Peace River Water Use Plan

Peace River Baseline TDGP/Temperature

GMSWORKS-2

Year 13 Monitoring Program - Annual Report

January 2021 to December 2021

Diversified Environmental Services
Box 6263,
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March 2022

PEACE RIVER WATER USE PLAN
IMPLEMENTATION PROGRAM

PEACE RIVER BASELINE TDGP/TEMPERATURE
GMSWORKS-2
YEAR 13 MONITORING PROGRAM - ANNUAL REPORT
January 2021 to December 2021

Prepared for:
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EXECUTIVE SUMMARY

Long-term monitoring of baseline water temperature and total dissolved gas pressure (TDGP) in the vicinity of the WAC Bennett and Peace Canyon dams is an essential component of the Peace Spill Protocol and the Peace River Flood Pulse Plan as set out by the Peace Water Use Plan Committee and the Peace Water Use Plan (WUP; BC Hydro 2010).

An objective of this program (GMSWORKS-2) was to collect data on spatial and temporal variations in water temperature between the WAC Bennett Dam forebay (Williston Reservoir) and a point 6.5 km downstream of the Pine River confluence for up to 10 years. Beginning in September 2008, 21 Tidbit v2 Model #UTBI-001 temperature sensor/logger units (Onset Corp., Bourne, MA) have been maintained at 18 locations.

During Year 8 (2016), six temperature loggers were added at 3 additional locations of specific interest to BC Hydro's Site C project, extending the project area downstream to the mouth of the Pouce Coupe River in Alberta. The additional sites were maintained by the GMSWORKS-2 program through a co-funding arrangement with the Site C project.

In 2020 (Year 12), responsibility for all monitoring sites within and downstream of the proposed Site C inundation area reverted from the Peace WUP to the Site C project. These included the additional Site C stations plus all original stations located downstream of the Peace Canyon Dam tailrace. The GMSWORK-2 program retained responsibility for monitoring stations in the WAC Bennett and Peace Canyon dam forebays and tailraces only.

This annual summary report describes data collection activities and results for the 6 temperature stations associated with the WAC Bennett and Peace Canyon dams and operated by the GMSWORKS-2 program during Year 13 (Jan-Dec 2021). These included 2 stations in the Bennett Dam forebay (gmsUP1 – 1 m depth and gmsUP2 – 10 m depth), 2 stations in the Bennett Dam tailrace (gmsDN1 – south bank and gmsDN2 – north bank), one station in the Peace Canyon Dam forebay (pcnUP1), and one station in the Peace Canyon Dam tailrace (pcnDN2).

Continuous hourly temperature data for Year 13 were recovered from all six stations including redundant back-up loggers at 3 stations.

In situ reference temperatures were recorded at the time of each field download event using a YSI® multi-parameter meter, for comparison to the corresponding hourly logger readings. Mean calibration errors for all temperature loggers were ≤ 0.2°C.

In addition to the collection of baseline water temperature data, the GMSWORK-2 program includes the maintenance of Total Dissolved Gas Pressure (TDGP) meters in a field-ready state for immediate deployment in the event of a spill at either the WAC Bennett or Peace Canyon dams. In April 2021, BC Hydro purchased five new HydroLab Model MS5 TGP meters to be dedicated to Peace Basin spill monitoring. These meters replaced much older Common Sensing Model DL6 and Point Four Model PT4 meters, which had proven relatively unreliable during previous spills due to their obsolescence.
The new meters were deployed in June-July 2021 to monitoring TDGP levels associated with a 7-day spill event between June 29 and July 6, 2021. Results of 2021 spill monitoring have been reported under separate cover through the GSMMON-11 program (DES 2022).

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1.0 INTRODUCTION

Long-term monitoring of baseline water temperature and total dissolved gas pressure (TDGP) in the vicinity of the WAC Bennett and Peace Canyon dams was identified as an essential component of the Peace Spill Protocol (PSP) and the Peace River Flood Pulse Plan as set out by the Peace Water Use Plan Committee and the Peace Water Use Plan (WUP; BC Hydro 2010). Data collected through the monitoring of these parameters are used to help assess and quantify the environmental effects of spills, as well as to provide information on the temperature regime of the Peace River under normal operating conditions and the influence of reservoir operations on downstream temperature. Long-term baseline temperature data will also be available for use by other projects and monitoring programs within and outside the Peace WUP.

An objective of this program (GMSWORKS-2) was to collect data on spatial and temporal variations in water temperature between the WAC Bennett Dam forebay (Williston Reservoir) and a point 6.5 km downstream of the Pine River confluence for up to 10 years. Beginning in September 2008, 21 Tidbit v2 Model #UTBI-001 temperature sensor/logger units (Onset Corp., Bourne, MA) have been maintained at 18 locations.

During Year 8 (2016), six temperature loggers were added at 3 additional locations of specific interest to BC Hydro's Site C project, extending the project area downstream to the mouth of the Pouce Coupe River in Alberta. The additional sites were maintained by the GMSWORKS-2 program through a co-funding arrangement with the Site C project.

In 2020 (Year 12), responsibility for all monitoring sites within and downstream of the proposed Site C inundation area reverted from the Peace WUP to the Site C project. These included the additional Site C stations plus all original stations located downstream of the Peace Canyon Dam tailrace. The GMSWORK-2 program retained responsibility for monitoring stations in the WAC Bennett and Peace Canyon dam forebays and tailraces only.

This annual summary report describes data collection activities and results for the 6 temperature stations associated with the WAC Bennett and Peace Canyon dams and operated by the GMSWORKS-2 program during Year 13 (Jan-Dec 2021). These included 2 stations in the Bennett Dam forebay (gmsUP1 – 1 m depth and gmsUP2 – 10 m depth), 2 stations in the Bennett Dam tailrace (gmsDN1 – south bank and gmsDN2 – north bank), one station in the Peace Canyon Dam forebay (pcnUP1), and one station in the Peace Canyon Dam tailrace (pcnDN2).

2.0 METHODS

Temperature data presented in this summary report were recorded between January 01, 2021 and December 31, 2021.

2.1 Temperature Monitoring

Upon commencement of the Peace River baseline temperature monitoring program in September 2008 (Year 1), 20 Tidbit v2 Model #UTBI-001 temperature sensor/logger units (0.2°C accuracy over 0°C to 50°C; 0.02°C resolution @ 25°C; Onset Corp., Bourne, MA) were deployed at 18 locations between the WAC Bennett Dam forebay and a site approximately 6.5 km downstream of the confluence of the Pine and Peace rivers (Fig. 1). During Years 2 and 3, revisions were made to monitoring site positioning and configuration to account for changes in bank conditions, to reduce the potential for logger stranding due to debris and flow level extremes, to increase redundancy in case of logger failure or loss, and to improve accessibility during high flow stage.

During 2020, responsibility for temperature monitoring sites within and downstream of the proposed Site C inundation area reverted from the Peace WUP program to the Site C project and the GMSWORK-2 program retained responsibility for the 6 stations in the GMS and PCN forebays and tailraces only. As a result, data for stations downstream of the Peace Canyon Dam tailrace do not appear in this summary report. A summary of temperature monitoring station location information as of the end of Year 13 appears in Appendix I.

Temperature loggers were programmed to record water temperature (°C) at 1 hour intervals throughout Year 13 (2021). Loggers continued to be housed in 38 mm x 100 mm steel nipples with threaded steel end caps, weighted with 5 kg steel anchors, and tethered to large bedrock fragments or log booms using 3.18 mm stainless steel cable.

Temperature data recorded and stored on each logger during 2021 were downloaded at approximately 3 month intervals by field transfer to a Model U-DTW-1 Hobo® waterproof shuttle (Onset Corp., Bourne, MA). Data from the shuttle were then downloaded to a desktop computer after each field session. The monitoring station in the WAC Bennett Dam forebay is located at one of the spillway log boom anchor buoys and must be accessed by boat during the ice-free season. All other monitoring stations can be access by vehicle from BC Hydro restricted-access areas in the WAC Bennett tailrace and the Peace Canyon Dam forebay and tailrace.

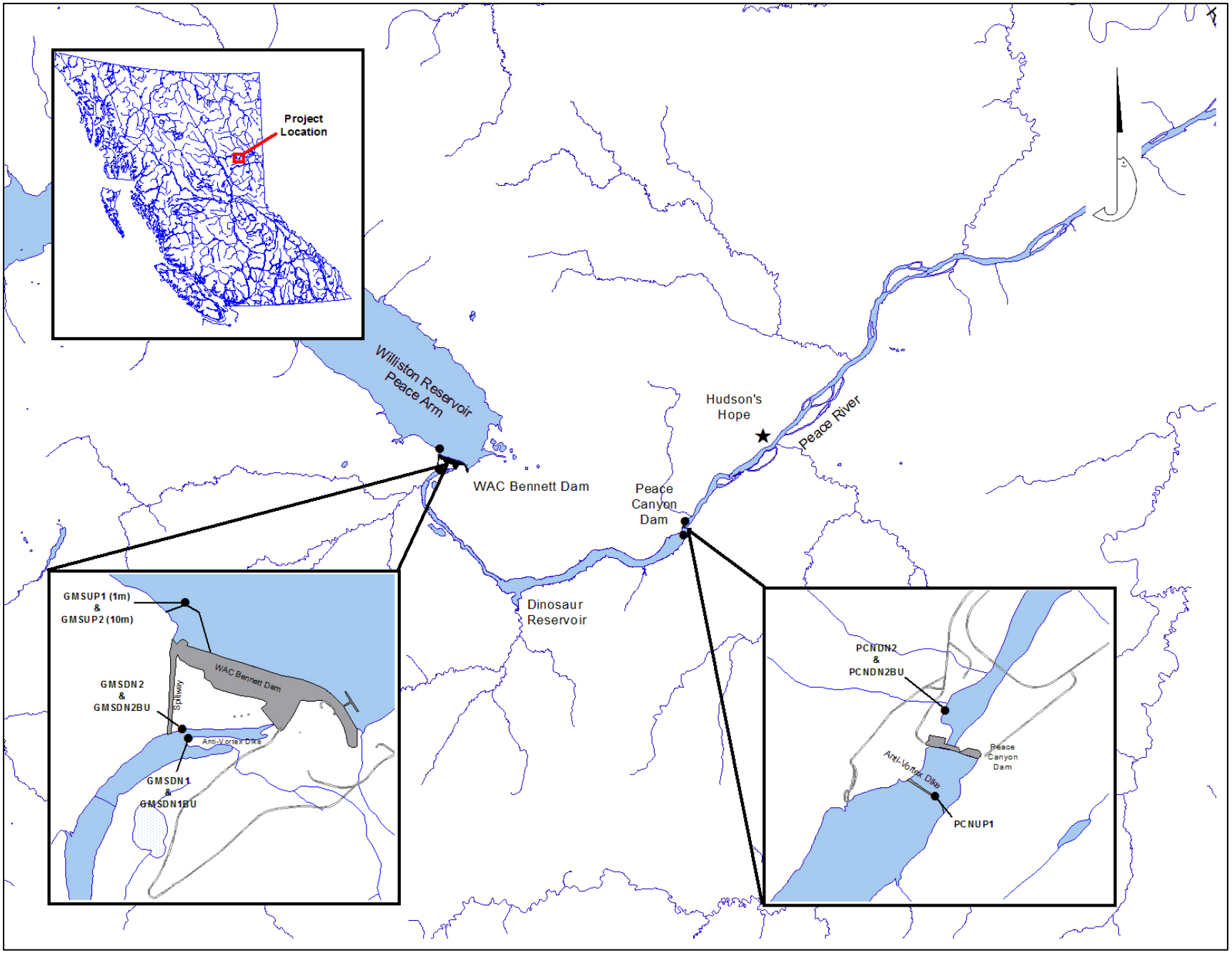

Figure 1. Location of temperature loggers deployed at WAC Bennett Dam and Peace Canyon Dam forebays and tailraces.

Conditions and observations at the time of each download event were documented in the field on hardcopy Download Information Forms and subsequently entered into digital format. *In situ* reference temperatures were recorded at the time of each field download event using a YSI® Professional Plus handheld multi-parameter instrument (Model No. E-528-ProPlus) for comparison to the corresponding hourly logger readings (within 30 minutes of reference temperature).

Data files were exported as .csv files using Onset® Hoboware Pro software (Ver. 3.7.16), amalgamated into single Excel worksheets for monitoring station, and plotted relative to time. Readings representing air temperature during periods of logger stranding above the waterline have been removed from data displayed graphically in this summary report.

2.1.1 Year 13 Site Logistics

No major logistical problems were encountered during Year 13.

2.2 Total Dissolved Gas Pressure (TDGP)

In April 2021, BC Hydro purchased five new HydroLab Model MS5 TGP meters to be dedicated to Peace Basin spill monitoring. These meters replaced much older Common Sensing Model DL6 and Point Four Model PT4 meters, which had proven relatively unreliable during previous spills due to their obsolescence. The 5 new HydroLab Model MS5 TGP meters were stored at the office of Diversified Environmental Services (DES) in a field-ready state during Year 13 and deployed during one 2021 spill event (DES 2022).

3.0 RESULTS AND DISCUSSION

3.1 Temperature Monitoring

Reference temperatures recorded during download events are presented in Appendix II along with corresponding logger temperatures and indicated error values. None of the loggers in use in 2021 exhibited a correctable zero error greater than 0.2°C (mean error 0.08°C; Appendix II).

Two loggers were replaced in Year 13, as they were approaching the end of their predicted lifespan of six years or were recording low voltage readings. Logger serial numbers listed in Appendix I correspond to the units in use at the time of the last quarterly download of 2021 data, completed in January 2022.

A summary of temperature data collection results and related conditions and limitations are discussed in the following sections. Download Information Forms completed during each download are provided in Appendix III.

3.1.1 WAC Bennett Dam Forebay and Tailrace

The WAC Bennett Dam forebay temperature monitoring station is located at the GMS spillway log boom and consists of a vertical cable suspended from the northernmost log boom steel buoy. Temperature is recorded with 2 loggers, the first located at 1 m depth (gmsUP1) and the second at a depth of 10 m (gmsUP2). Seamless water temperature data was recovered from both stations throughout Year 13 (Fig. 2). Although seasonal thermal stratification of Williston Reservoir is evident, the relatively small temperature differential between the 2 station depths suggests the primary thermocline lies deeper than 10 m. Temperature profiles recorded further up the Peace Reach during unrelated work in 2017 and 2018 found the primary seasonal thermocline to be deeper than 20 m (B. Culling, pers. obs.). Maximum temperature differentials recorded during late June and early July 2021 were greater than normal due to record-setting high air temperatures experienced during the same period.

The GMS tailrace monitoring sites are located on opposite banks, approximately 700 m downstream of the turbine outflow manifolds. Logger gmsDN1 records the temperature of water flowing from the south tailrace manifold, which originates from the shallowest penstock depths. Logger gmsDN2 samples water from the north tailrace manifold, which originates from a deeper average withdrawal point. The tethered steel capsule at both stations contains a back-up logger in addition to the primary unit (gmsDN1BU and gmsDN2BU). Continuous data was recovered for both gmsDN1, gmsDN2, and their respective backup loggers, with the exception of brief periods on the afternoons of June 8 and July 23, when the loggers appear to have been exposed to ambient air due to low turbine outflow coupled with very low levels in Dinosaur Reservoir.

As in previous years, water temperatures at gmsDN2 showed the lowest annual variation and are consistently cooler in the summer and warmer in the winter than gmsDN1 flow (Fig. 3), which originates closer to the surface of Williston Reservoir. Temperatures recorded at gmsUP1 (forebay surface) exhibit far greater annual variation than tailrace values (Fig. 3). In addition, the differential between the forebay surface temperature and tailrace temperatures was greater than normal is 2021 due to rapid surface warming in Williston Reservoir during the June/July record heat wave.

3.1.2 Peace Canyon Dam Forebay and Tailrace

The data logger recording temperature at the Peace Canyon Dam forebay (pcnUP1) is attached to the anti-vortex dam log boom, located approximately 450 m upstream of the dam face and records water temperature at 1 m depth. This station recorded seamless data throughout Year 13.

The Peace Canyon Dam tailrace loggers (pcnDN2 and pcnDN2BU) are located on the left downstream bank of the Peace River approximately 200 m downstream of the turbine outflow manifold. The primary and back-up loggers are installed in separate steel capsules on separate tethers anchored to the same bedrock slab. Both loggers recorded continuous data throughout Year 13, however, periodic atypical daily fluctuations from June 1-11 suggest the loggers may have been only partially wetted due to extremely low discharge. Although both loggers became embedded in shifting substrate during the 2021 PCN spill event, temperature readings did not appear to be effected.

A comparison of PCN tailrace temperature (pcnDN2) and GMS tailrace temperature (mean of gmsDN1 and gmsDN2) indicates a relatively small temperature change through Dinosaur Reservoir during all seasons (Fig. 4), with an annual mean differential in hourly readings of 0.5°C. Differential is lowest in fall through winter when turbine discharge, and thus, reservoir exchange rate, are typically highest. Conversely, temperature differentials across Dinosaur Reservoir were wider in June through August particularly when periods of hot weather coincide with decreased discharge and exchange rate. The reservoir warming effects of record-setting temperatures in late June and early July 2021 appear to have been mitigated by elevated discharge associated with the coinciding 2021 spill event.

Figures 5 compares daily mean temperature of water entering Dinosaur Reservoir (Bennett Dam tailrace gmsDN2) during 2021 with the average of daily mean water temperature for the previous 12 years (2009-2020). Water temperatures recorded in the WAC Bennett Dam tailrace in 2021 show some deviations from the 12-year average. Temperatures appeared cooler than average during June and July and significantly warmer than average in August and September. Variability in tailrace temperature is largely due to operational factors at the GMS generating station and may include variations in reservoir elevation and changes in volume contribution from penstock intake depths intervals. It is assumed that accelerated warming of Williston Reservoir during the June/July 2021 heat wave also contributed to higher than average GMS outflow temperatures during the following 2 months.

4.0 RECOMMENDATIONS

The battery life of the Tidbit v2 Model #UTBI-001 temperature sensors is estimated at approximately 5-6 years. Scheduled replacement of units should continue in 2022 (Appendix IV).

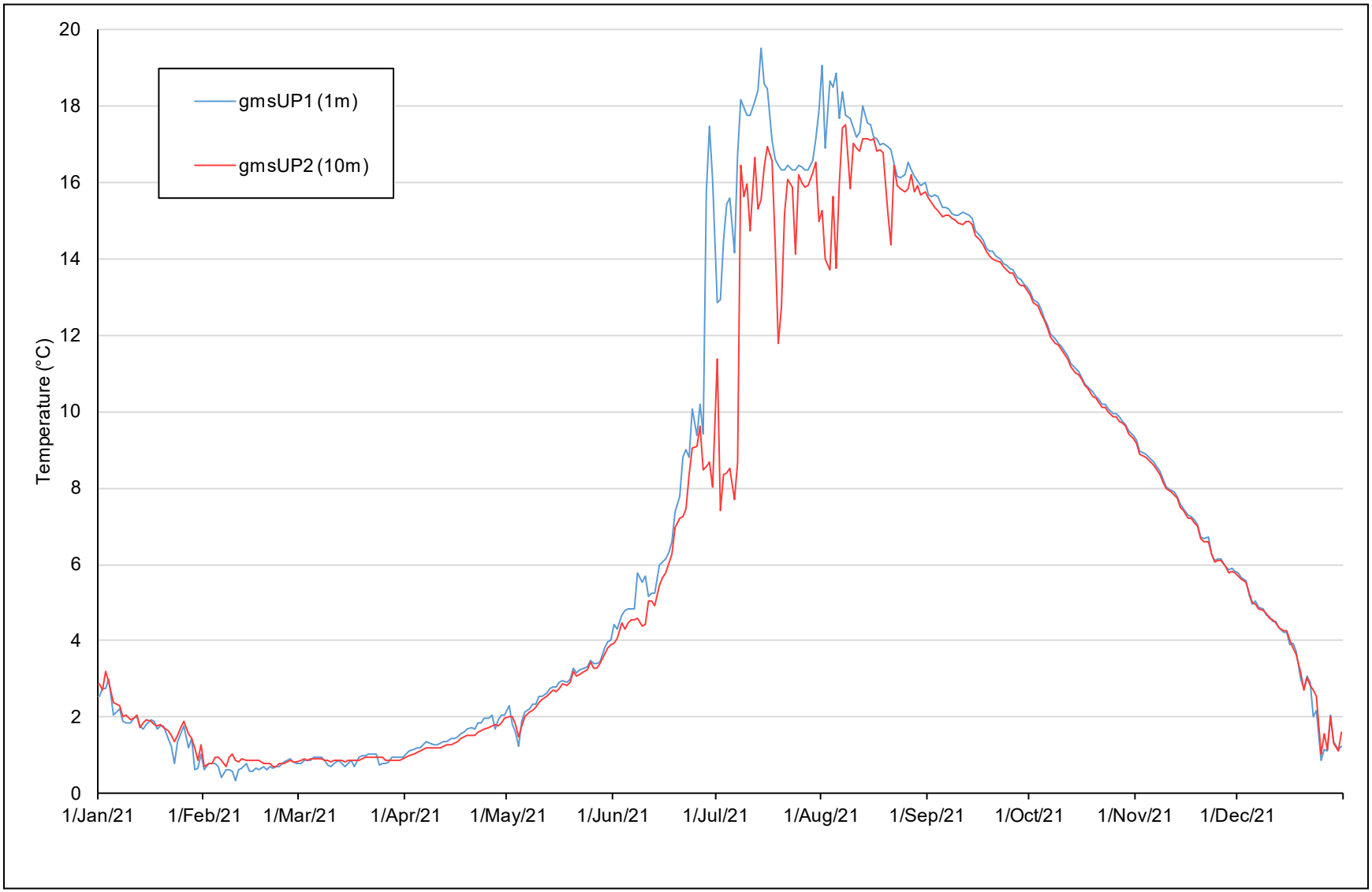

Figure 2. Comparison of daily mean water temperature at WAC Bennett Dam forebay station from 1 m depth (gmsUP1) and 10 m depth (gmsUP2) during Year 13, January 01, 2021 – December 31, 2021.

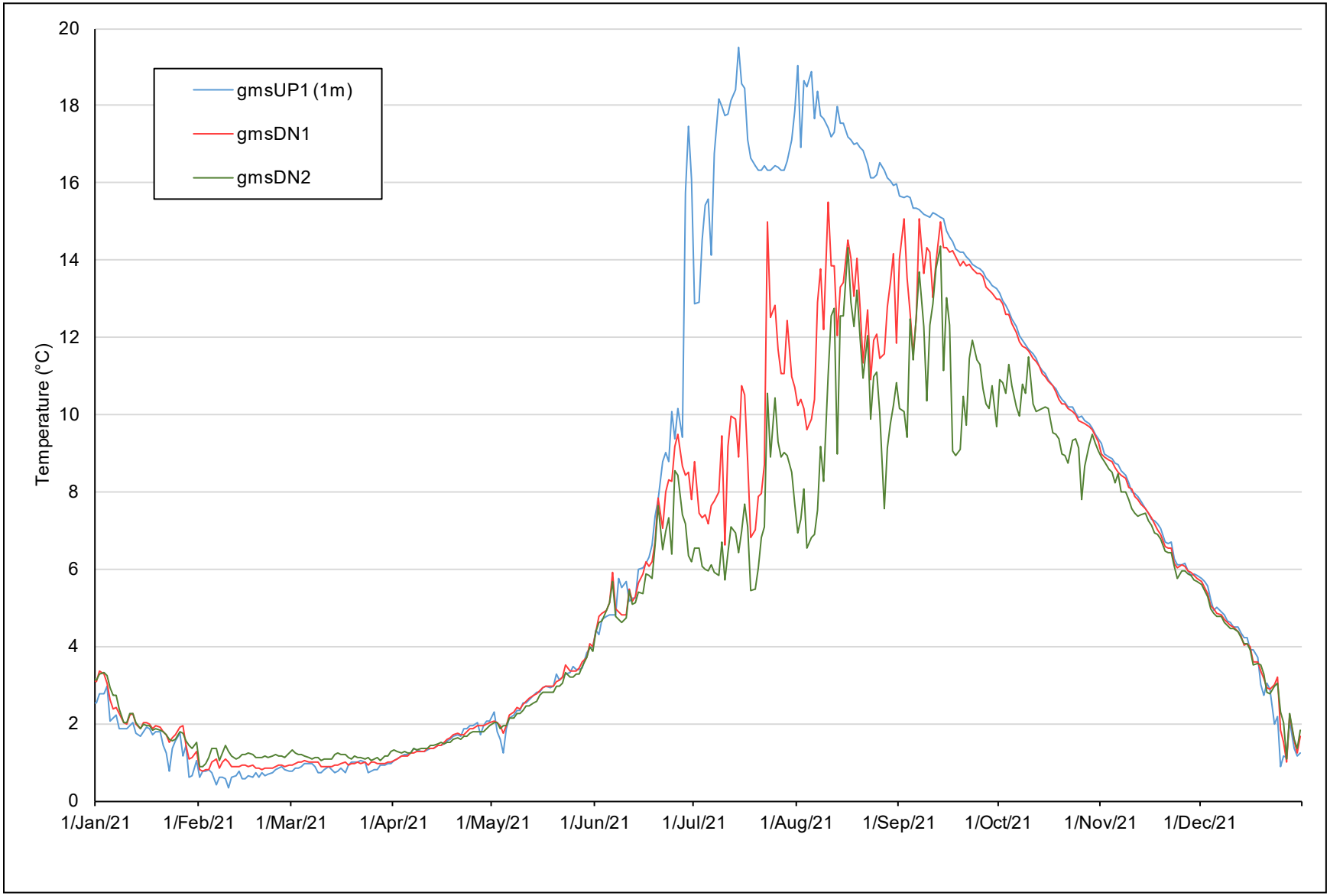

Figure 3. Comparison of daily mean water temperature at WAC Bennett Dam forebay surface (gmsUP1), and WAC Bennett Dam tailrace (gmsDN1 and gmsDN2) during Year 13, January 01, 2021 – December 31, 2021.

Figure 4. Comparison of daily mean water temperature at Peace Canyon forebay surface (pcnUP1), Peace Canyon tailrace (pcnDN2), and WAC Bennett Dam tailrace (gmsDN-MEAN) during Year 11, January 01, 2021 – December 31, 2021.

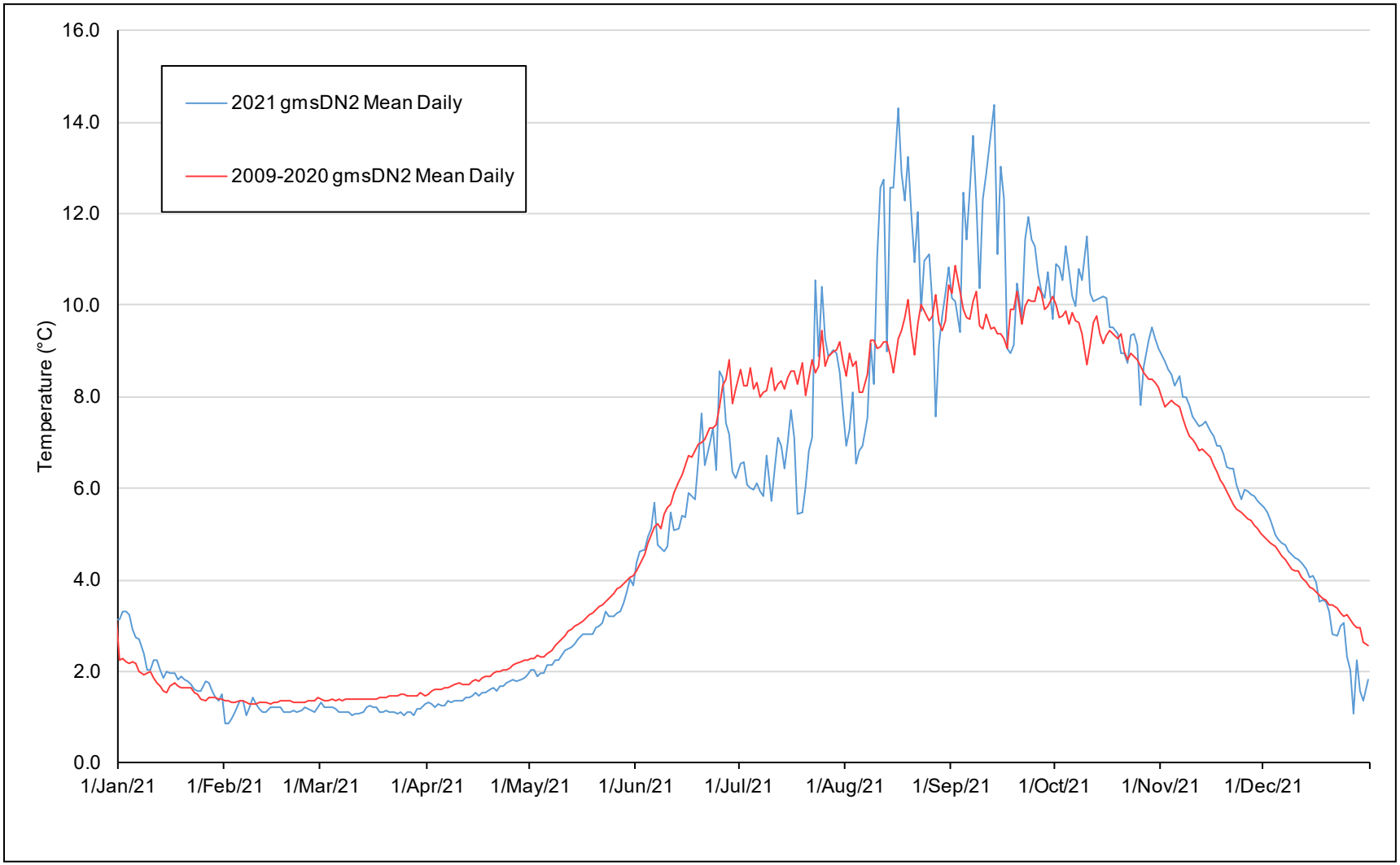

Figure 5. Comparison of Year 13 (2021) daily mean water temperature at WAC Bennett Dam tailrace north manifold (gmsDN2) with 2009 to 2020 daily mean water temperature (gmsDN2).

REFERENCES

BC Hydro. 2010. Peace River Water Use Plan; monitoring program terms of reference – Peace River Baseline TGP/Temp. BC Hydro, Vancouver, BC. 7pp.

DES (Diversified Environmental Services). 2022. Peace River Water Use Plan Peace River Spill Total Dissolved Gas Pressure/Temperature Monitoring Program – June/July 2021. Prepared for BC Hydro, 6911 Southpoint Drive, Burnaby, BC

Appendix I. Temperature monitoring station location information for Year 13, January 01, 2021 to December 31, 2021 (updated as of Jan 2022).

Site ID	Serial #	Location	UTM (Zone 10) East	UTM (Zone 10) North	Comment
gmsUP1	20823636	WAC Bennett Forebay	548841	6209022	steel buoy; 1 m depth
gmsUP2	20823637	WAC Bennett Forebay	548841	6209022	steel buoy; 10 m depth
gmsDN1	20655136	GMS Tailrace	548881	6207761	southbank; deflection wier riprap
gmsDN1BU	10676155	GMS Tailrace	548881	6207761	southbank; deflection wier riprap
gmsDN2	21199346	GMS Tailrace	548828	6207836	north bank; riprap below Tunnel portal #3
gmsDN2BU	20332121	GMS Tailrace	548828	6207836	north bank; riprap below Tunnel portal #3
pcnUP1	20823638	Peace Canyon Forebay	562710	6204068	anti-vortex log boom; 1 m depth
pcnDN2	20332187	Peace Canyon Tailrace	562803	6204854	north bank; rock slab
pcnDN2BU	21199347	Peace Canyon Tailrace	562803	6204854	north bank; rock slab

Appendix II. Reference temperature values and corresponding logger fix values recorded during download events in Year 13, January 01, 2021 to December 31, 2021.

Logger ID	Date	Fix Temp	Ref Temp	Error
gmsUP1	23-Feb-21	0.7	0.6	0.1
	29-Jun-21	13.8	14.0	-0.2
	19-Oct-21	10.5	10.4	-0.1
gmsUP2	23-Feb-21	0.8	0.7	0.1
	29-Jun-21	8.4	8.5	-0.1
	19-Oct-21	10.4	10.4	0.0
gmsDN1	23-Feb-21	0.9	0.8	0.1
	29-Jun-21	8.5	8.7	-0.2
	19-Oct-21	10.4	10.3	0.1
gmsDN1_BU	23-Feb-21	0.9	0.8	0.1
	29-Jun-21	8.5	8.7	-0.2
	19-Oct-21	10.4	10.3	0.1
gmsDN2	23-Feb-21	1.2	1.3	-0.1
	29-Jun-21	6.5	6.6	-0.1
	19-Oct-21	9.4	9.3	0.1
gmsDN2_BU	23-Feb-21	1.3	1.2	0.1
	29-Jun-21	6.6	6.6	0.0
	19-Oct-21	9.5	9.4	0.1
pcnUP1	23-Feb-21	0.9	1.1	-0.2
	29-Jun-21	8.7	8.7	0.0
	19-Oct-21	10.1	10.3	-0.2
pcnDN2	23-Feb-21	1.0	1.0	0.0
	29-Jun-21	8.7	8.7	0.0
	19-Oct-21	10.1	10.1	0.0
pcnDN2_BU	23-Feb-21	1.0	1.0	0.0
	29-Jun-21	8.7	8.7	0.0
	19-Oct-21	10.1	10.1	0.0

Appendix III. Year 13 download information forms, January 01, 2021 to December 31, 2021.

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	gmsUP1		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823636				**UTM**	548841	6209022	
DOWNLOAD DATE	23	Feb 2021	**DOWNLOAD TIME**	13:42				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	0.6	**AIR TEMP**	2.0		**ICE CONDITIONS**	60 cm		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#51											

SITE ID	gmsUP2		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823637				**UTM**	548841	6209022	
DOWNLOAD DATE	23	Feb 2021	**DOWNLOAD TIME**	13:39				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	0.7	**AIR TEMP**	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	10	m	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#52											

SITE ID	gmsDN2		**LOCATION**	GMS Tailrace RDB				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10669739				**UTM**	548828	6207836	
DOWNLOAD DATE	23	Feb 2021	**DOWNLOAD TIME**	12:37				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	1.3	AIR TEMP	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	200	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Primary Logger - Replac#11, SN 10669739											
Back-up logger gmsDN2BU in same capsule; Replac#37, SN 20332121 downloaded @ 12:37											
Both downloads OK											
cable OK (stainless steel cable section attached to galvanized cable around rock)											

SITE ID	gmsDN1		**LOCATION**	GMS Tailrace LDB				**BANK**	south		
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20655136				**UTM**	548881	6207761	
DOWNLOAD DATE	23	Feb 2021	**DOWNLOAD TIME**	12:54				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	0.8	**AIR TEMP**	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	200	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Primary logger - Replac#47 (SN 20655136) - Download OK											
Back-up logger gmsDN1BU in same capsule; Replac#19, SN 10676155; Downloaded OK @ 12:56											

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	pcnUP1		**LOCATION**	PCN Forebay				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20332186				**UTM**	562684	6204075	
DOWNLOAD DATE	23	Feb 2021	**DOWNLOAD TIME**	11:27				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	1.1	**AIR TEMP**	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	log boom	
COMMENTS											
dow nload OK											
stainless steel cable OK											
Replac#42											

SITE ID	pcnDN2		**LOCATION**	PCN Tailrace				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10156319				**UTM**	562803	6204854	
DOWNLOAD DATE	23	Feb 2021	**DOWNLOAD TIME**	11:08				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	1.0	**AIR TEMP**	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	rock	
COMMENTS											
Dow nload OK											
Replac#1											

SITE ID	pcnDN2_BU		**LOCATION**	PCN Tailrace				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10635061				**UTM**	562803	6204854	
DOWNLOAD DATE	23	Feb 2021	**DOWNLOAD TIME**	11:08				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	1.0	**AIR TEMP**	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	rock	
COMMENTS											
Dow nload OK											
Anchored to same rock as pcnDN2											
Replac#9											

SITE ID			**LOCATION**					**BANK**			
LOGGER TYPE			**LOGGER SERIAL #**					**UTM**			
DOWNLOAD DATE			**DOWNLOAD TIME**					**CREW**			
TEST RECORDER TYPE			**WATER TEMP**		**AIR TEMP**			**ICE CONDITIONS**			
LOGGER CONDITIONS											
WATER DEPTH		cm	**DISLODGED**			**REASON**					
BURIED			**FUNCTIONAL**			**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**		
COMMENTS											

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	gmsUP1		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823636				**UTM**	548841	6209022	
DOWNLOAD DATE	29	Jun 2021	**DOWNLOAD TIME**	8:51				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	14.0	**AIR TEMP**	25.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#51											

SITE ID	gmsUP2		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823637				**UTM**	548841	6209022	
DOWNLOAD DATE	29	Jun 2021	**DOWNLOAD TIME**	8:48				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	8.5	**AIR TEMP**	25.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	10	m	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#52											

SITE ID	gmsDN2		**LOCATION**	GMS Tailrace RDB				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10669739				**UTM**	548828	6207836	
DOWNLOAD DATE	29	Jun 2021	**DOWNLOAD TIME**	10:40				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	6.6	AIR TEMP	25.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	120	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	rock	
COMMENTS											
Primary Logger - Replac#11, SN 10669739											
Back-up logger gmsDN2BU in same capsule; Replac#37, SN 20332121 downloaded @ 10:40											
Both downloads OK											
cable OK (stainless steel cable section attached to galvanized cable around rock)											

SITE ID	gmsDN1		**LOCATION**	GMS Tailrace LDB				**BANK**	south		
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20655136				**UTM**	548881	6207761	
DOWNLOAD DATE	29	Jun 2021	**DOWNLOAD TIME**	11:36				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	8.7	**AIR TEMP**	25.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	120	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	rock	
COMMENTS											
Primary logger - Replac#47 (SN 20655136) - Download OK											
Back-up logger gmsDN1BU in same capsule; Replac#19, SN 10676155 downloaded @ 11:37											
Both downloads OK											
cable OK											

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	pcnUP1		**LOCATION**	PCN Forebay			**BANK**		north		
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20332186			**UTM**	562684	6204075		
DOWNLOAD DATE	29	Jun 2021	**DOWNLOAD TIME**	14:21			**CREW**	BC TE			
TEST RECORDER TYPE	YSI		**WATER TEMP**	8.7	**AIR TEMP**	36.0	**ICE CONDITIONS**	none			
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	log boom	
COMMENTS											
dow nload OK											
stainless steel cable OK											
Replac#42											

SITE ID	pcnDN2		**LOCATION**	PCN Tailrace			**BANK**		north		
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10156319			**UTM**	562803	6204854		
DOWNLOAD DATE	29	Jun 2021	**DOWNLOAD TIME**	13:22			**CREW**	BC TE			
TEST RECORDER TYPE	YSI		**WATER TEMP**	8.7	**AIR TEMP**	36.0	**ICE CONDITIONS**	none			
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Dow nload initially failed, then OK; logger 10156319 (RPL#1) replaced w ith 20332187 (Replc#43).											

SITE ID	pcnDN2_BU		**LOCATION**	PCN Tailrace			**BANK**		north		
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10635061			**UTM**	562803	6204854		
DOWNLOAD DATE	29	Jun 2021	**DOWNLOAD TIME**	13:21			**CREW**	BC TE			
TEST RECORDER TYPE	YSI		**WATER TEMP**	8.7	**AIR TEMP**	36.0	**ICE CONDITIONS**	none			
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Dow nload OK											
Anchored to same rock as pcnDN2											
Replac#9											

SITE ID			**LOCATION**				**BANK**				
LOGGER TYPE			**LOGGER SERIAL #**				**UTM**				
DOWNLOAD DATE			**DOWNLOAD TIME**				**CREW**				
TEST RECORDER TYPE			**WATER TEMP**		**AIR TEMP**		**ICE CONDITIONS**				
LOGGER CONDITIONS											
WATER DEPTH		cm	**DISLODGED**			**REASON**					
BURIED			**FUNCTIONAL**			**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE		
COMMENTS											

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	gmsUP1		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823636				**UTM**	548841	6209022	
DOWNLOAD DATE	19	Oct 2021	**DOWNLOAD TIME**	11:01				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	10.4	**AIR TEMP**	-2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#51											

SITE ID	gmsUP2		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823637				**UTM**	548841	6209022	
DOWNLOAD DATE	19	Oct 2021	**DOWNLOAD TIME**	11:04				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	10.4	**AIR TEMP**	-2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	10	m	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#52											

SITE ID	gmsDN2		**LOCATION**	GMS Tailrace RDB				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10669739				**UTM**	548828	6207836	
DOWNLOAD DATE	19	Oct 2021	**DOWNLOAD TIME**	11:39				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	9.4	AIR TEMP	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	120	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	rock	
COMMENTS											
Primary Logger - Replac#11, SN 10669739											
Back-up logger gmsDN2BU in same capsule; Replac#37, SN 20332121 downloaded @ 11:37											
Both downloads OK											
cable OK (stainless steel cable section attached to galvanized cable around rock)											

SITE ID	gmsDN1		**LOCATION**	GMS Tailrace LDB				**BANK**	south		
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20655136				**UTM**	548881	6207761	
DOWNLOAD DATE	19	Oct 2021	**DOWNLOAD TIME**	11:59				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	10.3	**AIR TEMP**	2.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	120	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	**TETHER TYPE**	rock	
COMMENTS											
Primary logger - Replac#47 (SN 20655136)											
Back-up logger gmsDN1BU in same capsule; Replac#19, SN 10676155 downloaded @ 12:00											
Both downloads OK											
cable OK											

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	pcnUP1		**LOCATION**	PCN Forebay				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20332186				**UTM**	562684	6204075	
DOWNLOAD DATE	19	Oct 2021	**DOWNLOAD TIME**	12:50				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	10.3	**AIR TEMP**	4.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	log boom	
COMMENTS											
dow nload initially failed but data recovered.											
Logger 20332186 (Replc#42) replaced w ith 20823638 (Replc#53).											
stainless steel cable OK											

SITE ID	pcnDN2		**LOCATION**	PCN Tailrace				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20332187				**UTM**	562803	6204854	
DOWNLOAD DATE	19	Oct 2021	**DOWNLOAD TIME**	13:16				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	10.1	**AIR TEMP**	4.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Dow nload OK											
Replc#43											

SITE ID	pcnDN2_BU		**LOCATION**	PCN Tailrace				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10635061				**UTM**	562803	6204854	
DOWNLOAD DATE	19	Oct 2021	**DOWNLOAD TIME**	13:18				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	10.1	**AIR TEMP**	4.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Dow nload OK											
Anchored to same rock as pcnDN2											
Replac#9											

SITE ID			**LOCATION**					**BANK**			
LOGGER TYPE			**LOGGER SERIAL #**					**UTM**			
DOWNLOAD DATE			**DOWNLOAD TIME**					**CREW**			
TEST RECORDER TYPE			**WATER TEMP**		**AIR TEMP**			**ICE CONDITIONS**			
LOGGER CONDITIONS											
WATER DEPTH		cm	**DISLODGED**			**REASON**					
BURIED			**FUNCTIONAL**			**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE		
COMMENTS											

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	gmsUP1		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823636				**UTM**	548841	6209022	
DOWNLOAD DATE	20	Jan 2022	**DOWNLOAD TIME**	12:03				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	0.6	**AIR TEMP**	6.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#51											

SITE ID	gmsUP2		**LOCATION**	GMS Forebay				**BANK**			
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20823637				**UTM**	548841	6209022	
DOWNLOAD DATE	20	Jan 2022	**DOWNLOAD TIME**	12:03				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	1.1	**AIR TEMP**	6.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	10	m	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	steel buoy	
COMMENTS											
Download OK											
Stainless steel cable OK											
Replac#52											

SITE ID	gmsDN2		**LOCATION**	GMS Tailrace RDB				**BANK**		north	
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	10669739				**UTM**	548828	6207836	
DOWNLOAD DATE	20	Jan 2022	**DOWNLOAD TIME**	13:05				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	1.6	AIR TEMP	6.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Primary Logger 10669739 (Replac#11) replaced with 21199346 (Replc#54)											
Back-up logger gmsDN2BU in same capsule; Replac#37, SN 20332121 downloaded @ 13:04											
Both downloads OK											
Repalced corroaded capsule											
cable OK (stainless steel cable section attached to galvanized cable around rock)											

SITE ID	gmsDN1		**LOCATION**	GMS Tailrace LDB				**BANK**	south		
LOGGER TYPE	Tidbit		**LOGGER SERIAL #**	20655136				**UTM**	548881	6207761	
DOWNLOAD DATE	20	Jan 2022	**DOWNLOAD TIME**	13:35				**CREW**	BC TE		
TEST RECORDER TYPE	YSI		**WATER TEMP**	1.2	**AIR TEMP**	6.0		**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	150	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Primary logger - Replac#47 (SN 20655136)											
Back-up logger gmsDN1BU in same capsule; Replac#19, SN 10676155 downloaded @ 13:35											
Both downloads OK											
cable OK											

BC HYDRO PEACE RIVER TEMPERATURE MONITORING - DOWNLOAD INFORMATION FORM

SITE ID	pcnUP1	**LOCATION**	PCN Forebay					**BANK**		north	
LOGGER TYPE	Tidbit	**LOGGER SERIAL #**	20823638					**UTM**	562684	6204075	
DOWNLOAD DATE	20	Jan	2022	**DOWNLOAD TIME**	14:36			**CREW**	BC TE		
TEST RECORDER TYPE	YSI	**WATER TEMP**	1.2	AIR TEMP	6.0			**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	log boom	
COMMENTS											
Download OK											
Replc#53											
stainless steel cable OK											
Change steel capsule next download											

SITE ID	pcnDN2	**LOCATION**	PCN Tailrace					**BANK**		north	
LOGGER TYPE	Tidbit	**LOGGER SERIAL #**	20332187					**UTM**	562803	6204854	
DOWNLOAD DATE	20	Jan	2022	**DOWNLOAD TIME**	14:55			**CREW**	BC TE		
TEST RECORDER TYPE	YSI	**WATER TEMP**	1.3	**AIR TEMP**	6.0			**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Download OK											
Replc#43											
Change steel capsule next download											

SITE ID	pcnDN2_BU	**LOCATION**	PCN Tailrace					**BANK**		north	
LOGGER TYPE	Tidbit	**LOGGER SERIAL #**	10635061					**UTM**	562803	6204854	
DOWNLOAD DATE	20	Jan	2022	**DOWNLOAD TIME**	15:00			**CREW**	BC TE		
TEST RECORDER TYPE	YSI	**WATER TEMP**	1.3	**AIR TEMP**	6.0			**ICE CONDITIONS**	none		
LOGGER CONDITIONS											
WATER DEPTH	100	cm	**DISLODGED**	no		**REASON**					
BURIED	no		**FUNCTIONAL**	wet		**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE	rock	
COMMENTS											
Download OK											
Logger 10635061 (RPL#9) replaced with 21199347 (Replc#55).											
Anchored to same rock as pcnDN2											
Change steel capsule next download											

SITE ID		**LOCATION**						**BANK**			
LOGGER TYPE		**LOGGER SERIAL #**						**UTM**			
DOWNLOAD DATE				**DOWNLOAD TIME**				**CREW**			
TEST RECORDER TYPE		**WATER TEMP**		AIR TEMP				**ICE CONDITIONS**			
LOGGER CONDITIONS											
WATER DEPTH		cm	**DISLODGED**			**REASON**					
BURIED			**FUNCTIONAL**			**IF DRY, HEIGHT ABOVE WATER**		cm	TETHER TYPE		
COMMENTS											

Appendix IV. Summary of temperature logger deployment dates and anticipated replacement dates.

Site ID	Serial #	Location	Date Deployed	Replace Date
gmsUP1	20823636	WAC Bennett Forebay	Nov 2020	2026
gmsUP2	20823637	WAC Bennett Forebay	Nov 2020	2026
gmsDN1	20655136	GMS Tailrace	Feb 2020	2026
gmsDN1BU	10676155	GMS Tailrace	Feb 2020	2026
gmsDN2	21199346	GMS Tailrace	Jan 2022	2028
gmsDN2BU	20332121	GMS Tailrace	Jul 2018	2024
pcnUP1	20823638	Peace Canyon Forebay	Oct 2021	2027
pcnDN2	20332187	Peace Canyon Tailrace	Feb 2020	2026
pcnDN2BU	21199347	Peace Canyon Tailrace	Jan 2022	2028