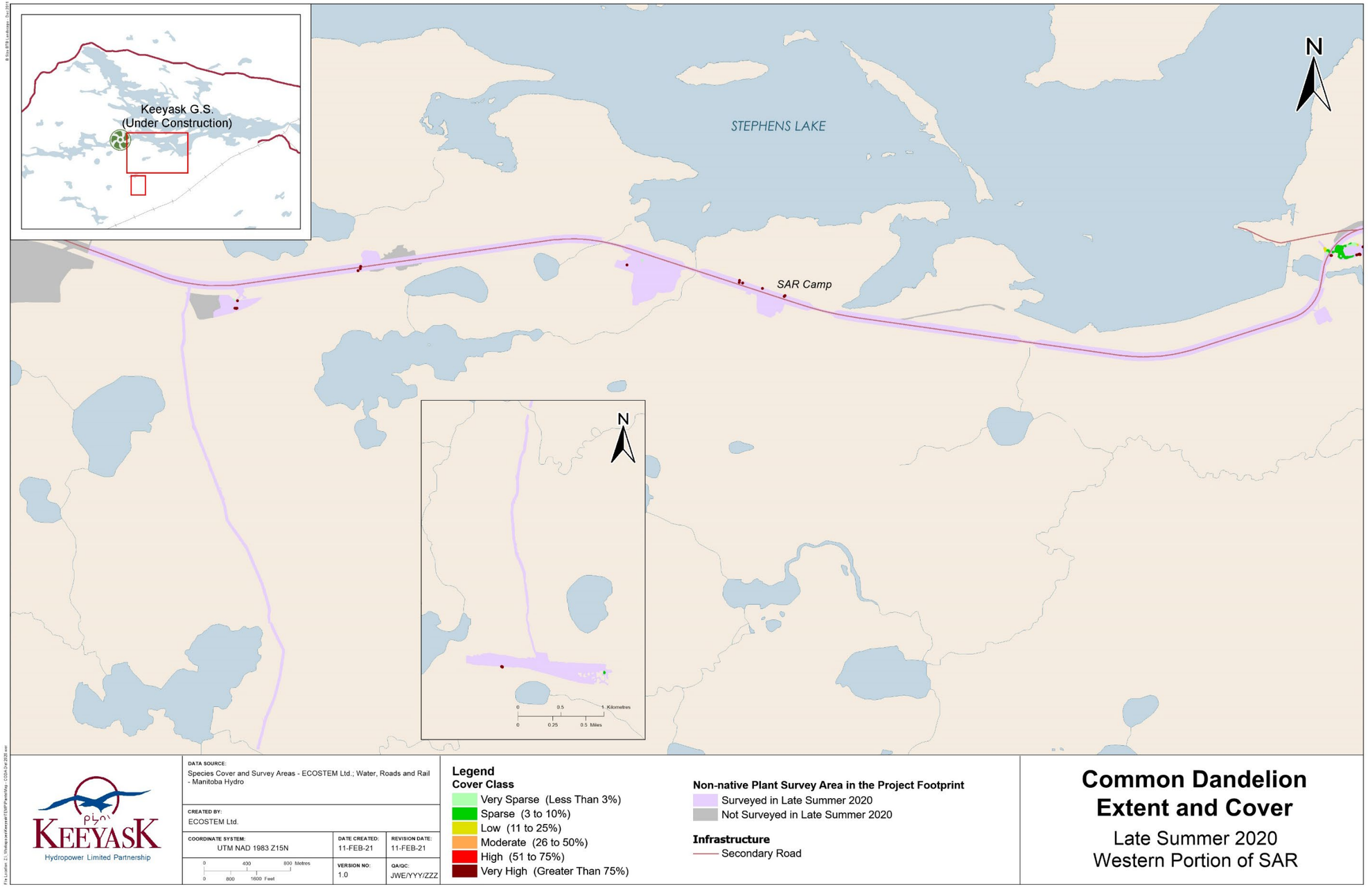
Map 7-5: The distribution and abundance (cover class) of lamb's quarters in the Project footprint along the South Dyke in late summer, 2020



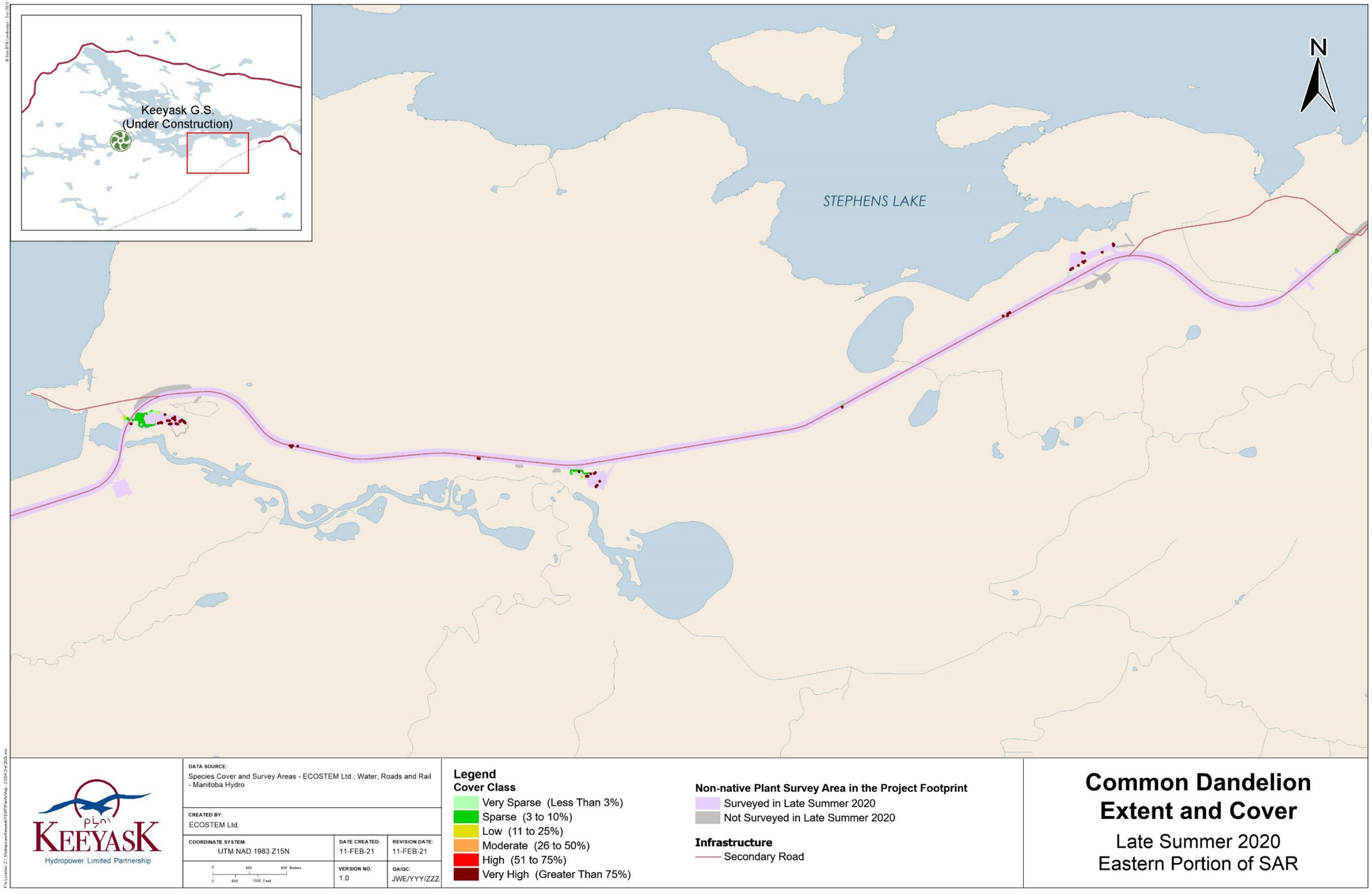
Map 7-6: The distribution and abundance (cover class) of common dandelion in the Project footprint along the western portion of the North Access Road in late summer, 2020



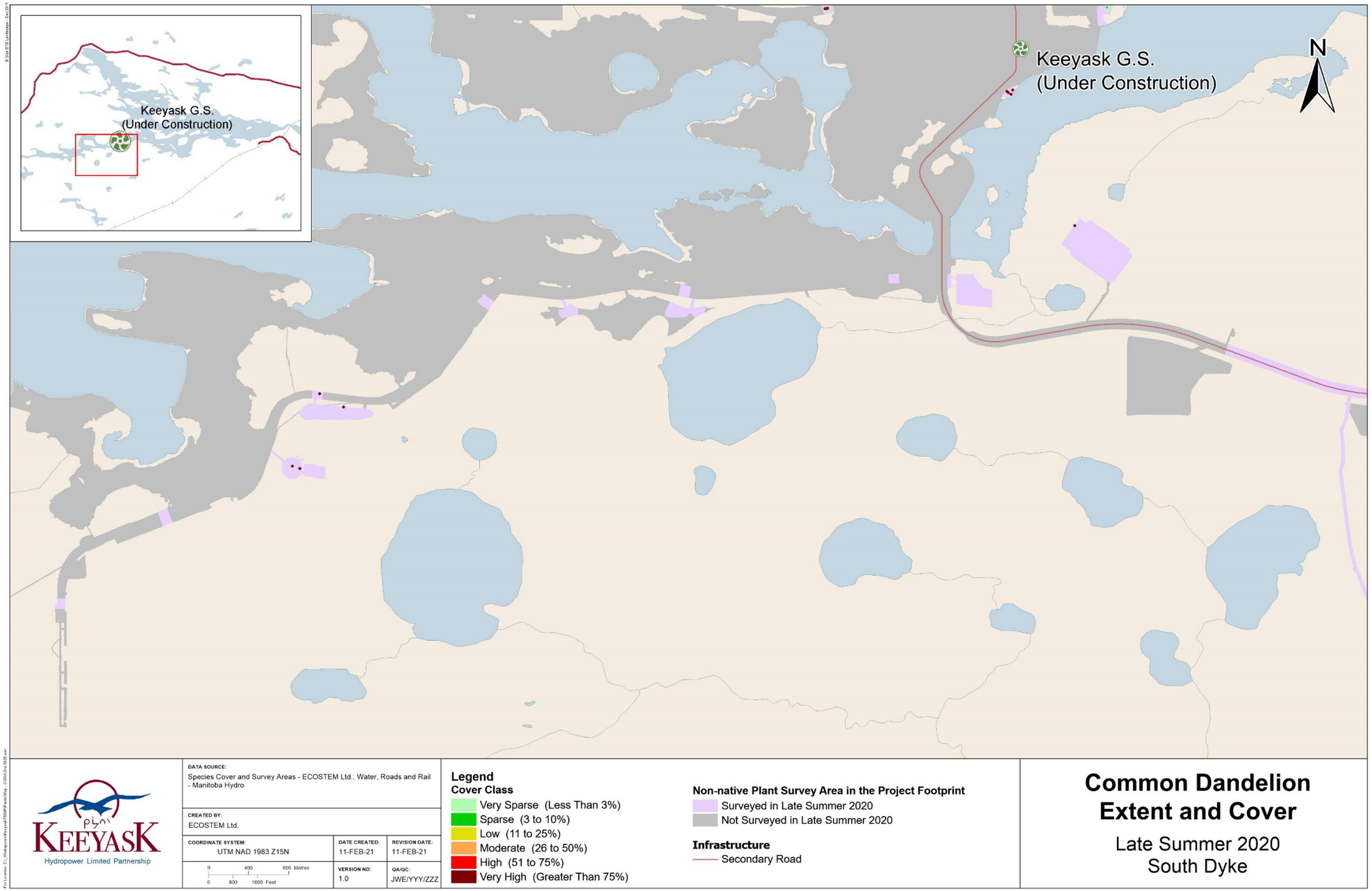
Map 7-7: The distribution and abundance (cover class) of common dandelion in the Project footprint along the eastern portion of the North Access Road in late summer, 2020



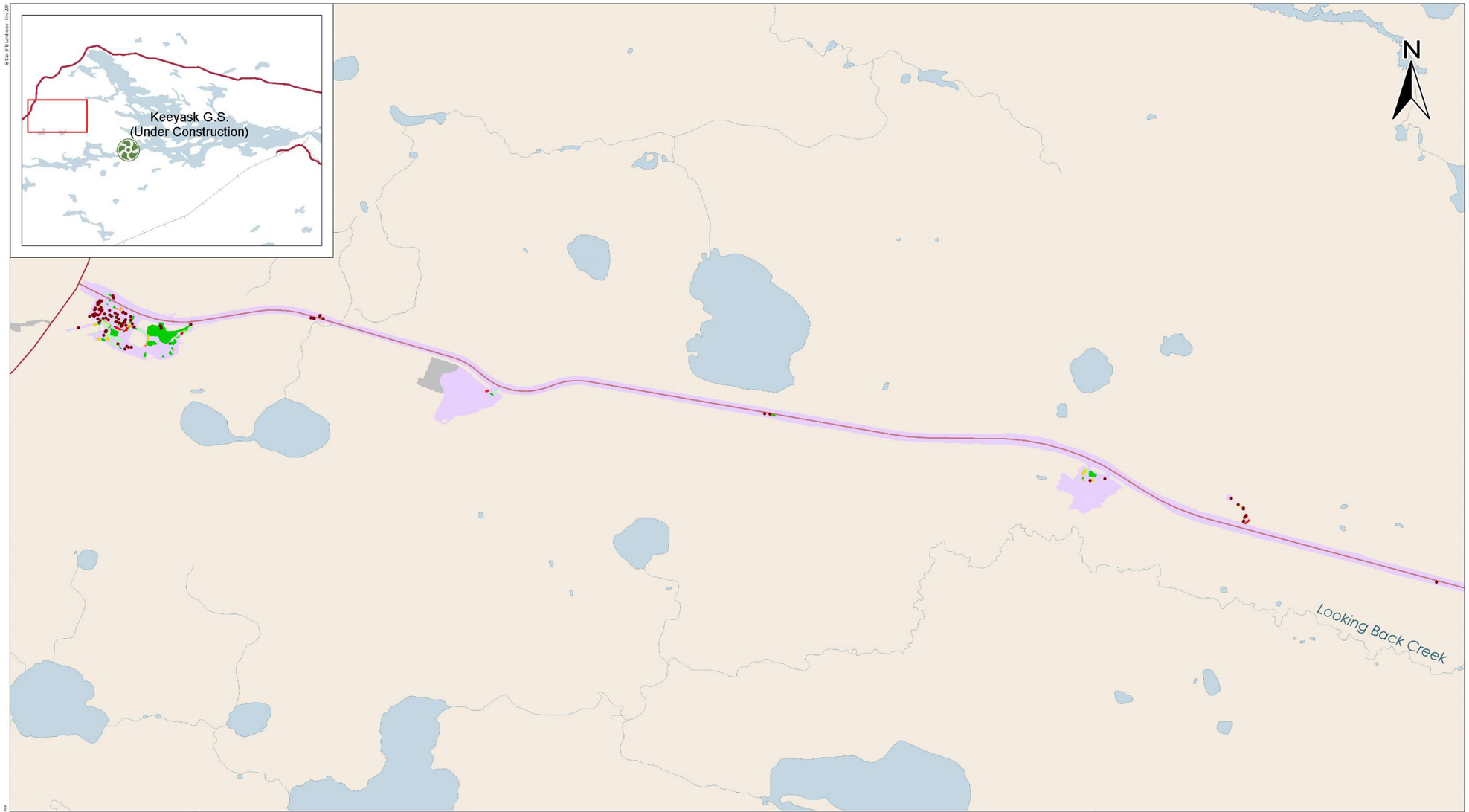
Map 7-8: The distribution and abundance (cover class) of common dandelion in the Project footprint along the western portion of the South Access Road in late summer, 2020



Map 7-9: The distribution and abundance (cover class) of common dandelion in the Project footprint along the eastern portion of the South Access Road in late summer, 2020



Map 7-10: The distribution and abundance (cover class) of common dandelion in the Project footprint along the South Dyke in late summer, 2020



[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

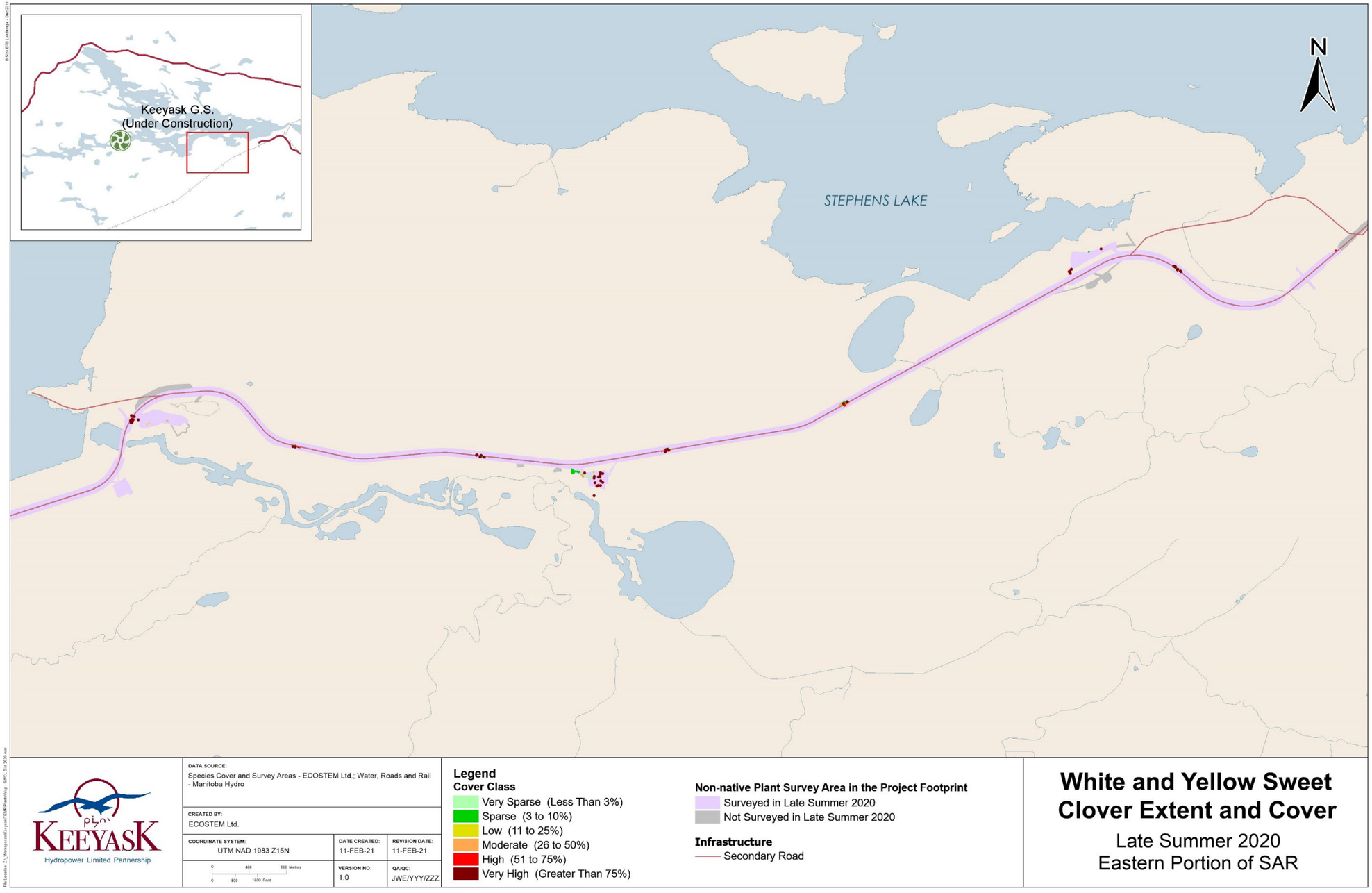
Map 7-11: The distribution and abundance (cover class) of sweet clover[1] in the Project footprint along the western portion of the North Access Road in late summer, 2020

[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

Map 7-12: The distribution and abundance (cover class) of sweet clover[1] in the Project footprint along the eastern portion of the North Access Road in late summer, 2020

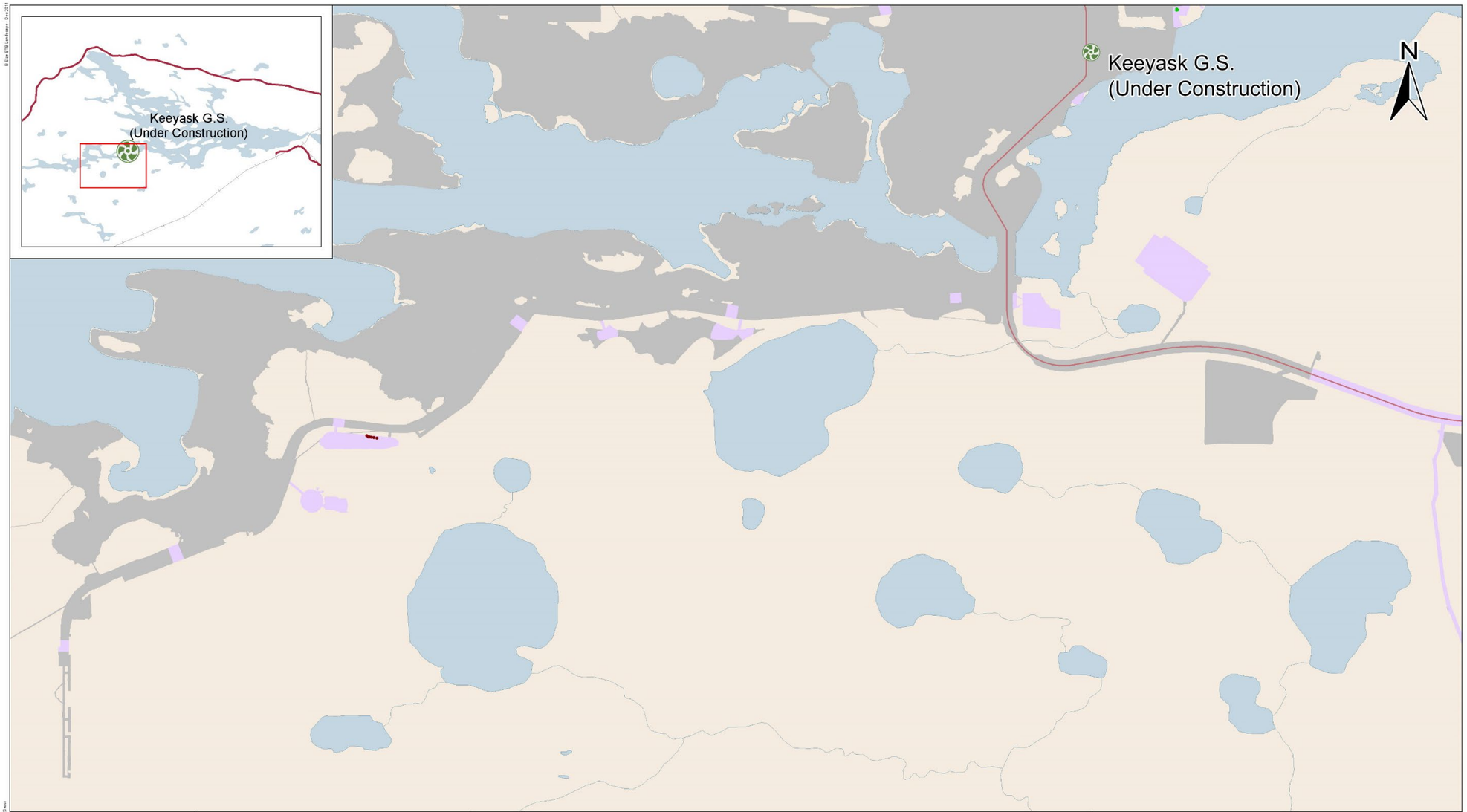
[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

Map 7-13: The distribution and abundance (cover class) of sweet clover[1] in the Project footprint along the western portion of the South Access Road in late summer, 2020



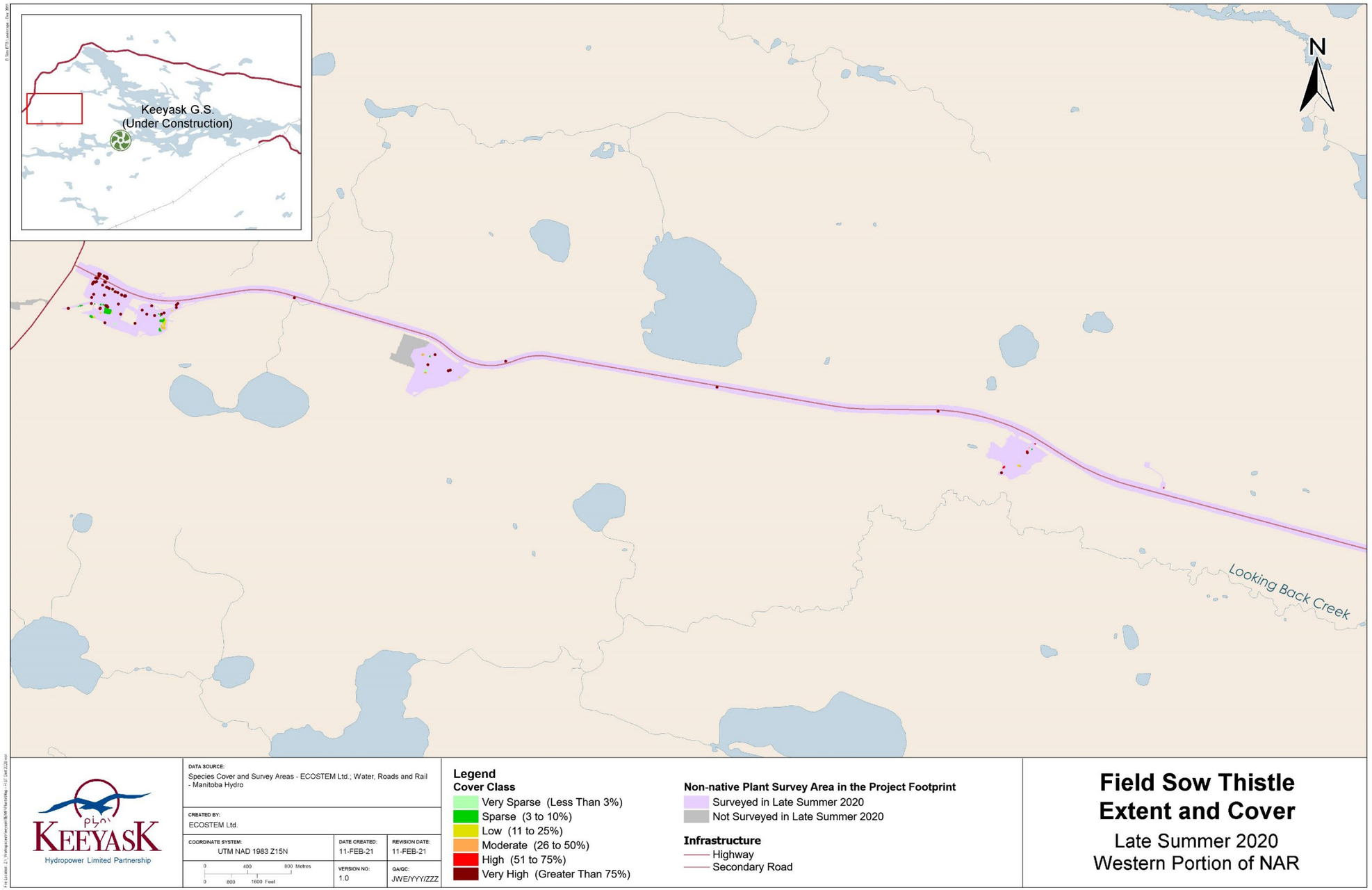
[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

Map 7-14: The distribution and abundance (cover class) of sweet clover[1] in the Project footprint along the eastern portion of the South Access Road in late summer, 2020

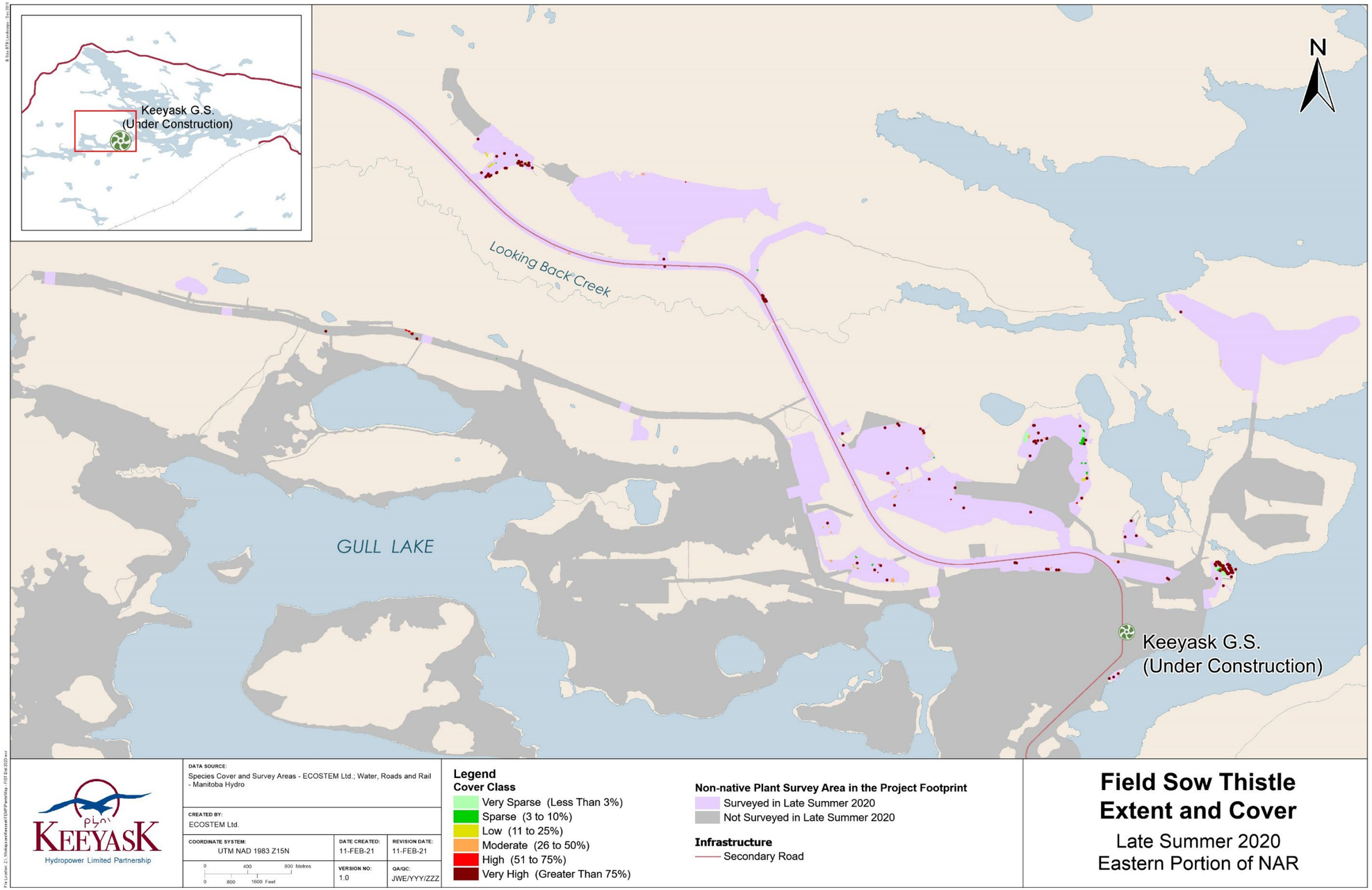


[1] Includes locations with unidentified white or yellow sweet clover due to lack of flowers.

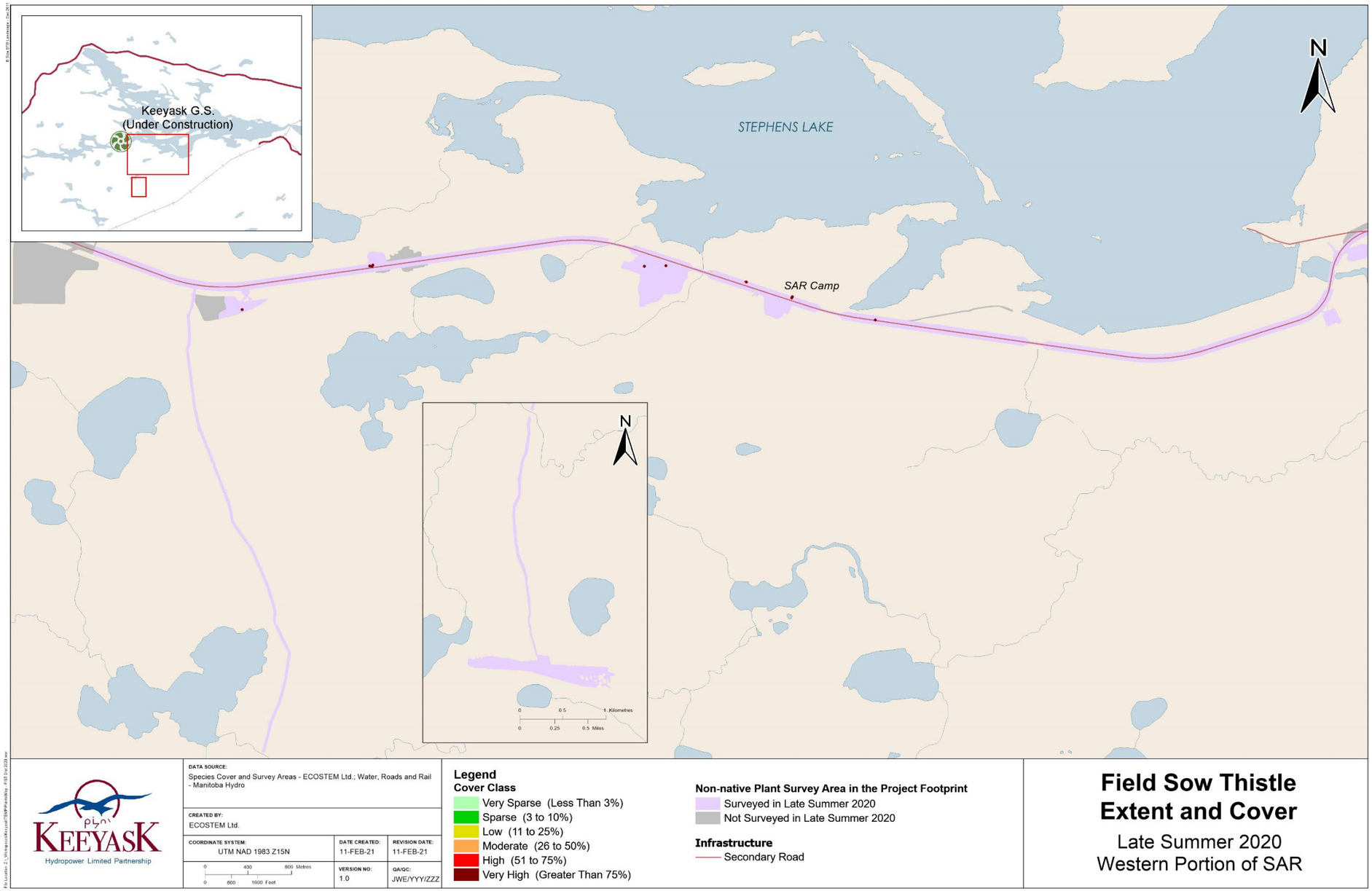
Map 7-15: The distribution and abundance (cover class) of sweet clover[1] in the Project footprint along the South Dyke in late summer, 2020



Map 7-16: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the western portion of the North Access Road in late summer, 2020

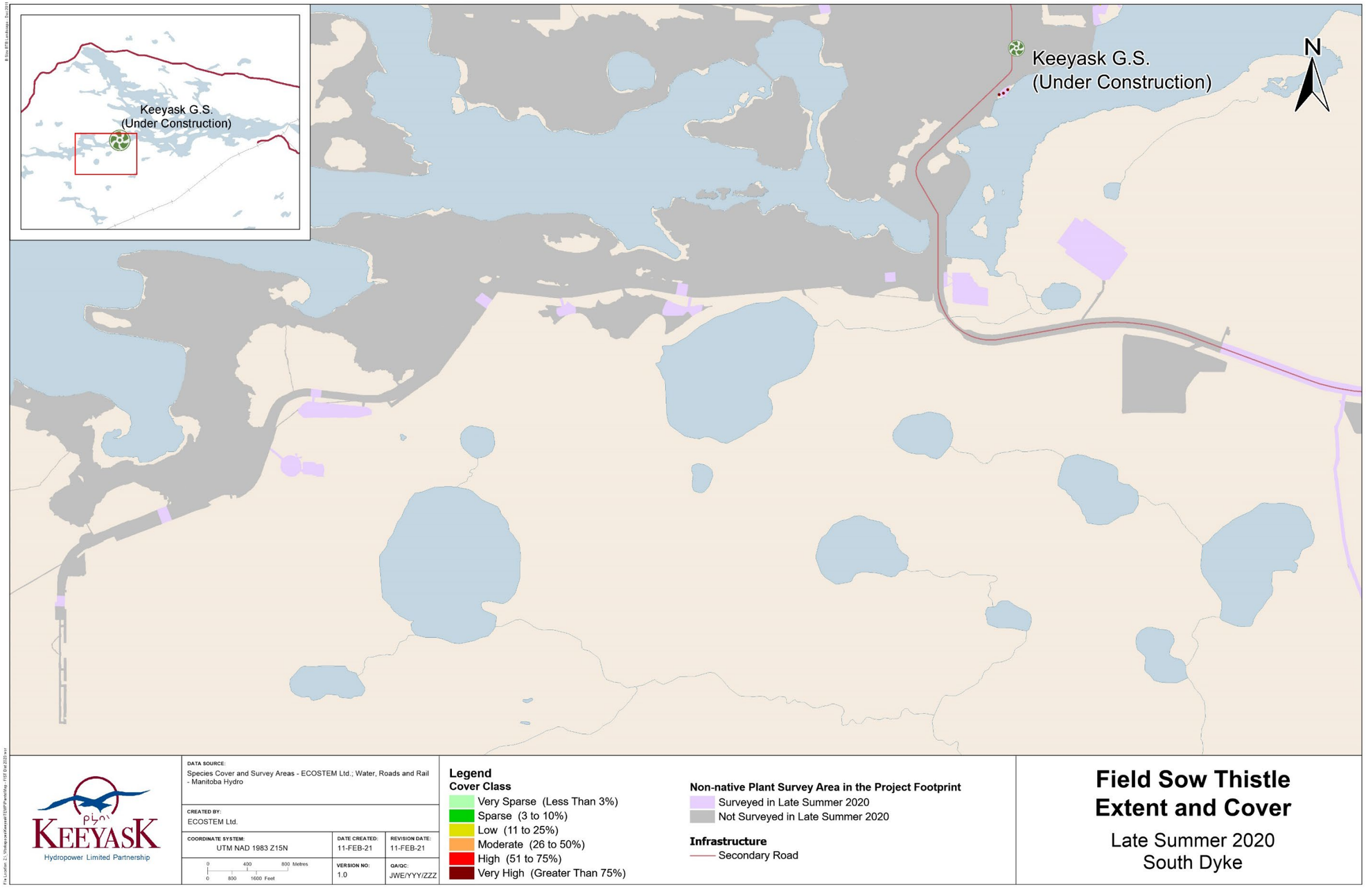


Map 7-17: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the eastern portion of the North Access Road in late summer, 2020

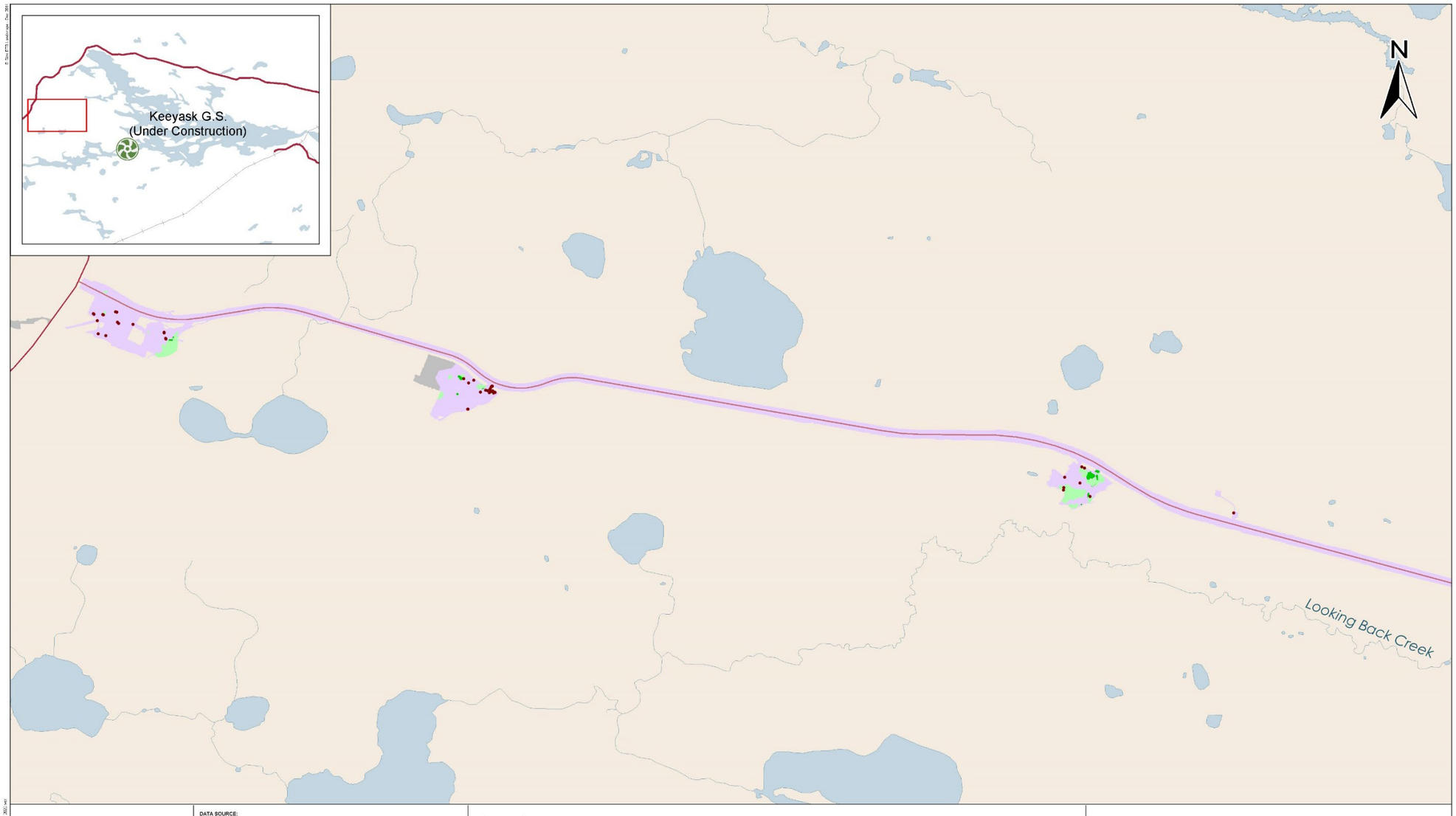


Map 7-18: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the western portion of the South Access Road in late summer, 2020

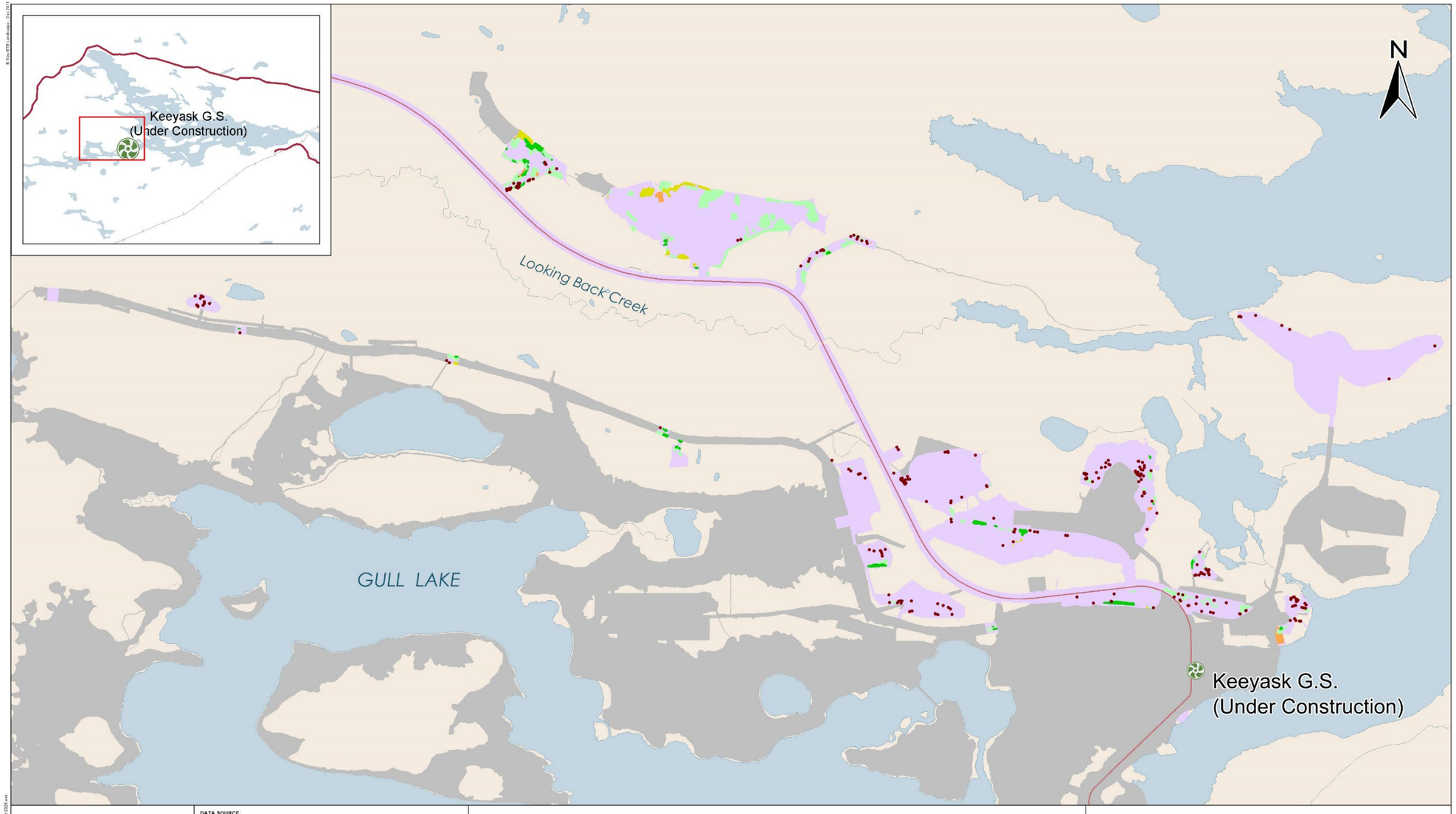
Map 7-19: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the eastern portion of the South Access Road in late summer, 2020



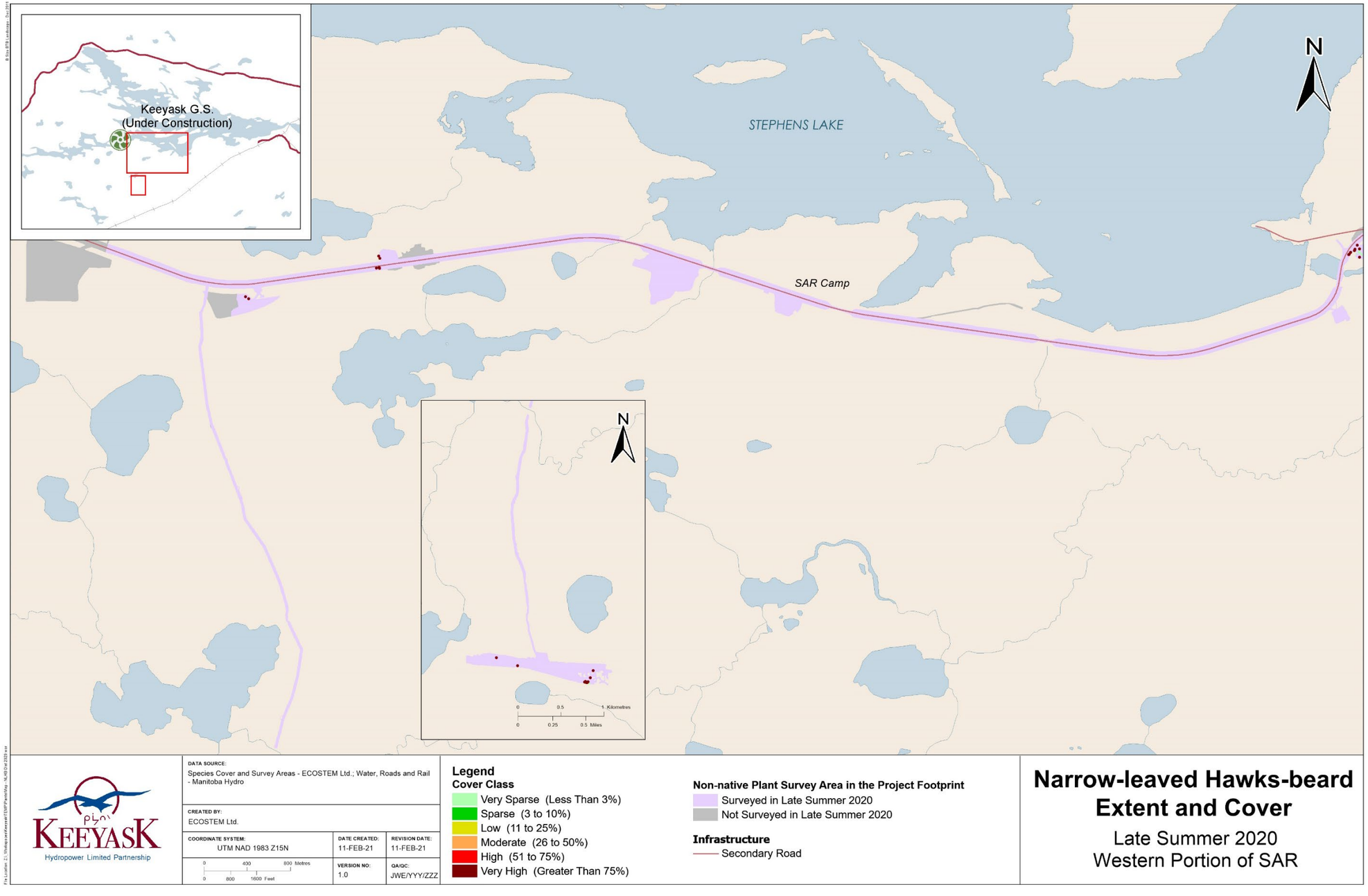
Map 7-20: The distribution and abundance (cover class) of field sow-thistle in the Project footprint along the South Dyke in late summer, 2020



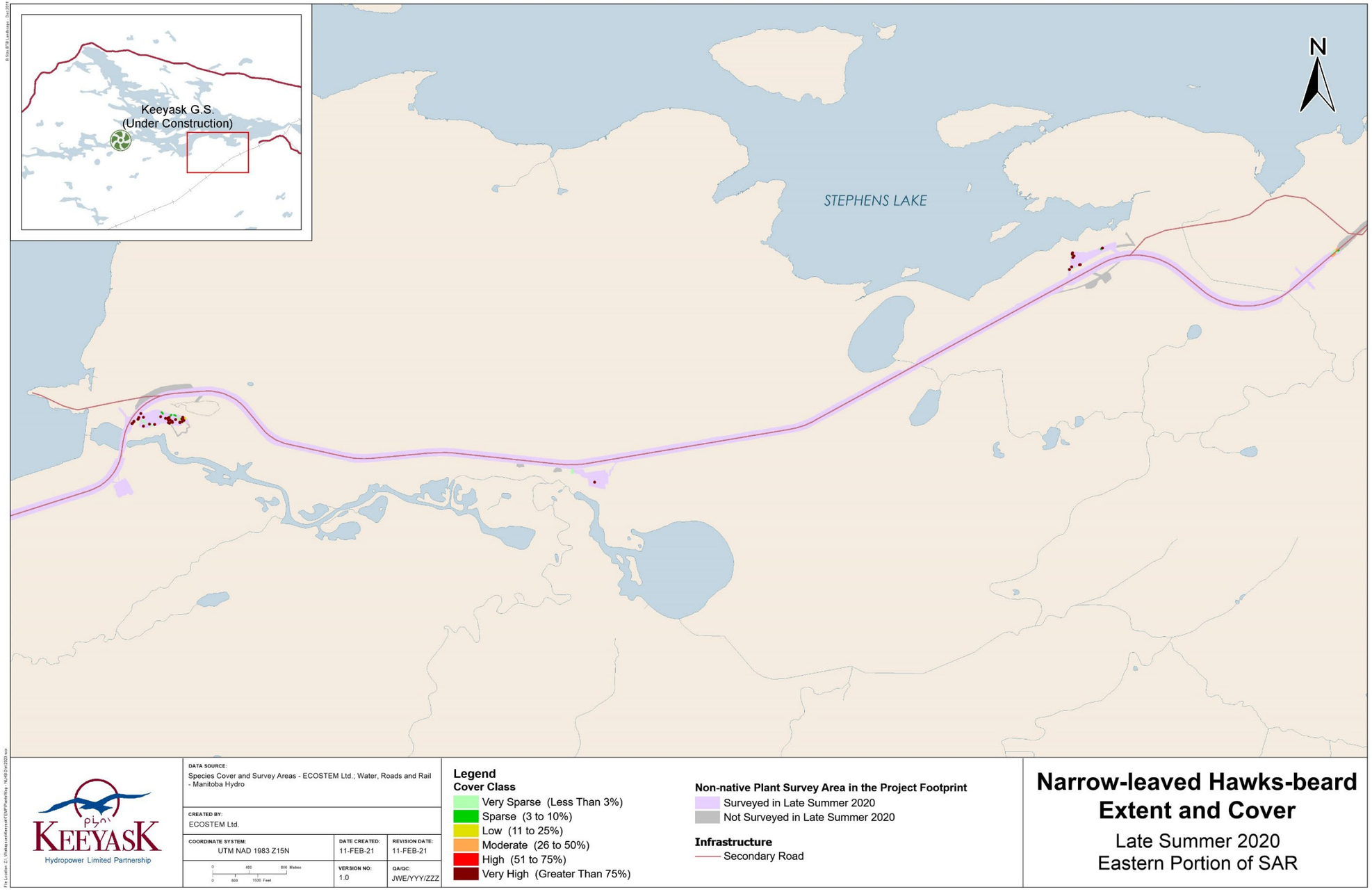
Map 7-21: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the western portion of the North Access Road in late summer, 2020



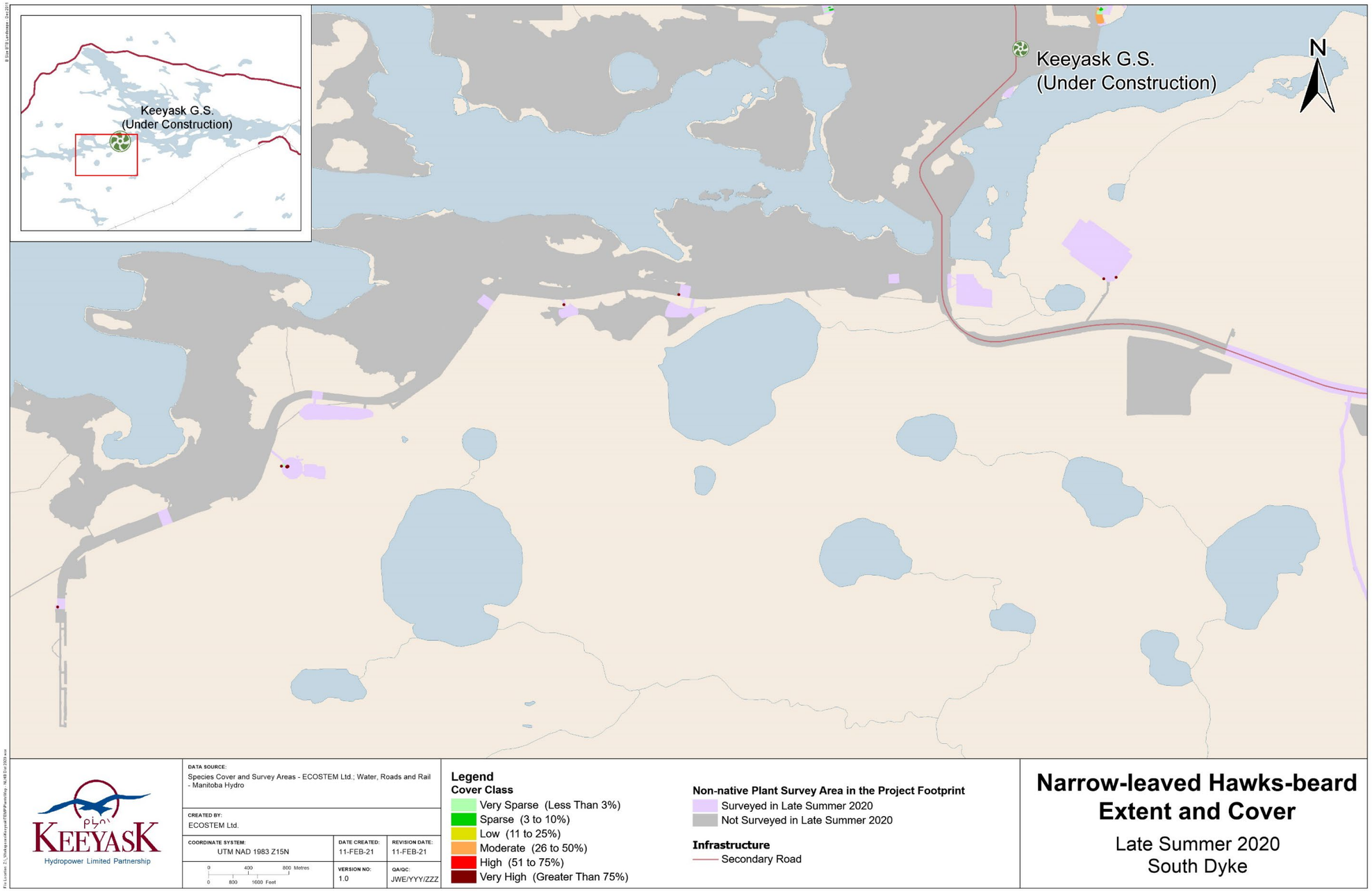
Map 7-22: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the eastern portion of the North Access Road in late summer, 2020



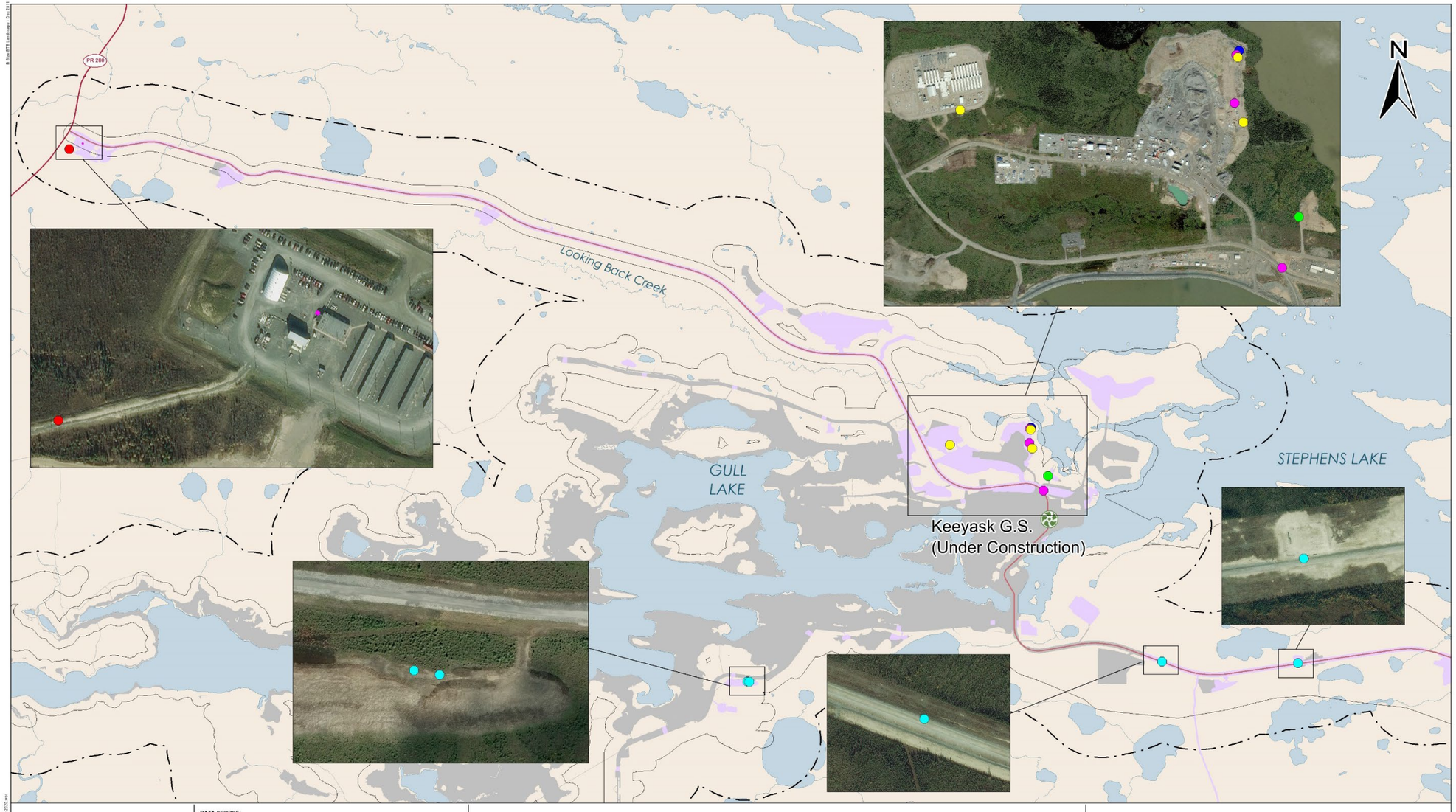
Map 7-23: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the western portion of the South Access Road in late summer, 2020



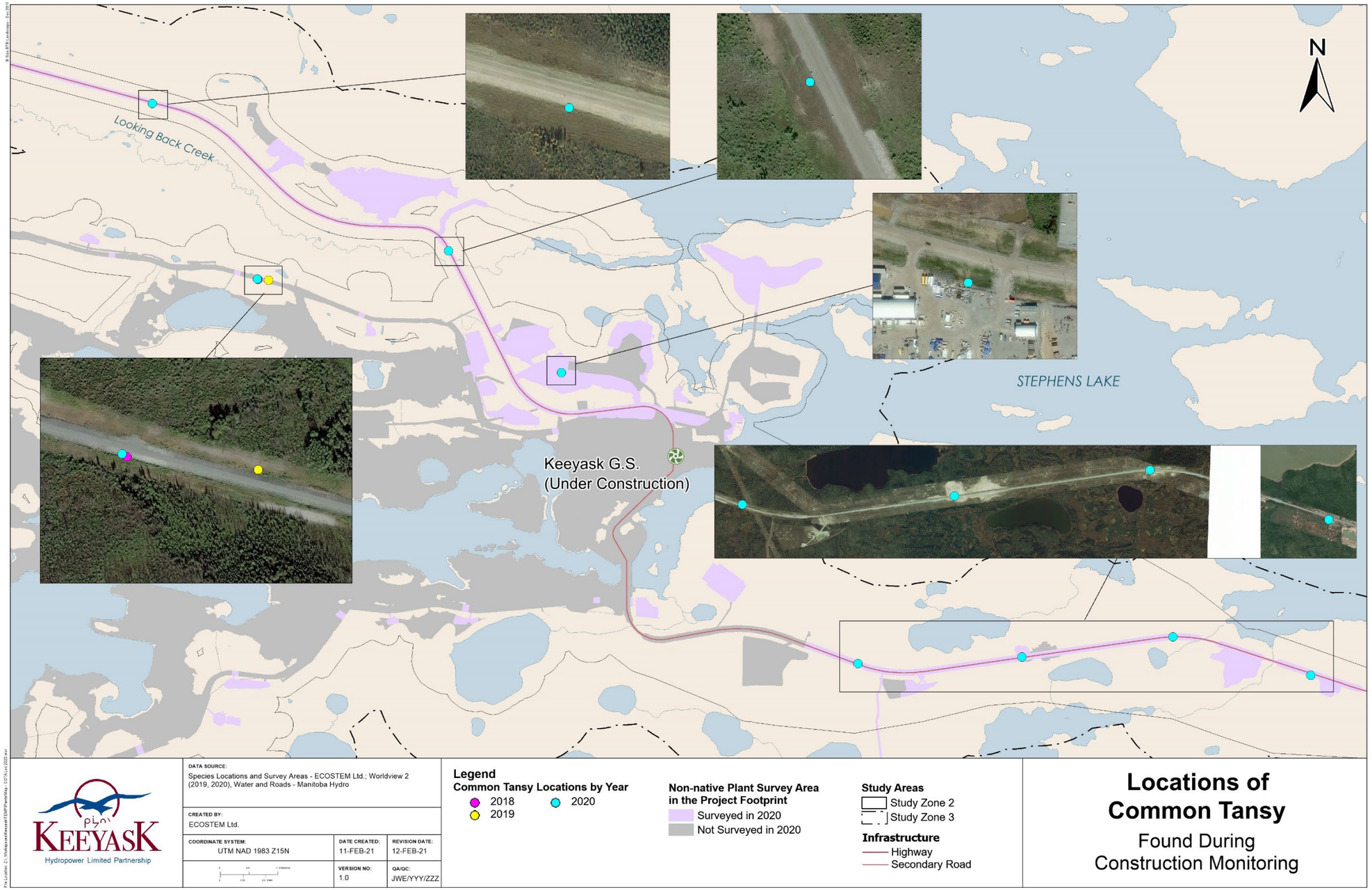
Map 7-24: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the eastern portion of the South Access Road in late summer, 2020



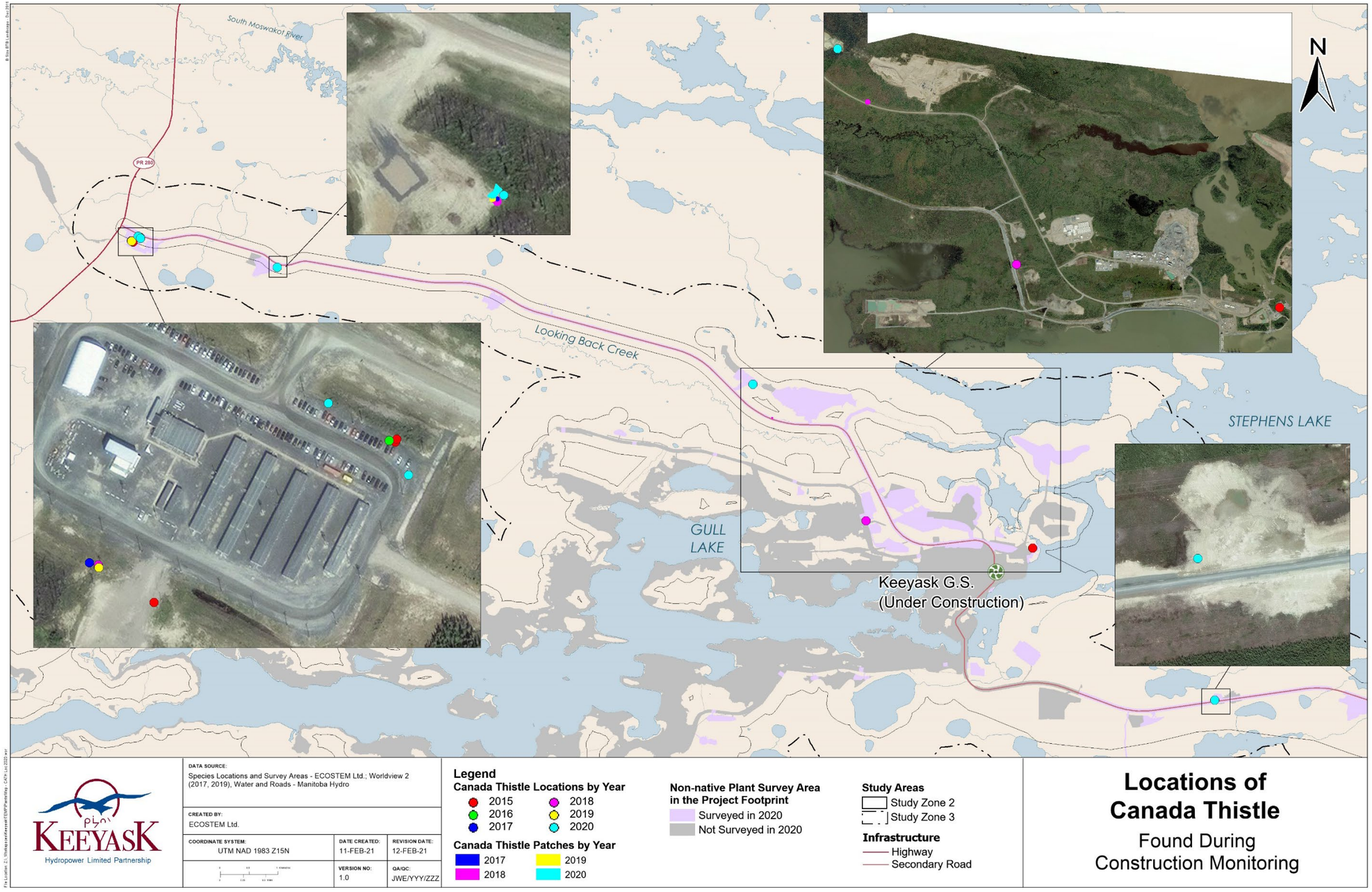
Map 7-25: The distribution and abundance (cover class) of narrow-leaved hawks-beard in the Project footprint along the South Dyke in late summer, 2020



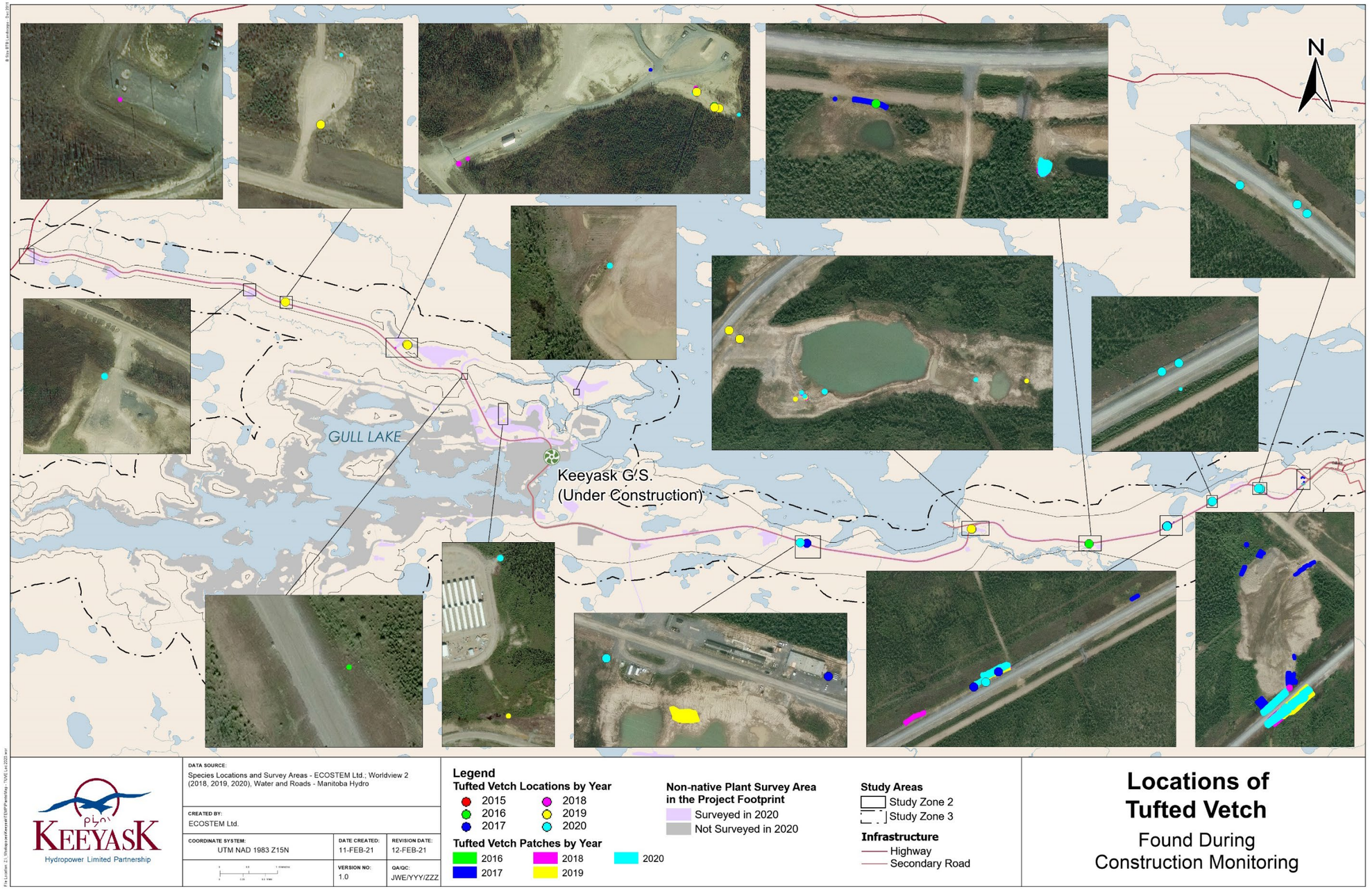
Map 7-26: Locations of scentless chamomile identified during Project construction monitoring



Map 7-27: Location of common tansy identified during Project construction monitoring



Map 7-28: Canada thistle locations identified during Project construction monitoring



Map 7-29: Tufted vetch locations identified during Project construction monitoring

APPENDIX 4:
ADDITIONAL NON-NATIVE PLANT RESULTS

Table 7-4: Total early and late summer non-native plant extent as a percentage of total area surveyed by year and Project component

Project Component	2014		2015		2016		2017[2]	2018[2]	2019[2]	2020[2]
	ES	LS	ES	LS	ES	LS	LS	LS	LS	LS
North Access Road	0.00	0.32	0.32	0.89	0.01	3.5	4.4	7.6	4.9	4.6
South Access Road	-	-	-	-	-	0.2	2.8	7.9	7.7	7.9
Camp & Work Areas	0.56	3.24	3.59	4.66	1.26	4.0	5.9	12.8	13.1	13.9
Borrow Area	0.02	0.33	0.64	3.09	0.85	2.1	5.1	8.9	8.0	11.5
North Dyke[1]	-	-	-	-	-	0.1	0.3	7.6	11.5	9.9
South Dyke[1]	-	-	-	-	0.00	0.0	0.1	0.2	0.2	10.7
Generating Station Area	-	-	-	-	-	0.5	0.2	-	-	1.0
Reservoir Clearing Area	-	-	-	-	-	-	-	-	-	-
All	0.30	1.83	1.98	3.70	0.72	2.4	4.3	9.6	9.9	11.9
Total non-native plant extent (ha)	*0.7*	*4.9*	*4.7*	*9.3*	*4.8*	*14.8*	*28.9*	*64.0*	*69.4*	*73.2*
Total area surveyed (ha)	*247*	*269*	*237*	*251*	*669*	*620*	*671*	*668*	*703*	*618*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".ES="Early Summer"; LS="Late Summer".
[1] Due to change in survey methods, 2020 values not directly comparable to previous years. See Section 2.2.1.
[2] Full early summer survey not undertaken in 2017, 2018, 2019 and 2020.

Table 7-5: Total early and late summer non-native plant cover as a percentage of total area surveyed by year and Project component

Project Component	2014		2015		2016		2017[2]	2018[2]	2019[2]	2020[2]
	ES	LS	ES	LS	ES	LS	LS	LS	LS	LS
North Access Road	0.00	0.01	0.02	0.07	0.00	0.25	0.38	0.62	0.45	0.50
South Access Road	-	-	-	-	-	0.01	0.36	1.21	2.17	3.96
Camp & Work Areas	0.06	0.34	0.46	0.77	0.18	0.58	0.73	1.20	1.05	1.54
Borrow Area	0.00	0.05	0.05	0.48	0.04	0.24	0.46	0.74	0.64	0.66
North Dyke[1]	-	-	-	-	-	0.00	0.01	0.79	1.10	0.43
South Dyke[1]	-	-	-	-	0.00	0.00	0.02	0.02	0.00	1.21
Generating Station Area	-	-	-	-	-	0.03	0.00	-	-	0.11
Reservoir Clearing Area	-	-	-	-	-	-	-	-	-	-
All	0.03	0.20	0.24	0.59	0.06	0.31	0.44	0.88	0.86	0.99
Total non-native plant cover (ha)	*0.08*	*0.53*	*0.57*	*1.49*	*0.43*	*1.89*	*2.98*	*5.85*	*6.02*	*6.13*
Total area surveyed (ha)	*247*	*269*	*237*	*251*	*669*	*620*	*671*	*668*	*703*	*618*

Notes: Numbers that round to zero shown as "0"; absences shown as "-".ES="Early Summer"; LS="Late Summer".
[1] Due to change in survey methods, 2020 values not directly comparable to previous years. See Section 2.2.1.
[2] Full early summer survey not undertaken in 2017, 2018, 2019 and 2020.

Table 7-6: Total approximate non-native species cover (m^2) and number of species in the Project footprint, by year and season

Common Name	2014		2015		2016		2017		2018		2019		2020
	ES	LS	ES	LS	ES	LS	ES[1]	LS	ES[1]	LS	ES[1]	LS	LS
Common Burdock	-	-	-	-	-	0	-	-	2	5	-	5	-
Wormwood	-	-	0	0	0	1	0	1	-	1	-	-	1
Canola	-	-	-	-	-	-	-	-	-	-	-	-	0
Shepherd's-Purse	-	-	-	-	-	-	-	-	-	-	-	0	0
Lamb's-quarters	89	2,903	1,115	8,844	990	6,342	131	15,229	-	19,709	0	25,817	11,113
Canada Thistle	-	-	0	0	-	0	-	1	1	2	-	1	5
Narrow-leaved Hawks-beard	-	-	-	-	-	586	191	1,314	-	11,040	0	10,808	13,778
Flixweed	-	-	-	-	-	-	-	-	-	-	-	-	0
Wormseed Mustard	-	-	-	-	-	-	-	-	-	-	-	495	470
Ox-eye Daisy	-	-	-	-	-	-	0	-	-	0	-	0	
Bird's-foot Trefoil	-	-	-	-	0	0	-	0	-	-	-	0	2
Pineapple-weed	-	-	7	18	0	29	-	325	-	74	-	32	78
Black Medick	-	0	-	1	-	-	-	0	-	-	-	-	3
Alfalfa	119	124	0	11	4	14	4	40	-	98	-	102	139
White Sweet Clover	-	532	1,742	2,252	900	3,015	11	4,949	-	11,508	-	7,839	8,907
Yellow Sweet Clover	-	0	-	2	7	109	-	254	-	543	0	1,235	2,652
Unidentified Sweet Clover	387	72	-	-	565	1,838	1,372	67	-	307	0	851	567
Spotted Lady's-Thumb	-	-	-	-	-	-	-	-	-	-	-	77	752
Common Timothy	-	-	-	-	-	0	101	0	-	0	0	0	13
Common Plantain	27	80	56	121	68	268	97	246	-	741	0	674	1,108
Curly Dock	-	-	-	-	-	100	19	19	-	148	0	204	465
Rye	-	0	-	-	-	-	-	-	-	-	-	-	
Smooth Catchfly	-	-	0	5	16	26	1	32	-	294	-	338	855
Field Sow-thistle	38	252	301	972	52	1,111	420	1,656	14	2,543	0	3,338	2,674
Common Tansy	-	-	-	-	-	-	-	-	-	0	-	0	2

Common Name	2014		2015		2016		2017		2018		2019		2020
	ES	LS	ES	LS	ES	LS	ES[1]	LS	ES[1]	LS	ES[1]	LS	LS
Common Dandelion	143	1,291	2,316	2,422	1,654	5,268	1,465	5,521	-	10,199	0	6,792	14,638
Alsike Clover	-	25	145	242	43	190	2	91	-	833	0	1,021	2,250
Red Clover	-	0	-	0	-	-	0	1	-	0	-	0	6
White Clover	-	0	-	0	0	0	-	-	-	-	-	0	0
Scentless chamomile	-	-	-	0	-	0	-	0	-	1	-	0	0
Wheat	-	-	-	-	-	30	-	21	0	-	-	-	
Tufted Vetch	-	-	-	-	0	0	2	38	2	170	0	563	821
Number of non-native species	7	12	11	16	13	21	16	21	5	21	10	25	27

Notes: Numbers that round to zero shown as "0"; absences shown as "-". ES="Early Summer"; LS="Late Summer".
[1] Full early summer survey not undertaken in 2017, 2018 and 2019. Cover only includes patches mapped using full method.
[2] Species difficult to distinguish until they flower are combined into a broader taxon. Unidentified sweet clover includes white sweet clover and yellow sweet clover.

Table 7-7: Total late summer non-native plant extent by project and year as a percentage of area surveyed

Footprint Use	2014	2015	2016	2017	2018	2019	2020
Keeyask Infrastructure Project	0.5	3.7	7.5	29.4	23.2	21.0	20.0
Both Keeyask Infrastructure and Keeyask Generation Projects	2.4	3.7	4.2	6.9	15.1	16.2	18.3
Keeyask Generation Project	-	-	0.3	0.4	4.1	5.2	5.2

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

Table 7-8: Total late summer non-native plant cover by project and year as a percentage of area surveyed

Footprint Use	2014	2015	2016	2017	2018	2019	2020
Keeyask Infrastructure Project	0.1	0.6	1.1	2.3	1.1	0.8	0.8
Both Keeyask Infrastructure and Keeyask Generation Projects	0.2	0.6	0.5	0.8	1.5	1.4	1.5
Keeyask Generation Project	-	-	0.06	0.03	0.4	0.5	0.6

Notes: Numbers that round to zero shown as "0"; absences shown as "-".

APPENDIX 5:
REED CANARYGRASS RESULTS

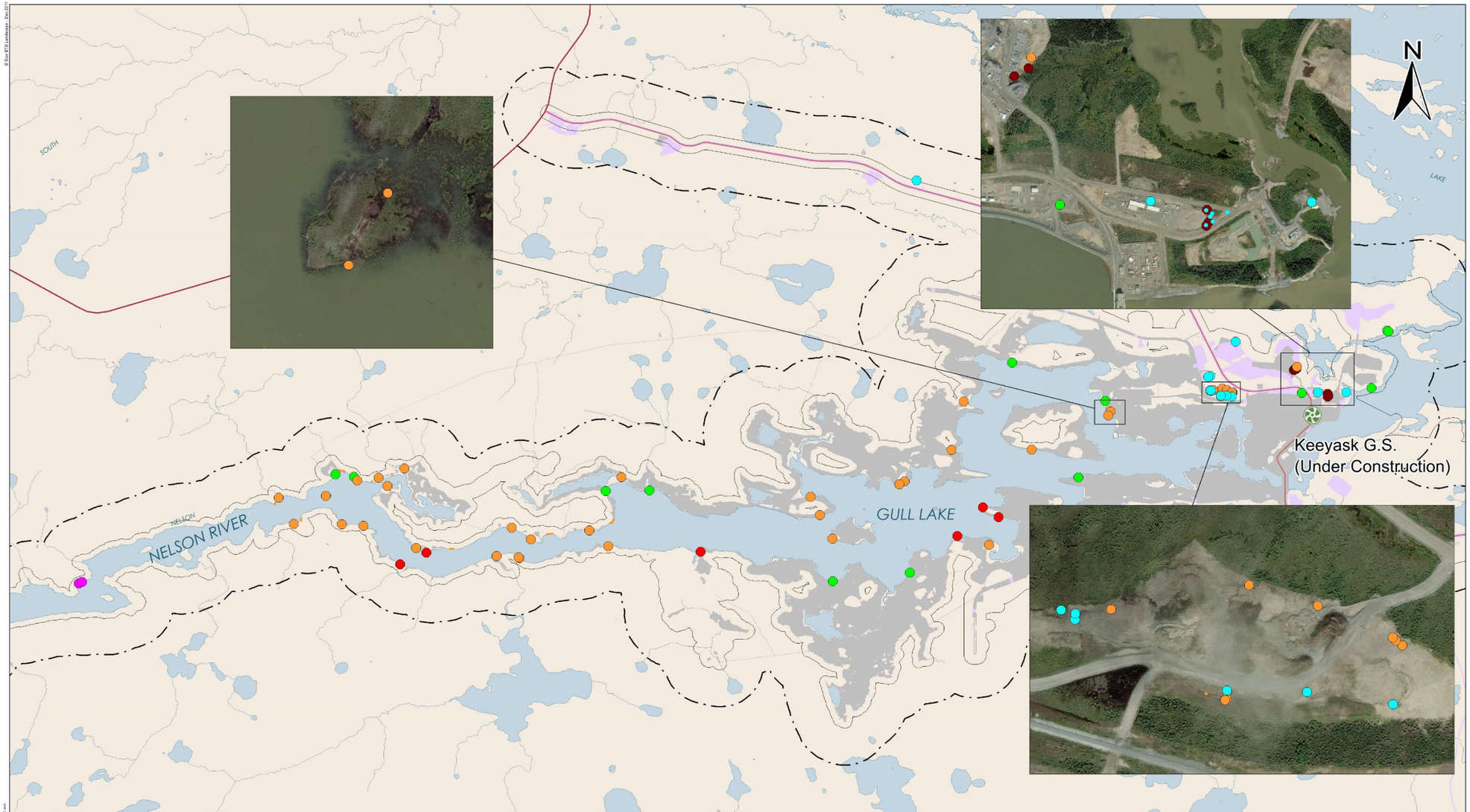
Reed Canarygrass

In 2020, reed canarygrass (*Phalaris arundinacea*; Photo 7-1) was recorded in five components of the Project footprint (Map 7-30). Plants were found at 18 sites scattered in EMPA D12 and Work Area B, and one site each in the Main Camp, Cemetery Site and Work Area C, at two sites in EMPA D16, and at one site near the upstream boat launch.

The plant has previously been found at 26 sites near and along the Nelson River shoreline between Clark and Stephens Lakes during plant surveys in 2003, 2004 and 2007, at five sites in the Project footprint in 2018, and in 2019 it was found at 10 sites in the footprint, and 42 sites along the shoreline upstream of the Keeyask Generating Station. It is uncertain whether the plant was introduced by Project construction activity, or if it spread to this location from a pre-existing population outside of the Project footprint.

Due to the reasons stated in Section 2.7, reed canarygrass found during the monitoring is not being included as a non-native species. Recorded plant locations will be monitored, however, and mitigation options will be considered in the future if the plant appears to become invasive.

Photo 7-1: Reed canarygrass growing in Work Area B on August 26, 2018



Map 7-30: Reed canarygrass locations identified before and during Project construction monitoring