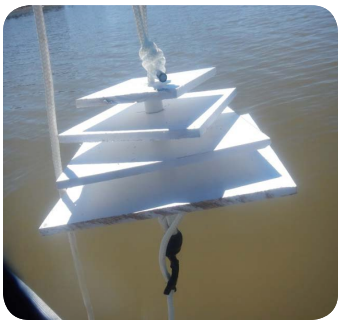
Keeyask Generation Project

Zebra Mussel Monitoring Plan

Zebra Mussel Monitoring Report

ZMMP-2024-01



KEEYASK

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

2023 -2024

KEEYASK GENERATION PROJECT

ZEBRA MUSSEL MONITORING PLAN

REPORT #ZMMP-2024-01

ANNUAL REPORT

APRIL 2023 TO MARCH 2024

Prepared by

Manitoba Hydro

&

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SUMMARY

Zebra mussels are an aquatic, invasive species that grow on hard materials in the water, such as rocks and pipes, and can become so prolific they cause major problems for utilities. They were first introduced to North America in the 1980s from Europe and/or Asia, where they were carried in the bilge water of oceangoing ships that was released into North American waterways. They are a major problem because they do not have predators in North America and therefore, grow freely on submerged surfaces (Figure 1). The first zebra mussel was found in Lake Winnipeg in 2013. Shortly after, they were detected in the Nelson River and they were first found at the Keeyask station in 2020. They have multiplied and been detected consistently at Keeyask since that time.

Figure 1: Once present, zebra mussels grow on hard surfaces that are in the water, as shown on this boat propeller. Each mussel is approximately the size of a fingernail.

The *Zebra Mussel Monitoring Plan* (ZMMP) was developed and is being implemented in accordance with the Keeyask *Environment Act* Licence to monitor and manage the impacts of zebra mussels on the Keeyask Project.

Now that construction is complete, in-water activity is mostly limited to boat traffic associated with ongoing operation phase monitoring and mitigation work by personnel who are familiar with preventative measures required to prevent zebra mussels from spreading. For this reason, the focus of zebra mussel monitoring during the operation phase is tracking the number of "veligers" (microscopic mussel larvae) and adult mussels found around Keeyask over time.

Veligers were first found in Gull Lake in 2019 and monitoring is ongoing. During 2023, three samples were collected from the Keeyask reservoir. Each sample contained veligers and a total of 217 veligers were found. The number caught is lower than last year (603), but remains higher than in 2020 and 2021 when 28 and 89 veligers were found, respectively.

2023 marked the fourth year when adult zebra mussels were found on monitoring substrate located in and around the generating station. Five hundred and nine zebra mussels were found on four substrates in the Keeyask Reservoir and 717 were found on the four from Stephens Lake. There were no mussels found on the two substrates in Clark Lake, which is consistent with all past results.

Zebra mussels will be monitored again at the same locations in 2024.

Since they have arrived at Keeyask, there is a requirement to treat the station's critical piping using chlorine and potash (pending regulatory approval) as a preventative measure to protect station operation. Treatment in 2023 was successful in eliminating zebra mussels within the station and depending on the numbers that grow in the station's bioboxes, treatment may need to be carried out again in 2024.

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1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt (MW) hydroelectric generating station at Gull (Keeyask) Rapids on the lower Nelson River in northern Manitoba. The Project is approximately 725 kilometres (km) northeast of Winnipeg, 35 km upstream of the existing Kettle Generating Station, where Gull Lake flows into Stephens Lake, 60 km east of the community of Split Lake, 180 km east-northeast of Thompson and 30 km west of Gillam. Construction of the Project began in July 2014. The reservoir impoundment took place in 2020 and the generating station and spillway became fully operational in March 2022.

Although none of the aquatic invertebrate species identified during the environmental assessment of the Project were listed as invasive in accordance with the Invasive Species Council of Manitoba's listing at the time (KHLP 2012), the Project's *Environment Act* Licence #3107 (Clause 18) indicated the Keeyask Hydropower Limited Partnership (KHLP) must develop a Zebra Mussel Monitoring Plan to "*monitor and adaptively manage impacts to the Development (Project) associated with zebra mussels and participate with the Government of Manitoba on treatment programs within the Keeyask reservoir.*"

The *Zebra Mussel Monitoring Plan* (ZMMP) was submitted by the KHLP in December 2015 (KHLP 2015) and was subsequently approved by Manitoba Sustainable Development. This report summarizes the results and activities conducted from April 2023 to March 2024 in accordance with the ZMMP and describes mitigation being undertaken by the KHLP to prevent growth within the station infrastructure.

2.0 ZEBRA MUSSEL MONITORING 2023

The ZMMP in 2023 was comprised of water quality sampling and colonization by adult mussels. The collection of biological samples described in this report was authorized by Manitoba Natural Resources and Northern Development under terms of the Scientific Collection Permit #57172605 (SCP 19-2023) and Aquatic Invasive Species (AIS) permit 20-2023.

2.1 VELIGER SAMPLING

Zebra mussel veligers (larval mussels) were sampled at three locations upstream from the Keeyask GS on September 20, 2023 (Figure 2). Samples were collected with a plankton net consisting of a 27 cm diameter ring with bridle; a 1 meter long, 63-micron mesh net; and a removable weighted cod end for sample retrieval. Samples were collected using the vertical tow (used in areas of water 6 meters or more in depth) method. The net was released, allowed to sink to ~1 m above the bottom. It was allowed to sit for 30 seconds and pulled up at a rate of approximately 0.5 m/s. This was repeated between two and three times to retrieve a single sample over 1,000 L.

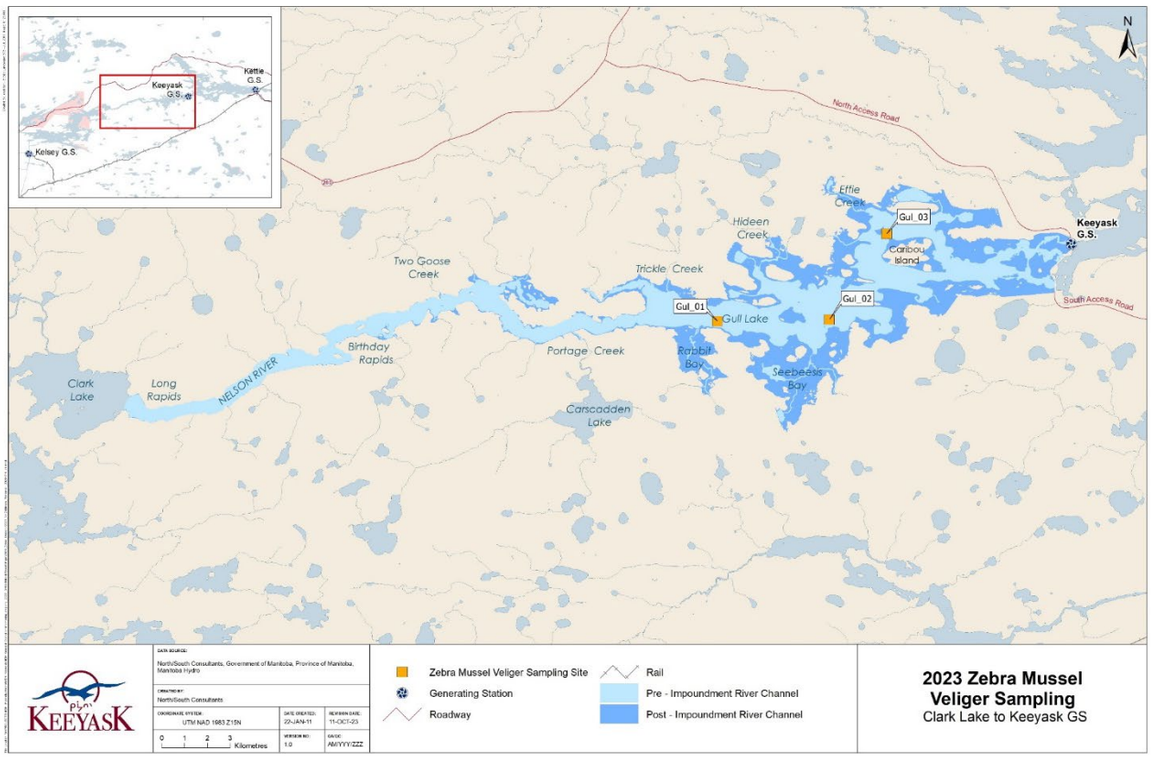

Figure 2: Sampling sites for zebra mussel veliger monitoring in the Keeyask Study Area, September 20, 2023.

All sampling information was recorded onto field data sheets that included sample date and time, sample ID, water temperature (˚C), location (UTM), Secchi depth (m), water depth (m), water velocity (m/sec), start time, and tow distance (m). Site specific data are presented in Table 2.1.

After retrieval, the entire net was rinsed from the outside to ensure all sample material was washed into the cod end. Contents were thoroughly rinsed into a labelled sample jar. Samples were preserved using 70% denatured ethanol (alcohol to sample ratio = 2:1). All samples were stored for transport in a cooler and sent to ALS Laboratories (Winnipeg, MB) for analysis.

2.1.1 RESULTS

Table 2.1 shows Zebra mussel veligers were found in all three samples collected in September 2023 (see Certificate of Analysis from ALS Laboratories). A total of 43 veligers were collected at

GUL-01, 86 at GUL-02, and 88 at GUL-03. Zebra mussel veligers have been collected in the area since 2021.

Table 2.1: Site specific data collected at zebra mussel veliger sampling sites upstream of the Keeyask GS construction site during September 2023.

Sample ID	Sample Date	Water Temperature (˚C)	15V (NAD 83)		Water Depth (m)	Secchi Depth (m)	Sample Method	Number of Tows	Number of Veligers
			Easting	Northing					
GUL-01	20-Sep-23	14	348372	6243813	11.3	0.5	Vertical	2	43
GUL-02	20-Sep-23	14	353294	6243888	14.6	0.5	Vertical	2	86
GUL-03	20-Sep-23	14	355807	6247652	16.8	0.5	Vertical	2	88

2.2 COLONIZATION/ADULT SAMPLING

Substrate samplers were used to sample adult zebra mussels in Clark Lake, the Keeyask reservoir, and Stephens Lake (figures 4 & 5). Substrate samplers consisted of a series of four square plates that are 6, 8, 10, and 12 inches in size, pyramiding from smaller plates at the top down to larger plates at the bottom (Figure 3). The plates were made of ⅛-inch PVC board with ¾-inch PVC pipe for spacers (1-inch sections) between the plates, held together with rope.

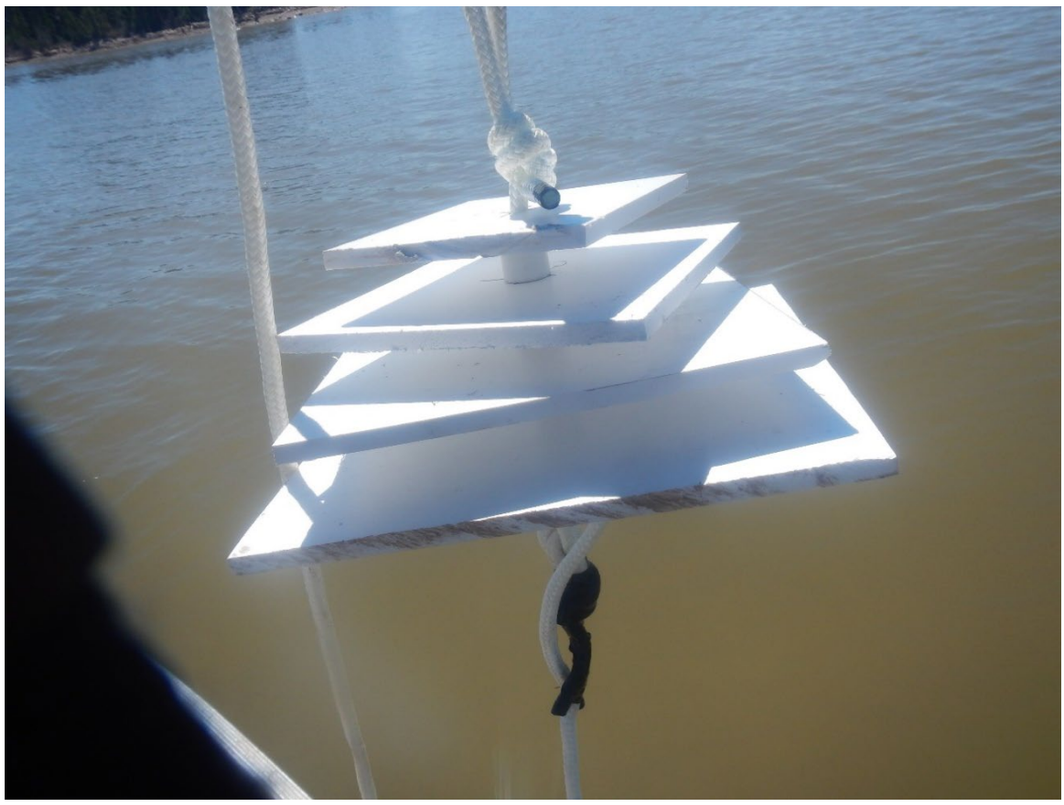

Figure 3: Adult zebra mussel sampler set in the Keeyask area, 2023.

Substrate samplers were deployed in June and removed in October, 2023, to sample over the course of the open-water period. Each sampler was attached to a concrete anchor and suspended in the middle of the water column using a submerged float. A surface float was attached to enable retrieval. Each sampler was set in an off-current area with at least 3 meters of water. Sampling locations loosely followed areas used for water quality monitoring. Two samplers were set near each of five mainstem water quality sampling areas: Clark Lake, the Keeyask reservoir in Gull Lake, the Keeyask reservoir near the upstream side of the GS, nearfield Stephens Lake, and farfield Stephens Lake (Figure 4 & Figure 5).

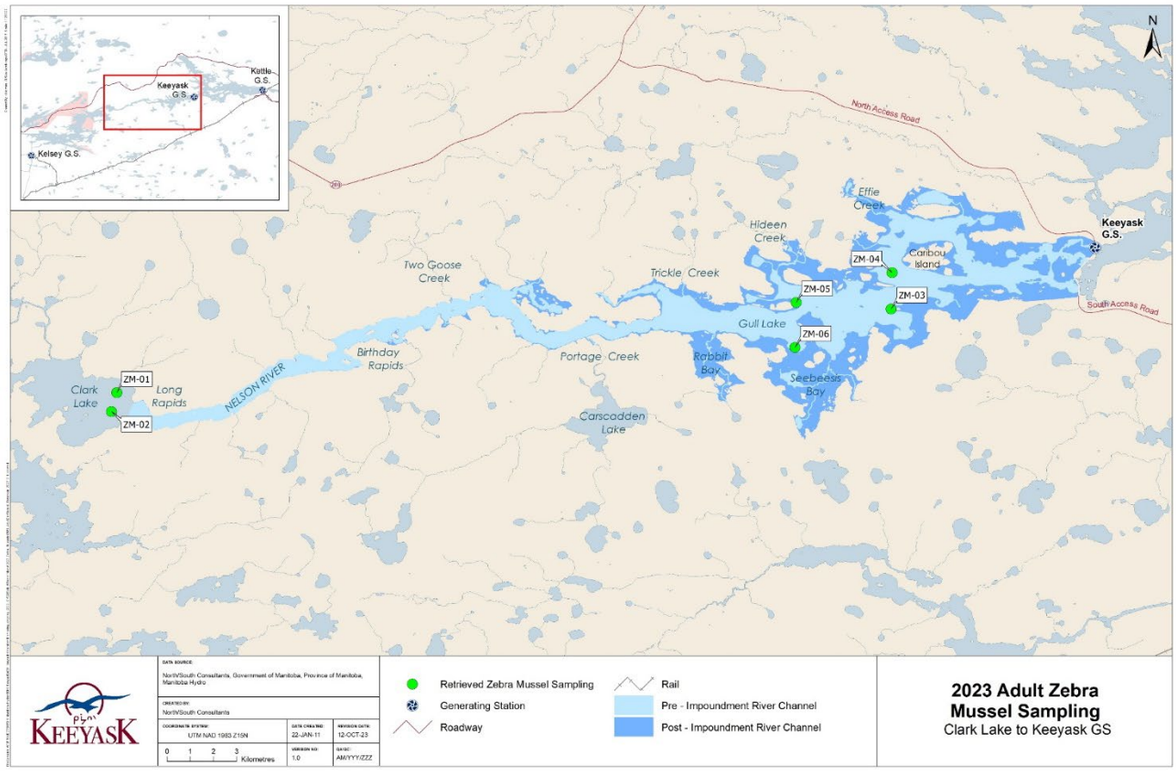

Figure 4: Sampling sites for adult zebra mussel monitoring in Clark Lake and the Keeyask reservoir, 2023.

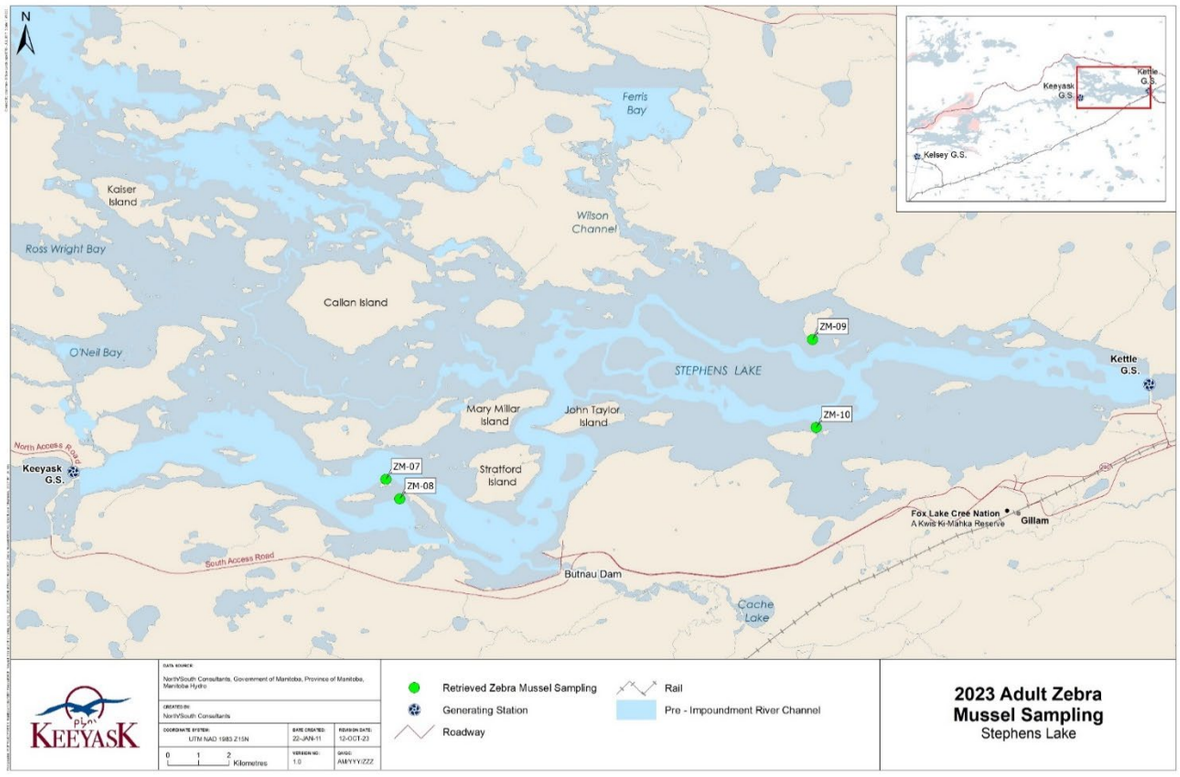

Figure 5: Sampling sites for adult zebra mussel monitoring in Stephens Lake, 2023.

2.2.1 RESULTS

All ten substrate samplers were retrieved following the 2023 open-water period. A total of 1,226 adult zebra mussels were observed on the samplers (Table 2.2). No zebra mussels were collected on the two samplers set in Clark Lake. A total of 509 were collected from the four samplers set in the Keeyask reservoir. The remaining 717 were collected on the four samplers in Stephens Lake. The largest number of zebra mussels were collected on the set near the south shore in the downstream portion of Stephens Lake (ZM-10; n = 477; Figure 5 and Figure 6). At all sites, zebra mussels ranged in size from 1.0 to 5.5 mm.

Table 2.2: Site specific data and results for adult zebra mussel substrate samplers set in Clark Lake, the Keeyask reservoir, and Stephens Lake between June and October, 2023.

Site	Location	Set Depth (m)	Set Date	Pull Date	Sampling Days	Total #	Size Range (mm)	Average Size of 30 Mussels (mm)
ZM-01	Clark Lake	5.2	3-Jun-23	1-Oct-23	121	0	-	-
ZM-02	Clark Lake	5.0	3-Jun-23	1-Oct-23	121	0	-	-
ZM-03	Keeyask reservoir	6.0	6-Jun-23	30-Sept-23	117	45	1.0-4.0	2.0
ZM-04	Keeyask reservoir	7.0	4-Jun-23	29-Sept-23	118	69	1.0-4.5	2.6
ZM-05	Keeyask reservoir	6.0	4-Jun-23	30-Sept-23	119	315	2.0-5.5	3.3
ZM-06	Keeyask reservoir	7.0	6-Jun-23	30-Sept-23	117	80	1.0-5.0	3.0
ZM-07	Stephens Lake	6.0	7-Jun-23	2-Oct-23	118	56	1.0-4.0	2.3
ZM-08	Stephens Lake	6.0	7-Jun-23	2-Oct-23	118	74	1.0-4.0	2.1
ZM-09	Stephens Lake	7.0	2-Jun-23	26-Sept-23	117	110	1.0-2.0	1.4
ZM-10	Stephens Lake	6.5	2-Jun-23	26-Sept-23	117	477	1.0-3.0	1.6

Figure 6 shows colonization on one of the plates of ZM-09 at the end of the season. The number has increased dramatically from 800 mussels found at the same location in 2021 (Figure 7). The average size of 30 mussels (mm) collected on substrate samplers ranged from 2.0 to 3.3 mm in the Keeyask reservoir and 1.4 to 2.3 mm in Stephens Lake. Adult zebra mussels sampled in 2022 were slightly larger than in 2023, ranging from an average of 2.5 to 4.4 mm in the Keeyask reservoir, and 2.4 to 4.0 mm in Stephens Lake

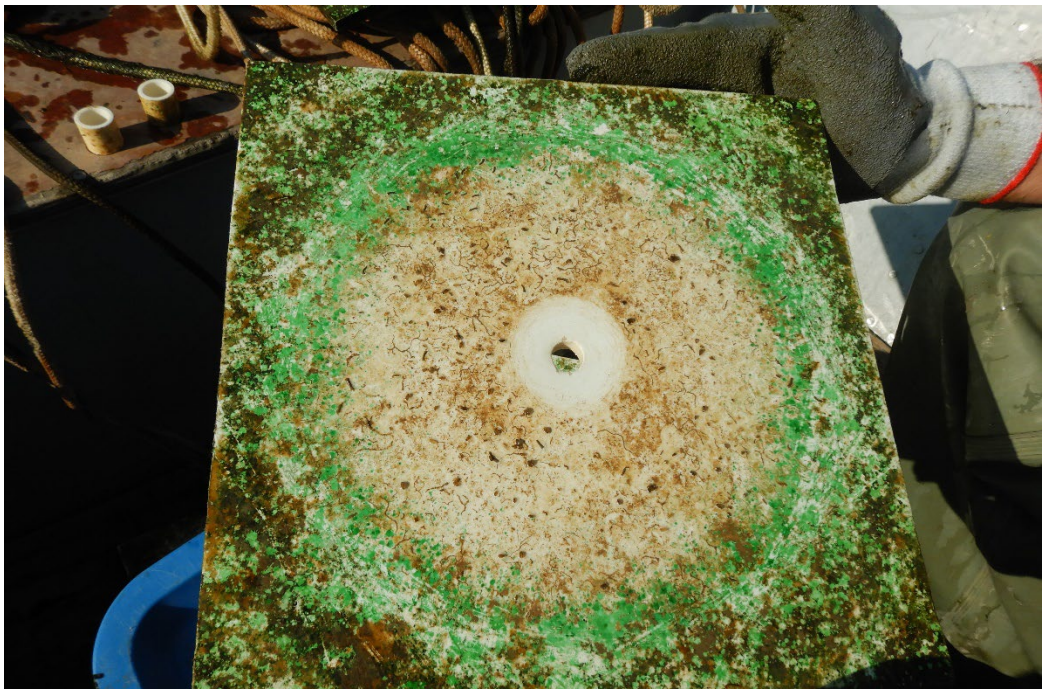

Figure 6: Adult zebra mussels attached to plate of a sampler at site ZM-10 at the end of the 2023 sampling period.

Annual sampling for zebra mussel veligers will continue and will next be conducted in August/September 2024. Adult zebra mussel samplers will be set in spring and removed in fall 2024.

3.0 ZEBRA MUSSEL TREATMENT

3.1 PROCEDURE

Zebra mussels impact Keeyask by growing inside station piping, which could constrict water flow to critical systems required for turbine unit cooling and fire protection (Figure 7). Zebra mussels are eliminated by adding liquid chlorine (similar to household bleach) at a low-level and circulating it through the critical station piping. The concentration of free chlorine[1] required to kill zebra mussels is similar to the amount that would be found in municipal drinking water. This is a proven and highly effective method to control growth and it is commonly used by other hydroelectric generating stations in North America.

Figure 7: Example of zebra mussels growing inside a water pipe.

[1] The chlorine that is added to river water quickly combines with organic material (like algae, bacteria or organic carbon), which makes it less effective at killing zebra mussels. Additional chlorine must be added to make sure there is enough uncombined or "free" chlorine (at 0.06 ppm) remaining. This form of chlorine is much more potent and effective at deactivating zebra mussels.

When using chlorine, the water treated must be dechlorinated before it is returned to the river to prevent harming aquatic life. Adding a carefully calculated dose of sodium bisulfite is a tried and tested way to neutralize chlorine in wastewater effluent. It is injected into the station piping slightly ahead of the location where the station water is returned to the river so that no residual chlorine remains.

Treatment at Keeyask is undertaken on an as-needed basis; typically once every year. Water is circulated through monitoring devices called “bioboxes” (Figure 8), which receive the same water that circulates through the station’s piping. The bioboxes are designed to promote zebra mussel growth on metal plates located inside of them (Figure 9), which can easily be observed and used to estimate the extent of the infestation in a given year. Bioboxes are also used to determine how long treatment with chlorine is required. They are monitored throughout treatment and once 100% of the zebra mussels are killed in the biobox, treatment concludes for the year, since all zebra mussels within the station piping should also be dead.

Figure 8: Example of a Biobox

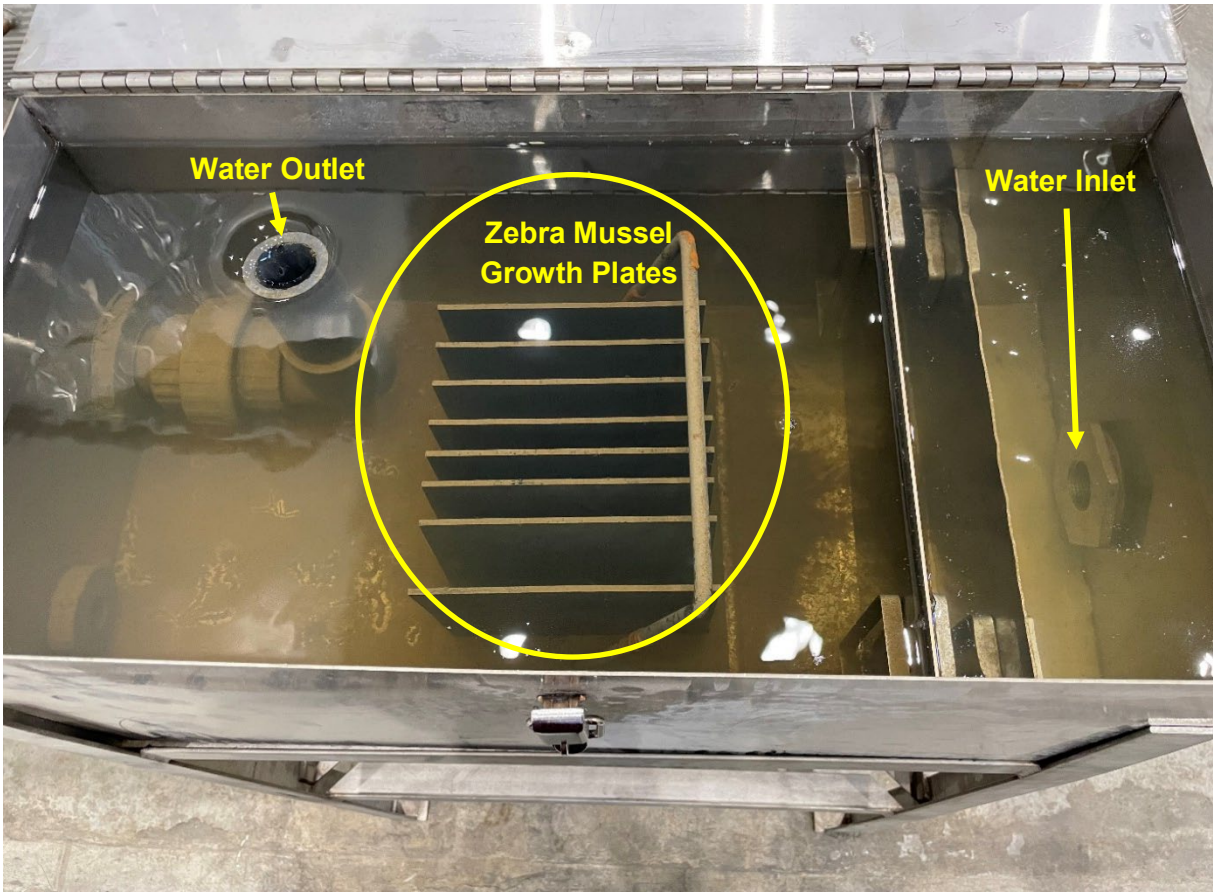

Figure 9: Typical Biobox internal set-up.

3.2 TREATMENT AT KEEYASK

Zebra mussel treatment in 2023 was successfully conducted for 16 days at Keeyask between August 18 and September 2. During this time frame, all seven units underwent treatment using 0.06 ppm of free chlorine. On September 2nd, 100% zebra mussel mortality was observed at all biobox locations and treatment was concluded for the year.

Throughout treatment, sodium bisulfite was used to dechlorinate the treated water before it was returned to the river. Water samples were collected from the treated water before release to confirm that no chlorine was present before discharge. Because sodium bisulfite uses up oxygen during dechlorination, dissolved oxygen (DO) levels were also monitored before the water was returned to the river; they consistently exceeded 4.0 mg/L prior to discharge to the tailrace.

3.3 TREATMENT PROPOSED IN 2024

Depending on the extent of zebra mussels growing in the bioboxes, treatment using chlorine at Keeyask may take place again in fall 2024.

On behalf of the KHLP, Manitoba Hydro is currently seeking approval from Manitoba Environment and Climate Change to use potash to treat the fire suppression system piping for zebra mussels. Unlike chlorine, potash isn't used up by organic material in the station piping and does not require replenishment to kill zebra mussels. This makes determining the dose for killing zebra mussels more straightforward. It is also cheaper and much easier to ship, handle and store than liquid chlorine. Finally, treated water that leaves the station does not require neutralization, as the key ingredient in potash for zebra mussel treatment are potassium ions (K+), and the concentration released will have no effect on aquatic life and create no measurable change to the natural K+ concentrations already found in the Nelson River.

4.0 CONCLUSIONS

The Keeyask ZMMP was implemented in 2023 in accordance with the Keeyask *Environment Act* Licence and included veliger sampling in the Keeyask reservoir and colonization sampling in Clark Lake, the Keeyask reservoir and Stephens Lake.

In 2023, 217 zebra mussel veligers were collected during instream monitoring on Gull Lake. Similar to past years, adult mussels were not found on artificial monitoring substrates in Clark Lake, 509 were found growing on four substrates in the reservoir and 717 were growing on substrates from Stephens Lake. Annual sampling for veligers and adult mussels will continue next in August/September 2024.

Mitigation to treat zebra mussels growing within piping at Keeyask was carried out successfully in 2023. Depending on the extent of the zebra mussel infestation measured in the bioboxes in 2024, treatment may take place again using chlorine and potash, pending regulatory approval of the latter.

5.0 LITERATURE CITED

Keeyask Hydropower Limited Partnership. 2012. Keeyask Generation Project Environmental Impact Statement: Response to EIS Guidelines, Winnipeg, Manitoba. June 2012. 1,200 pp.

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