Helmer Dam Interim Fish Habitat Suitability Study

Town of Hanna

11 September 2020

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Revision History and Approvals			
Project Name		Helmer Dam Revitalization	
Project Number		10733	
Report Title		Helmer Dam Fish Habitat Suitability Study	
Document #		C-2354	
Report Author(s)		Jacson Laliberte	
Date	***Version***	***Review Type***	***Reviewed by***
August 27, 2020	Draft	Progress	Dayna Solmie
September 11, 2020	Draft	Final	Kent Kristensen

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1.0 Introduction

1.1 Project Description

Triton understands that the Town of Hanna wishes to undertake a revitalization of the Helmer Dam to improve the water and habitat quality of Helmer Reservoir in order to support a recreational fishery (the Project). Phase 1 of the Project includes a summer and winter fish and fish habitat assessment to determine if the reservoir can support various species such as Rainbow Trout (*Oncorhynchus mykiss)*or Yellow Perch (*Perca flavescens)*throughout the year. The information collected during Phase 1 is intended to allow the Town of Hanna and their partners to make recommendations for the improvement and revitalization of the Helmer Reservoir for multi-season fishing use.

1.2 Background

Helmer Reservoir is located in Parkland-Prairie Watershed Unit 2 in Alberta, which also includes the Red Deer, Battle, and North Saskatchewan rivers. The reservoir is located at SW 18-31-14 W4M, near the Town of Hanna (Figure 1). Fish stocking reports indicate that the reservoir was stocked with Rainbow Trout by the Government of Alberta (GoA) between the years of 2009 and 2019 (GoA 2020a).

1.3 Objectives

The objective of the fish and fish habitat assessment of Helmer Reservoir and surrounding area is to:

- Assess current habitat suitability for sportfish species
- Recommend measures to improve the aquatic habitat
- Recommend measures to improve the terrestrial habitat
- Recommend sportfish species that will overwinter in the reservoir

The following report summarizes interim field results collected by Triton to assess fish and fish habitat quality in Helmer Reservoir during the summer of 2020. A final report will follow once the winter sampling is completed and summarized.

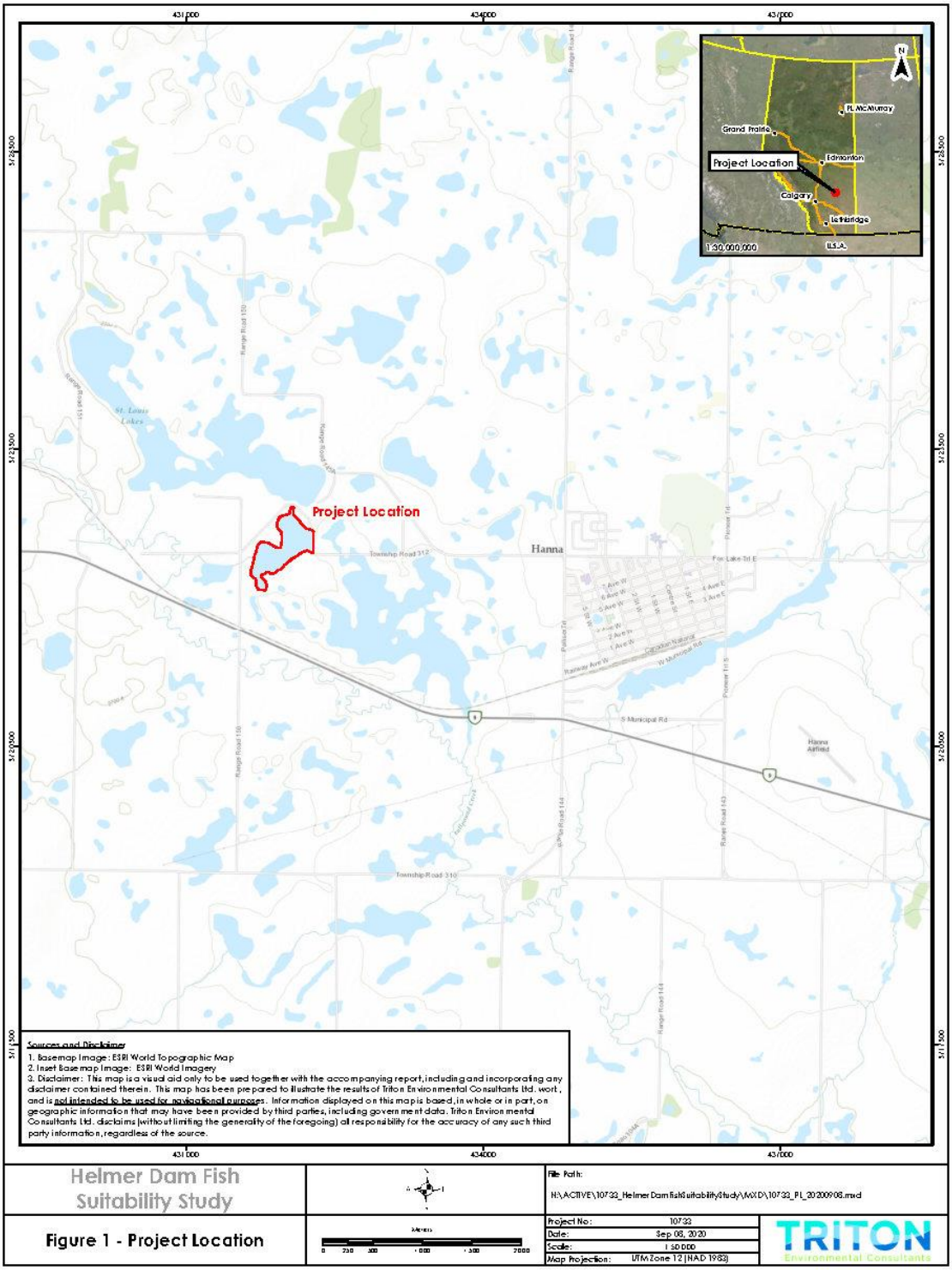


Figure 1-Project Location

2.0 Methods

2.1 Study Area

Helmer Reservoir is a small reservoir located near the Town of Hanna. The reservoir is located immediately below the Helmer Dam spillway and drains into Bullpound Creek, which is within the Red Deer River Basin watershed (https://geodiscover.alberta.ca/geoportal/, September 2020).

To assess water quality suitability within Helmer Reservoir, Triton staff collected 5 water samples from locations near the inlet (north), outlet (SW) and from representative habitats within the reservoir (Table 1 and Figure 2). Fish community data was obtained from 4 sampling locations using minnow trapping (MT1 to MT4) and from two gill net sets (GN1 and GN2) (Table 1 and Figure 2).

Table 1. Sampling Location Details of Helmer Dam Fish Suitability Study – Summer 2020

Station #	*Total Depth (m)*	*UTM Coordinates*	*Water Quality*
H1	2.9	12U 431726 E 5722190 N	YSI, Chl-a, TP, NO_2-N, NO_3-N, TN, TKN, BOD, turbidity
H2	4.5	12U 431917 E 5722307 N	YSI, Chl-a, TP, NO_2-N, NO_3-N, TN, TKN, BOD, turbidity
H3	5.2	12U 432049 E 5722732 N	YSI, Chl-a, TP, NO_2-N, NO_3-N, TN, TKN, BOD, turbidity
H4	5.2	12U 432122 E 5722555 N	YSI, Chl-a, TP, NO_2-N, NO_3-N, TN, TKN, BOD, turbidity
H5	3.6	12U 432225 E 5722631 N	YSI, Chl-a, TP, NO_2-N, NO_3-N, TN, TKN, BOD, turbidity
MT1	1.2	12U 432096 E 5722808 N	---
MT2	0.8	12U 432003 E 5722615 N	---
MT3	0.6	12U 432228 E 5722631 N	---
MT4	0.5	12U 432122 E 5722556 N	---
GN1	3.0	12U 431806 E 5722285 N	---
GN2	3.0	12U 432064 E 5722484 N	---

Note: YSI – includes temperature, dissolved oxygen, pH, and specific conductivity; GN – Gill Net, MT – Minnow Trap, Chl-a – Chlorophyll-a, TP – Total Phosphorus, NO_2-N – Nitrite as N, NO_3-N – Nitrate as N, TN – Total Nitrogen, BOD – Biochemical Oxygen Demand

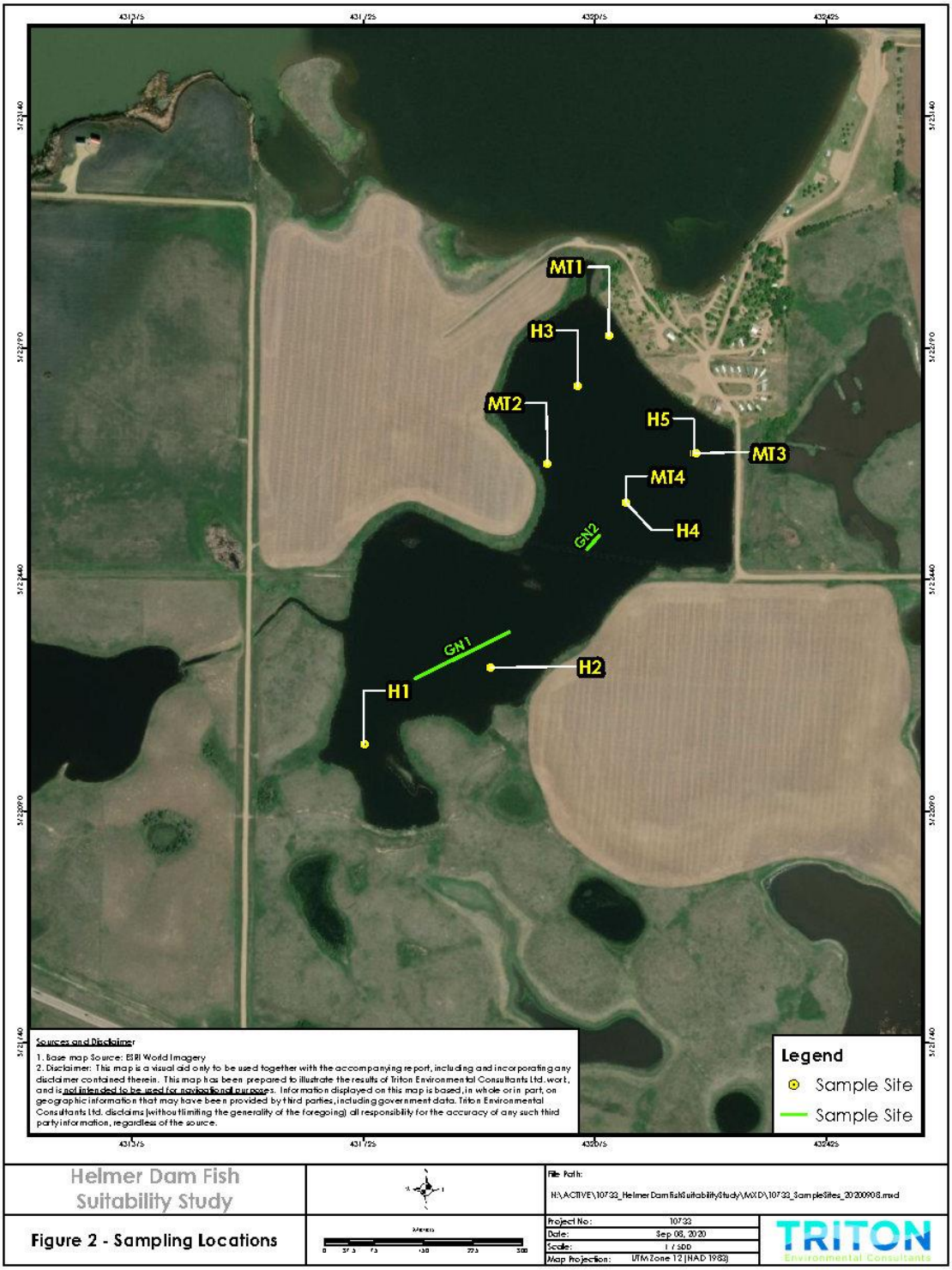


Figure 2 – Sampling Locations during Summer 2020 Field Program

2.2 Water Quality

Water samples were analyzed to characterize the chemical composition of the reservoir water and to further identify any potential concerns for fish suitability.

The following parameters were measured during summer 2020:

- Secchi Depth
- Dissolved Oxygen (DO)
- Temperature
- Electrical Conductivity (EC) and Specific Conductivity (SPC)
- pH
- Turbidity
- Nutrients
- Chlorophyll-a (Chl-a)
- Biochemical Oxygen Demand (BOD)

2.3 Fish Assessment

A fish survey using both gill netting and minnow trapping was conducted to determine the presence of Rainbow Trout and other resident fish species. Fish were collected according to the protocols and specifications of fish research licence (FRL) 20-3015 issued by the GoA.

2.3.1 Gill Netting

North American Gear (NA1) (GoA 2018a) nets were used to sample Helmer Reservoir. Eight panels of 3.1 m in length and 1.8 m in height with mesh size of 0.5, 2.0, 2.5, 3.0,3.5, 4.0, 4.5, and 5.0 inches were used. Nets were set during the day and checked the following morning according to FRL requirements. Gill nets were set at mid-column depths to effectively sample cooler water which would be preferred by Rainbow Trout at the time of sampling.

2.3.2 Minnow Trapping

Standard Gee-type minnow traps with a mesh size of 5 mm were set overnight throughout the reservoir in clusters of two to three traps at varying depths. Traps were baited with cat food. Minnow trapping total effort was recorded as trap-hours (number of minnow traps set multiplied by set time in hours).

2.3.3 Fish Processing and Release

Captured Rainbow Trout were measured for fork length (mm) and weight (g) prior to being photographed and properly disposed of according to section 10(d) in fish research licence 20-3015. Where large numbers (>100) of a single fish species were encountered at a sample location, a representative sample of that species was measured for length. Fish were held in aerated holding tubs filled with water from the reservoir. Water

temperature in the holding tubs was monitored and water was refreshed frequently to maintain suitable water quality. Holding times were kept to a minimum and fish were transferred to the release location immediately following processing. Due to the high ambient air temperatures at the time of the survey, fish captured from minnow traps were identified to species, enumerated, and released immediately to reduce the risk of stress and mortality.

2.4 Wildlife Habitat Summary

Triton staff made efforts to observe and identify any wildlife present in and around Helmer Reservoir during the field study.

2.5 Decontamination

Triton staff strictly follows the GoA's Decontamination Protocol for Work in or Near Water (GoA 2020b) to avoid the potential spread of whirling disease and other invasive species. The Town of Hanna and Helmer Reservoir are located within the White Zone, indicating that the risk of the spread of whirling disease is low or the presence of species at risk of being infected with the disease are not present. Decontamination of equipment following work at Helmer Reservoir was a Level 1 decontamination which required all equipment to be cleaned and drained, after completing work at the site.

3.0 Results

Triton field staff assessed water quality, fish habitat suitability, and wildlife presence over two days from August 18 to19, 2020. Weather conditions were good with clear sky and high ambient air temperatures of 31 and 24°C (Photograph 1). Results from the field activities are summarized below.

3.1 Water Quality

Water quality characteristics for sub-surface (1 m depth) and deep (2 or 3 m depth) samples are presented in Table 2 below. Water quality in Helmer Reservoir at the time of summer sampling was characteristic of a hypereutrophic water body based on the concentrations of total phosphorus (TP) and total nitrogen (TN) in excess of 2.13 mg/L and 3.7 mg/L, respectively (Table 2). Temperatures in the sub-surface layer ranged between 20.5 and 21.6°C, while temperatures in the deeper samples ranged between 18.4 and 20.8°C (Table 2). Dissolved oxygen concentrations were observed to be high and well above saturation in the near-surface layer, while concentrations in the deep layer were lower at all stations, especially at H3-H5 which were all below 3.15 mg/L. Chlorophyll-a was highest at stations H1 and H2, however, significant levels of primary production were indicated at all stations and depths. BOD varied between sampling locations and were generally highest at H1 and H2.

3.1.1 Secchi Depth

Secchi depth varied between 1.11 and 1.74 m in depth, indicating a euphotic zone of between 2.22 and 3.48 m at the time of sampling (Table 2 and Figure 3). The depth of the euphotic zone available for photosynthesis to occur is between 58% and 76.5% of the total volume of water available in Helmer Reservoir.

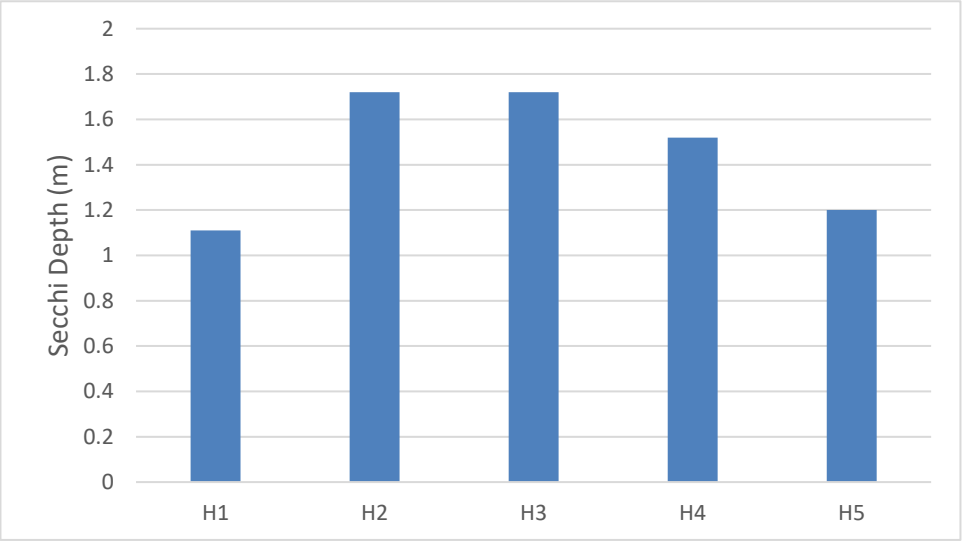


Figure 3 – Secchi Depth (m) from Summer water quality sampling

Table 2. Water Quality of Helmer Dam – Summer 2020

Station	**H1**		**H2**		**H3**		**H4**		**H5**	
UTM Coordinates	12U 431726 E 5722190 N		12U 431917 E 5722307 N		12U 432049 E 5722732 N		12U 432122 E 5722555 N		12U 432225 E 5722631 N	
Date	19-Aug-2020		19-Aug-2020		19-Aug-2020		19-Aug-2020		19-Aug-2020	
Total Depth (m)	2.9		4.5		5.2		5.23		3.6	
Secchi Depth (m)	1.11		1.72		1.72		1.52		1.2	
Sub-sample	Sub-surface	Deep	Sub-surface	Deep	Sub-surface	Deep	Sub-surface	Deep	Sub-surface	Deep
Sample ID	**WQ1A**	**WQ1B**	**WQ2A**	**WQ2B**	**WQ3A**	**WQ3B**	**WQ4A**	**WQ4B**	**WQ5A**	**WQ5b**
Sample Depth (m)	1.00	2.00	1.00	3.00	1.00	3.00	1.00	3.00	1.00	2.00
Temperature (°C)	21.2	20.8	21.6	19.8	20.5	18.3	21.6	18.4	21.2	18.4
DO%	135.3	118.2	170.9	85.3	126.4	18.4	148.7	24.6	147.9	35.7
DO (mg/L)	11.72	10.72	14.72	7.12	11.24	1.73	12.96	2.16	12.98	3.15
pH	9.27	9.29	9.33	9.27	9.35	9.25	9.32	9.23	9.33	9.23
Specific Conductivity (µS/cm°C)	2376	2380	2381	2367	2373	2349	2379	2349	2378	2351
Conductivity (µS/cm)	2203	2179	2218	2130	2171	2045	2225	2047	2206	2054
Turbidity (NTU)	12.4	10.86	5.22	3.94	3.86	3.2	3.4	3.48	5.77	2.84
Chlorophyll-a (µg/L)	94.1	168	125	107	37.0	22.7	69.3	28.6	65.7	24.5
Total Phosphorus (mg/L)	2.28	2.34	2.22	2.13	2.13	2.27	2.25	2.26	2.15	2.21
BOD (mg/L)	8	13	10	7	3	3	5	3	5	3
Nitrate (mg/L)	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate-N (mg/L)	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrite (mg/L)	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrite-N (mg/L)	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen (mg/L)	7.0	5.8	4.7	4.8	4.1	4.2	3.7	4.1	4.3	3.9
Total Nitrogen (mg/L)	7.0	5.8	4.7	4.8	4.1	4.2	3.7	4.1	4.3	3.9

Note: * Sub-surface: 1m from water surface, Deep: 2-3m from surface and 1m above bottom

3.1.2 Biological Oxygen Demand

Biological oxygen demand varied between 3 and 13 mg/L at the time of sampling (Table 2 and Figure 4). BOD was generally lower at H3 to H5, which were deeper sites than H1 and H2.

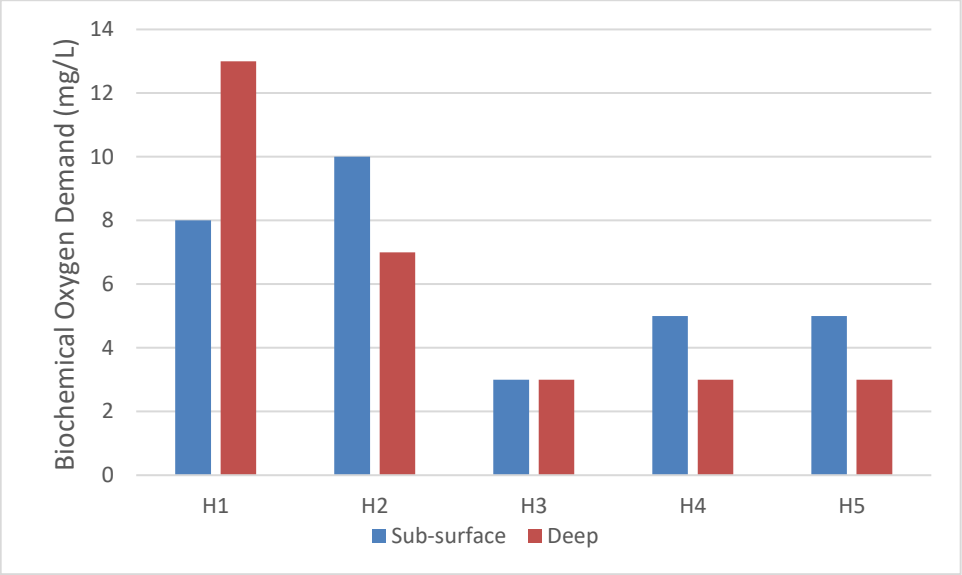


Figure 4 – BOD (mg/) from Summer water quality sampling

3.1.3 Nutrients

Total nitrogen varied between 3.7 and 7.0 mg/L across sampling locations and was fairly similar within each station (Table 2 and Figure 5). Total phosphorus varied between 2.13 and 2.34 mg/L across sampling locations and was more variable than nitrogen within each station (Table 2 and Figure 6).

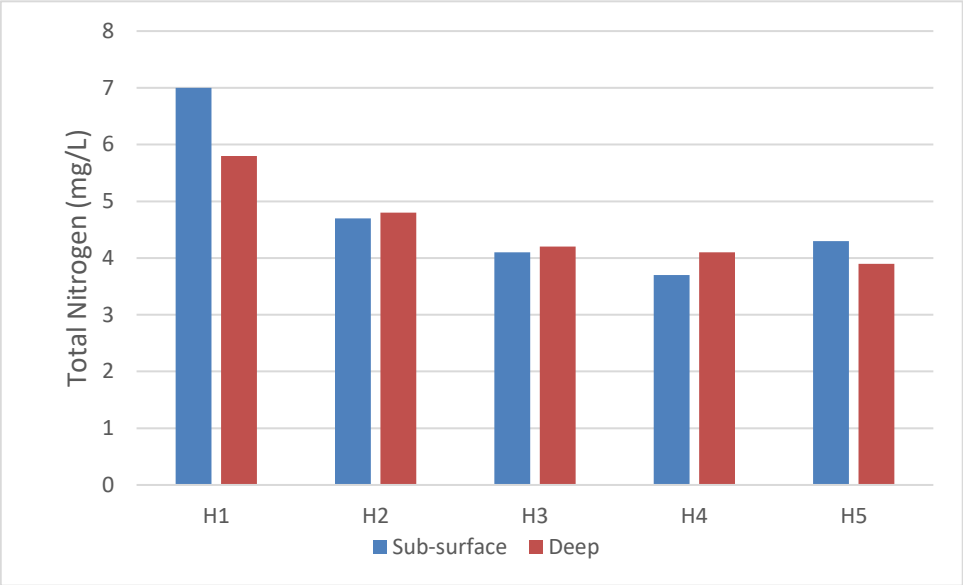


Figure 5 – Total Nitrogen (mg/L) from Summer water quality sampling

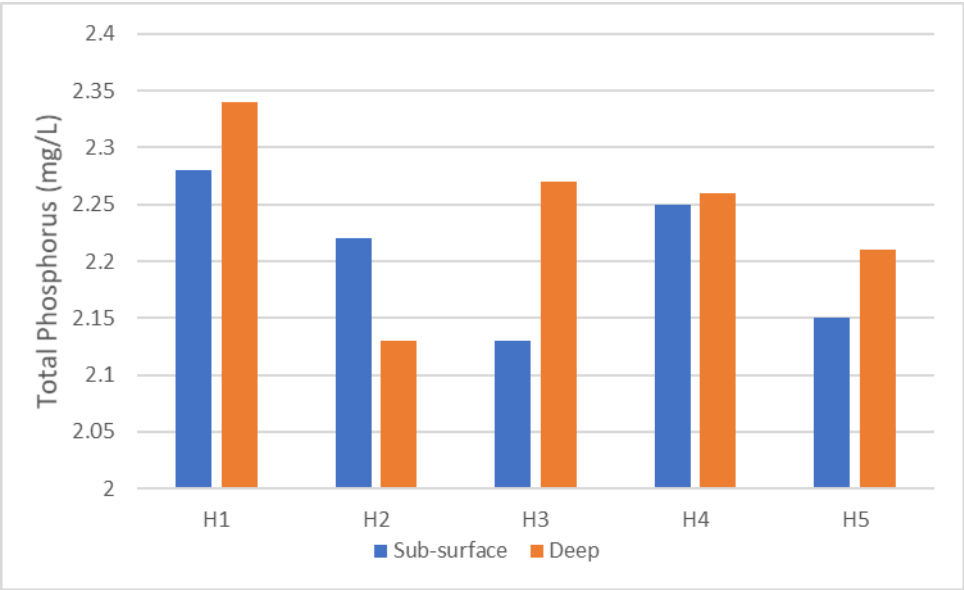


Figure 6 – Total Phosphorus (mg/L) from Summer water quality sampling

3.1.4 Chlorophyll-a

Chlorophyll-a varied between 22.7 and 168 µg/L, was highest at the shallowest stations (WQ1 and WQ2), and generally higher in the sub-surface samples than the deep samples (Table 2 and Figure 7). Chlorophyll-a levels were indicative of a high level of primary productivity, particularly in the euphotic zone at the time of sampling.

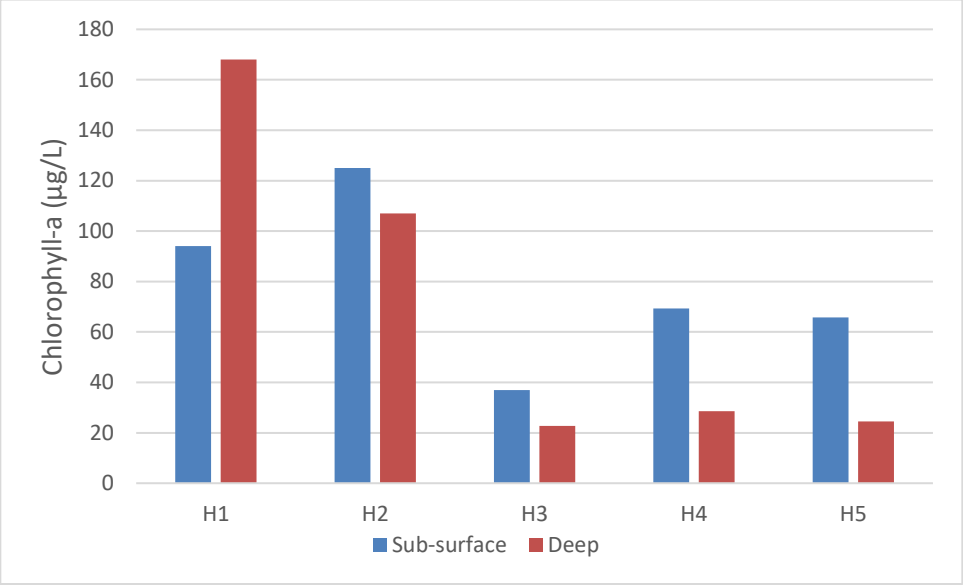


Figure 7 – Chlorophyll-a (µg/L) from Summer water quality sampling

3.1.5 pH

Water in Helmer Reservoir was found to be basic and exceeding Alberta surface water quality guidelines for the protection of freshwater aquatic life (PAL)of 9.0 (GoA 2018b) at all sampling locations (Table 2 and Figure 8). The guideline allows for variance of up to 0.5 pH units from background levels and past sampling in May of 2009 found similar pH results (Appendix 2), therefore, these pH levels may be within the natural background range.

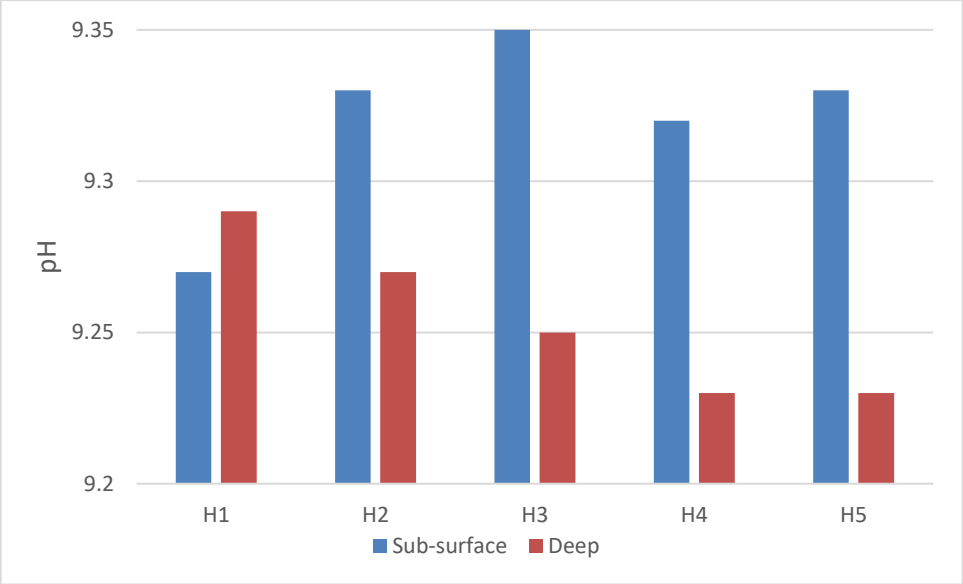


Figure 8 – pH from Summer water quality sampling

3.2 Fish and Fish Habitat

Fish survey results for the Summer sampling completed by Triton field staff are summarized below in Tables 3 and 4. Four Rainbow Trout were captured (two in each gill net set) and only Fathead Minnow (*Pimephales promelas*) and Lake Chub (*Couesius plumbeus*) were captured in the minnow traps (Table 4).

Catch rates for Rainbow Trout in the gillnets was 0.113 fish/hr, while catch rates ranged between 0 to 4.71 fish/hr in the minnow traps (Figure 9).

Measured Rainbow Trout had an average fork length of 336.5 mm and an average weight of 564 g. Condition of Rainbow Trout captured was fair to good with condition factors ranging between 1.29 and 1.58 (Table 5 and Photographs 2-5).

Table 3. Fishing Effort and Method Details of Helmer Reservoir – Summer 2020

Station #	Date	Depth of Sets (m)	Gill Net		Minnow Trap	
			Net #	Total Effort (hrs)	Trap #	Total Effort (hrs)
MT1	Aug 18-19	1.2	---	---	2	47.8
MT2	Aug 18-19	0.8	---	---	2	47.8
MT3	Aug 18-19	0.6	---	---	3	71
MT4	Aug 18-19	0.5	---	---	3	71.25
GN1	Aug 18-19	3.0	1	17.75	---	---
GN2	Aug 18-19	3.0	1	17.75	---	---

Note: GN – Gill Net, MT – Minnow Trap

Table 4. Fish Catch Summary of Helmer Reservoir – Summer 2020

Method	Fish Species		
	Fathead Minnow	Lake Chub	Rainbow Trout
Gill Nets	0	0	4
Minnow Traps	79	223	0
Total	79	223	4

Note: GN – Gill Net, MT – Minnow Trap

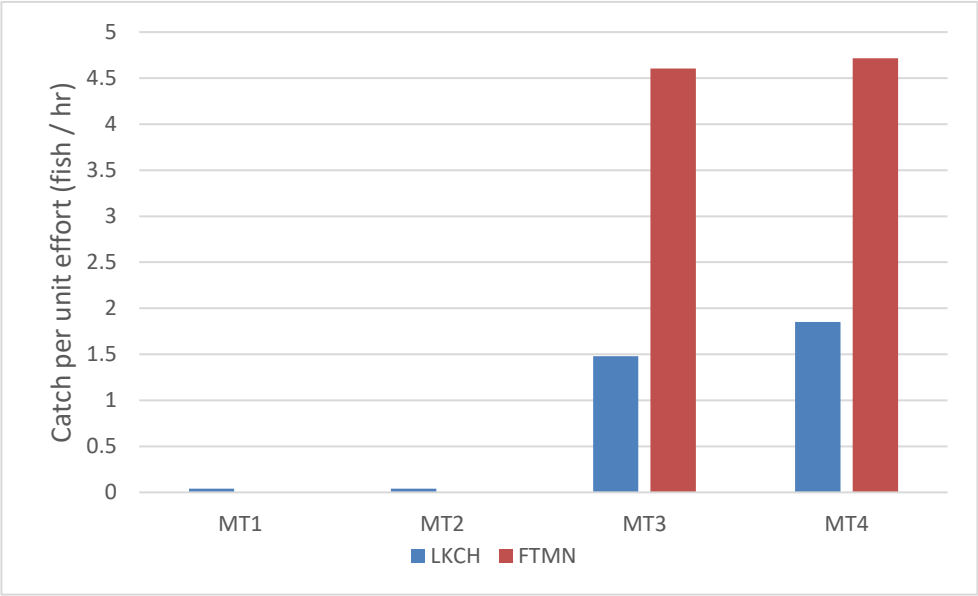


Figure 9 – Catch Per Unit Effort (CPUE – fish / hr) from minnow traps - Summer 2020

Table 5. Rainbow Trout Condition Factors – Summer 2020

Individual	Fork Length (mm)	Weight (g)	Condition Factor
1	332	555	1.52
2	358	725	1.58
3	330	462	1.29
4	326	514	1.48

3.3 *Wildlife Summary*

Wildlife encountered and reported in the area (FWMIT GoA 2020c) includes birds such as, American White Pelican (*Pelecanus erythrorhynchos*) or the Burrowing Owl (*Athene cunicularia*), some amphibians, Canadian Toad (*Anaxyrus hemiophrys*) or Western Painted Turtle (*Chrysemys picta*), and mammals like the Pronghorn (*Antilocapra americana*) or American Badger (*Taxidea taxus*).

4.0 Discussion

4.1 Water Quality

Helmer Reservoir has high levels of nutrients and solutes (TN, TP, SPC), resulting in high levels of biological activity (BOD, and chlorophyll-a) at all sampling locations (Table 1). As such, Helmer Reservoir would be classified as a hypereutropic system according to Yang et al. (2008). The result is high levels of primary productivity, measured as chlorophyll-a, throughout the littoral zone of the reservoir due to significant growth of phytoplankton and aquatic vegetation (Photograph 6).

There is also no apparent vertical stratification of temperature associated with a thermocline at the time of sampling, although it would likely be present during late spring and early summer. The reservoir is not likely sufficiently deep to maintain a thermocline throughout the open-water season and, as a result, water temperatures remain above 18°C in late summer to early fall close to the bottom.

The high degree of primary productivity (Chl-a) in the reservoir also results in a high degree of biological activity associated with BOD, which can result in increased depletion of DO near the benthos, where photosynthesis is lower. The resulting pattern produces high water temperatures throughout the reservoir and low DO concentrations in the areas of the reservoir where cooler, deeper water occurs.

pH levels in Helmer reservoir have been shown to vary seasonally and winter 2021 sampling will help confirm whether seasonal pH fluctuations are still occurring and what implications this might have on stocked fish populations.

Given the surrounding agricultural environment, runoff associated with nearby farmland may play a roll in the eutrophication of this reservoir and others in the area.

4.2 Fish Habitat Quality

Temperature and dissolved oxygen levels play a significant role in determining the types of fish species capable of thriving in Helmer Reservoir. Based on the evidence, it would seem plausible that Helmer Reservoir does not exist as a thermally stratified system by mid- to late-summer, indicating that thermal stress and/or anoxia may occur for stocked Rainbow Trout periodically.

4.2.1 Rainbow Trout

Temperatures exceeding 20°C throughout the water column may be common, and temperatures exceeding the incipient lethal temperature of 25°C for Rainbow Trout may be possible close to the surface during summer months. Where temperatures are within their preferred range of 12-18°C, for adult Rainbow Trout in the deeper sections of the reservoir, DO concentrations in those areas appear to be well below their preferred DO concentration of ≥9.0 mg/L, and sometimes below the incipient lethal concentration of

3.0 mg/L (Raleigh et al. 1984). This is likely exacerbated during the winter months when oxygen levels decline further up the water column, resulting in winter kills.

Although Rainbow Trout were rarely captured during the survey, captured individuals were in good condition, indicating that they were provided with ample food resources in the form of either aquatic invertebrates or forage fish. Low numbers of trout captured may be a result of a combination of summer or winter kills, and high levels of angler harvest.

4.2.2 Yellow Perch

Yellow Perch are likely a much more suitable option for stocking into Helmer Reservoir to provide recreational fishing opportunities than Rainbow Trout currently. Yellow Perch are much more capable of surviving and thriving at water temperature ranges observed in the reservoir during summer sampling in 2020. Dissolved oxygen concentrations may still present a problem for perch occasionally as their lethal limit is dependent on temperature. The lethal DO concentration at 26°C is ~3.1 mg/L, however, they have been observed to survive at lower concentrations in colder water (Krieger et al. 1983). Based on qualitative observations of Helmer Reservoir, aquatic vegetation appears to be abundant and Yellow Perch prefer lake environments with moderate amounts of vegetation and littoral zones which can be useful for spawning and rearing (Krieger et al. 1983).

Dissolved oxygen concentrations at all sub-surface stations exceeded those required for the survival of Rainbow Trout and Yellow Perch, however, sampling at depth revealed DO concentrations in the lethal concentration range for Rainbow Trout and possibly Yellow Perch.

Additionally, pH levels in the reservoir also have been shown to exceed the upper tolerance level of 9.0 for fish, which might result in reduced growth and survival of trout and perch if these pH levels are persistent through the year.

4.3 Recommendations

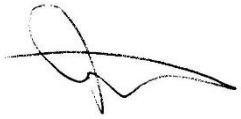
A possible solution to the winterkill problem would be the installation of an aeration system that is capable of maintaining ice-free area(s) during the winter months which would promote re-oxygenation of the reservoir. This solution would require additional investigation to determine whether such a system would be feasible on a waterbody the size of Helmer Reservoir. Additionally, maintaining reservoir fullness as much as possible through the hottest portions of the summer might maintain some level of thermal stratification for sufficient time to reduce heat stress in stocked trout. The above efforts may have some positive impact on the ability of the reservoir to successfully host Rainbow Trout or Yellow Perch, however, investigating the sources of eutrophication of the reservoir and possible mitigations may be more important for reducing nutrient loads, EC,

and pH to levels that will enable healthier and more resilient aquatic communities in the future.

5.0 Closure

This report was produced to provide the Town of Hanna with guidance for the Project. If you have further questions or concerns about the content or requirements contained within this Plan, please contact the undersigned.

Triton Environmental Consultants Ltd.



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6.0 References

[GoA] Government of Alberta. 2020a. Fish Stocking Report. Accessed August 2020. Available at: https://open.alberta.ca/publications/fish-stocking-list

[GoA] Government of Alberta. 2020b. Alberta Decontamination Protocol for Work in or Near Water. Accessed September 2020. Available at: https://open.alberta.ca/dataset/9b126cfd-b637-4dd2-838e-b43d12c8993a/resource/d89b106e-af61-4858-a991-12caadd0869d/download/aep-decontamination-protocol-for-work-in-or-near-water.pdf

[GoA] Government of Alberta. 2020c. Fish and Wildlife Internet Mapping Tool (FWIMT). Accessed September 2020. Available at: https://maps.alberta.ca/FWIMT_Pub/Viewer/?TermsOfUseRequired=true&Viewer=FWIMT_Pub

[GoA] Government of Alberta. 2018a. North American Standard Index Netting Sampling Protocol for Alberta. Fisheries Management, Alberta Environment and Parks. Edmonton, Alberta. 21 pp.

[GoA] Government of Alberta. 2018b. Environmental Quality Guidelines for Alberta Surface Waters. Water Policy Branch, Alberta Environment and Parks. Edmonton, Alberta. 58 pp.

Krieger, D. A., J. W. Terrell, and P. C. Nelson. 1983. Habitat suitability information: Yellow perch. U.S. Fish Wildl. Servo FWS/OBS-83/10.55. 37 pp.

Raleigh, R. F., T. Hickman, R. C. Solomon, and P. C. Nelson. 1984. Habitat suitability information: Rainbow trout. U.S. Fish Wildl. Servo FWS/OBS-82/10.60. 64 pp.

Yang, X., X. Wu, H. Hao, and Z. He. 2008. Mechanisms and assessment of water eutrophication. Journal of Zhejiang University SCIENCE B, 9(3): 197-209.

APPENDIX 1

FIELD PHOTOS

Photographs

Photograph 1: View of Helmer Reservoir from staging area after field work on August 18, 2020.

Photograph 2: Rainbow Trout #1 captured in GN1 on August 19, 2020.

Photograph 3: Rainbow Trout #2 captured in GN1 on August 19, 2020.

Photograph 4: Rainbow Trout #3 captured in GN2 on August 19, 2020.

Photograph 5: Rainbow Trout #4 captured in GN2 on August 19, 2020.

Photograph 6: High density of aquatic vegetation in littoral zone of Helmer Reservoir on August 18, 2020.

APPENDIX 2

WATER QUALITY ANALYSIS RESULTS

2910 12TH STREET NE
CALGARY, ALBERTA
CANADA T2E 7P7
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FAX (403)735-2771
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CLIENT NAME: TRITON ENVIRONMENTAL
SUITE 200, 215 12 AVE SE
Calgary, AB T2G1A2
(403) 818-2670
ATTENTION TO: Helene Dussalt
PROJECT: 10733
AGAT WORK ORDER: 20C640147
WATER ANALYSIS REVIEWED BY: Dev Vyas, Inorganics Laboratory Manager
DATE REPORTED: Aug 27, 2020
PAGES (INCLUDING COVER): 10
VERSION*: 1

Should you require any information regarding this analysis please contact your client services representative at (403) 735-2005

Notes

Disclaimer:

- *All work conducted herein has been done using accepted standard protocols, and generally accepted practices and methods. AGAT test methods may incorporate modifications from the specified reference methods to improve performance.*
- *All samples will be disposed of within 30 days following analysis, unless expressly agreed otherwise in writing. Please contact your Client Project Manager if you require additional sample storage time.*
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Certificate of Analysis

AGAT WORK ORDER: 20C640147

PROJECT: 10733

CLIENT NAME: TRITON ENVIRONMENTAL

SAMPLING SITE:

ATTENTION TO: Helene Dussalt

SAMPLED BY:Prosanna Yemmaner

Chlorophyll-a in Water

DATE RECEIVED: 2020-08-20 **DATE REPORTED: 2020-08-27**

				WQ1A Station 1	WQ1B Station 1	WQ2A Station 2	WQ2B Station 2	WQ3A Station 3	WQ3B Station 3	WQ4A Station 4	WQ4B Station 4
		SAMPLE DESCRIPTION:		1m	2m	1m	3m	1m	3m	1m	3m
		SAMPLE TYPE:		Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:		2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19
Parameter	**Unit**	**G / S**	**RDL**	**1369886**	**1369926**	**1369927**	**1369928**	**1369929**	**1369930**	**1369931**	**1369932**
Chlorophyll-a	µg/L		0.25	94.1	168	125	107	37.0	22.7	69.3	28.6

				WQ5A Station 5	WQ5B Station 5
		SAMPLE DESCRIPTION:		1m	2m
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2020-08-19	2020-08-19
Parameter	**Unit**	**G / S**	**RDL**	**1369933**	**1369934**
Chlorophyll-a	µg/L		0.25	65.7	24.5

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis performed at AGAT Vancouver (unless marked by *)

Certified By:

Results relate only to the items tested. Results apply to samples as received.

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Certificate of Analysis

AGAT WORK ORDER: 20C640147

PROJECT: 10733

CLIENT NAME: TRITON ENVIRONMENTAL

SAMPLING SITE:

ATTENTION TO: Helene Dussalt

SAMPLED BY:Prosanna Yemmaner

Water Analysis - BOD, Total Phosphorus

DATE RECEIVED: 2020-08-20 **DATE REPORTED: 2020-08-27**

				WQ1A Station 1	WQ1B Station 1	WQ2A Station 2	WQ2B Station 2	WQ3A Station 3	WQ3B Station 3	WQ4A Station 4	WQ4B Station 4
		SAMPLE DESCRIPTION:		1m	2m	1m	3m	1m	3m	1m	3m
		SAMPLE TYPE:		Water	Water	Water	Water	Water	Water	Water	Water
		DATE SAMPLED:		2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19
Parameter	**Unit**	**G / S**	**RDL**	**1369886**	**1369926**	**1369927**	**1369928**	**1369929**	**1369930**	**1369931**	**1369932**
Biochemical Oxygen Demand (BOD)	mg/L		2	8	13	10	7	3	3	5	3
Total Phosphorus	mg/L		0.08	2.28	2.34	2.22	2.13	2.13	2.27	2.25	2.26

				WQ5A Station 5	WQ5B Station 5
		SAMPLE DESCRIPTION:		1m	2m
		SAMPLE TYPE:		Water	Water
		DATE SAMPLED:		2020-08-19	2020-08-19
Parameter	**Unit**	**G / S**	**RDL**	**1369933**	**1369934**
Biochemical Oxygen Demand (BOD)	mg/L		2	5	3
Total Phosphorus	mg/L		0.08	2.15	2.21

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Certified By:

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Certificate of Analysis

AGAT WORK ORDER: 20C640147

PROJECT: 10733

CLIENT NAME: TRITON ENVIRONMENTAL

SAMPLING SITE:

ATTENTION TO: Helene Dussalt

SAMPLED BY:Prosanna Yemmaner

Water Analysis - Total Nitrogen (TKN, Nitrate-N, Nitrite-N)

DATE RECEIVED: 2020-08-20 **DATE REPORTED: 2020-08-27**

				WQ1A Station 1	WQ1B Station 1		WQ2A Station 2	WQ2B Station 2	WQ3A Station 3	WQ3B Station 3	WQ4A Station 4
		SAMPLE DESCRIPTION:		1m	2m		1m	3m	1m	3m	1m
		SAMPLE TYPE:		Water	Water		Water	Water	Water	Water	Water
		DATE SAMPLED:		2020-08-19	2020-08-19		2020-08-19	2020-08-19	2020-08-19	2020-08-19	2020-08-19
Parameter	**Unit**	**G / S**	**RDL**	**1369886**	**1369926**	**RDL**	**1369927**	**1369928**	**1369929**	**1369930**	**1369931**
Nitrate	mg/L		0.5	<0.5	<0.5	0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate-N	mg/L		0.02	<0.02	<0.02	0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Nitrite	mg/L		0.10	<0.10	<0.10	0.10	<0.10	<0.10	<0.10	<0.10	<0.10
Nitrite-N	mg/L		0.01	<0.01	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen	mg/L		0.2	7.0	5.8	0.1	4.7	4.8	4.1	4.2	3.7
Total Nitrogen	mg/L		0.5	7.0	5.8	0.5	4.7	4.8	4.1	4.2	3.7

				WQ4B Station 4	WQ5A Station 5	WQ5B Station 5
		SAMPLE DESCRIPTION:		3m	1m	2m
		SAMPLE TYPE:		Water	Water	Water
		DATE SAMPLED:		2020-08-19	2020-08-19	2020-08-19
Parameter	**Unit**	**G / S**	**RDL**	**1369932**	**1369933**	**1369934**
Nitrate	mg/L		0.5	<0.5	<0.5	<0.5
Nitrate-N	mg/L		0.02	<0.02	<0.02	<0.02
Nitrite	mg/L		0.10	<0.10	<0.10	<0.10
Nitrite-N	mg/L		0.01	<0.01	<0.01	<0.01
Total Kjeldahl Nitrogen	mg/L		0.1	4.1	4.3	3.9
Total Nitrogen	mg/L		0.5	4.1	4.3	3.9

Comments: RDL - Reported Detection Limit; G / S - Guideline / Standard

Analysis performed at AGAT Calgary (unless marked by *)

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Quality Assurance

CLIENT NAME: TRITON ENVIRONMENTAL

PROJECT: 10733

SAMPLING SITE:

AGAT WORK ORDER: 20C640147

ATTENTION TO: Helene Dussalt

SAMPLED BY:Prosanna Yemmaner

Water Analysis

RPT Date: Aug 27, 2020			DUPLICATE				REFERENCE MATERIAL			METHOD BLANK SPIKE			MATRIX SPIKE		
PARAMETER	Batch	Sample Id	Dup #1	Dup #2	RPD	Method Blank	Measured Value	Acceptable Limits		Recovery	Acceptable Limits		Recovery	Acceptable Limits	
								Lower	Upper		Lower	Upper		Lower	Upper
Water Analysis - Total Nitrogen (TKN, Nitrate-N, Nitrite-N)															
Nitrate	1369927	1369927	<2.5	<2.5	NA	< 0.5	92%	70%	130%	94%	80%	120%	88%	70%	130%
Nitrite	1369927	1369927	<1.0	<1.0	NA	< 0.05	87%	70%	130%	87%	80%	120%	87%	70%	130%
Total Kjeldahl Nitrogen	1369886		7.03	6.78	3.6%	< 0.1	84%	70%	130%	101%	80%	120%	99%	70%	130%

Comments: Matrix spike NA: Spike level < native concentration. Matrix spike acceptance limits do not apply and are not calculated.
Duplicate NA: results are less than 5X the RDL and RDP will not be calculated.

Nitrate and Nitrite: The regulatory hold time for the analysis of nitrate and/or nitrite in water is 72 hours.

Water Analysis - BOD, Total Phosphorus															
Biochemical Oxygen Demand (BOD)	6127	0100	< 2	< 2	NA	< 2	90%	80%	120%						
Total Phosphorus	1323987		<0.08	<0.08	NA	< 0.08	95%	70%	130%	89%	80%	120%	86%	70%	130%

Comments: If the RPD value is NA, the results of the duplicates are under 5X the RDL and will not be calculated.

Chlorophyll-a in Water									
Chlorophyll-a	1374387	BS	949	991	4.3%	< 0.25	93%	85%	115%

Certified By:

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Results relate only to the items tested. Results apply to samples as received.

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Method Summary

CLIENT NAME: TRITON ENVIRONMENTAL

AGAT WORK ORDER: 20C640147

PROJECT: 10733

ATTENTION TO: Helene Dussalt

SAMPLING SITE:

SAMPLED BY:Prosanna Yemmaner

PARAMETER	AGAT S.O.P	LITERATURE REFERENCE	ANALYTICAL TECHNIQUE
Water Analysis			
Chlorophyll-a		SM 10200 H	SPECTROPHOTOMETER
Biochemical Oxygen Demand (BOD)	MIC 1500	SM 5210 B & SM 4500-O	DISSOLVED OXYGEN PROBE
Total Phosphorus	WATR 0200; INST 0140	SM 3030 E; SM 3120 B TW	ICP/OES
Nitrate	INST 0150	SM 4110 B	ION CHROMATOGRAPH
Nitrate-N	INST 0150	SM 4110 B	CALCULATION
Nitrite	INST 0150	SM 4110 B	ION CHROMATOGRAPH
Nitrite-N	INST 0150	SM 4110 B	CALCULATION
Total Kjeldahl Nitrogen	INST-0430	EPA 351.2	AQ-2 DISCRETE ANALYZER
Total Nitrogen		CALCULATION	CALCULATION

Results relate only to the items tested. Results apply to samples as received.

APPENDIX 3

FISH CAPTURE DATA

Fish Capture Data

Species	Captured Count	Life Stage	Sex	Fork Length (mm)	Total Length (mm)	Weight (g)
LAKE CHUB	223	Juvenile/Immature	U	average 60	average 63	average 6
FATHEAD MINNOW	79	Juvenile/Immature	U	65	68	4.2
RAINBOW TROUT	1	Adult/Mature	F	332	342	555
RAINBOW TROUT	1	Adult/Mature	F	358	368	725
RAINBOW TROUT	1	Adult/Mature	F	330	340	462
RAINBOW TROUT	1	Adult/Mature	M	326	332	514