Acid Rock Drainage and Metal Leachate Management Plan – Water Quality Annual Report: January 1 to December 31, 2020

Site C Clean Energy Project

March 31, 2021

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Acronyms

ABA	acid base accounting
AFDE	Aecon, Flatiron, Dragados, and EBC
ARD/ML	acid rock drainage/metal leaching (or leachate)
BCWQG	British Columbia Water Quality Guidelines for Protection of Aquatic Life
CEMP	construction environmental management plan
CVC	conventional vibrated concrete
DOC	diversion outlet cofferdam
DTIP	diversion tunnel inlet portal
DTOP	diversion tunnel outlet portal
EAC	Environmental Assessment Certificate
EOP	end of pipe (in relation to discharge limits)
EPP	environmental protection plan
IDZ	initial dilution zone
IEM	Independent Environmental Monitor
LB	left bank (of the Peace River, when facing downstream)
LBCD	left bank cofferdam
LBDA	left bank draiange adit
LBDT	left bank drainage tunnel
LBEX	left bank excavation
MCW	main civil works
MWTF	mobile water treatment facility
Non-PAG/NPAG	non-potentially acid generating
PAG	potentially acid generating
PRHP	Peace River Hydro Partners
RB	right bank (of the Peace River, when facing downstream)
RBDT	right bank drainage tunnel
RCC	roller compacted concrete
RSEM	relocated surplus excavated materials (area)
SBIAR	south bank initial access road
TSS	total suspended solids
QP	Qualified Professional

1. ACID ROCK DRAINAGE AND METAL LEACHATE MANAGEMENT PLAN

1.1 Background and Reporting Requirements

The Acid Rock Drainage and Metal Leachate Monitoring Plan has been developed in accordance with the following regulatory conditions:

- Condition 7 of the Site C Project's Federal Decision Statement, issued to BC Hydro on October 14, 2014 and re-issued November 25, 2014, which requires BC Hydro to:
- "…develop, in consultation with Environment Canada and Natural Resources Canada, a water quality management plan to address environmental effects to the aquatic environment from the Designated Project, including acid rock drainage and metal leaching."
- Condition 3 of the Site C Project's Environmental Assessment Certificate, (EAC #E14-02), issued to BC Hydro on October 14, 2014, which requires BC Hydro to:
- "…. develop a water quality monitoring program, [which] must be detailed in the Acid Rock Drainage and Metal Leachate Management Plan."

The Site C Project's Construction Environmental Management Plan (CEMP; Revision 7 dated September 4, 2020), Appendix E – Acid Rock Drainage and Metal Leachate Management Plan fulfills the requirements of the water quality management plan referenced in the above conditions.

This update satisfies the annual reporting requirements specified by these conditions, covering the reporting period from January 1 to December 31, 2020.

2. OVERVIEW OF SITE ACTIVITIES IN 2020

2.1 General Description of Site Activities

Site C construction activities continued through 2020, the fifth full year of construction that was initiated in July 2015 and is scheduled to be completed in 2025.

Major construction activities conducted as part of the Site C Clean Energy Project in 2020 involving ground disturbance included site preparation and construction of access roads, construction management of relocated surplus excavated materials (RSEM) management facilities, excavations on both banks of the river, construction of water conveyance and containment structures, off dam site highway segment construction, quarry operations, and commencement of shoreline protection works at Hudson's Hope. A major project milestone in 2020 was the completion of the excavation of twin diversion tunnels on the Left Bank, and the diversion of the Peace River through these tunnels as scheduled in Q3. The isolated section of the river channel will be dewatered, the dam core will be placed and compacted, and once the dam core is in place, the dam, generating station, and spillways will be completed.

The water quality monitoring programs that have been implemented on site by BC Hydro and their contractors have been developed to fulfill requirements of the CEMP within the water conveyance structures, RSEM facilities, and within the Peace River. The focus of this report is the Site C dam site, as that is where the vast majority of Potentially Acid Generating (PAG) shale exposures occur.

Bedrock material (including weathered bedrock, and colluvium) underlying the dam site is characterized to be PAG, with most stratigraphic units expected to become acidic within one year of being exposed to the atmosphere. Environmental management protocols are implemented in all construction areas by BC Hydro to prevent or mitigate the development of acid rock drainage and metal leaching (ARD/ML) conditions. Overburden and soil materials are not potentially acid generating (Non-PAG) and are not managed the same as excavated PAG materials at the Dam Site. Rock sampling is conducted on PAG materials to evaluate if the material is acid-generating (AG).

Each construction area is required to have a BC Hydro approved environmental protection plan (EPP) which describes ARD/ML mitigation and management plans relevant to the site work as per the CEMP Appendix E. A chance find procedure is included in the EPP document where exposure or disturbance of bedrock is not anticipated as part of the construction activities. As of December 31, 2020 (cumulatively since the start of project construction), 1,421 EPPs (including revisions) have been reviewed by BC Hydro covering all contractors and scopes of work. In the calendar year 2020, 357 of these EPPs (including revisions) were submitted to and reviewed by BC Hydro). Implementation of these plans is the responsibility of site contractors, and is overseen by BC Hydro, the Independent Environmental Monitor (IEM) and ARD/ML Qualified Professionals (QPs).

The location of construction areas and water management structures relevant to ARD/ML material management are described below and are shown on Figure 1 (dam site) and Figure 2 (off dam site). On the dam site, the areas are categorized per their location on the Right (south) Bank or Left (north) Bank of the Peace River, and are listed by excavation site, followed by permanent storage facility. Complete details of the site activities related to ARD/ML, including material excavation, placement, mitigation and monitoring programs should be referenced in the attached appendices.

The water management system is continuously adapted as earthworks are undertaken, and generally utilizes a series of one or more conveyance and holding structures, including ditches, sumps, and settling ponds. Ultimately, the majority of PAG contact water is diverted to one of five RSEM sediment pond facilities for discharge to the Peace River. Higher risk water is directed through the Mobile Water Treatment Facility (MWTF) for treatment prior to discharge to an RSEM sediment pond. The active PAG-contact sediment ponds on the dam site are as follows:

- RSEM R5A;
- RSEM R5B;
- RSEM R6;
- RSEM L5; and

- RSEM L6.

On the dam site, bedrock material excavation and disposal during 2020 totalled 419,000 m^3, including approximately 200,000 m^3 on the Left Bank primarily from the Central Cofferdam and approximately 219,000 m^3 on the Right Bank primarily from the Spillway Approach Channel and Dam and Core Buttress.

Most of the material excavated on the Left Bank was placed in RSEM Area L5, including the L5 Extension and RSEM Area L5 Starter Dyke, and relatively minor amounts were placed in L5 Garbage Creek and RSEM Area L6. All material on the Right Bank was placed in RSEM Area R5A.

2.2 ARD/ML Mitigation Hierarchy

Mitigation measures implemented to minimize exceedances of discharge limits due to ARD/ML include material management (e.g. excavating or covering bedrock exposure), water management to contain water that may be influenced by ARD/ML, and water treatment to neutralize pH and remove total and dissolved metals.

The primary mitigation strategy for ARD/ML is material management to limit exposure of AG material and the generation of PAG contact water. Monitoring of weathered material becoming acidic due to exposure for several months determines when mitigation is required, in addition to monitoring of material placed in RSEM disposal areas and weathered material covered with recently excavated bedrock or overburden. In 2020, a total of 246 samples were collected for rinse pH analysis from various locations on the Left and Right Banks of the dam site as an effective program for identifying the onset of ARD/ML and to identify areas where mitigation may be required. Of these, 10% of the samples underwent more extensive geochemical testing including Acid Base Accounting (ABA) and metals analysis. Throughout the year, weathered PAG material was excavated or covered to minimize potential ARD/ML(e.g. the lower slopes of RSEM Area L5, L5 Extension and RSEM Area R5A were graded to design configuration with the placement of the final non-PAG cover layer which reduced the PAG-exposed area in both storage facilities).

The secondary mitigation strategy is water management, including diversion of non-contact runoff from above the project to around the construction site and retaining as much contact water as possible within the site. Water that must be released is directed to RSEM sediment control ponds from where it is discharged to the Peace River.

The tertiary mitigation strategy is water treatment, wherein contact water not anticipated to meet end of pipe (EOP) discharge limits is conveyed to the MWTF which was commissioned in mid-2018 on the Right Bank near the west end of the Approach Channel. Water requiring treatment was transferred to a Pre-Treatment pond for treatment by the MWTF prior to discharge via the RSEM Area R5B sediment pond. The MWTF was relocated in May 2020 to the RSEM R6 Area with discharge directed to the RSEM R6W sediment pond.

2.3 Dam Site Activities Related to PAG Material Management

2.3.1 Right Bank PAG Material Management

Acid-Generating material was identified in the Approach Channel, parts of RSEM Area R5A, exposures within the RSEM Area R5B catchment (777 Haul Road excavation, West Ditch, and ACDC Ditch), along a minor exposure west of RSEM Area R5B, along the South Bank Initial Access Road (SBIAR), and from a small exposure in Area A. No AG samples were collected from the Right Bank Dam Core.

Excavations on the Right Bank of the Site C Project during 2020 amounted to 219,158 m^3 of PAG bedrock. Most of this material was produced from excavations in the Approach Channel and Spillway (144,417 m^3) and Dam and Core Buttress and Core Trench (68,817 m^3). See Appendix A for full breakdown of excavation volumes from different locations.

Most of the material excavated in 2020 on the Right Bank was deposited in RSEM R5A which, at the end of 2020, contained 5,456,423 m^3 of PAG rock. Material deposition at RSEM R5A Starter Dyke commenced in Q2 2020, and this area contained 57,232 m^3 by end of 2020. The PAG material previously deposited in RSEM R5B remains covered by NPAG material. No additional PAG was placed in this RSEM in 2020.

A total volume of just over 700,000 m^3 of water was discharged from the Right Bank in 2020. A total of over 617,000 m^3 of water was discharged from the RSEM R6E and R6W ponds in 2020. This included roughly 346,000 m^3 from the RSEM Area R6 East Sediment Control Pond and roughly 271,000 m^3 from the RSEM Area R6 West Sediment Control Pond (RSEM R6E and RSEM R6W), and just over 86,000 m^3 from the RSEM Area R5B Sediment Control Pond (RSEM R5B). A relatively small volume (a little over 2,500 m^3) was also discharged from the RSEM Area R5A Sediment Control Ponds (RSEM R5A Ponds A to C) for a few days following large rain events in June and July 2020.

Right Bank Core Trench

The core trench excavation is located in the Right Bank Cofferdam. Water from groundwater seepages and PAG and shotcrete contact water runoff that accumulate on the floor of the excavation are collected in the core trench sump. Water from the core trench was briefly directed to the RSEM Area L5 West sediment control pond in late April 2020, during the MWTF relocation, and to the RSEM Area R5B sediment control pond in mid-June following the mid-June precipitation event at the site.

Approach Channel

PAG material was excavated in 2020, exposing fresh PAG surfaces in the central and eastern areas of the Approach Channel.

In 2020, surface runoff, groundwater seepage and PAG-contact waters from the Approach Channel were intercepted and managed with a network of sumps, ditches, baker tanks and active water management (i.e., pumps, hoses and water trucks). PAG-contact water accumulations on the lower Approach benches and at the RBAC Sump, and ARD influenced runoff from PAG exposures in the western Approach Channel area were directed to the MWTF throughout 2020. Groundwater seepage and runoff from the upper Approach Channel bench is generally directed to an RSEM PAG-contact sediment control pond, whereas PAG-contact waters are transferred to the MWTF for treatment.

South Bank Initial Access Road

Between February and March of 2017, a road cut was constructed on the Right Bank to enable two-way haulage and site vehicle access from the upper terrace near Area A and Area 21 down to the floodplain level in RSEM R6. The SBIAR excavation involved removal of approximately 139,000 m^3 of bedrock, and placement of approximately 206,000 m^3 of embankment fill material. The bedrock material was transported to RSEM R5A and runoff water is channelled to RSEM R6. No additional excavation has occurred at SBIAR during 2020.

Routine monitoring of runoff water quality from approximately 12,500 m^2 of exposed bedrock was completed by Tetra Tech on behalf of BC Hydro (Appendix C).

Area 30

Runoff from the stockpiled aggregates accumulate in the Area 30 sediment control pond, located along the northern edge of Area 30 which discharges to the adjacent wetlands through a rip-rap lined channel.

Area A

Area A is located south-east of the dam construction area, and east of SBIAR. Within this area, Non-PAG overburden and aggregate are excavated and transported to the Phase 2 Crusher to produce aggregate that is temporarily stored.

Phase 2 Crusher water is directed to a sludge pond in Area A to settle TSS, and clarified water is recycled within the crusher circuit.

Samples were obtained from ponded water in Area A at the North Ditch and ponded water at the toe of Non-PAG gravel piles. Samples were collected monthly from January to July. Field measurements were collected during this sampling as well as in October and December.

Roller Compacted Concrete Buttress Excavation Area

The Roller Compacted Concrete (RCC) Buttress Excavation area will house the future powerhouse, spillway and related facilities.

In 2020, the RCC area was dewatered to a ditch on the northern edge of the RCC area (Zula Ditch) and to a baker tank. The baker tank was the final collection point for all RCC waters until mid- October when the baker tank was decommissioned for Winter, and the final collection point for water managed by PRHP was shifted to the Zula Ditch. Analytical samples were collected on an approximate weekly basis, and field measurements were regularly collected. The RCC waters were treated with carbon dioxide to reduce pH, as needed (generally slightly alkaline due to cement influence), prior to transfer and discharge through the RSEM R5B, R6 East, or R6 West sediment control ponds

A separate baker tank previously used in 2019 to manage RCC water, contained residual RCC water which was dewatered to RSEM R6 West sediment control pond in 2020.

Conventional Vibrated Concrete Batch Plant

The Conventional Vibrated Concrete (CVC) Batch Plant produces concrete and is located on the northeastern side of Area 21 (part of RSEM R6). A baker tank is located adjacent the plant to collect CVC discharge, which is treated to reduce pH prior to periodic discharge to RSEM R6 East Pond via the SBIAR ditch.

Mobile Water Treatment Facility

From January to April 2020, the MWTF and associated infrastructure were located in the RSEM R5B area catchment., and treated effluent was directed to the RSEM R5B sediment control pond from the Sludge Pond outlet. In late April, the MWTF was relocated to RSEM Area R6, and from May through December, PAG-contact water that required treatment was redirected to the New Pre-treatment Pond established in RSEM Area R6 (the former AK Pond). This water was treated in the relocated MWTF and discharged through a newly constructed Sludge Pond for solids settling and pH adjustment. The final treated effluent was pumped from the new sludge pond outlet to the RSEM R6W sediment control pond. Water treatment was effective throughout 2020.

2.3.2 Right Bank RSEMs

There are three catchment RSEM areas within the construction site on the Right Bank:

- RSEM Area R6 (which includes Area 20/21, the Right Bank Drainage Tunnel [RBDT] and associated facilities to the south, and RCC Buttress Excavation to the west, adjacent to the future power house), as well as Area 23 and the Approach Channel, from which contact water is conveyed to the MWTF, and treated water is discharged from the RSEM Area R6 sediment ponds. This also includes Area A, from which contact water is directed to the North Ditch and transferred to R6 East or R6 West sediment control ponds.
- RSEM Area R5B (which included the Approach Channel until contact water from this area was redirected after the MWTF was relocated to the RSEM-R6 catchment in late May); The RSEM Area R5B sediment pond became obsolete after the MWTF was relocated in late May 2020 and will be decommissioned in 2021. An R5B sump is being constructed to store water from the former RSEM R5B sediment pond catchment. The R5B sump water will be pumped to the MWTF or RSEM R6 sediment pond.
- RSEM Area R5A (which includes the area where the majority of excavated PAG material is being deposited on the west side of the Moberly River), from which contact water is conveyed to the RSEM Area R5A sediment ponds. Water management transitioned in 2020 Q3 from Phase 1 ponds to the Phase 2 ponds that are located at higher elevation within the RSEM area.

Activities within each of the RSEM areas on the Right Bank are discussed below. Water quality monitoring within the RSEM catchment is described by Lorax (Appendix A). Monitoring of water quality associated with the RSEM pond discharges is referenced in Sections 3.1.1 (pond water quality), 3.1.2 (toxicity), and 3.1.3 (Peace River water quality downstream of discharges). Monitoring of the groundwater quality in the RSEM areas is referenced in Section 3.1.4.

RSEM Area R6

The RSEM R6 facility is not permitted for long term storage of PAG material and has only a small short-term storage area for stockpiling of surplus excavated bedrock material from RBDT development. Bedrock material placed in the facility is relocated to RSEM R5A.

The long term RSEM R6 sediment pond was constructed and completed in April 2017 and is permitted to receive some PAG contact water, into one of an eastern or western pond cell depending on water levels and water quality within each cell. Surface water runoff from the south (Area 20/21, SBIAR, and RBDT) and west (RCC Buttress Excavation) is conveyed to the RSEM Area R6 sediment ponds (east and west ponds). Water is pumped between the east and west ponds to provide additional retention time for particulate settling, when needed. Monitoring of the water in the RSEM R6 sediment pond is conducted by daily water quality sampling and through use of continuous data logger probes (pH, turbidity, temperature and conductivity) and instantaneous discharge flow meters (Appendix A)

The monitoring records for the RSEM R6 sediment control ponds indicate these ponds discharged most days in 2020, except during discrete periods in February and March due to freezing conditions, and in May due to low water level.

In 2020, the RSEM R6 East sediment control pond received surface runoff and periodic discharges from the CVC Batch Plant (CVC-BT) via the SBIAR ditch (RSEM-R6-EP-USSD) as well as site waters periodically transferred from Area A North Ditch and the RCC area. The RSEM R6 West sediment control pond received surface runoff and periodic water transfers from water storage facilities across the site depending on management needs, including the Area A North Ditch, Area 21 waters, groundwater seepage from the Approach Channel, and contact water from the RCC area (RCC-NE-SUMP-BT). In early May, the RSEM R6 West pond began receiving MWTF treated effluent and subsequently waters from the RSEM Area R5B catchment that were diverted during Q3.

RSEM Area R5B

The RSEM R5B facility was approved for PAG placement as of July 2016. Construction of the RSEM R5B facility was completed and began receiving PAG in early October 2016. The RSEM R5B sediment became obsolete after the MWTF was relocated in late May 2020, and the RSEM R5B sediment pond was deactivated in early September 2020.

Due to exposed AG bedrock in the RSEM Area R5B catchment associated with natural bedrock exposures and inactive roads, runoff from this area is collected in the R5B Sump and treated, if necessary.

The RSEM storage capacity was reached by the end of 2016, and the facility received only approximately 3,500 m^3 in 2017, with total stored volume of approximately 357,000 m^3. No additional material was stored in this facility after 2017.

Since deactivation of the RSEM R5B sediment control pond early September 2020, all previous inflows have been redirected to the RSEM R6 sediment control ponds. Since July, PAG influenced runoff from PAG exposures in the western extent of the Approach Channel have been intercepted at R5B West Ditch by a sump and were periodically transferred to the MWTF. Water management within RSEM Area R5B catchment will transition to the Phase 2 R5B Sump located upslope from the RSEM R5B sediment control pond. Construction of the Phase 2 R5B Sump and conveyance ditches commenced in Q4 2020. Commissioning of the Phase 2 R5B Sump (which will convey water on to the RSEM R6 sediment pond, rather than directly to the Peace River) is anticipated to occur in 2021, at which point the RSEM R5B sediment control pond will be decommissioned and backfilled.

Monitoring of the water in the RSEM R5B sediment pond was conducted by daily water quality sampling and through use of continuous data logger probes (pH, turbidity, temperature and conductivity) and instantaneous discharge flow meters.

RSEM Area R5A

Construction of the RSEM R5A facility commenced in December 2016 and it began receiving material in January 2017. The facility will be upstream from the dam and is permitted for permanent storage of up to approximately 9,300,000 m^3 of material. By the end of 2020, RSEM R5A contained a total volume of 5,456,423 m^3 of PAG rock. Material deposition at RSEM R5A Starter Dyke commenced in Q2 2020, and this area contained 57,232 m^3 by end of 2020.

On the Right Bank in 2020, portions of exposed AG material identified in the Approach Channel were excavated and placed in the RSEM R5A, however, extensive excavation planned in 2021 will remove portions of AG material that still remain. A major portion of AG material identified and sampled in the RSEM Area R5A was covered with NPAG material in 2020 Q3 and Q4, with future placement of excavated PAG limited to upper benches in the southern portion of the facility.

Surface water runoff from the RSEM Area R5A catchment drains to a series of four long sediment pond cells constructed adjacent to the perimeter dike. A non-contact intercept ditch upgradient of the RSEM area was completed in 2018, which discharges to the Moberly River south of the confluence with the Peace.

The Phase 1 RSEM Area R5A sediment control ponds were used to manage runoff in the RSEM Area R5A catchment from January through September 2020. For each RSEM R5A pond, water quality monitoring stations were located in-pond (the SP station) or at EOP. Occasional samples were obtained in-pond from each of the four RSEM sediment control ponds in RSEM Area R5A, and EOP from RSEM R5A Pond A when discharging.

The RSEM R5A sediment control ponds did not discharge in 2020 with the exception of discrete events in June and July due to water accumulations associated with heavy rainfall events. On June 30th, and July 3rd to 6th, relatively small volumes of water were pumped directly from RSEM R5A Pond A to the Peace River in accordance with the RSEM Area R5A sediment control pond pumping plan. Site reports estimate that small volumes of passive discharge occurred on July 3rd from RSEM R5A Pond B (9 m^3) and July 4th from Pond C (1.2 m^3).

The Phase 1 RSEM R5A sediment control ponds were decommissioned and backfilled in September 2020, and runoff in RSEM Area R5A was redirected to the partially constructed Phase 2 RSEM R5A ponds from September 19, 2020 onwards. Water levels in the Phase 2 ponds were low for the balance of 2020, and there were no discharges. The Phase 2 ponds are expected to be commissioned for passive discharge in 2021.

2.3.3 Left Bank PAG Material Management

On the Left Bank in 2020, AG material on exposed surfaces were sampled and identified in RSEM Area L5, RSEM Area L5 Extension, Central Cofferdam/Dam Core, Left Bank Drainage Adit (LBDA) and Left Bank Excavation (LBEX). Mitigation measures involved shotcrete application to stabilize steep benches excavated into the slopes above the portals to minimize contact with precipitation. LBDA and Dam Core AG material was excavated and trucked to RSEM Area L5, where a large section was covered with NPAG material in 2020 Q3 and Q4. Future placement of excavated PAG bedrock will be reduced to smaller areas on the upper benches of the facility.

Excavated PAG bedrock from the Left Bank totalled 199,800 m^3. The largest excavation volume were located around the Central Cofferdam. The excavation volume from this area was 157,352 m^3, with the most significant excavation occurring in January through March 2020. Other excavation areas on the Left bank included the Upstream Cofferdam, Inlet Cofferdam, Diversion Tunnel Inlet Portal (DTIP). Diversion Tunnel Outlet Portal (DTOP), LBDA, LBEX, and the Left Bank Debris Boom Anchor (LBDB). Additional details of theses excavation volumes and areas are provided in Appendix A.

At the end of the 2020, RSEM Area L5 contained 1,009,108 m^3, the RSEM Area L5 Extension contained 495,240 m^3, L5 Garbage Creek contained 24,240 m^3, RSEM Area L6 contained 64,345 m^3, and the RSEM Area L5 Starter Dyke contained 4,869 m^3. No material was added to the Left Bank Dam Core stockpile in 2020. There is 12,345 m^3 of PAG material remaining at this location.

A total of just over 67,000 m^3 of water was discharged from the Left Bank in 2020. The majority of this was from the RSEM Area L5E sediment control pond from May through July. RSEM L5E discharged daily from April through September 2020, with peak discharge (greater than 10 L/s) occurring during major rain events in mid-May, mid-June, early July and late July 2020.

2.3.4 Left Bank RSEMs

There is one large and several smaller catchment areas on the Left Bank. Contact water catchments on the Left Bank are as follows and includes two RSEM areas, L5 and L6:

- The combined RSEM Area L5 and LBEX catchments, from which contact water is conveyed to the RSEM Area L5 sediment control ponds. The RSEM Area L5 Extension is located within the RSEM Area L5 catchment. The Phase 1 RSEM Area L5 sediment control ponds were backfilled in 2020 Q3 and water management in this area has transitioned to the RSEM Area L5 Phase 2 ponds that are located at higher elevation within the RSEM;

- The Left Bank Cofferdam area, in which surface water runoff and cement contact water are collected in sumps, treated for pH and directed to the RSEM Area L5 sediment control pond; and
- The small RSEM Area L6, from which contact water is generally conveyed to the RSEM Area L6 sediment pond.

RSEM Area L5 and L5 Extension

The Phase 1 RSEM L5 East and West sediment control ponds continued operation through 2020 until their decommissioning. Backfilling and decommissioning of the RSEM L5 West pond was completed July 23 and the RSEM L5 East pond was decommissioned on September 20th and backfilled shortly thereafter. On September 12th, in advance of the planned Peace River diversion, water management in RSEM L5 area was transitioned to the Phase 2 RSEM L5 East sediment control pond while construction of the Phase 2 primary and emergency discharge channels and appurtenances was underway.

In 2020, the majority of the PAG material was placed in RSEM Area L5 and the RSEM Area L5 Extension.

RSEM Area L6

The RSEM L6 sediment control pond receives runoff water from the RSEM Area L6, and water transferred from other Left Bank locations on the Left Bank, and discharges through a culvert onto a rip rap protected outfall, which descends the bank to the Peace River. Water quality is monitored at EOP station when discharging, and otherwise at the in-pond station.

In 2020, PAG-contact water from RSEM Area L6 was managed effectively by trucking to the MWTF or retaining it within the site and avoiding discharge. Continued excavation or covering of weathered PAG material and adequate water retention capacity will be required for effective ARD/ML mitigation and preventing exceedance of the project-specific discharge limits during snowmelt and storm events.

2.4 Off Dam Site Activities Related to PAG Material Management

2.4.1 Reservoir Clearing

Western Reservoir Project, Eagle Road – Incidental PAG exposure

During site clearing road construction activities bedrock shale was encountered along Eagle Road, Section 20.1 D, 0+035 ~ 0+107 in November 2020, with possibility that more will be encountered up to a total of 168 m along the road cut; all shale bedrock is assumed to be PAG and must be treated accordingly.

The volume of bedrock material assumed to be PAG and excavated and encapsulated near the 20.1D Road was measured post excavation to be 794 banked cubic meters. Shale will remain exposed at the toe of the road cut slopes, and possibly under the adjacent portion of the road bench, for the functional life of the access road, after which point it will be decommissioned.

A disposal and water quality monitoring plan was provided by the contractor in accordance with the CEMP Appendix E S.5.2.2.

2.4.2 Transmission Line Right of Way

An incidental volume of approximately 60 m^3 was encountered as a chance find during excavation of micro-piles which encountered bedrock during excavation in November 2020. There are no other know PAG exposures, storage or excavations in close proximity to the project.

The contractor prepared a disposal plan in accordance with the CEMP Appendix E S.5.2.2. The location of the proposed PAG disposal (burial/encapsulation) is located at approximately elevation 806 m above sea level and is well above and at a distance from the planned flooding level for the Peace River.

2.4.3 Highway 29 Realignment

Planned and incidental PAG excavation and exposures associated with the Highway 29 Realignment works occurred in 2020. Areas of construction which encountered PAG materials include the following segments and activities:

- Bear Flat Cache Creek, PAG material excavation from Pier 1 and Pier 6 test piles.
- Halfway River Bridge, PAG excavated from the west escarpment parallel to the highway, and from the east bridge abutment.
- Farrell Creek, PAG excavated from westernmost pier for shale slope terracing.
- Dry Creek, PAG excavated from the access bridge development.
- Lynx Creek, PAG from spoils of geotechnical drilling.

PAG Disposal Areas were constructed for permanent disposal of PAG excavation associated with Highway 29 Realignment construction within several of the segments. PAG Areas with associated volumes of PAG disposed in 2020 include:

- Bear Flat Cache Creek, 20 m^3
- Halfway River Bridge, Areas B and C, 51,000 m^3
- Farrell Creek, 3,800 m^3
- Dry Creek, 3,000 m^3 from Dry Creek plus 2 m^3 from Lynx Creek excavation.

Exposed PAG from excavations were mitigated by engineered covers, or by temporary covers in accordance with design and the individual segments PAG Management Plans, and in accordance with the CEMP Appendix E, S.5.2.2.

All PAG disposal areas were constructed and monitored in accordance with the CEMP, Appendix E, S.5.2.2.

3. OVERVIEW OF WATER QUALITY MONITORING PROGRAMS RELATED TO ACID ROCK DRAINAGE AND METAL LEACHING

The CEMP Appendix E identifies responsibilities specific to BC Hydro and the contractor. In 2020, BC Hydro, as owner, and Peace River Hydro Partners, as MCW contractor, engaged QPs in ARD/ML to assist with implementation of the various water quality monitoring programs identified in Table 1. Additional qualified professionals were engaged by off dam site contractors as warranted. These roles were filled in accordance with CEMP Appendix E, S.6.1.2.

Lorax Environmental, PRHP's QP for ARD/ML, monitors surface water quality within the construction site, groundwater quality and levels at RSEM Area R5A and R5B, and observes and tests to assess the geochemical characteristics of bedrock that has been disturbed in the course of construction, such as exposed, excavated and relocated bedrock and RSEM sediment pond dredgate and sludge removal from mobile water treatment facility reactor and settling ponds. In addition to overseeing these water quality monitoring programs, Lorax provided general materials management and professional advice on the topic of ARD/ML,

BC Hydro's QP, Tetra Tech Canada Inc., acted in the capacity of auditor of contractor compliance with CEMP Appendix E, while also providing professional advice on the topic of ARD/ML to BC Hydro.

The results of the 2020 ARD/ML water quality program are summarized below. The network of monitoring stations for the Site C project has been adapted as site conditions change, with some stations that were established early in the construction phase no longer in use, and other new stations added.

Table 1 Water Quality Monitoring Programs related to the ARD/ML Management Plan (CEMP Appendix E)

	Program Description	CEMP Appendix E Reference	Frequency	Duration	Geographic Extent	Program Responsibility	Monitoring Program Qualified Professional (QP), 2020
Monitoring associated with PAG-contact RSEM Sediment Ponds	**Collected/Contained Water**						
	PAG-contact RSEM Sediment Pond Water Quality Water quality sampling, and installation and operation of data loggers for measurement of pH, turbidity and electrical conductivity from PAG containing RSEM sediment ponds.	7.3.2	Hourly (*in situ* measurements) Daily (water quality sampling)	Ongoing from December 2016	RSEM sediment ponds conveying PAG-contact water	Contractor (Peace River Hydro Partners)	Lorax Environmental
	RSEM Sediment Pond Toxicity Collection of acute toxicity tests (96hr LC50) from water in PAG-contact RSEM sediment ponds	7.2.1, 7.3.1	Bi-monthly In event of failure, additional sample 96 hours after first failed sample, additional samples every 96 hours until sample passes. Targeted acute toxicity if pH drops below 6.5 for more than one hour.	Ongoing from November 2016	RSEM sediment ponds conveying PAG-contact water	BC Hydro	ASKI Environmental Reclamation and Ecofish Research Ltd.
	Groundwater						
	Groundwater Monitoring Install groundwater monitoring wells upgradient and downgradient of RSEM R5A and R5B, and water quality monitoring of groundwater.	7.2.5, 7.3.3	Quarterly	October 2016 to August 2020	RSEM R5A and RSEM R5B	Contractor (Peace River Hydro Partners)	Lorax Environmental
	Peace River Surface Water						
	Peace River Mixing Dynamics and Water Quality Monitoring Field verification of modelled river mixing dynamics for the RSEM discharge sites, assessment of appropriateness of Initial Dilution Zone (IDZ) sample sites through discharge plume characterization, and collection of surface water quality samples at established upstream, far-field downstream and IDZ locations in the Peace River.	6.1.1, 7.2.3, 7.3.4	Monthly during RSEM discharge events	Ongoing from December 2016	Peace River at locations upstream and downstream of PAG containing RSEM areas	BC Hydro	ASKI Environmental Reclamation and Ecofish Research Ltd.
Other Monitoring	**Surface Water**						
	Dam Site Road Cut Water Quality Monitoring Water quality monitoring at construction-related road cuts into PAG material.	5.2.1.7	Monthly (except while dry/frozen) for first year of observation, then quarterly thereafter	Ongoing from fall 2016	Throughout the dam site (left and right Peace River banks)	BC Hydro & Contractor (Peace River Hydro Partners), in their respective work areas	Tetra Tech Canada Inc. (on behalf of BC Hydro) Lorax Environmental (on behalf of Peace River Hydro Partners)

Program Description		CEMP Appendix E Reference	Frequency	Duration	Geographic Extent	Program Responsibility	Monitoring Program Qualified Professional (QP), 2020
	Off Dam Site Project Components Water quality monitoring at excavations into PAG material during construction of these project components. Planned and incidental PAG exposures in 2020 during Highway 29 realignment construction, including approximate PAG Material volume disposed: - Bear Flat Cache Creek (20 m^3) - Halfway River Bridge (51,000 m^3) - Farrell Creek (3,800 m^3) - Dry Creek (3,000 m^3) - Lynx Creek (2 m^3, sent to Dry Creek disposal) Incidental PAG exposures in 2020 during Reservoir Clearing and Transmission Line construction, including approximate PAG material volume disposed: - Peace River Middle Reservoir (225 m^3) - Western Reservoir South Bank Clearing (794 m^3) - Transmission Line (5L5 & 5L6; 60 m^3)	5.2.2	Once prior to initial discharge, then monthly (except while dry/frozen) for first year of observation, then quarterly thereafter	Ongoing from time of exposure until decommis sioning	Throughout exposure area, as appropriate	Contractor (various)	Various

3.1 Summary of Implementation Status: Monitoring Programs Associated with PAG-contact RSEM Sediment Ponds

A summary of RSEMs that are designated to contain PAG material and/or PAG-contact water, and an indication of those that were operational with sediment ponds in 2020, is provided in Table 2.

Table 2 Summary of PAG-contact RSEM Sediment Pond Operational Status in 2020

RSEM	Status in 2020
Right Bank	
RSEM R5A (Phase 1)	Operational until decommissioned in Q3
RSEM R5A (Phase 2)	Constructed and operational for storing water as of Q3, but not commissioned for discharge as of Q4
RSEM R5B	Operational until decommissioned in Q3
RSEM R6 (PRHP)[1]	Operational
Left Bank	
RSEM L5 (Phase 1)	Operational until decommissioned in Q3
RSEM L5 (Phase 2)	Constructed and operational for storing water as of Q3, but not commissioned for discharge as of Q4
RSEM L6	Operational

NOTES:
[1] The RSEM R6 ponds operated by the Main Civil Works Contractor, PRHP, are differentiated from the RSEM R6 pond operated by the Generating Station and Spillways contractor, AFDE (which is a non-PAG contact pond). RSEM R6 does not receive PAG material, but the sediment ponds operated by PRHP receive PAG-contact water.

In 2020, a total of 1,654 surface water quality samples were collected for laboratory analysis from a total of sixty-one (61) stations, including twenty-nine (29) stations on the Left Bank and thirty-two (32) stations on the Right Bank. Additionally, continuous *in situ* measurements of pH, conductivity and turbidity were collected by installed instruments and dataloggers in the RSEM Area L5, L6, R6 and R5B sediment ponds during periods when the ponds were managed to discharge. Field measurements of the same parameters were obtained at other locations to monitor conditions across the site.

In 2020, as a result of snow melt and larger precipitation events, minor exceedances were measured in water discharged from PAG-containing RSEM sediment ponds to the Peace River. These four events included: 1) a minor discharge of alkaline water from the RSEM Area L5W pond (April 19, 2020) during rapid snow melt, 2) discharge exceedances from RSEM Area L5E, R5B, R6W following heavy rains (mid-June, 2020), 3) discharge exceedances from RSEM Area L5E, R5A-B, R5B and R6W ponds following very heavy rains (early July 2020), and 4) one day exceedance from RSEM Area R6E pond discharge (early November 2020).

3.1.1 PAG-contact RSEM Sediment Pond Water Quality

A brief summary of monitoring undertaken at PAG-contact RSEM sediment ponds is provided below; a detailed description is included in Appendix A.

In general, operational PAG-contact RSEM sediment ponds are subject to the following monitoring regime:

- Continuous (minimum hourly) measurements of pH, turbidity, and electrical conductivity via *in situ* sonde.
- Continuous measurements of discharge volume to the Peace River.
- Daily collection of water quality samples for laboratory analysis of total and dissolved metals, pH, total suspended solids (TSS), turbidity, sulphate, nitrates, conductivity, temperatures, conductivity, and hardness (plus hydrocarbons, if applicable due to a spill event).

These monitoring measures are undertaken except when the pond is dry or frozen.

PAG-contact RSEM sediment pond water quality is subject to EOP discharge limits, as described in the CEMP Appendix E (Table 2), for the following parameters: total metals (cadmium, cobalt, copper, zinc), TSS, and pH. Water quality and flow data are used to calculate metals loading of each PAG-contact RSEM sediment pond to the Peace River on a weekly basis.

Any exceedance of EOP discharge limits in laboratory analysis of water discharged from PAG-containing RSEM sediment ponds to the Peace River is reported within 24 hours of receiving the analytical water quality results. Exceedances are also noted in weekly reports. Exceedance of EOP limits does not indicate non-compliance with CEMP requirements; it indicates only that additional water management measures may be required.

RSEM R5A

The RSEM R5A ponds remained circumneutral to slightly alkaline. Metal concentrations were periodically measured above the applicable guidelines; however, concentrations in discharged water generally remained below guidelines and/or discharge limits. Elevated concentrations were likely due to snow melt and rainfall causing turbid runoff in RSEM Area R5A.

The RSEM R5A sediment control ponds generally did not discharge in 2020, with the exception of discrete events in June and July. The heavy rains in early July led to discharge from RSEM R5A Sediment Control Ponds A, B, and C. No discharge was reported in 2020 at Pond D. The majority of discharged was Pond A discharge that was pumped to the mainstem of the Peace River. Small amounts of water also passively discharged from Pond B (9 m^3, July 3) and Pond C (1.2 m^3, July 4). An analytical sample was collected from Pond B and the concentration of iron exceeded the acute BC Water Quality Guideline (BCWQG) value for aquatic life. EOP samples were collected from Pond A during periods of active discharge to the Peace River (June 30, July 4, and July 5). The water quality in these samples met RSEM EOP limits. *In situ* field measurements were collected for each pond at the time of sampling and continuous monitoring sondes were deployed to RSEM R5A sediment ponds A and B while discharging.

RSEM R5B

In 2020, the RSEM R5B sediment control pond passively discharged through a pipe to a rip rap protected outfall, which descended the bank to the Peace River, until the pond was deactivated early September 2020. Water quality was monitored periodically at the in-pond station and daily with both analytical samples and *in situ* field samples, when discharging at the EOP station. Continuous water quality measurements were also collected form the sonde deployed at the in-pond station.

The R5B sediment control pond was circumneutral to alkaline. Metal concentrations were generally low and below the discharge limits, excluding total cadmium (maximum concentration in discharged waters of 0.00079 mg/L compared with an EOP limit of 0.00029 mg/L) and total zinc concentrations (maximum concentration in discharged waters of 0.103 mg/L compared with an EOP limit of 0.033 mg/L) between June 16-24 and July 5-9.

The monitoring results for June 16-24 and July 5-9 showed elevated field conductivity measurements, and it was speculated that PAG influenced run-off in the R5B West Ditch catchment likely resulted in increased total cadmium and total zinc in the pond. The elevated cadmium and zinc were primarily present in dissolved form, indicating ARD influence that likely originated from the rinsing of PAG exposures in the western extent of the Approach Channel and conveyed by the R5B West Ditch. In order to prevent future exceedances, a sump has been constructed along the R5B West Ditch, upstream of the R5B pond, to intercept and store runoff during heavy rains.

RSEM R6

Analytical water quality monitoring of RSEM R6 East and West Sediment control ponds was conducted throughout 2020, including daily at EOP when discharging or occasional in-pond sampling as water levels allowed. The continuous measurement *in situ* sonde was deployed in-pond throughout 2020 at RSEM R6 East pond, excluding an approximate three-week period in May when the pond was not discharging due to low water levels. Continuous *in situ* sonde measurements in RSEM R6 West pond occurred from late April onwards during periods when the pond was discharging. The RSEM R6 East and West sediment ponds remained circumneutral to slightly alkaline. There were occasional exceedances of the discharge limits in 2020 attributed to PAG-influenced runoff from rainfall events.

Heavy rains in mid-June led to a slumping of material upslope of the RSEM R6 Pre-Treatment Pond into the RSEM Pond. In response to elevated levels in the Pre-Treatment Pond, dewatering was initiated to direct pumping to RSEM R6 West Sediment Control Pond for 13 hours on June 15. Discharge from RSEM R6 West sediment control pond slightly exceeded the discharge limit for total zinc on June 16 and were reduced to below EOP limits when pumping stopped.

The heavy rain in early July resulted in exceedances of EOP limits for both total cadmium (maximum concentration of 0.00067 mg/L compared with an EOP limit of 0.00029 mg/L) and total zinc (maximum concentration of 0.0842 mg/L compared with an EOP limit of 0.033 mg/L) in the RSEM R6 West discharge from July 5-8. The sump that has been constructed in RSEM

R5B as previously mentioned will help prevent future exceedances from this pond, as it will intercept and store runoff that will now be conveyed to RSEM R6.

On November 3 water was pumped from the RSEM R6 West Pond to the RSEM R6 East Pond temporarily to allow tie-in of a new lined passive discharge channel from the MWTF to the RSEM R6 West Pond. The concentration of total zinc exceeded the RSEM EOP limit (maximum concentration of 0.0439 mg/L compared with an EOP limit of 0.033 mg/L) from the RSEM R6 East pond discharge on this one day. The cause of the exceedance is not certain, though may be partly related to sample contamination (see Appendix A for details).

RSEM L5

Analytical water samples were collected from the Phase 1 RSEM L5 East and West sediment control ponds at EOP on a daily basis when discharging; otherwise in-pond samples were periodically collected. *In situ* field measurements were collected in parallel with analytical samples, with few exceptions.

Field and analytical measurements of the RSEM L5 West pond discharges met the RSEM EOP limits, except April 19 when pH increased to 9.4 due to a temporary failure of the pH treatment system for alkaline shotcrete contact water from Left bank Cofferdam (LBCD) sump. Site staff estimated that relatively small volume (approximately 85 m^3) of slightly alkaline was discharged from RSEM L5 West Pond while the CO_2 tank from the system was being replaced.

Carbon dioxide sparging was periodically applied near the East pond discharge pipe intake to reduce pH at EOP. Concentrations of TSS and metals in analytical samples from Phase 1 RSEM L5 East and West sediment control ponds were generally low except at RSEM L5 East discharge during discrete periods in June and July following heavy rains.

Water samples collected at the RSEM L5 East EOP discharge location exceeded RSEM EOP discharge limits for total cadmium and total zinc from June 15 to June 19 in association with heavy rains mid-June that led to rinsing of ARD/ML oxidation products from the stockpiled material.

The RSEM L5 East discharge exceeded total cadmium RSEM EOP limits from July 5-7. This was associated with the heavy rain in early July that led to rinsing of ARD/ML oxidation products from oxidized stockpiled material.

RSEM L6

The RSEM L6 sediment control pond did not discharge in 2020 except June 17 to 23, and on June 27. Water was discharged due to elevated water levels associated with significant precipitation in June and water transfers from the diversion outlet cofferdam (DOC) and LBCD sumps. Analytical water samples were periodically collected from May to through October. A continuous monitoring sonde was deployed in-pond from June 20th to 28th and for several days in July.

All water quality samples collected from the RSEM L6 sediment control pond met the RSEM EOP limits, including periods during which the pond discharged. The pH in all analytical samples and field measurements was circumneutral to slightly alkaline, with low TSS and moderate sulphate levels. Low concentrations of cadmium, cobalt, copper, and zinc, primarily in the dissolved form, were also observed.

3.1.2 RSEM Sediment Pond Toxicity

A brief summary of toxicity testing undertaken at PAG-contact RSEM sediment ponds in 2020 is provided below; a detailed description is included in Appendix B.

In general, acute toxicity of RSEM pond water was conducted on a bi-monthly basis throughout 2020, provided sufficient water was available for sampling. Acute toxicity was evaluated using a standard laboratory assay (rainbow trout 96-h LC50 test) performed on water samples collected directly from the outflow of each RSEM pond (or the pond itself when not discharging). In addition, a targeted monitoring program is initiated if a trigger is exceeded that suggests there might be elevated risk to aquatic biota due to poor water quality in the pond, as indicated by *in situ* pH measurements.

Changes made the acute toxicity testing program in response to a Water Sustainability Act Order issued to the Project in February 2019, as described in the 2019 annual report, were officially incorporated into the CEMP in Revision 7 (September 2020).

<u>RSEM R5A</u>

Construction of the Phase 1 RSEM R5A ponds was completed mid-July 2017 with a pond design consisting of four individual cells (A, B, C, and D). In 2020, sampling was not completed in January or February as the ponds were frozen. Starting in March 2020, all four cells were sampled on a bi-monthly sampling schedule until the ponds were decommissioned on September 20, 2020 (only one pond had sufficient water for sampling in September prior to decommissioning).

In 2020, all 13 samples collected from the four RSEM R5A ponds (four from pond A, three from ponds B, C and D) passed the acute toxicity test.

No toxicity sampling of the Phase 2 RSEM R5A-A ponds (R5A-P2A, R5A-P2B, R5A-P2C, R5A-P2D) was conducted in 2020 as the ponds did not contain sufficient water for sampling. Toxicity sampling for the Phase 2 RSEM R5a-A ponds will begin once sufficient water is available in the ponds for sample collection.

<u>RSEM R5B</u>

Acute toxicity sampling of RSEM R5B pond water commenced on November 30, 2016. In 2020, toxicity samples were collected from RSEM R5B on a bi-monthly basis from January until September, after which sampling ceased as the pond was no longer used for water management.

In 2020, all five samples collected from the RSEM R5B pond passed the acute toxicity test.

RSEM R6

The two RSEM R6 ponds (RSEM R6E and RSEM R6W) are divided by a berm, and acute toxicity samples are collected from each pond provided there is sufficient water for sample collection. Acute toxicity sampling began in March 2017 for R6W and in April 2017 for R6E. In 2020, RSEM R6 toxicity samples were collected on a bi-monthly sampling schedule starting in January. As a precautionary measure, a targeted toxicity sample was collected from RSEM R6W in June 2020 following human error whereby water was briefly discharged directly to the Peace River without prior treatment in the MWTF.

In 2020, all 13 samples collected from the two RSEM R6 ponds (seven samples from RSEM R6W and six from RSEM R6E) passed the acute toxicity test.

RSEM L5

The two Phase 1 RSEM L5 ponds were divided by a berm (RSEM L5E and RSEM L5W), and construction of the two ponds was completed in December 2018. In 2020, toxicity samples were collected from both RSEM L5 ponds on a bi-monthly basis from March (the ponds were frozen in January and February) through July. The ponds had insufficient water for sample in September 2020 prior to their decommissioning on September 20.

In 2020, all six samples collected from the two Phase 1 RSEM L5 ponds (three samples from RSEM L5W and three from RSEM L5E) passed the acute toxicity test.

The Phase 2 RSEM L5-P2 pond was constructed in September 2020; acute toxicity sampling began in October 2020 once there was sufficient water in the pond for sample collection. No further sampling took place in 2020 as the pond was frozen in December.

In 2020, one pre-discharge sample collected from the single RSEM L5-P2 pond passed the acute toxicity test. This sample was collected prior to the pond being fully operational.

RSEM L6

Construction of the RSEM L6 pond was completed in 2019. Bi-monthly toxicity sample collection in RSEM L6 commenced in March 2019. In 2020, sampling was done on a bi-monthly basis beginning in January.

In 2020, all six samples collected from the RSEM L6 pond passed the acute toxicity test.

3.1.3 Peace River Mixing Dynamics and Water Quality Monitoring

A brief summary of Peace River mixing dynamics and water quality monitoring work undertaken in relation to discharge from PAG-contact RSEM sediment ponds is provided below; a detailed description is included in Appendix B.

Initial Dilution Zone Mixing Study and Discharge Plume Characterization

Monitoring of RSEM pond discharge plumes within the Initial Dilution Zone (IDZ) has been conducted to characterize dilution under a variety of pond discharge and Peace River flows.

Prior to the construction of RSEM sediment ponds and any associated discharges, water quality modelling was undertaken by the project to examine the predicted mixing capacity of the Peace River through a 100 m IDZ. To confirm this predicted mixing, and the suitability of the IDZ approach for discharges from PAG-contact RSEM sediment ponds, actual mixing was evaluated through field studies undertaken in previous years. For comparison to modelling results, field-verified mixing coefficients were obtained at the IDZ, e.g. using natural tracers from the Moberly River inflow for RSEM R5B.

This study demonstrated ample mixing through the 100 m IDZ and confirmed the appropriateness of the IDZ compliance location that was recommended based on modelling results. These conclusions remained valid throughout 2020 and are expected to be valid over the range of RSEM pond water quality, discharge rates, and Peace River flow scenarios that were modelled for the project.

To further confirm that the proposed IDZ sampling locations (100 m downstream from the RSEM discharge points, 1 m from shore, 10-15 cm water depth) were appropriate, the discharge plume for each active RSEM pond was characterized using in situ specific conductivity. Measurements of specific conductivity, which is elevated in RSEM pond water relative to the Peace River, were taken along the IDZ at regular depths and distances from shore under various Peace River flow/RSEM discharge combinations between January and August 2017.

This previous study demonstrated that the RSEM discharge plume is generally fully mixed with the Peace River 20 m to 40 m downstream of the pond discharge location, but when present at the 100 m IDZ, is detectable at the proposed 10-15 cm depth 1 m from shore.

There was no additional discharge plume characterization work warranted in 2020.

RSEM Discharge/Peace River Surface Water Quality Monitoring

To evaluate compliance with water quality limits applicable at the IDZ locations downstream of each PAG-contact RSEM sediment pond discharge location (CEMP Appendix E, Table 2), a full suite of water quality parameters (including physical parameters, nutrients, anions, total metals and dissolved metals) was measured *in situ* and/or sampled for laboratory analysis.

Sampling was undertaken on a monthly basis throughout the year for those ponds that were discharging in that month, and on a 5 in 30-day schedule during a period of high and a period of low flow in the year. Sampling was conducted at the IDZ locations, and also at a site upstream (upstream of all Site C construction influences), immediately upstream (just upstream of individual RSEM discharge locations), and far-field downstream (downstream of all Site C construction influences). TSS discharge limits at EOP, which are prescribed as the BC water quality guidelines for freshwater aquatic life (CEMP Appendix E, Table 2) and thus, are dependent upon background Peace River water clarity conditions, were determined through measurements collected by automated turbidity gauges located on either bank of the Peace River, upstream of the confluence with the Moberly River. Site-specific TSS:turbidity relationships were continually re-evaluated through frequent sampling through a range of Peace River and tributary flow conditions.

Overall, during the monitoring conducted in 2020, there were no observations of exceedances in the Peace River of the BC water quality guidelines for the protection of aquatic life that were related to discharge of water from the RSEM ponds. Similar to annual monitoring in 2017, 2018, and 2019, and to baseline monitoring prior to the start of Site C construction, there were natural exceedances in the Peace River of the BC water quality guidelines for the protection of aquatic life. Natural exceedances occurred predominantly during the freshet period (April to the end of June), and were observed at all sample sites. Exceedances were most often associated with elevated concentrations of suspended solids in the Peace River.

3.1.4 Groundwater Monitoring

A brief summary of groundwater monitoring undertaken at PAG-contact RSEMs is provided below, see Appendix A for details.

The groundwater monitoring program at RSEM R5A and R5B was initiated in 2016 and completed in 2020 to fulfill the requirements of CEMP Appendix E, S.7.25 and S.7.3.3. The program included quarterly monitoring of water quality and continuous monitoring of water levels. Groundwater quality in the downgradient wells was evaluated with respect to compliance targets specified in the CEMP and the Groundwater Quality Mitigation Plan.

All monitoring wells were decommissioned on September 23-25, 2020, in advance of the October 2020 river diversion and flooding, and sealed with bentonite.

Groundwater monitoring wells were installed in advance of the operation of RSEM areas R5A and R5B to monitor and characterize potential effects to groundwater due to seepage from PAG material in the RSEM facilities. Groundwater was monitored in four wells installed at RSEM R5A: three were installed downgradient at the toe of the RSEM (GW-1, GW-2, GW-3), and one was installed upgradient (GW-4, replaced with GW-4A in 2018 due to blockage). Similarly, at RSEM R5B, four groundwater wells were installed for monitoring: three downgradient (GW-6, GW-7, GW-8), and one upgradient (GW-10b) (Appendix A, Figure 4-1 and 4-2).

The monitored groundwater levels were strongly influenced by the fluctuation of water levels in the Peace River.

RSEM R5A

Groundwater major ion composition ranged from calcium bicarbonate-type at GW-3 and GW-4A to calcium-sulphate-type at GW-1 and mixed cation-sulphate-type at GW-2 in 2020. Groundwater compositions shifted towards higher sulphate and lower bi-carbonate proportions over the course of the monitoring period.

Groundwater concentrations of the PAG indicator parameters (pH, specific conductivity, total dissolved solids, dissolved sulphate, sodium, chloride, cadmium, chromium, cobalt, copper and zinc) at the RSEM R5A area monitoring wells were generally stable during the September 2016 to July 2020 monitoring period with a few exceptions. Field pH ranged from 6.2 to 7.5 throughout the 2016 through 2020 monitoring program. The lowest pH values (pH <6.7) at GW-1 and GW-2 observed in 2019 and 2020 samples were also observed in the background well GW-4A. PAG indicator parameters (dissolved chloride, sodium, and sulphate) remained stable from 2016 through 2020, except at GW-2 where increases in dissolved chloride and sodium were observed.

Although exceedances of Trigger 3 Compliance Targets (sustained change of downgradient groundwater quality relative to background) were periodically observed in the downgradient wells from 2017 through 2020 and the observed trends may be influenced by construction activities in RSEM R5A, the magnitude of the increases and the different parameters displaying increases at the monitoring wells, suggest that PAG-contact seepage did not contribute to widespread degradation of groundwater quality adjacent to RSEM R5A during the monitoring period.

RSEM R5B

Groundwater major ion compositions at RSEM R5B ranged from calcium-bicarbonate-type at GW-10b to mixed-cation-sulphate-type at GW-6, calcium-sulphate type at GW-7 and sodium-sulphate type at GW-8 in 2020 Q3.

Groundwater quality in RSEM R5B groundwater wells GW-7 and GW-8 frequently exceeded Trigger 3 Compliance Targets from 2017 through July 2020, which indicated GW quality was affected by the project and most likely associated with PAG storage and water management at RSEM R5B. GW-7 and GW-8 PAG indicator parameters concentrations (specific conductivity, total dissolved solids, dissolved sodium, chloride and sulphate) showed a sharp increase in September 2017 but leveled off in stable range since June 2019, and GW-8 displayed a rapid decrease in the final July 2020 measurement.

The result of Trigger 3 sustained changes in groundwater quality resulted in development of Trigger 4 alert concentrations for GW-7 and GW-8. Water quality remained compliant for all 10 PAG indicator parameters throughout the monitoring program, which confirmed that seepage from RSEM R5B was of low risk to increase concentrations in the river above the BCWQG values.

3.2 Summary of Implementation Status: Other Monitoring Programs

3.2.1 Dam Site Road Cut Water Quality Monitoring

Two large double lane dam site road cuts referred to as River Road (exposed in 2015) on the Left Bank between Howe Pit and the Peace River, and the South bank Initial Access Road (SBIAR), exposed in early 2017, on the Right Bank between Area A and RSEM R6 have been constructed to allow site vehicle access from the upper terrace to the lower flood plain.

Continued exposure of bedrock materials from both of these road cuts requires that routine water quality monitoring be conducted by BC Hydro as required by CEMP Appendix E S.5.2.1.7.

Additional monitoring locations were added in October 2020 at the L2 Powerhouse Area and the LBDB to monitor water quality from exposed PAG slopes. The monitoring program includes locations at the discharge points and at midstream locations as well as locations upstream from the discharge to characterize variation to water chemistry within the catchment due to mixing and inflow of water from multiple sources.

A brief summary of the 2020 monitoring results for the dam site road cut water quality program is included below, see Appendix C for details.

River Road

A total of twelve (12) monitoring locations have been established in the River Road catchment near Blind Corner to monitor the effectiveness of the limestone riprap in the ditch line and on the rock slope, and to observe longer term influences from the PAG outcrop at Blind Corner and run-off/seepage from Howe Pit on the water collected in the River Road ditch. Surface runoff along River Road, which contacts bedrock at Blind Corner, is conveyed via a pipe to the River Road ditch line for infiltration.

During 2020, outside of dry or frozen conditions, lab samples were collected from River Road during eight (8) sampling events resulting in a sum of eighteen samples. Samples were collected from the discharge LBRR-DD location during three sample events, in February, April and September. There was a BCWQG exceedance of total iron in February and April 2020, and dissolved aluminum in February 2020. These exceedances are interpreted to be directly related to washing, or flushing, of sediment and secondary mineral precipitant during freshet (or precipitation following a dry period), as water contacted accumulated sediment within the ditch in addition to the exposed shale, colluvium and overburden cut-banks.

Water quality measurements along River Road have indicated that run-off water quality is influenced by active ARD/ML processes within the River Road ditch catchment, particularly from the Blind Corner shale slope. Although flows are generally low and ephemeral, and the ditch is lined with limestone as a mitigation measure, there is some potential for run-off to impact downstream water quality. Continuation of the monitoring program will enable evaluation of the effectiveness of mitigation strategies that are implemented on the shale at Blind Corner.

South Bank Initial Access Road

Surface runoff which contacts the bedrock at SBIAR is channelled via a lined ditch to RSEM R6 pond for management prior to being discharged to the Peace River and does not have a direct downstream receptor.

A total of five (5) monitoring locations are established at the SBIAR area to monitor for potential long-term influence on water quality from construction of the SBIAR facility.

The SBIAR sampling locations were monitored on a monthly basis and water quality samples were collected for twelve months between January and December 2020. Of the total forty-five samples collected from SBIAR locations in 2020, occurrences of exceedances to the BCWQG were measured for total iron (5), dissolved iron (1), dissolved aluminum (5), total zinc (2) and total manganese (3). While the monitoring program concluded that ARD/ML processes are active on exposed bedrock at SBIAR locations, none of this water was discharged directly to the Peace River. The results of this monitoring will be taken into consideration in the implementation of mitigation measures in future.

Left Bank Debris Boom Anchor

A road cut was made into PAG shale during construction and installation of the debris boom anchor location on the left bank in summer 2020. The area above 420 m elevation will be exposed for 3-4 years, prior to flooding to the final reservoir elevation of approximately 460 m elevation.

ARD/ML mitigation measures were subsequently implemented, including erosion control and PAG neutralization with the placement of limestone riprap and check dams at the toe of the PAG shale slope, and in ditches along the western border of the LBDB area to 420 m elevation (the height of the headpond subsequently formed following river diversion in the early fall of 2020). Slopes were also recontoured and readied to accept seed, with some seeding on the disturbed slope bordered by the debris boom structure, 420 m highwater mark and ditch below the “LBP Pond” that collects water in this area (refer to Appendix C) in 2020. In early 2021, seeding is planned for completion on all exposed soil areas on the slope.

Water quality sample locations were then established and first sampled on October 8, 2020 and then monthly thereafter to characterize water quality in this LBDB area for ARD/ML monitoring in the ditches and pond that convey and collect water from this exposure, prior to any discharge into the Peace River. While two of the locations (representing an upstream pond and nearby natural PAG exposure) were able to be sampled during this period, most of these sample locations, including those at discharge points to the environment, were dry or frozen from October to December and were not able to be sampled and did not appear to be discharging to the Peace River.

L2 Powerhouse Area

Two sample locations were established in the L2 Powerhouse area adjacent to the powerhouse on the Right Bank and first sampled on October 8, 2020 and sampling continued on November 20, December 4, and December 14, 2020 at the L2 Powerhouse. The L2 area was identified for sampling due to the exposure of a PAG slope during excavation for the Powerhouse. The sample locations are established to evaluate water quality related to the area and the potential impact from the PAG slope, and specifically to confirm the extensive mitigations implemented here (including thorough coverage of the slope with an impermeable liner and placement of neutralizing limestone riprap in areas where runoff water is conveyed) are effective, since this runoff water is being conveyed through the Generating Stations and Spillways contractor (AFDE) RSEM R6 pond, which is a non-PAG contact pond.

Dissolved aluminum was noted to exceed the BCWQG guideline (100 µg/L) value in multiple sample events. The concentrations indicated an initial increasing trend from October 8 (48.3 µg/L) to November 20 (258 µg/L) and December 4 (552 µg/L), with a subsequent decrease during the December 14 sample event, during which two filter sizes were used: a standard 0.45 µm filter (340 µg/L) and 0.10 µm filter (235 µg/L). Alkaline pH and values of other metals associated with a PAG signature below BC WQGs were otherwise measured. Therefore, it is inferred that the elevated dissolved aluminum values are not representative of a PAG leachate issue and are possibly related to the construction activities/concrete in the Powerhouse area.

3.2.2 Off Dam Site Water Quality Monitoring

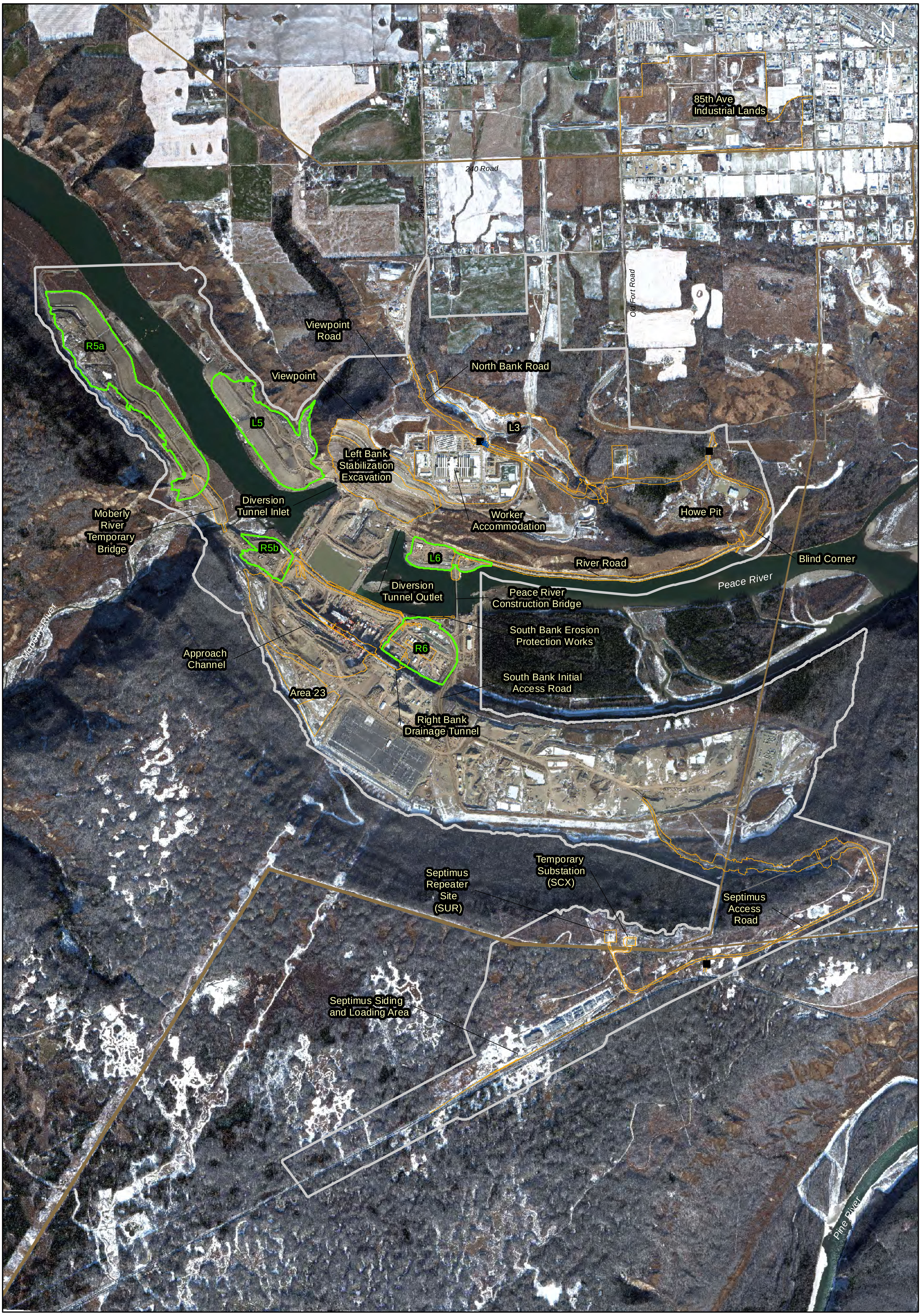
Water quality monitoring at off-dam site exposures was completed in accordance with the CEMP, Appendix E S.5.2.2, at a frequency of monthly except when frozen or when a great frequency was recommended by the contractor's QP (ARD).

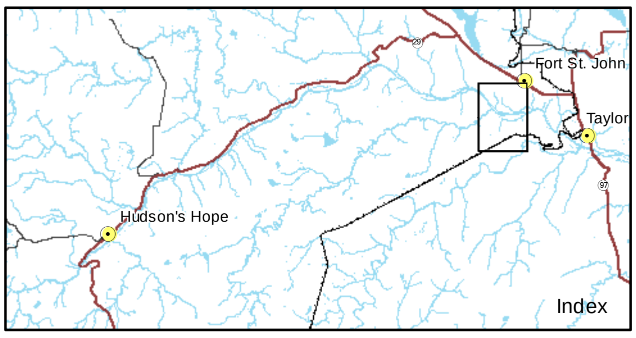
Water quality monitoring for all construction area PAG contact surface water was be confirmed to meet BC WQG prior to discharge into the receiving environment

4. SITE AUDITS

BC Hydro has engaged Tetra Tech as QP (ARD), in accordance with the CEMP Appendix E S. 6.1.2, to inspect and monitor various construction areas with potential for ARD/ML since June 2016. Site audits completed during 2020 for the project were limited due to travel restrictions associated with the COVID-19 pandemic, but were conducted as follows:

- June 9-10, 2020: The site audit was conducted by James Barr, P.Geo., of Tetra Tech. The site visit involved visiting construction areas on the Main Civil Works site with stored or exposed shale rock (PAG), RSEM Ponds and the surface water features potentially influenced by PAG materials were observed. While visiting these locations, observations were made based on visual inspection and detailed investigations were not conducted, however, some *in situ* water sample collection was conducted to verify the local ambient site conditions.
- September 3, 2020: A site audit of Portage Mountain Quarry and Highway 29 realignment project sites was conducted by BC Hydro Natural Resource Specialist with advisement from Lara Reggin, P.Geo., of Tetra Tech. The BC Hydro staff visited the quarry and several active sites along the Highway 29 realignment which received and used riprap produced in the quarry. The purpose of the site audit was specifically to confirm that riprap produced at Portage Mountain Quarry and used at Highway 29 realignment sites did not have potential for ARD/ML.





Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Dam Site Imagery from PhotoSat taken Oct 24, 2020

Legend

- PAG-contact RSEMs
- Components
- Dam Site Area

1:30,000

0 0.5 1 km

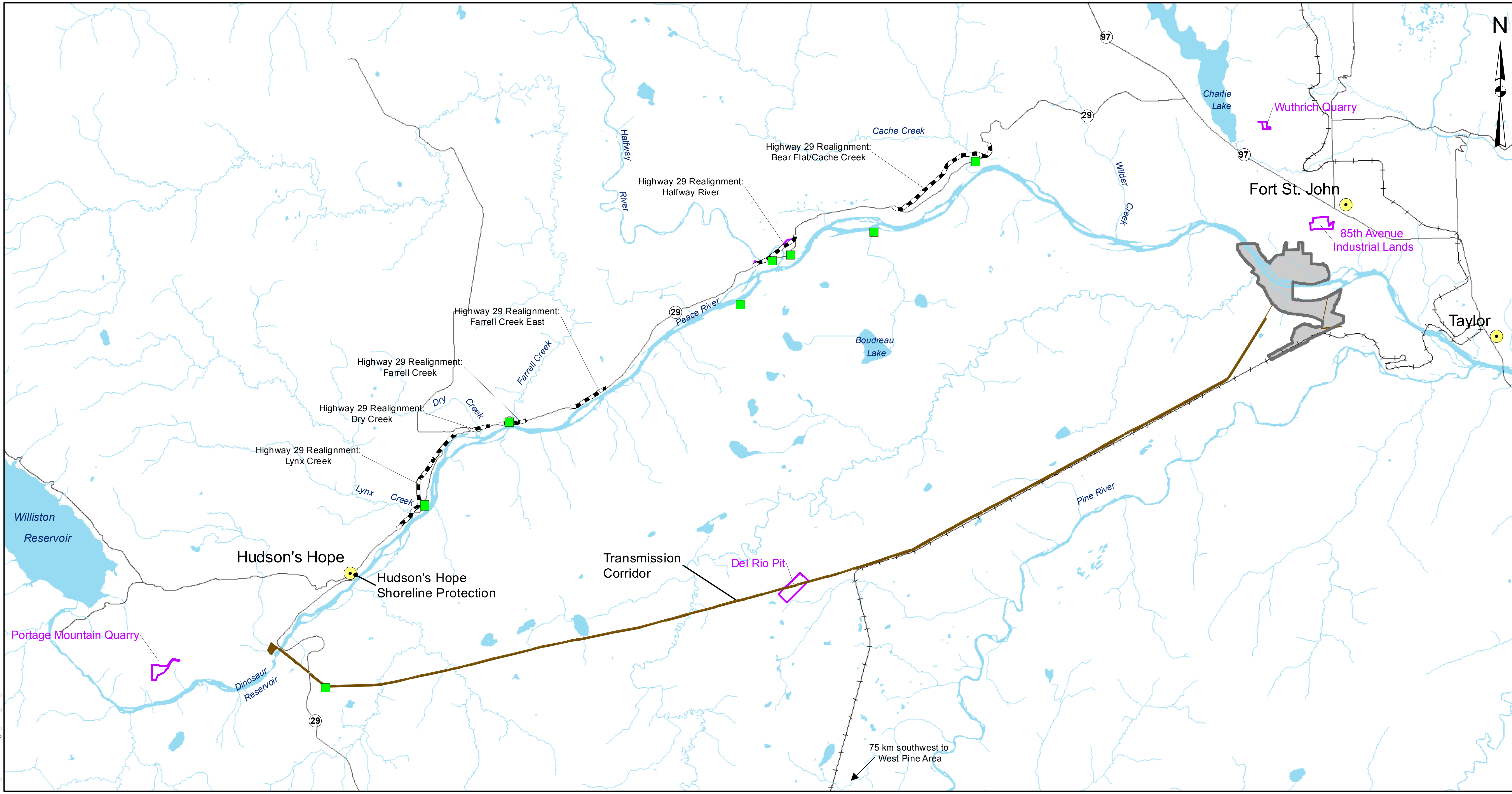
BC Hydro

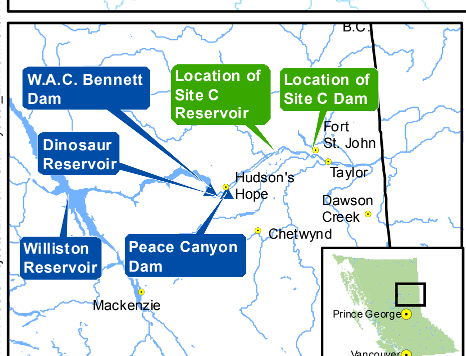
Figure 1
Overview - Dam Site

Date	Mar. 04, 2021	DWG NO	1016-N11-01082	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals.

Path: X:\ArcGIS\Projects\Monitoring\WaterQuality\2020AnnRep_ARD_1016_N11_01082.mxd





1:250,000
0 10 km

Legend

- PAG Material Disposal Sites
- Dam Site Area
- Transmission Corridor
- Highway 29 Realignment
- Existing Railway
- Existing Road
- City/District Municipality
- Off-site Construction Material Sources

Map Notes:
1. Datum: NAD83
2. Projection: UTM Zone 10N
3. Base Data: Province of B.C.

BC Hydro

Figure 2
Overview – Off Damsite

Date	Mar 4, 2021	1016-N11-01081	R 0

Construction of the Site C Clean Energy Project is subject to required regulatory and permitting approvals

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Appendix A