Keeyask Generation Project

Terrestrial Effects Monitoring Plan

Mercury in Wildlife Monitoring Report

TEMP-2023-16

KEEYASK

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KEEYASK GENERATION PROJECT

TERRESTRIAL EFFECTS MONITORING PLAN

REPORT #TEMP-2023-16

MERCURY MONITORING IN WILDLIFE

YEAR 1 OPERATION

2022

Prepared for

Manitoba Hydro

By

Wildlife Resource Consulting Services MB Inc.

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SUMMARY

Background

Construction of the Keeyask Generation Project (the Project) at Gull Rapids began in July 2014, the reservoir was flooded in early September 2020, and the generating station was fully operational in March 2022**.** The Keeyask Hydropower Limited Partnership (KHLP) was required to prepare a plan to monitor the effects of construction and operation of the generating station on the terrestrial environment. Monitoring results will help the KHLP, government regulators, members of local First Nation communities, and the general public understand how construction and operation of the generating station will affect the environment, and whether more needs to be done to reduce harmful effects.

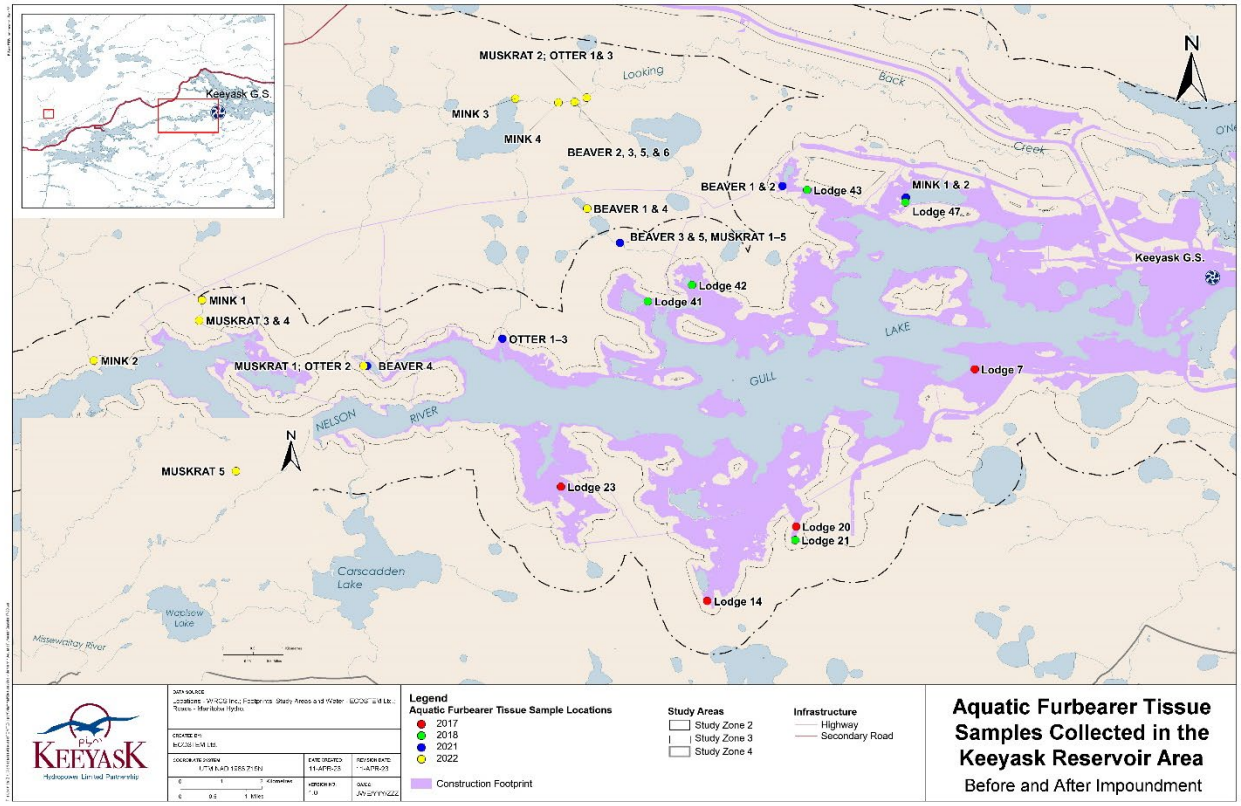
Reservoir flooding (also called impoundment) was expected to increase mercury levels in the Keeyask reservoir, which could affect aquatic furbearers such as beaver, muskrat, mink, and river otter. Potential Project effects included increased mercury levels in fish, and in mink and river otter, which are both fish-eating aquatic furbearers. Effects on aquatic furbearers are linked to domestic resource use and human health.

Why is the study being done?

The objective of the study is to compare mercury levels in aquatic furbearers before the Keeyask reservoir was impounded with post-impoundment levels to determine if the concentration of mercury in beaver, muskrat, mink, and river otter changes during Project operation.

What was done?

Tissue samples (liver, leg muscle, and kidney) from beaver, muskrat, mink, and river otter trapped near the Keeyask reservoir in the winters of 2021/22 and 2022/23 were analyzed for mercury. All sampled animals were trapped by the registered trapline holder from Tataskweyak Cree Nation. Tissue samples were also collected in the future reservoir area by the registered trapline holder in the winters of 2016/17 and 2017/18, during Project construction but before the reservoir was impounded.



Aquatic Furbearer Tissue Samples Collected in the Keeyask Reservoir Area before (2016/17, 2017/18) and after (2021/22, 2022/23) Impoundment

What was found?

No increase in mercury levels in beaver, muskrat, or mink was observed shortly after the reservoir was impounded, but mercury levels in some river otters increased. Caution should be used in the interpretation of these results because sample sizes were relatively small.

What does it mean?

No change in mercury levels in beavers was anticipated after the reservoir was impounded because of the very small amounts of mercury taken up by the plants that they eat. Small increases in mercury levels in muskrats were expected because they eat aquatic animals, which were expected to accumulate mercury after impoundment. As predicted, mercury levels in beaver and muskrat tissue collected after the reservoir was impounded remained low and no increase was observed during the winters of 2021/22 and 2022/23.

Mercury levels in mink and river otter were expected to increase after reservoir impoundment. Mercury levels in mink were somewhat lower after the reservoir was impounded than before, likely because their diet is mainly small mammals and only occasionally fish. The increased mercury levels in river otters suggested that some whose ranges overlapped the reservoir were beginning

to accumulate mercury in their tissues, as anticipated. Mercury levels in river otters in 2021/22 and 2022/23 were well within the peak range predicted in the Environmental Impact Assessment.

What will be done next?

Mercury levels in tissues from aquatic furbearers trapped during Project operation will continue to be analyzed and added to the existing database for comparison with mercury levels in aquatic furbearers before the reservoir was impounded. If samples from other wild foods such as waterfowl, moose, or snowshoe hare are submitted by the partner First Nations during Project operation, these will also be analyzed to monitor mercury in the environment. Results from this study are provided to the Project toxicologist to review for potential risks to human health.

STUDY TEAM

We would like to thank Sherrie Mason and Rachel Boone of Manitoba Hydro and Ron Bretecher of North/South Consultants Inc. for logistical assistance in the field. We would also like to thank Dr. James Ehnes of ECOSTEM Ltd. for GIS cartographic services. Biologists and other personnel who contributed to the study included:

- Robert Berger, Wildlife Resource Consulting Services MB Inc. (WRCS) – Reporting
- Andrea Ambrose, WRCS – Data analysis and reporting
- Jonathan Saunders – Licensed trapper, Tataskweyak Cree Nation (TCN)
- Curtis Saunders – Trapping assistant, TCN
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TABLE OF CONTENTS

1.0 INTRODUCTION 1
2.0 METHODS 3
3.0 RESULTS 6
4.0 DISCUSSION 12
5.0 SUMMARY AND CONCLUSIONS 13
6.0 LITERATURE CITED 14

LIST OF TABLES

Table 1: On-system Aquatic Furbearer Tissue Samples Collected before (2016/17, 2017/18) and after (2021/22, 2022/23) Reservoir Impoundment 3
Table 2: Mercury Concentration in On-system Aquatic Furbearers after Reservoir Impoundment, Winter 2022/23 6
Table 3: Mean Mercury Concentration (mg/kg wwt) in On-system Beaver and Muskrat Tissue before (2003–2018) and after (2021/22, 2022/23) Reservoir Impoundment 7
Table 4: Model Estimates of Mean and Most-likely Range of Total Mercury Concentration (mg/kg wwt) in the Liver and Muscle of Beaver and Muskrat that Forage within the Keeyask Reservoir and/or Stephens Lake 8
Table 5: Mean Mercury Concentration (mg/kg wwt) in On-system Mink and River Otter Tissue before (2003–2018) and after (2021/22, 2022/23) Reservoir Impoundment 9
Table 6: Model Estimates of Mean and Most-likely Range of Total Mercury Concentration (mg/kg wwt) in the Liver of Mink and River Otter that Forage within the Keeyask Reservoir and/or Stephens Lake 10
Table 7: Estimates of Mean and Most-likely Range of Total Mercury Concentration (mg/kg wwt) in the Muscle of Wild Foods 11

LIST OF FIGURES

Figure 1: Mean Mercury Concentration in On-system Beaver Tissue before and after Reservoir Impoundment 7
Figure 2: Mean Mercury Concentration in On-system Muskrat Tissue before and after Reservoir Impoundment 8
Figure 3: Mean Mercury Concentration in On-system Mink Tissue before and after Reservoir Impoundment 9
Figure 4: Mean Mercury Concentration in On-system River Otter Tissue before and after Reservoir Impoundment 10

LIST OF MAPS

Map 1: Aquatic Furbearer Tissue Samples Collected in the Keeyask Reservoir Area before (2016/17, 2017/18) and after (2021/22, 2022/23) Impoundment 5

LIST OF APPENDICES

Appendix 1: Mercury in Wildlife Results 2003–2008, 2017–2018, and 2021/22 15
Appendix 2: Laboratory Results 2022/23 17

1.0 INTRODUCTION

The Keeyask Generation Project (the Project) is a 695-megawatt hydroelectric generating station (GS) located at the former Gull Rapids on the lower Nelson River in northern Manitoba where Gull Lake flows into Stephens Lake. Project construction began in July 2014, the reservoir was impounded in early September 2020, and the GS was fully operational in March 2022.

The *Keeyask Generation Project Response to EIS Guidelines* (the EIS), completed in June 2012, provides a summary of predicted effects and planned mitigation for the Project. 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). The *Keeyask Generation Project Terrestrial Effects Monitoring Plan* (TEMP) was developed as part of the licensing process for the Project. Monitoring activities for various components of the terrestrial environment were described, including the focus of this report, mercury in wildlife, during the construction and operation phases.

Mercury is a naturally occurring metal that exists in several forms in the environment. Microorganisms in soil and water can transform mercury from one form to another. Methylmercury, a common form of organic mercury, can easily enter the aquatic food web and bioaccumulate when higher-level organisms absorb it from the lower-level organisms that they consume. Methylmercury levels typically increase in water after flooding, as the inorganic mercury released from inundated soil is converted to organic mercury by bacteria feeding on decomposing plants (St. Louis et al. 2004). Because plants typically accumulate relatively low levels of mercury (Lindsay and Bookhout 1978), methylmercury levels in herbivorous aquatic furbearers such as beaver (*Castor canadensis*) and omnivores such as muskrat (*Ondatra zibethicus*) are considerably lower than in carnivorous aquatic furbearers such as mink (*Neovison vison*) and river otter (*Lontra canadensis*), which eat fish and other aquatic animals (Sheffy and St. Amant 1982).

Reservoir impoundment was expected to increase methylmercury ("mercury") levels in the Keeyask reservoir, which could affect aquatic furbearers. Potential Project effects included increased mercury concentrations in fish, and in mink and river otter—both fish-eating aquatic furbearers. Effects on aquatic furbearers are linked to domestic resource use. Mercury levels in beaver, muskrat, mink, and river otter were measured in tissue samples collected before Project construction began. Because impoundment flooded habitat within the reservoir footprint, beaver and muskrat were trapped out of the future reservoir area in the winters of 2016/17 and 2017/18 to prevent prolonged exposure and displacement deaths (Wildlife Resource Consulting Services MB Inc. 2018). Tissue samples from trapped animals were collected and submitted for mercury analysis. Additional samples were collected in the winters of 2021/22 and 2022/23, after the reservoir was impounded. All sampled animals were trapped by the Registered Trap Line (RTL) 15 registered trapline holder (Tataskweyak Cree Nation) each winter.

As described in Section 7.0 of the TEMP, the objective of the study is to compare mercury levels in aquatic furbearers before and during Project construction with post-impoundment levels to determine if the concentration of mercury in beaver, muskrat, mink, and river otter changes during Project operation. Mercury levels in waterfowl and other wild foods such as moose (*Alces alces*) and snowshoe hare (*Lepus americanus*) are to be monitored if tissue samples are submitted by partner First Nations resource users, to monitor mercury levels in the environment after the Keeyask reservoir is flooded. Results from this study are provided to the Project toxicologist to review for potential risks to human health.

2.0 METHODS

During Project construction, tissue samples (leg muscle, liver, and/or kidney) from six beavers, one muskrat, and two river otters trapped at beaver lodges in the future reservoir area (Map 1) in March 2017 and January and February 2018 were analyzed for mercury (Table 1). For testing purposes, submissions of beaver organs were limited to kidneys in 2016/17 and 2017/18. After the reservoir was impounded, additional samples from aquatic furbearers trapped from RTL 15 (categorized as "on-system" because it overlapped the Nelson River and was also located in Study Zone 5) in winter 2021/22 included five beavers, five muskrats, two mink, and three river otters. In winter 2022/23, samples from six beavers, five muskrats, four mink, and three river otters were collected. No samples from other wildlife species were submitted during the Project's construction and early operation monitoring periods.

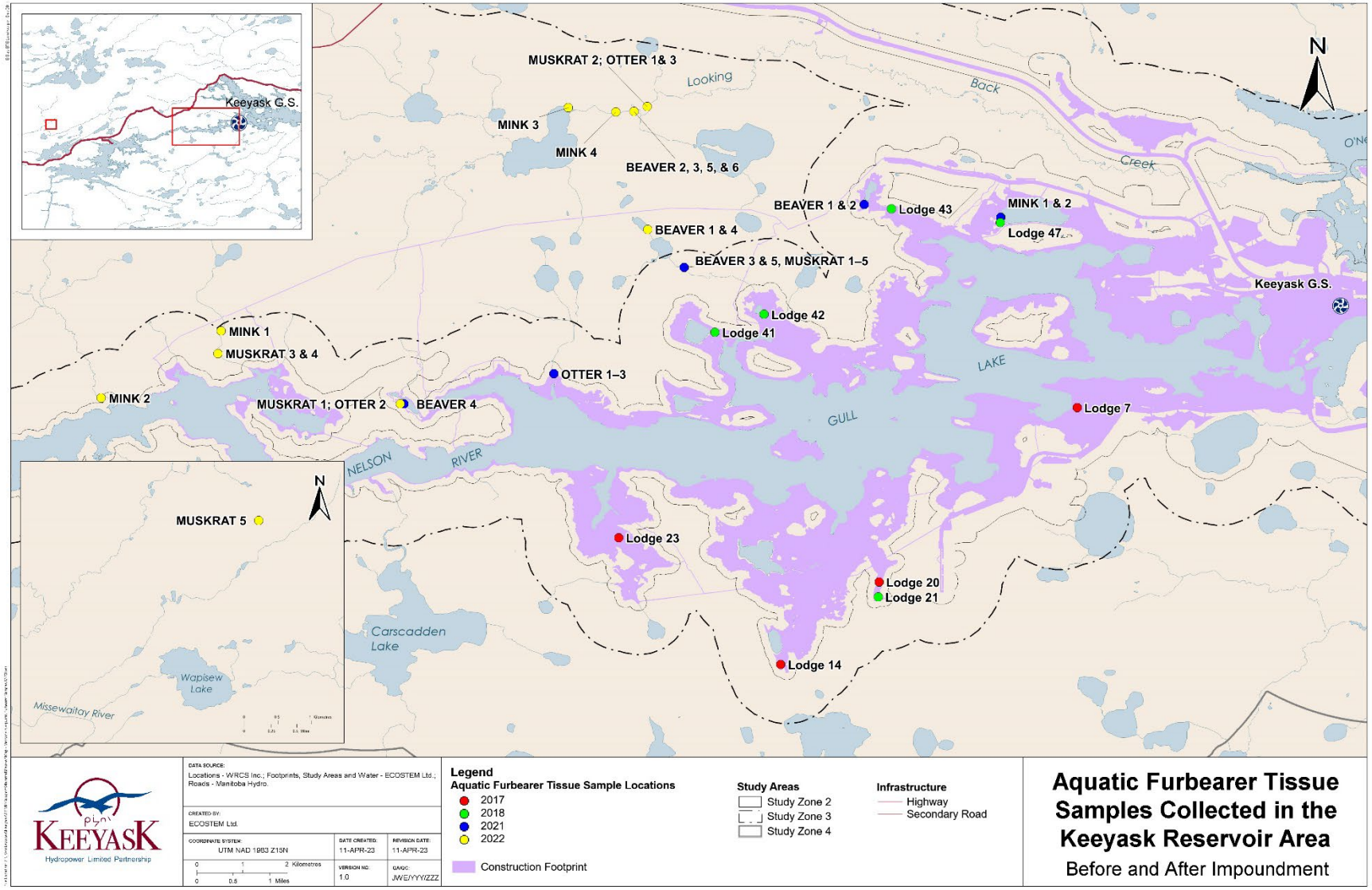
Table 1: On-system Aquatic Furbearer Tissue Samples Collected before (2016/17, 2017/18) and after (2021/22, 2022/23) Reservoir Impoundment

Winter Trapped	Species	Lodge or Individual	Tissue Collected	Location
2016/17	Beaver	Lodge 7	Muscle	15 V 357954 6244917
	Beaver	Lodge 23	Muscle, kidney	15 V 347619 6241984
	River otter	Lodge 14	Liver, muscle, kidney	15 V 351273 6239131
	River otter	Lodge 20	Liver, muscle, kidney	15 V 353487 6240990
2017/18	Beaver	Lodge 21	Muscle, kidney	15 V 353469 6240652
	Beaver	Lodge 41	Muscle, kidney	15 V 349789 6246611
	Beaver	Lodge 42	Muscle	15 V 350894 6247016
	Beaver	Lodge 47	Muscle	15 V 356236 6249204
	Muskrat	Lodge 43	Liver, muscle, kidney	15 V 353769 6249395
2021/22	Beaver	BEAVER 1	Liver, muscle, kidney	15 V 353154 6249488
	Beaver	BEAVER 2	Liver, muscle, kidney	15 V 353154 6249488
	Beaver	BEAVER 3	Liver, muscle, kidney	15 V 349098 6248074
	Beaver	BEAVER 4	Liver, muscle, kidney	15 V 342782 6245002
	Beaver	BEAVER 5	Liver, muscle, kidney	15 V 349098 6248074
	Muskrat	MUSKRAT 1	Liver, muscle, kidney	15 V 349098 6248074
	Muskrat	MUSKRAT 2	Liver, muscle, kidney	15 V 349098 6248074
	Muskrat	MUSKRAT 3	Liver, muscle, kidney	15 V 349098 6248074
	Muskrat	MUSKRAT 4	Liver, muscle, kidney	15 V 349098 6248074
	Muskrat	MUSKRAT 5	Liver, muscle, kidney	15 V 349098 6248074
	Mink	MINK 1	Liver, muscle, kidney	15 V 356229 6249198
	Mink	MINK 2	Liver, muscle, kidney	15 V 356229 6249198
	River otter	OTTER 1	Liver, muscle, kidney	15 V 346158 6245678
	River otter	OTTER 2	Liver, muscle, kidney	15 V 346158 6245678
	River otter	OTTER 3	Liver, muscle, kidney	15 V 346158 6245678
2022/23	Beaver	BEAVER 1	Liver, muscle, kidney	15 V 348273 6248930
	Beaver	BEAVER 2	Liver, muscle, kidney	15 V 347962 6251588

Winter Trapped	Species	Lodge or Individual	Tissue Collected	Location
2022/23	Beaver	BEAVER 3	Liver, muscle, kidney	15 V 347962 6251588
	Beaver	BEAVER 4	Liver, muscle, kidney	15 V 348273 6248930
	Beaver	BEAVER 5	Liver, muscle, kidney	15 V 347962 6251588
	Beaver	BEAVER 6	Liver, muscle, kidney	15 V 347962 6251588
	Muskrat	MUSKRAT 1	Liver, muscle, kidney	15 V 342782 6245002
	Muskrat	MUSKRAT 2	Liver, muscle, kidney	15 V 348263 6251699
	Muskrat	MUSKRAT 3	Liver, muscle, kidney	15 V 338588 6246134
	Muskrat	MUSKRAT 4	Liver, muscle, kidney	15 V 338588 6246134
	Muskrat	MUSKRAT 5	Liver, muscle, kidney	14 V 651972 6244812
	Mink	MINK 1	Liver, muscle, kidney	15 V 338663 6246643
	Mink	MINK 2	Liver, muscle, kidney	15 V 335956 6245133
	Mink	MINK 3	Liver, muscle, kidney	15 V 346482 6251670
	Mink	MINK 4	Liver, muscle, kidney	15 V 347556 6251572
	River otter	OTTER 1	Liver, muscle, kidney	15 V 348263 6251699
	River otter	OTTER 2	Liver, muscle, kidney	15 V 342782 6245002
	River otter	OTTER 3	Liver, muscle, kidney	15 V 348263 6251699

Tissue samples were kept frozen until submission to ALS Environmental for mercury analysis, where the EPA 200.31/EPA 1631E (mod) method was used. Results were reported as milligrams of mercury per kilogram of wet weight (mg/kg wwt).

Results from the samples collected during Project construction (the winters of 2016/17 and 2017/18) were compiled with those from samples collected voluntarily from on-system traplines in the Split Lake, York Landing, and Fox Lake Resource Management Areas from February 2003 to April 2008, well before Project construction and reservoir impoundment. The home ranges of the sampled animals were presumed to overlap the regulated water system. Pre-impoundment samples were compared with those collected in the winters of 2021/22 and 2022/23, after the reservoir was impounded and when mercury was expected to begin to accumulate within aquatic furbearers' tissues. Pre-impoundment mercury levels in aquatic furbearers are provided in Appendix 1. For results reported as <0.01 mg/kg wwt, a value of 0.0099 was used to calculate mean mercury levels in aquatic furbearer tissues, and a value of 0.00099 was used for results reported as <0.001 mg/kg wwt.



Map 1: Aquatic Furbearer Tissue Samples Collected in the Keeyask Reservoir Area before (2016/17, 2017/18) and after (2021/22, 2022/23) Impoundment

3.0 RESULTS

Mercury levels remained low in beaver and muskrat tissue in winter 2022/23, with some variation among sampled animals (Table 2). Mercury levels were generally greater in mink and river otter tissue samples. Greater levels were measured in the tissues of MINK 3 than in the other mink. Mercury levels in river otter tissues were considerably greater in OTTER 2 than in the other two individuals. Complete laboratory analysis results from the 2022/23 samples are provided in Appendix 2.

Table 2: Mercury Concentration in On-system Aquatic Furbearers after Reservoir Impoundment, Winter 2022/23

Species	Individual	Year Trapped	Mercury Concentration (mg/kg wwt)[1]		
			Liver	Muscle	Kidney
Beaver	BEAVER 1	2022	0.0012	0.0017	0.0182
	BEAVER 2	2022	0.0014	0.0017	0.0028
	BEAVER 3	2022	0.0012	0.0015	0.0043
	BEAVER 4	2022	0.0019	0.0019	0.0165
	BEAVER 5	2022	0.0012	0.0026	0.0027
	BEAVER 6	2022	0.0017	0.0020	0.0056
	Range		0.0012–0.0019	0.0015–0.0026	0.0027–0.0182
Muskrat	MUSKRAT 1	2022	0.0578	0.0372	0.102
	MUSKRAT 2	2022	0.0017	0.0088	0.0039
	MUSKRAT 3	2022	0.0017	0.0117	0.0026
	MUSKRAT 4	2022	0.0019	0.0135	0.0037
	MUSKRAT 5	2022	0.0592	0.0390	0.109
	Range		0.0017–0.0592	0.0088–0.0390	0.0026–0.109
Mink	MINK 1	2022	0.418	0.314	0.558
	MINK 2	2022	0.587	0.699	0.566
	MINK 3	2022	2.14	1.25	1.56
	MINK 4	2022	0.637	0.570	0.849
	Range		0.418–2.14	0.314–1.25	0.558–1.56
River otter	OTTER 1	2022	0.519	0.160	0.408
	OTTER 2	2022	6.17	1.21	4.60
	OTTER 3	2022	0.403	0.220	0.590
	Range		0.403–6.17	0.160–1.21	0.408–4.60

1. Decimal places reported as in results from the laboratory.

Mean mercury levels in beaver liver and muscle tissue were low before and after reservoir impoundment (Table 3; Figure 1). Similar mercury levels in muskrat liver and muscle tissue were also observed before and after the reservoir was impounded (Figure 2). The apparent reduction in mercury levels in beaver and muskrat tissues after impoundment is most likely the result of

improvements in detection limits over time, where more precise measurements of mercury were made in the laboratory in recent years.

Table 3: Mean Mercury Concentration (mg/kg wwt) in On-system Beaver and Muskrat Tissue before (2003–2018) and after (2021/22, 2022/23) Reservoir Impoundment

	Liver		Muscle	
	Pre-impoundment	**Post-impoundment**	**Pre-impoundment**	**Post-impoundment**
Beaver	0.008 (16)[1]	0.003 (11)	0.008 (40)	0.004 (11)
Muskrat	0.022 (5)	0.016 (10)	0.013 (7)	0.015 (10)

1. Number of samples is in parentheses.

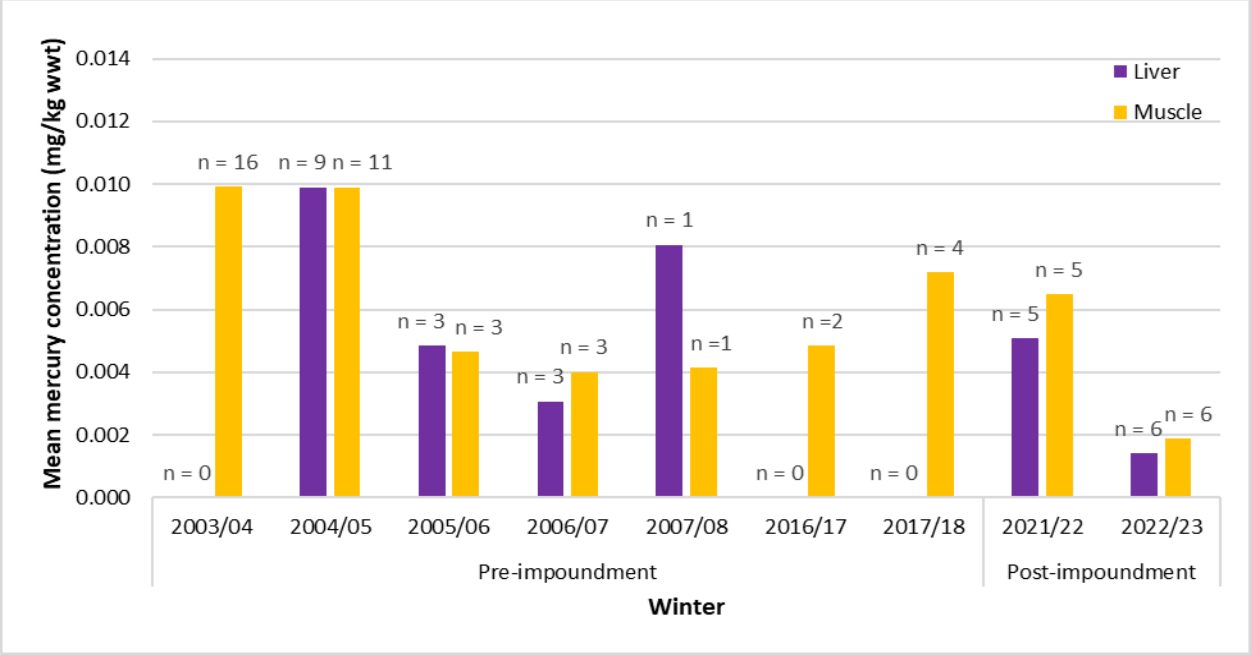


Figure 1: Mean Mercury Concentration in On-system Beaver Tissue before and after Reservoir Impoundment

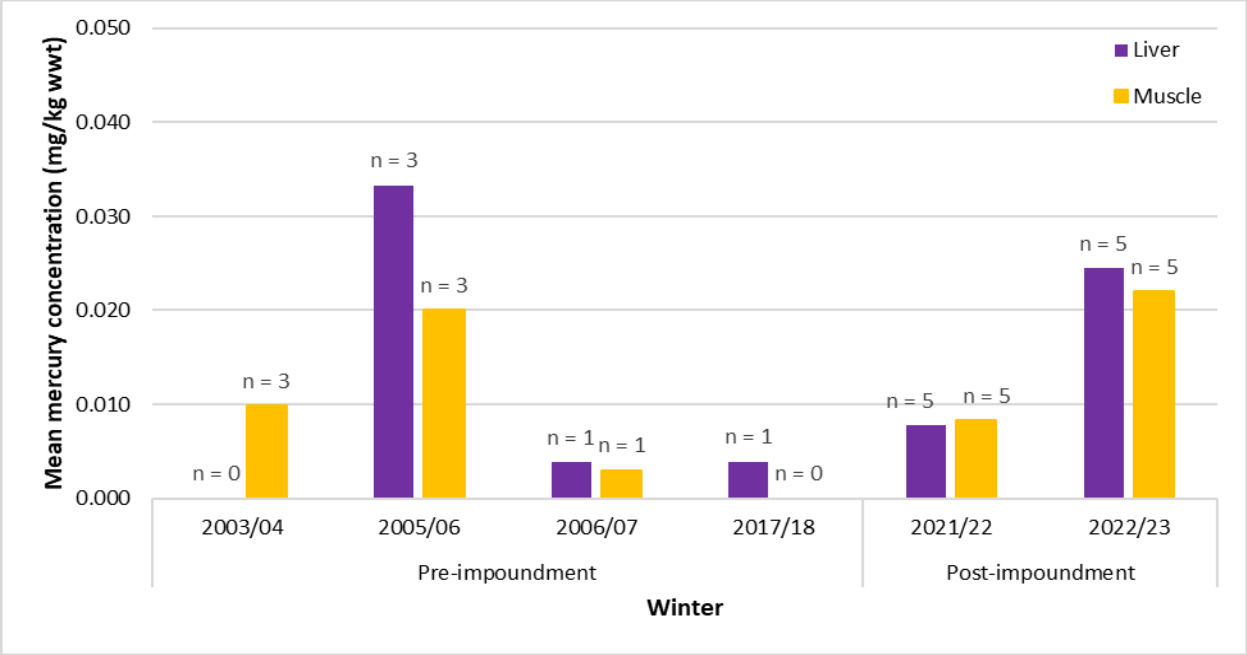


Figure 2: Mean Mercury Concentration in On-system Muskrat Tissue before and after Reservoir Impoundment

After reservoir impoundment, mercury levels in beaver liver tissue ranged from 0.001 to 0.011 mg/kg wwt and ranged from 0.001 to 0.016 in muscle tissue. Mercury levels in muskrat liver tissue ranged from 0.002 to 0.061 mg/kg wwt and in muscle tissue ranged from 0.003 to 0.039 mg/kg wwt over the same period. Mercury levels in all beaver liver and muscle samples collected after reservoir impoundment were within the early and peak ranges predicted in the EIS (Table 4). Mercury levels in most muskrat liver and muscle samples collected after impoundment were within the early range predicted in the EIS, and all were within the expected peak range.

Table 4: Model Estimates of Mean and Most-likely Range of Total Mercury Concentration (mg/kg wwt) in the Liver and Muscle of Beaver and Muskrat that Forage within the Keeyask Reservoir and/or Stephens Lake

Species	Existing Environment	Peak	Long-term
	Day 1	Year 3 to 7	Years 20–30
Beaver	0.01 (<0.01–0.05)	0.01 (<0.01–0.05)	0.01 (<0.01–0.05)
Muskrat	0.02 (<0.01–0.06)	0.04 (<0.01–0.12)	0.02 (<0.01–0.06)

Mean mercury levels in mink liver and muscle tissue were somewhat lower after the reservoir was impounded than before (Table 5; Figure 3), but mean mercury levels in river otter liver and muscle tissue increased after the reservoir was impounded (Figure 4).

Table 5: Mean Mercury Concentration (mg/kg wwt) in On-system Mink and River Otter Tissue before (2003–2018) and after (2021/22, 2022/23) Reservoir Impoundment

	Liver		Muscle	
	Pre-impoundment	**Post-impoundment**	**Pre-impoundment**	**Post-impoundment**
Mink	2.310 (9)[1]	0.916 (6)	1.150 (18)	0.672 (6)
River otter	1.708 (14)	4.134 (6)	0.591 (16)	0.864 (6)

1. Number of samples is in parentheses.

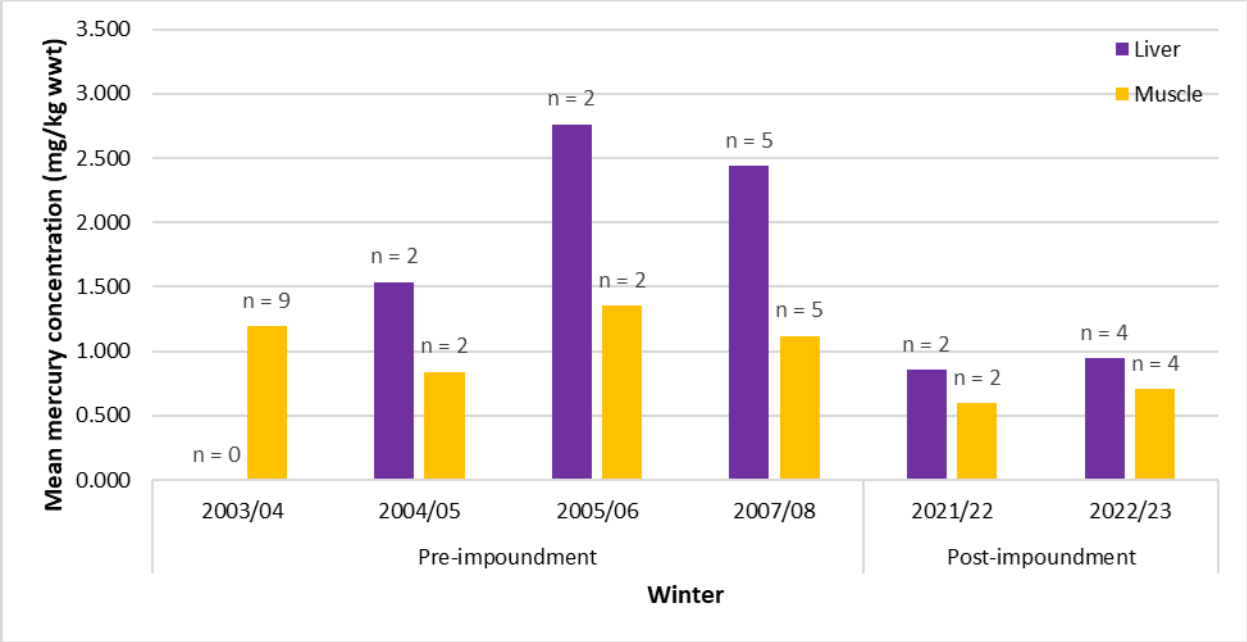


Figure 3: Mean Mercury Concentration in On-system Mink Tissue before and after Reservoir Impoundment

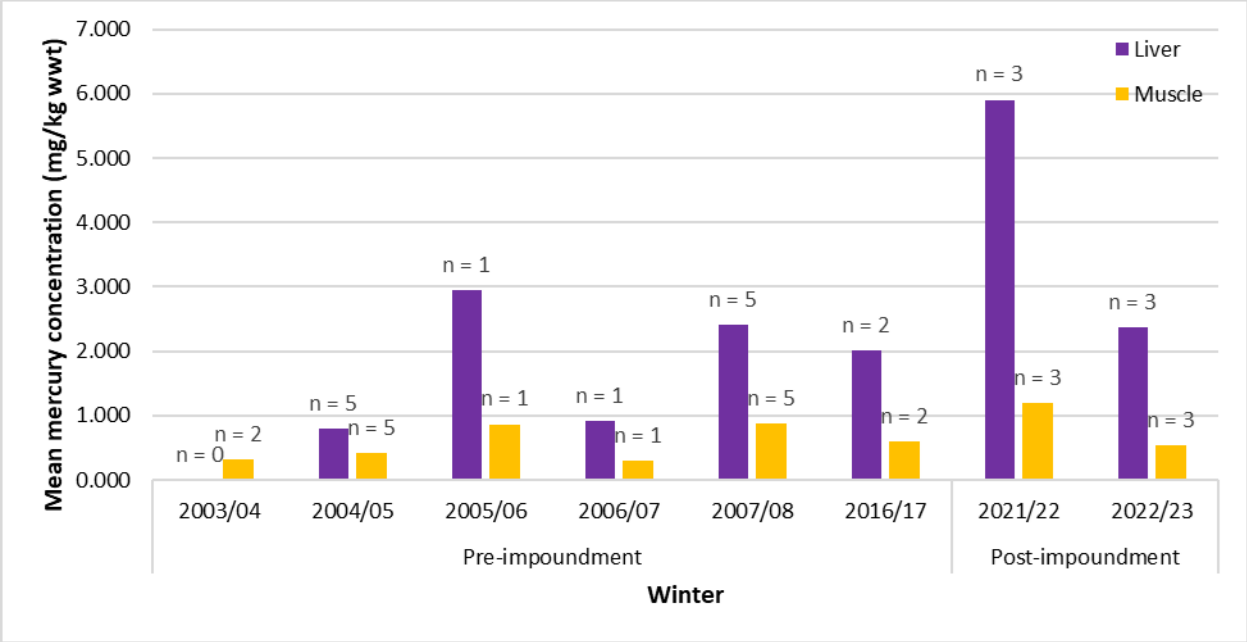


Figure 4: Mean Mercury Concentration in On-system River Otter Tissue before and after Reservoir Impoundment

After reservoir impoundment, mercury levels in mink liver tissue ranged from 0.418 to 3.040 mg/kg wwt, within the early and peak ranges predicted in the EIS (Table 6). Mercury levels ranged from 0.303 to 11.000 mg/kg wwt in river otter liver tissue, well within the predicted peak range.

Table 6: Model Estimates of Mean and Most-likely Range of Total Mercury Concentration (mg/kg wwt) in the Liver of Mink and River Otter that Forage within the Keeyask Reservoir and/or Stephens Lake

Species	Existing Environment	Peak	Long-term
	Day 1	Year 3 to 7	Years 20–30
Mink	1.52 (0.56–3.16)	4.00 (0.56–30.60)	1.52 (0.56–3.16)
River otter	0.55 (0.28–3.97)	6.00 (0.28–17.63)	0.55 (0.28–3.97)

For other wild foods, no change in mercury was anticipated for Canada goose (*Branta canadensis*), moose, or snowshoe hare (Table 7). A small increase was predicted for mallard (*Anas platyrhynchos*). No samples from local resource users were submitted in 2021/22 or 2022/23 to verify these EIS predictions.

Table 7: Estimates of Mean and Most-likely Range of Total Mercury Concentration (mg/kg wwt) in the Muscle of Wild Foods

Species	Existing Environment	Peak	Long-term
	Day 1	Year 3 to 7	Years 20–30
Canada goose[1]	0.03	~0.03	0.03
Mallard[1]	0.04	<0.19	0.04
Moose[2]	0.07 (<0.01–0.17)	0.07 (<0.01–0.17)	0.07 (<0.01–0.17)
Snowshoe hare[2]	0.05 (<0.01–0.12)	0.05 (<0.01–0.12)	0.05 (<0.01–0.12)

1. Model-predicted for fish inhabiting the Keeyask reservoir.
2. Mercury concentration was a literature estimate and may have greater uncertainty than other species for which measured values were obtained from the study area.

4.0 DISCUSSION

The Keeyask reservoir was impounded in September 2020. Aquatic furbearer tissue samples from winter 2021/22 and 2022/23 were collected early in the predicted mercury accumulation process to monitor for the potential bioaccumulation of mercury over time. Changes in mercury levels were expected for certain aquatic furbearer species, which these early results will help to confirm. No results of mercury monitoring in aquatic furbearers could be found for other hydroelectric reservoirs in Canada for comparison.

No change in mercury levels in beavers was anticipated after the Keeyask reservoir was impounded due to the minute quantities of mercury taken up by the vegetation that they consume. As expected, mean mercury levels in beaver tissue collected after reservoir impoundment were low and there had been no apparent increase since the pre-impoundment samples were collected from 2003 to 2018.

Marginal increases in mercury levels in muskrats were anticipated after reservoir impoundment because they forage on aquatic plants and animals, the latter of which will likely accumulate more mercury in the reservoir following impoundment. No increase in mean mercury levels in muskrat liver tissue was observed after the first two years of reservoir impoundment. Mercury levels in muscle tissue were marginally greater after impoundment than before, but all values were well within the peak range predicted in the EIS.

Mercury levels in mink were expected to increase after reservoir impoundment, peak approximately seven years later, and then return to pre-Project levels after 20 to 30 years. The mean mercury level in mink liver tissue was lower after reservoir impoundment than before and all values were well within the early and peak ranges predicted in the EIS. Because minks' diet is primarily small mammals supplemented with fish and other wildlife (Eagle and Whitman 1998), mercury would be expected to accumulate relatively slowly in their tissues.

Mercury levels in river otters were expected to increase after reservoir impoundment, peak approximately seven years later, and then return to pre-Project levels after 20 to 30 years. The mean mercury level in river otter liver samples was greater after reservoir impoundment than before, suggesting that some river otters whose ranges likely overlapped the Keeyask reservoir were beginning to accumulate mercury in their tissues. Mercury levels in the livers of river otters collected after impoundment were well within the peak range predicted in the EIS. Because the sample sizes for all aquatic furbearers, particularly mink and river otter, were relatively small, caution should be used in the interpretation of the results.

No tissue samples from wild foods such as Canada goose, mallard, moose, and snowshoe hare have been submitted for analysis to date. Small increases in mercury levels in mallard were anticipated after reservoir impoundment; no changes in Canada goose, moose, and snowshoe hare were expected. If tissue samples of these wild food species are submitted during Project operation, they will be analyzed for mercury content. Results from all mercury in wildlife monitoring are shared with the Project toxicologist to assess potential risks to human health.

5.0 SUMMARY AND CONCLUSIONS

No increase in mercury levels in beaver, muskrat, or mink was observed in winter 2021/22 and 2022/23, shortly after the Keeyask reservoir was impounded. Increased mercury levels in some river otters were observed. Mercury levels in all sampled animals were within the peak ranges predicted in the EIS. Caution should be used in the interpretation of these results because sample sizes were relatively small. Mercury concentrations in tissues from aquatic furbearers trapped during Project operation will be analyzed and added to the existing database for comparison with mercury concentration in aquatic furbearers before reservoir impoundment. If samples from other wild foods such as waterfowl, moose, or snowshoe hare are submitted for analysis by local resource users, they will be analyzed for mercury content. Results from all mercury in wildlife monitoring are shared with the Project toxicologist to assess potential risks to human health.

6.0 LITERATURE CITED

Eagle, T.C. and Whitman, J.S. 1998. Mink. In Wild Furbearer Management and Conservation in North America. Edited by M. Novak, J.A. Baker, M.E. Obbard, and B. Malloch. Ontario Ministry of Natural Resources, Peterborough, ON. pp. 615–624.

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APPENDIX 1:
MERCURY IN WILDLIFE RESULTS
2003–2008, 2017–2018, AND 2021/22

Table A-1: Mercury Concentration (mg/kg wwt) in On-system Aquatic Furbearer Liver and Muscle Tissue 2003–2008, 2016/17–2017/18, and 2021/22

Species	Period[1]	Liver			Muscle		
		Mean	Range[2]	Number	Mean	Range[2]	Number
Beaver	2003–2008	0.008	0.003–0.010	16	0.009	0.003–0.01	34
	2016/17–2017/18	–	–	0	0.006	0.003–0.012	6
	2021/22	0.005	<0.0010–0.0109	5	0.006	<0.0010–0.0159	5
Muskrat	2003–2008	0.026	0.004–0.061	4	0.013	0.003–0.027	7
	2016/17–2017/18	0.004	0.004	1	–	–	0
	2021/22	0.008	0.0055–0.0133	5	0.008	0.0041–0.0141	5
Mink	2003–2008	2.310	1.36–3.04	9	1.150	0.553–2.237	18
	2016/17–2017/18	–	–	0	–	–	0
	2021/22	0.858	0.585–1.13	2	0.599	0.539–0.659	2
River otter	2003–2008	1.658	0.303–3.81	12	0.591	0.127–1.52	14
	2016/17–2017/18	2.007	0.354–3.66	2	0.594	0.588–0.600	2
	2021/22	5.903	2.12–11.0	3	1.198	0.480–2.48	3

1. 2003–2008: before Project construction; 2017–18: during Project construction before reservoir impoundment; 2021/22: during Project construction after reservoir impoundment
2. Decimal places reported as in results from the laboratory.

Table A-2: Mercury Concentration (mg/kg wwt) in On-system Aquatic Furbearer Kidney Tissue 2016/17–2017/18 and 2021/22

Species	Period[1]	Mean[2]	Range[2]	Number
Beaver	2016/17–2017/18	0.030	0.0086–0.0428	3
	2021/22	0.020	0.0018–0.0447	5
Muskrat	2016/17–2017/18[3]	–	–	–
	2021/22	0.033	0.0226–0.052	5
Mink	2016/17–2017/18	–	–	–
	2021/22	0.636	0.597–0.674	2
River otter	2016/17–2017/18	1.33	1.28–1.38	2
	2021/22	3.16	1.46–5.83	3

1. 2017–18: during Project construction before reservoir impoundment; 2021/22: during Project construction after reservoir impoundment
2. Decimal places reported as in results from the laboratory.
3. Analysis of the one sample submitted failed.

APPENDIX 2:
LABORATORY RESULTS 2022/23

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CERTIFICATE OF ANALYSIS

Work Order	: **WP2301236**	Page	: 1 of 7
Client	: **Wildlife Resource Consulting Services MB Inc.**	Laboratory	: Winnipeg - Environmental
Contact	: Timothy Kroeker	Account Manager	: Craig Riddell
Address	: 495-B Madison Street Winnipeg MB Canada R3J 1J2	Address	: 1329 Niakwa Road East, Unit 12 Winnipeg MB Canada R2J 3T4
Telephone	: 204 452 2197	Telephone	: +1 204 255 9720
Project	: ----	Date Samples Received	: 03-Feb-2023 11:23
PO	: ----	Date Analysis Commenced	: 03-Mar-2023
C-O-C number	: ----	Issue Date	: 04-Apr-2023 15:05
Sampler	: ----		
Site	: ----		
Quote number	: Mercury in Tissue		
No. of samples received	: 54		
No. of samples analysed	: 54		

This report supersedes any previous report(s) with this reference. Results apply to the sample(s) as submitted. This document shall not be reproduced, except in full.

This Certificate of Analysis contains the following information:

- General Comments
- Analytical Results

Additional information pertinent to this report will be found in the following separate attachments: Quality Control Report, QC Interpretive report to assist with Quality Review and Sample Receipt Notification (SRN).

Signatories

This document has been electronically signed by the authorized signatories below. Electronic signing is conducted in accordance with US FDA 21 CFR Part 11.

Signatories	*Position*	*Laboratory Department*
Christine Mason	Department Manager - Chemistry	Metals, Winnipeg, Manitoba
Oleksandr Busel		Metals, Winnipeg, Manitoba

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General Comments

The analytical methods used by ALS are developed using internationally recognized reference methods (where available), such as those published by US EPA, APHA Standard Methods, ASTM, ISO, Environment Canada, BC MOE, and Ontario MOE. Refer to the ALS Quality Control Interpretive report (QCI) for applicable references and methodology summaries. Reference methods may incorporate modifications to improve performance.

Where a reported less than (<) result is higher than the LOR, this may be due to primary sample extract/digestate dilution and/or insufficient sample for analysis.

Where the LOR of a reported result differs from standard LOR, this may be due to high moisture content, insufficient sample (reduced weight employed) or matrix interference.

Please refer to Quality Control Interpretive report (QCI) for information regarding Holding Time compliance.

Key : CAS Number: Chemical Abstracts Services number is a unique identifier assigned to discrete substances
LOR: Limit of Reporting (detection limit).

Unit	*Description*
%	percent
mg/kg wwt	milligrams per kilogram wet weight

<: less than.

>: greater than.

Surrogate: An analyte that is similar in behavior to target analyte(s), but that does not occur naturally in environmental samples. For applicable tests, surrogates are added to samples prior to analysis as a check on recovery.

Test results reported relate only to the samples as received by the laboratory.

UNLESS OTHERWISE STATED on SRN or QCI Report, ALL SAMPLES WERE RECEIVED IN ACCEPTABLE CONDITION.

Page : 3 of 7
Work Order : WP2301236
Client : Wildlife Resource Consulting Services MB Inc.
Project : ----

Analytical Results

Sub-Matrix: Tissue (Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MINK1KIDNEY	MINK1MUSCLE	MINK1LIVER	MINK2KIDNEY	MINK2MUSCLE
					Client sampling date / time	12-Dec-2022	12-Dec-2022	12-Dec-2022	12-Dec-2022	12-Dec-2022
						WP2301236-001	WP2301236-002	WP2301236-003	WP2301236-004	WP2301236-005
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		71.0	76.2	70.0	72.8	74.8
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.558	0.314	0.418	0.566	0.699

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Tissue (Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MINK2LIVER	MINK3KIDNEY	MINK3MUSCLE	MINK3LIVER	MINK4KIDNEY
					Client sampling date / time	12-Dec-2022	24-Dec-2022	24-Dec-2022	24-Dec-2022	24-Dec-2022
						WP2301236-006	WP2301236-007	WP2301236-008	WP2301236-009	WP2301236-010
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		71.9	71.3	70.8	70.3	73.4
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.587	1.56	1.25	2.14	0.849

Please refer to the General Comments section for an explanation of any qualifiers detected.

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Page : 4 of 7
Work Order : WP2301236
Client : Wildlife Resource Consulting Services MB Inc.
Project : ----

Analytical Results

Sub-Matrix: Tissue
(Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	MINK4MUSCLE	MINK4LIVER	OTTER1KIDNEY	OTEER1MUSCHLE	OTTER1LIVER
					Client sampling date / time	24-Dec-2022	24-Dec-2022	17-Dec-2022	17-Dec-2022	17-Dec-2022
						WP2301236-011	WP2301236-012	WP2301236-013	WP2301236-014	WP2301236-015
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		74.1	72.7	74.9	73.9	73.5
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.570	0.637	0.408	0.160	0.519

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Tissue
(Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	OTTER2KIDNEY	OTTER2MUSCLE	OTTER2LIVER	OTTER3KIDNEY	OTTER3MUSCLE
					Client sampling date / time	21-Dec-2022	21-Dec-2022	21-Dec-2022	22-Dec-2022	22-Dec-2022
						WP2301236-016	WP2301236-017	WP2301236-018	WP2301236-019	WP2301236-020
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		75.9	73.4	71.6	60.2	74.4
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		4.60	1.21	6.17	0.590	0.220

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Tissue
(Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	OTTER3LIVER	BEAVER1KIDNEY	BEAVER1MUSCLE	BEAVER1LIVER	BEAVER2KIDNEY
					Client sampling date / time	22-Dec-2022	13-Dec-2022	13-Dec-2022	13-Dec-2022	24-Dec-2022
						WP2301236-021	WP2301236-022	WP2301236-023	WP2301236-024	WP2301236-025
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		72.1	79.4	75.1	76.7	81.6
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.403	0.0182	0.0017	0.0012	0.0028

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Page : 5 of 7
Work Order : WP2301236
Client : Wildlife Resource Consulting Services MB Inc.
Project : ----

Analytical Results

Sub-Matrix: Tissue
(Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	BEAVER2MUSCLE	BEAVER2LIVER	BEAVER3KIDNEY	BEAVER3MUSCLE	BEAVER3LIVER
					Client sampling date / time	24-Dec-2022	24-Dec-2022	24-Dec-2022	24-Dec-2022	24-Dec-2022
						WP2301236-026	WP2301236-027	WP2301236-028	WP2301236-029	WP2301236-030
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		63.7	76.4	80.4	73.8	77.6
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.0017	0.0014	0.0043	0.0015	0.0012

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Tissue
(Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	BEAVER4KIDNEY	BEAVER4MUSCLE	BEAVER4LIVER	BEAVER5KIDNEY	BEAVER5MUSCLE
					Client sampling date / time	27-Dec-2022	27-Dec-2022	27-Dec-2022	29-Dec-2022	29-Dec-2022
						WP2301236-031	WP2301236-032	WP2301236-033	WP2301236-034	WP2301236-035
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		80.9	75.1	75.2	81.0	72.0
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.0165	0.0019	0.0019	0.0027	0.0026

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Tissue
(Matrix: Biota)

Analyte	CAS Number	Method	LOR	Unit	Client sample ID	BEAVER5LIVER	BEAVER6KIDNEY	BEAVER6MUSCLE	BEAVER6LIVER	MUSKRAT1KIDNEY
					Client sampling date / time	29-Dec-2022	29-Dec-2022	29-Dec-2022	29-Dec-2022	14-Dec-2022
						WP2301236-036	WP2301236-037	WP2301236-038	WP2301236-039	WP2301236-040
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		79.3	78.8	70.8	75.0	80.3
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.0012	0.0056	0.0020	0.0017	0.102

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Page : 6 of 7
Work Order : WP2301236
Client : Wildlife Resource Consulting Services MB Inc.
Project : ----

Analytical Results

Sub-Matrix: Tissue (Matrix: Biota)					Client sample ID	MUSKRAT1MUSCLE	MUSKRAT1LIVER	MUSKRAT2KIDNEY	MUSKRAT2MUSCLE	MUSKRAT2LIVER
					Client sampling date / time	14-Dec-2022	14-Dec-2022	20-Dec-2022	20-Dec-2022	20-Dec-2022
Analyte	CAS Number	Method	LOR	Unit		WP2301236-041	WP2301236-042	WP2301236-043	WP2301236-044	WP2301236-045
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		80.6	74.7	74.0	77.3	73.0
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.0372	0.0578	0.0039	0.0088	0.0017

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Tissue (Matrix: Biota)					Client sample ID	MUSKRAT3KIDNEY	MUSKRAT3MUSCLE	MUSKRAT3LIVER	MUSKRAT4KIDNEY	MUSKRAT4MUSCLE
					Client sampling date / time	23-Dec-2022	23-Dec-2022	23-Dec-2022	26-Dec-2022	26-Dec-2022
Analyte	CAS Number	Method	LOR	Unit		WP2301236-046	WP2301236-047	WP2301236-048	WP2301236-049	WP2301236-050
						Result	Result	Result	Result	Result
Physical Tests										
Moisture	----	E144	0.50	%		72.4	76.6	72.9	72.6	74.9
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.0026	0.0117	0.0017	0.0037	0.0135

Please refer to the General Comments section for an explanation of any qualifiers detected.

Analytical Results

Sub-Matrix: Tissue (Matrix: Biota)					Client sample ID	MUSKRAT4LIVER	MUSKRAT5KIDNEY	MUSKRAT5MUSCLE	MUSKRAT5LIVER	----
					Client sampling date / time	26-Dec-2022	28-Dec-2022	28-Dec-2022	28-Dec-2022	----
Analyte	CAS Number	Method	LOR	Unit		WP2301236-051	WP2301236-052	WP2301236-053	WP2301236-054	--------
						Result	Result	Result	Result	----
Physical Tests										
Moisture	----	E144	0.50	%		71.3	71.6	76.7	70.7	----
Metals										
Mercury	7439-97-6	E510A	0.0010	mg/kg wwt		0.0019	0.109	0.0390	0.0592	----

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Page	:	7 of 7
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