

Board briefing – DAM SAFETY QUARTERLY REPORT**Executive Summary**

The purpose of this report is to update the Capital Projects Committee of the Board of Directors on key dam risk management activities during the period from October 1, 2020 to December 31, 2020 and to provide reasonable assurance that the safety of dams operated by BC Hydro continues to be managed to the established guidelines and criteria of the Dam Safety Program. To keep the Committee as fully abreast of the Dam Safety Program as possible, some notable developments that took place after December 31 but before the completion of this report have also been included. The key highlights from F2021 Q3 documented in this report are:

- There was a net increase of 1.84 in the aggregated Vulnerability Index with the discovery at Buntzen Dam that the generating unit wicket gate closure speed could result in penstock pressures slightly exceeding the historical maximum design pressure. See page 2 for details.
- Unplanned closure of the intake gate to the Wahleach tunnel on December 13 resulted in its rapid dewatering. There was no damage to the rock along the tunnel alignment and no unexpected movements of the slope above the Wahleach Generating Station, which was returned to service on January 7, 2021. See page 5 for details.
- Field investigations of the sinkholes in the left abutment at Ruskin Dam continue to indicate that they are related to seepage from heavy rainfall events rather than from seepage through the dam but have shown the existence of eroded clays under them to be deeper and broader than expected. Temporary protective works are now in place and a project is being initiated to design and implement a permanent fix. See page 7 for details.
- OMS Manual updates remained on plan, with four completed in Q3 and six completed year-to-date. Three additional updates are on track for completion in Q4, but the update for Ruskin Dam is expected to lag into F2022 Q1 as the upgrade project's construction report is not yet available for reference.
- Late delivery and required revisions to some Dam Safety Review reports by external Review Engineers has led to a slip in the work plan. Two reports scheduled for issue in December are now expected to be issued in February. Two other reports are forecast to be issued in Q4, but the Strathcona Dam report is not expected to be issued until F2022 Q1.
- The Civil Preventative Maintenance Program made significant improvements over Q3 and spillway gate maintenance activities just outpaced the identification of new issues. Integration of Dam Safety into maintenance planning activities is progressing well.
- Bugaboo Dam in the Kootenays has been successfully lowered and is being reclassified as a "minor dam", allowing the retention of a wetland in the dam's forebay with minimal ongoing requirements for monitoring and reporting. See page 15 for details.

Impacts of COVID-19 on Dam Safety:

- Critical dam safety activities, such as surveillance, inspection and spillway gate testing, continued with minimal interruption under safe work protocols.

Board briefing – DAM SAFETY QUARTERLY REPORT**Risk Profile of BC Hydro's Dams****Dam Safety Contribution to Enterprise Risk**

Dam Safety is assigned a high “risk priority” within BC Hydro’s Enterprise Risk report. Please refer to that report for additional details.

Vulnerability Index Update

Identified physical deficiencies in BC Hydro’s dams and the degree of concern that exists with respect to their impact on the integrity and performance of the dam are characterized by the Vulnerability Index. The Vulnerability Index for each currently identified issue at each dam site is shown in Figure 1. Dams are sequenced from left to right in order of increasing downstream consequences, per the BC Dam Safety Regulation. Changes in Vulnerability Index for actual and potential deficiencies (including those related to spillway reliability) aggregated across the entire fleet of dams, are tracked on a quarterly basis and shown in Figure 2.

Notable changes in Vulnerability Index in F2021 Q3 are described below and identified in Figure 1. There was one Vulnerability Index addition and no Vulnerability Index reductions in the database.

- 1** A Vulnerability Index **increase** of 1.84 (PN deficiency) at **Buntzen Dam**.
An engineering review of the penstock has determined that the current generating unit wicket gate closure speed could result in penstock pressures slightly exceeding the historical maximum design pressure. The increased pressure results in the allowable stress in the penstock being exceeded, but the stress remains below the steel’s yield strength and there is no significant concern for penstock damage. Engineering is evaluating alternate wicket gate closure times to reduce penstock pressures and address this issue.

The characterization of issues and their rating using the Vulnerability Index is now recognized to constitute engineering content and to be subject to engineering quality management requirements. Last year, Dam Safety implemented new procedures to ensure that any new or revised entries in the database meet those requirements and are supported by sealed engineering reports and covered by sealed memoranda prepared by the responsible Dam Safety Engineer. Because of this, there are some deficiencies that have been addressed by project work that as of the end of Q3 had not yet been closed out in the Issues Database as the Dam Safety Engineers assemble and review the relevant project documentation and prepare their own engineering memos to properly document the changes.

The installation of a concrete plug in the power tunnel at Spillimacheen Dam was reported last quarter. With the completion of engineering documentation, the issue at Spillimacheen (see the F20 Q4 report) has now been completed and the Vulnerability Index of 3.42 has been removed. This activity occurred after the end of F21 Q3, however, so is not reflected in this report’s charts and will be fully recorded in next quarter’s report.

Other physical deficiencies have recently been resolved for which re-rating of the Vulnerability Indices and/or closure of the associated issues is in progress, including the grouting of the vertical movement gauges in Mica and Revelstoke Dams to eliminate their potential to induce hydraulic fracturing or internal erosion the cores of those dams (also reported last quarter), and recently completed spillway gate improvements at WAC Bennett Dam and Ruskin Dam.

Board briefing – DAM SAFETY QUARTERLY REPORT

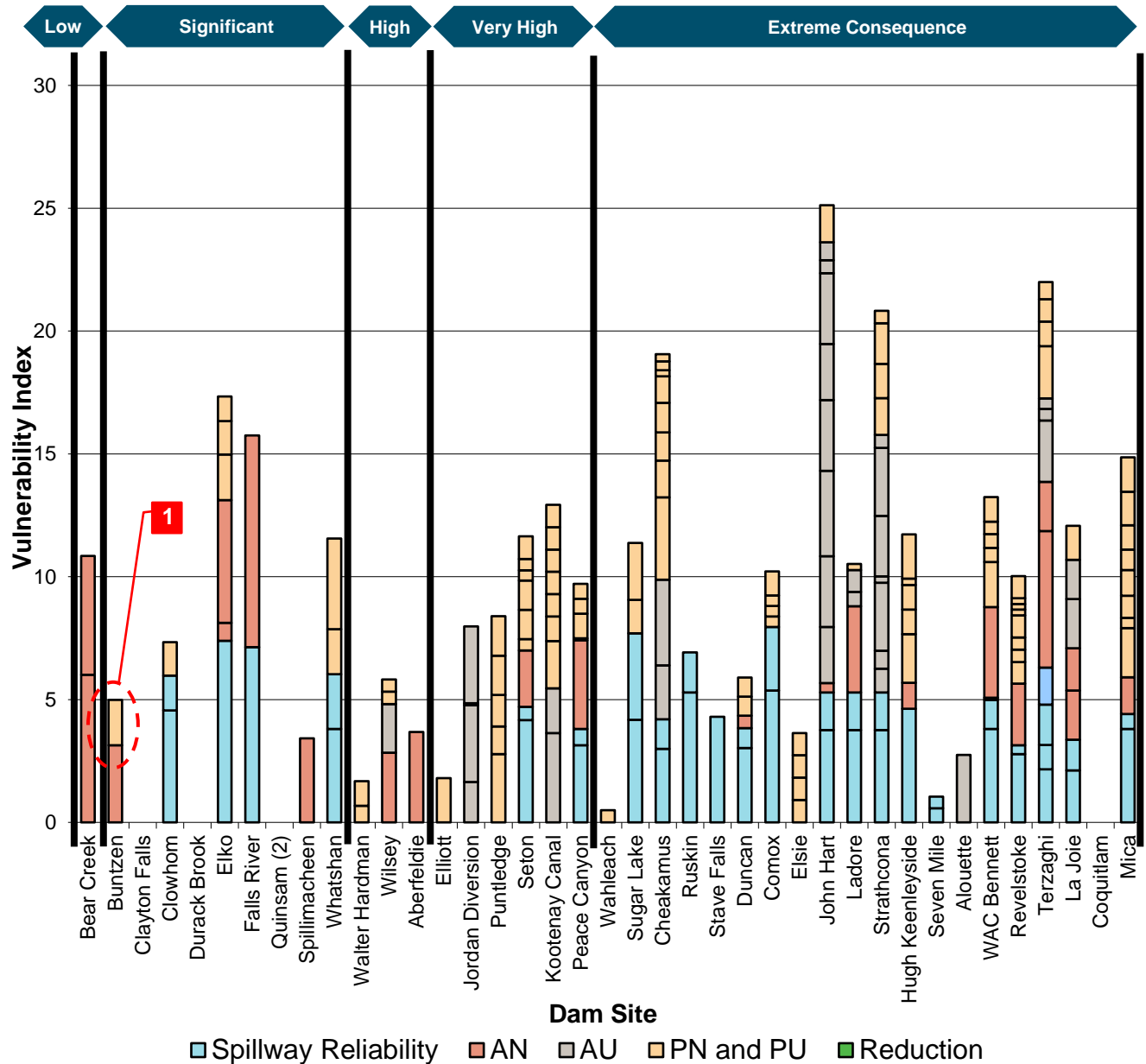


Figure 1 Dam Safety overall risk profile at the end of F2021 Q3, as represented by the Vulnerability Index. There were changes this quarter as indicated by the numbered boxes.

- AN** *Actual* deficiency (demonstrated to exist) under *normal* load conditions (associated with daily or short-term operations)
- AU** *Actual* deficiency (demonstrated to exist) under *unusual* load conditions (associated with flood and earthquake loading)
- PN and PU** *Potential* deficiency (requiring further investigation to demonstrate existence) under either normal or unusual conditions
- Spillway Reliability** Actual or potential deficiency related to reliability of the dam’s spillway and/or other flood discharge systems

Board briefing – DAM SAFETY QUARTERLY REPORT

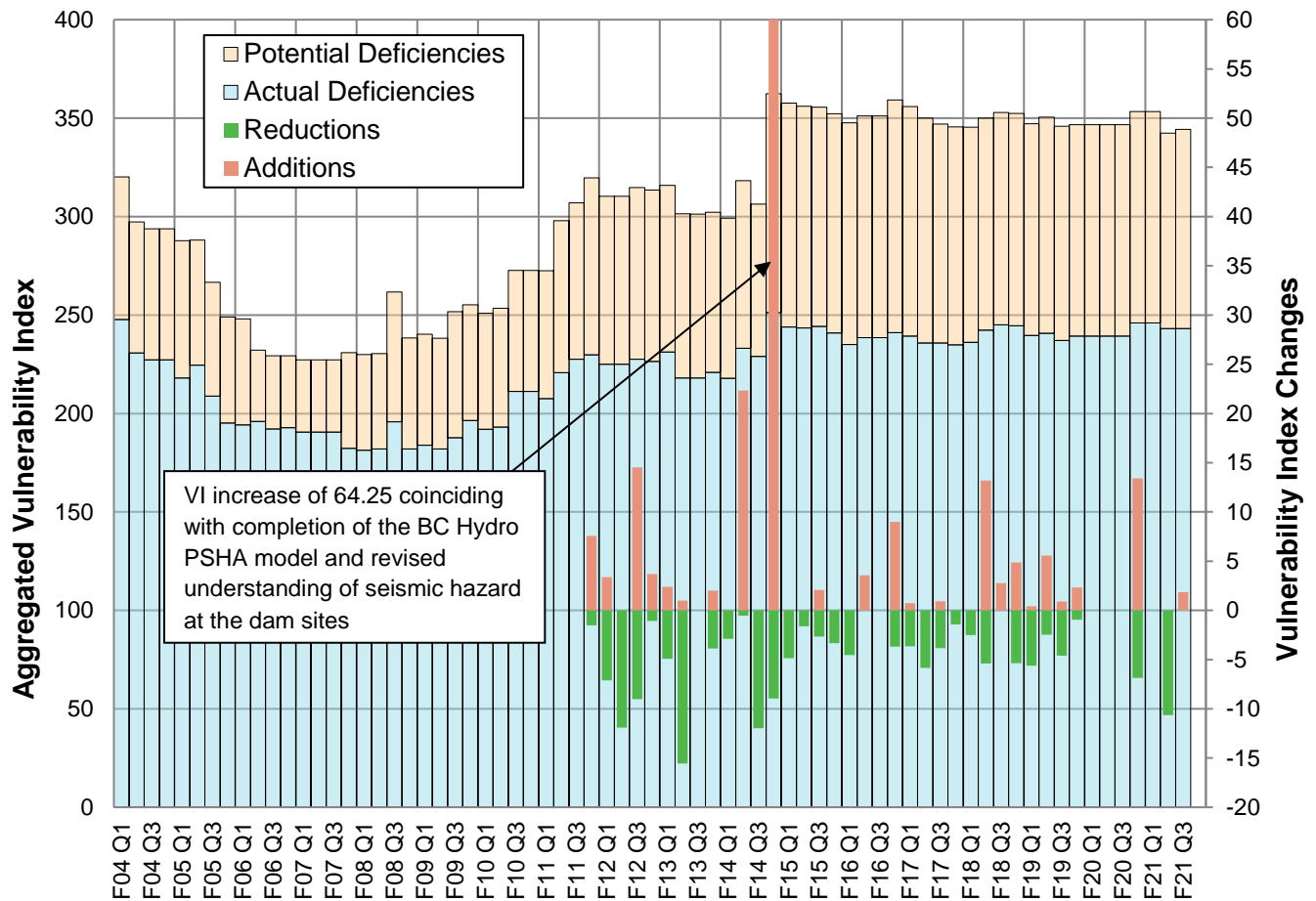


Figure 2 Changes and trends in the Vulnerability Index aggregated across the BC Hydro system. Note: the bars are “stacked” such that total aggregated Vulnerability Index is given by the top of the Potential Deficiencies bar.

Non-Conformances in the Dam Safety Program

Activities to review, resolve and close non-conformance issues continued in F2021 Q3. A total of 39 non-conformance issues were completed and 22 new non-conformance issues were added to the database for a net reduction of 17 issues in Q3 and 44 issues in calendar year 2020.

Since 2018 when this issue was targeted for special attention, Dam Safety’s focus on resolving non-conformance issues, combined with recent efforts to critically assess existing and new issues to distinguish true non-conformances from less urgent recommendations and suggestions for improvement, have been effective in reducing the number of outstanding issues. In this period there has been a net reduction of 139 non-conformance issues, or 25 percent. See Figure 3.

To help sustain this progress, a clarified definition of non-conformances is being developed and documented for use by Dam Safety Engineers and Dam Safety Reviewers. Additionally, new procedures for quality management of database entries and updates are being drafted for inclusion in a general revision to the Dam Safety Program Management System.

Board briefing – DAM SAFETY QUARTERLY REPORT

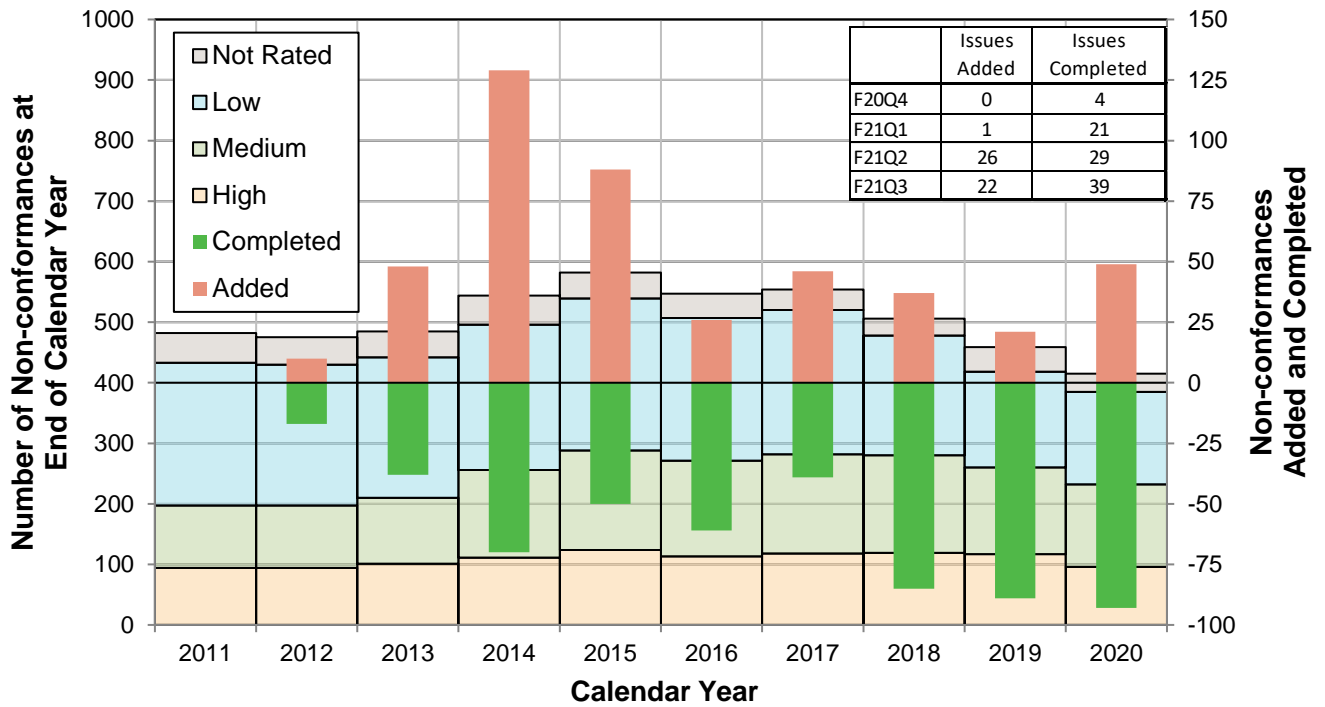


Figure 3 Changes and trends in the total number of non-conformances within the Dam Safety Program. Note: this data is plotted by calendar year.

New Issues

Wahleach Tunnel Sudden Dewatering

On the evening of December 12, 2020, Fraser Valley Operations received an alarm that the diesel generator that supplies power for Wahleach Generating Station’s Intake at Jones Lake had failed. As backup power at the intake is supplied by a battery bank that has capacity expected to last 24 hours and given safety concerns for driving the narrow mountain roads in the dark, a decision was made to wait until daylight to send crews up to investigate the alarm. At approximately 7:00am of December 13, before the crew arrived at the Intake, Fraser Valley Operations received a communication failure alarm triggered by the loss of power at the battery bank. On loss of power, the protection systems activated as designed and closed the intake gate. With the generating unit still online, this resulted in a rapid dewatering of the tunnel between Jones Lake and Wahleach GS.

Following the incident, Wahleach GS was taken out of service until the impacts could be assessed.

Firstly, the stability of the slope above the Wahleach GS is closely monitored even though significant work was completed in the 1990s to improve it. Changes in water pressure in the rock surrounding the tunnel can impact stability and short-term, minor slope displacements are observed whenever the tunnel is dewatered, even in controlled circumstances. The displacements recorded by instruments installed in the tunnel and slope were promptly reviewed by Dam Safety slope specialists and found to be similar to those observed during planned dewatering activities, alleviating slope stability concerns.

Board briefing – DAM SAFETY QUARTERLY REPORT

Secondly, rapid dewatering of a high pressure tunnel like this can cause it significant damage. A similar incident at Wahleach in 2011 caused significant rockfall from the tunnel and shaft walls that almost filled the 3-bay rock trap, which is the last line of defence against rock fragments entering the penstock and turbine and causing serious damage to the facility. It was determined that the unit would have to remain offline until an inspection of the lower section of the tunnel could be completed. The process to dewater the remainder of the tunnel, assure safe entry and inspect the tunnel and rock trap required close collaboration between Stations Field Operations and Dam Safety and was completed on 23 December. The tunnel was found to be in good condition with only a few scattered pieces of loose rock, one bay of the rock trap about 1/3 full and the other two bays completely empty. With these positive results, the unit was returned to service on January 7, 2021.

Stations Field Operations and Dam Safety are now conducting a root cause analysis of this event. The role played by existing operating orders and alarm response procedures in exacerbating this incident will be examined. The results of this review of the incident are expected by the end of March 2021.

Peace Canyon Loss of Communications

On January 3, 2021 the deluge system at Peace Canyon Generating Station activated after a sprinkler head was damaged, causing a flood that extended into the communications room. Electronics in the communications room were damaged, including those for the alarms and controls at the G.M. Shrum and Fraser Valley Operations control centres for the Peace Canyon generating units and spillway gates (though operating data remained visible). In response, Peace Canyon was promptly placed into local control and electricians were stationed at site to control the generating units and spillway gates, as required, and thereby control of Dinosaur Reservoir was maintained. There was no impact to Dam Safety's Automated Data Acquisition System. Repairs to the damaged electronics were completed and remote control and alarm visibility was restored on January 6.

Update on Existing Issues**Dam Safety Response to COVID-19**

Dam Safety staff are generally continuing to work from home or dispatch from home to the dam sites and reservoir slopes. Dam Safety critical work has continued with very little impact; during Q3 there were no inspections or spillway gate tests missed.

Downton Reservoir (La Joie Dam) Surcharge

Last quarter's report informed the Capital Projects Committee that, to mitigate the impacts of an extended outage of the Seton Generating Station on increased flows in the Seton River that could imperil salmon runs, a temporary surcharge of Downton Reservoir to a maximum elevation of 740.0 m was authorized on September 24, 2020 to be in effect through December 31, 2020. This allowed the reservoir to rise above the current Normal Maximum Reservoir Level of 734.0 m that has been in place since 2015 to manage the risk of failure of La Joie Dam following a major earthquake and the cascading failure of Terzaghi Dam downstream.

The reservoir entered a state of surcharge on October 8 that continued until November 11, reaching a peak reservoir elevation of 735.05 m. During this period, the reservoir was managed under an Interim Dam Safety Risk Management Plan and monitored by the Bridge River Dam Safety Engineer. Notably, the total contained water volume in the two reservoirs never reached levels that could lead to a cascading failure of Terzaghi Dam in the event of an earthquake-induced failure of La Joie Dam.

Board briefing – DAM SAFETY QUARTERLY REPORT**Ruskin Dam – Left Abutment**

As reported in the Fiscal 2020 Q4 report, two sinkholes developed on the downstream slope of Ruskin Dam's left abutment, just upstream of the powerhouse and adjacent to buried ductwork. Subsequent investigations, including dynamic cone penetrometer testing, have since identified that there has been erosion of native clays to a depth of approximately 5 metres below the surface in an area where ground disturbance may have occurred as the result of construction of buried ductwork and foundation structures for a disconnect switch on the upstream side of the powerhouse, which also coincides with the alignment of the Unit 3 water conveyance tunnel.

Instrumentation is showing a clear pattern that seepage and erosion of soils in the slope are directly linked to heavy rainfall events. There is no indication of any connection between the reservoir and observed seepage, so this situation is not considered to pose a risk to the dam. Nevertheless, ongoing erosion of this nature does pose a threat to the foundation of the structure supporting the Unit 3 disconnect switch and the anchors that were installed to stabilize the powerhouse's north wing in the event of an earthquake. It also increases the risk of slope movements that could damage the downstream filter blanket that was constructed to improve the earthquake resistance of the left abutment. In the short term, however, Engineering does not anticipate sudden slope movements that could lead to such damage. Given the potential for localized ground movements, however, worker activities in the area are being limited to those necessary and in the presence of an Engineering representative familiar with the hazard.



Figure 4 Ruskin Dam left abutment as at 8 January 2021.

Left: Locations of the two sinkholes relative to the powerhouse.

Right: Polyethylene sheets being installed to protect the slope from rainfall.

As an interim measure, polyethylene sheets have been installed on the slope to prevent heavy rainfalls from seeping into the slope and causing further erosion. See Figure 4(b), above.

Dam Safety is initiating the Ruskin Sinkhole Remediation Project to develop and implement a permanent fix. Engineering resources have been assigned which, in some cases, has meant deferring other Dam Safety projects. A specialized drilling and sampling program is being organized for February and alternatives for in-situ ground improvement or removal and replacement of the eroded clays are being developed. The project intends to engage contractors and external experts early in the design process to assist in developing these alternatives and implementing the fix.

Board briefing – DAM SAFETY QUARTERLY REPORT

Compliance with Processes and Regulations

Regulatory Communications – BCUC

There were no further communications with the British Columbia Utilities Commission regarding the safety of BC Hydro dams on the Peace River in Q3 beyond those described in last quarter's report.

Regulatory Communications – Comptroller of Water Rights

Regulatory Communications with the Provincial Dam Safety Office consisted of authorization to decommission Bugaboo Dam and scheduling of the annual meeting between the Comptroller's Office and BC Hydro Dam Safety to take place in February 2021. In addition, OMS Manuals and Dam Safety Reviews were submitted as discussed in the following sections.

Operation, Maintenance and Surveillance Manuals

Each dam has an Operation, Maintenance and Surveillance Manual ("**OMS Manual**") for Dam Safety that identifies responsibilities and expectations within BC Hydro for maintaining the safety of the dam. The OMS Manuals are a requirement under the Dam Safety Regulation and must be updated every seven to ten years, depending upon the dam's failure consequences classification.

The work and delivery plans for the OMS Manual updates are depicted in Figure 5(a), below. Overall, there are ten OMS Manuals scheduled for updating in F2021. Updates to the Bear Creek, Quinsam Diversion, Quinsam Storage and Whatshan Dams were completed in Q3 and the year-to-date delivery of updates remains on plan.

OMS Manual updates for Elko, Buntzen, and Coquitlam Dams are scheduled for completion in Q4 and work on these is continuing generally to plan. All three of these updates are forecast to be completed on schedule in Q4.

Also scheduled for delivery in Q4 is a significant revision to the OMS Manual for Ruskin Dam following the recent major upgrades. Work on this Manual has progressed as far as it can until additional information is available from the project. Specifically, delivery of the construction report which contains much of the detailed information that comprises OMS Manual content is behind schedule and now isn't expected to be complete until the summer of 2021. The delay to progression of the OMS Manual accounts for the lagging number in "Work Plan Completion" in Figure 5(a) and the table below. The Project Engineer, who has also been occupied with responding to the sinkhole incident described above, is arranging to free up time in February to assist Dam Safety in acquiring the required information and to provide descriptions of new dam systems for inclusion in the Manual, prior to completion of the construction report. These efforts notwithstanding, the OMS Manual update for Ruskin Dam is now forecast to be late and not completed until Q1 of F2022.

	Year-To-Date			Year-End	
	Actual	Target	Indicator	Forecast	Target
OMS Manual updates completed	6	6	✓	9	10
Completion of F21 work plan	75%	86%	✗	Measure only	

Board briefing – DAM SAFETY QUARTERLY REPORT

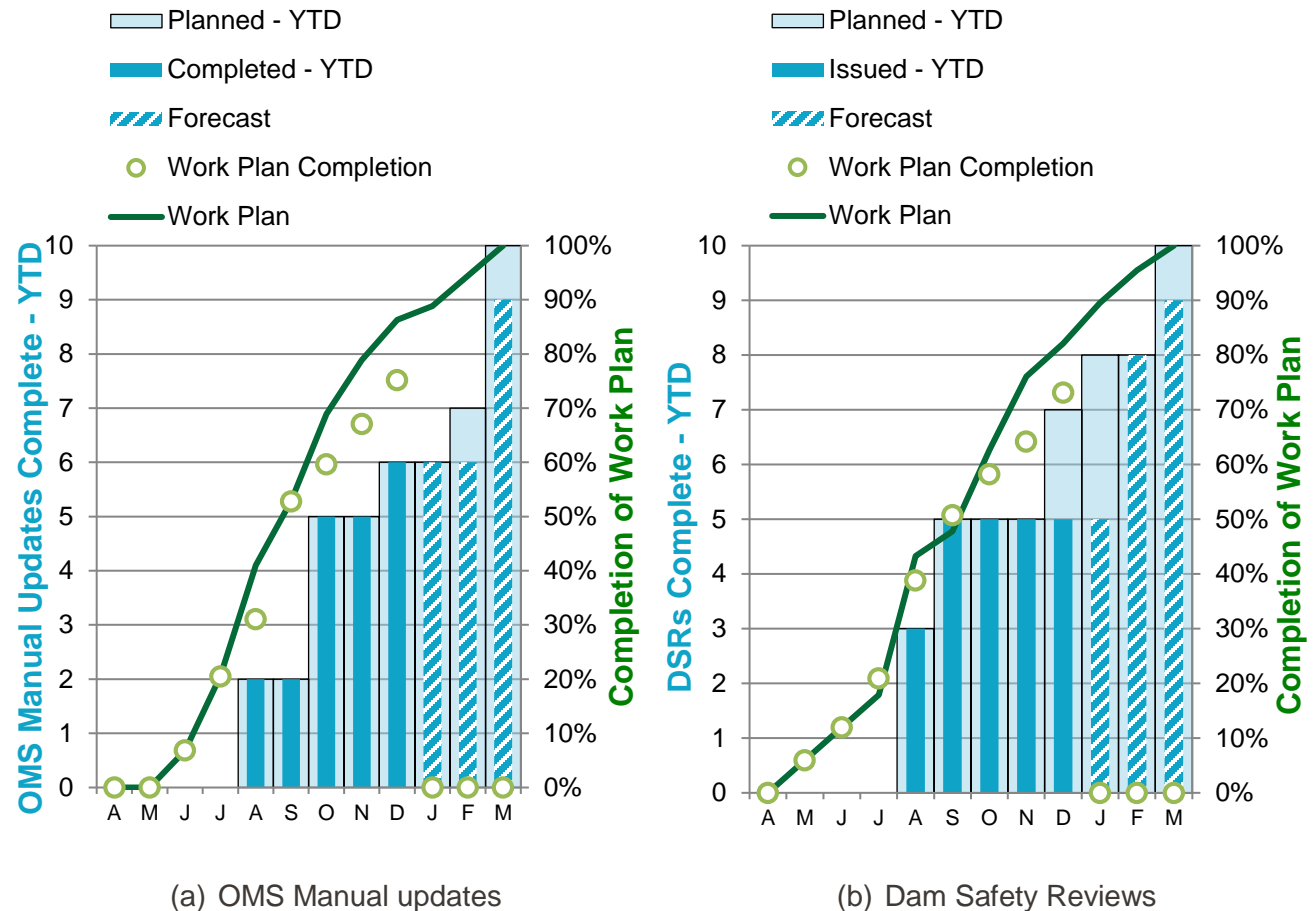


Figure 5 F2021 work and delivery plans for (a) OMS Manual updates and (b) Dam Safety Reviews.

Dam Safety has been working to a schedule for delivery of OMS Manual updates that is intended to return the currency of BC Hydro’s OMS Manuals to a state of full compliance and was provided to the Comptroller of Water Rights in January of 2020. Delivery to this schedule has been Dam Safety’s priority over this past year. Of the eleven Manual updates identified at that time as being overdue and the two additional updates that were due in 2020, nine updates have since been completed (six in F21) and three are forecast for completion to that schedule this March. The sole outlier to having achieved full compliance at that time will be the Ruskin Dam OMS Manual. This delay in achieving full compliance is disappointing but does not erase the fact that, through discipline and much effort, a significant backlog of updates will have been eliminated in just over one year’s time.

A discussion of the coming year’s schedule for OMS Manual updates – including completion of the overdue Ruskin update – will be held with the Comptroller’s office in February’s meetings.

Dam Safety Reviews

Dam Safety Reviews are a regulatory requirement carried out at minimum intervals of every five to ten years for High, Very High and Extreme consequence dams.

Board briefing – DAM SAFETY QUARTERLY REPORT

The work and delivery plans for the Dam Safety Reviews are depicted in Figure 5(b), above, and are summarized in the table below. In all, ten Dam Safety Reviews are scheduled for completion in F2021. Five of those Dam Safety Reviews were issued in Q2 and work is currently active on the other five, namely: Aberfeldie, Coquitlam, Jordan, Strathcona, and Sugar Lake. Draft reports were received from the external Review Engineers for Aberfeldie, Jordan, and Sugar Lake in Q3.

The Aberfeldie and Jordan Dam Safety Reviews were both due to have final reports submitted in December but on reviewing the draft reports received from the external Review Engineers, it was determined that further work on those reports would be required before they could be issued. At the time of writing this report, revised reports for these two dams have been received and are being reviewed. Both are expected to be issued in February.

The draft report for Sugar Lake Dam was received from the Review Engineer in mid-December and reviewed by Dam Safety and discussed with the Review Engineer in January. The final report for this Dam Safety Review is also expected to be issued in February.

The draft report for the Coquitlam Dam Safety Review is due at the end of January and it is expected that it can be reviewed and finalized for issuing on schedule in March. The draft report for the Strathcona Dam Safety review, however, is now two months overdue. Dam Safety has been told that the draft will be delivered shortly but, given the complexity of the dam and the volume of information that is likely to require review, our forecast now is that this Dam Safety Review will not be issued until Q1 of F2022.

	Year-To-Date			Year-End	
	Actual	Target	Indicator	Forecast	Target
Dam Safety Reviews completed	5	7	✘	9	10
Completion of F21 work plan	73%	82%	✘	Measure only	

While it is disappointing that the scheduled completion of Dam Safety Reviews will fall short in F21, it is important to understand that the delivery schedule and work plan in Figure 5(b) and the table above are purely internal BC Hydro targets. Dam Safety Reviews are due within a given year and are not prescribed by the Comptroller of Water Rights to be delivered in any given month or quarter. From a regulatory perspective, therefore, there are no implications to the “late” completions of Dam Safety Reviews described above; the required regulatory schedule will be met. There will, however, be impacts to Dam Safety’s work plan for F2022 as completion of the Strathcona Dam Safety Review will have to be accommodated therein.

Surveillance

Inspections

Routine weekly / monthly inspections are a regulatory requirement. These visual inspections are carried out by trained inspectors within Dam Safety or Stations Field Operations using checklists prepared by the Dam Safety Engineer. The purpose of these inspections is to identify changing conditions at a dam, reservoir or appurtenant structure that could threaten the safety of the dam.

All 411 scheduled site inspections were completed in Q3.

Board briefing – DAM SAFETY QUARTERLY REPORT

Routine Inspections	F21 Year-to-date	F20	F19	F18	F17	F16
Completed	1232	1642	1638	1595	1583	1594
Missed	1	6	2	16	29	24

Instrumentation and Monitoring

Dam Safety Surveillance collects checks and assesses about 2 million data points a month. A vast majority of the data is collected and checked against threshold values automatically by the Automated Data Acquisition System (ADAS). Even though most of the data is checked automatically it is essential that qualified staff review the data regularly to ensure the systems are functioning as expected. The Dam Safety Technologists in each region regularly check instrumentation data plots for all dams to ensure the ADAS system is functioning as expected, identify any unusual trends, and ensure continued accuracy of the data being for ongoing engineering assessment. They are tasked to perform three such checks per week. During Q3, 213 checks were completed, exceeding the target of 195.

Reservoir Slopes

Dam Safety's Slope Surveillance Program completed two site landslide inspections (Seven Mile Reservoir; Revelstoke Rock Slopes) and maintained continuous monitoring of the Reservoir Slopes Instrumentation System. Reservoir slopes specialists also provided ongoing oversight of the Downie Slide Instrumentation Project and the 731 Block Slope Stabilization Project, both associated with Revelstoke Dam.

All reports for the F21 landslide inspections have been completed.

Unusual Events or Observations

The Dam Safety On Call Person (DSOP) responded to 88 calls in Q3 of F2021, which included instrumentation alarms, operational inquiries, operations notifications during high inflows and earthquake notifications.

Maintenance

As described in the F2021 Q1 Report, Dam Safety has taken on elements of maintenance planning and, jointly with Generating Stations Maintenance Planning within Stations Asset Planning, will prepare and administer the annual maintenance plans for the dams and generating stations. The two groups are presently developing a set of principles that will form the basis for how they will interact to develop, manage and oversee the combined generation stations maintenance plan.

Civil Maintenance

As of the end of Q3, the Civil Maintenance Program had completed 34 projects against a plan of 36, with a total year-to-date spend of \$2.408M against a plan of \$2.630M. The program is on track to catch up to its planned spend and project completion by the end of F2021. Project completions include Sugar Lake Dam left bank road repairs, and Peace Canyon spillway sill concrete repairs. The program was also able to complete a notable first; a remotely operated vehicle ("**ROV**") survey and inspection

Board briefing – DAM SAFETY QUARTERLY REPORT

of the Wahleach tunnel vertical shaft that promises to eliminate the need for dangerous rope access inspections. The final report is expected in Q4 and this work will be highlighted in next quarter's report.

There were slight modifications to the Civil Maintenance Program in Q3. One new project – Lower Buntzen penstock expansion coupling repair – was added to the plan and the program total budget was reduced to \$2.890M from \$3.019M as completed projects have come in under budget.

Last quarter, Dam Safety began reporting to the Capital Projects Committee on the Civil Preventative Maintenance Program, which is in its first full year of implementation. The Q2 report noted a slow start and underperformance for the program due, in part, to impacts from COVID-19 work protocols but more significantly to this being a new program. It is encouraging to report that the Civil Preventative Maintenance Program has since made very good progress in improving its delivery and catching up from the slow start. In Q3, 257 preventative maintenance tasks were completed on a plan of 141; and over the year to date, 620 preventative maintenance tasks have been completed on a plan of 726.

Spillway Gate Testing and Maintenance

During Q3 of F2021, all 63 scheduled gate tests at 23 sites were carried out. No gate system failed to operate on demand during testing. In seven cases, while gates did operate on demand, certain individual components of the gate system that are critical to one or more operational paths of a gate – “lines of defence” – malfunctioned. Three of those were corrected within the quarter. A total of 41 condition-based or corrective maintenance issues were identified in Q3 of F2021 while a total of 42 new and previous issues were addressed. Ten of the issues addressed were “line of defence” issues, while the remainder were other deficiencies.

The total number of outstanding issues has remained stable, with a slight decrease from 167 at the end of Q2 to 166 at the end of Q3. These 166 issues comprise 145 corrective and condition-based maintenance issues recorded in Passport, 10 other issues being tracked by Dam Safety but not in Passport, and 11 issues that are to be resolved through small capital projects and are being tracked through the capital planning process.

Overall in 2020, the number of issues resolved exceeds the number of issues identified. This progress is shown in Figure 6, below, which plots the numbers of issues identified (tan bars) and closed (blue bars) in each *fiscal* year.

The observant reader will note that the numbers of issues being reported are higher than in previous quarters' reports. In the past, Dam Safety has tracked multiple Work Orders of related items (e.g., SPOG1 spring plates, SPOG3 spring plates) as a single line item. During Q3, to improve correlation with Passport and the reporting of our maintenance delivery partners, Dam Safety has adjusted the tracking spreadsheet by separating those multiple Work Orders into separate line items. Consequently, due entirely to this described “accounting” change, the number of issues being reported has increased. Further, plots in previous quarters' reports have referred to statistics collected on a calendar year basis; with this quarter's report, statistics for spillway gate issues and maintenance are collected and reported on a fiscal year basis.

Progress in reducing the number of outstanding issues has slowed in Q3 as compared to Q2, but this is primarily a result of the number of new issues identified (41 in Q3 vs. 17 in Q2) rather than a lack of progress in resolving issues (42 in Q3 vs. 45 in Q2).

Board briefing – DAM SAFETY QUARTERLY REPORT

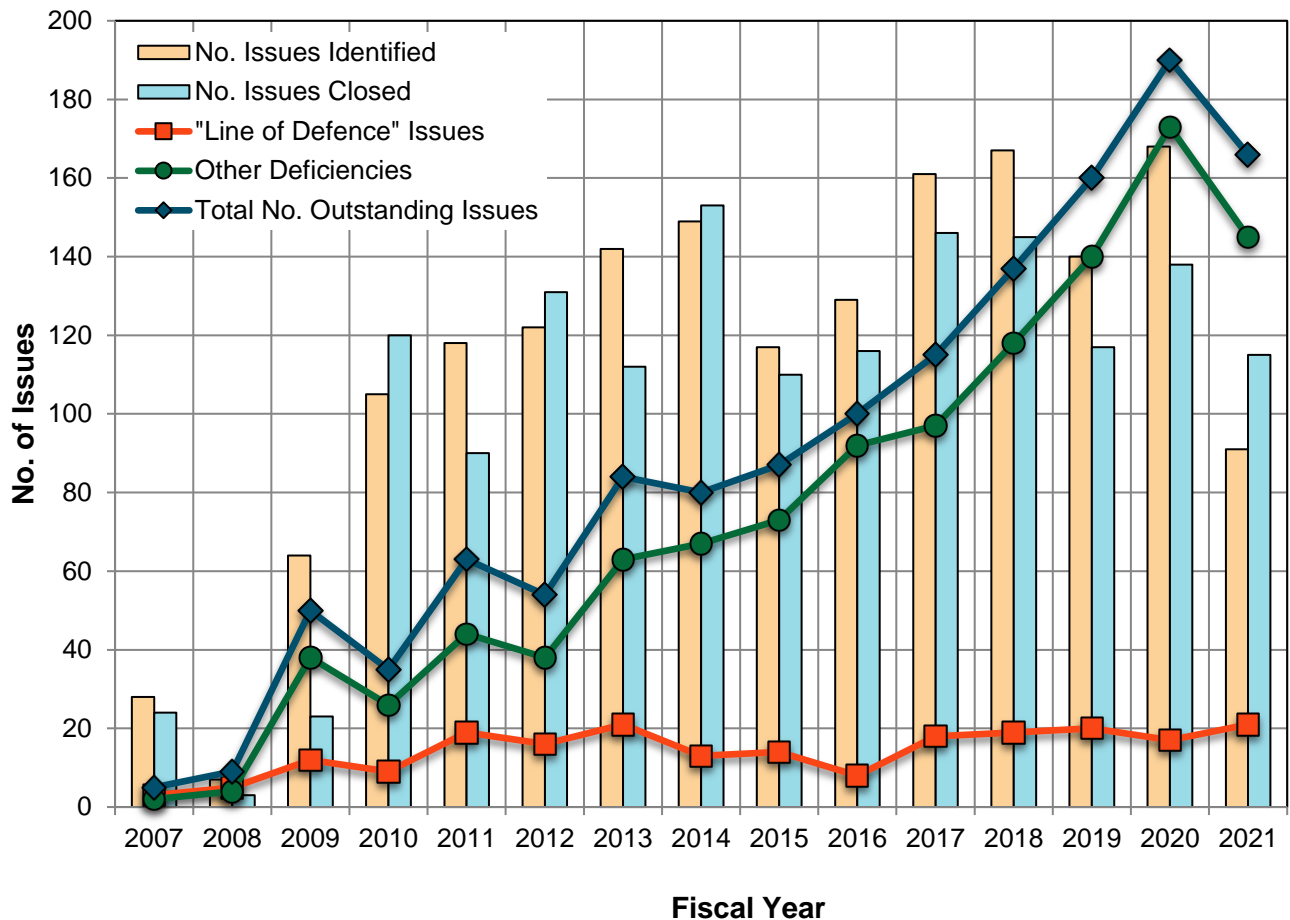


Figure 6 Number of cumulative identified and outstanding spillway gate corrective and condition-based maintenance and procedural issues at the end of each fiscal year.

During Q3 Dam Safety continued engagement with Stations Asset Planning and delivery partners in Program and Contract Management to maintain focus on the gate reliability issues and to explore opportunities for improvement in execution and reporting. Program and Contract Management conducted a “deep dive” on outstanding gate reliability issues that are in the F21 plan to proactively identify execution risks and to communicate the status of the plan to Dam Safety. At the time of writing there were 66 work orders in Passport related to dam safety gate reliability that have been approved for completion in F2021; 23 of those were planned for F21 execution based on prioritization of the outstanding inventory and 43 were approved in-year. 51 of those 66 work orders had been completed up to the end of Q3. This is a significant increase in plan completion over Q2 (23 completed at that time) and demonstrates a concerted focus on this subset of maintenance work. In addition, there are three outstanding issues being actioned through active capital projects.

As stated in the F2021 Q2 Report, Dam Safety has adapted existing practices for prioritization of maintenance work orders to better reflect the operational and safety-critical nature of spillway gate systems. In Q3 Dam Safety began the roll-out of the changes to the prioritization. Communication of the changes to impacted groups will continue over the course of Q4 with the expectation that they will be incorporated into the F22 Stations Business Rules.

Board briefing – DAM SAFETY QUARTERLY REPORT**Emergency Preparedness and Public Safety**

Emergency Preparedness is managed by Security & Emergency Management. Dam Safety reports on the updating of emergency plans for compliance with the BC Dam Safety Regulation as part of annual compliance reporting to the Comptroller of Water Rights. Public safety near dams and reservoirs is managed by the Public Safety team in Safety Engineering & Work Methods. Dam Safety reports on Public Safety activities related to dams during the Dam Safety Reviews. Please refer to other reports for quarterly updates on emergency preparedness and public safety around dams.

Capital Projects

Summaries of Dam Safety Capital projects are available for reference in the Dam Safety “book” in Diligent. This section provides updates for the newly launched projects and for the projects where significant developments occurred or milestones were achieved.

In Q3 of F2021, Dam Safety and Stations Asset Planning reached agreement in principle on which assets would fall under each group’s respective management. The principal change is that Dam Safety is assuming full responsibility for asset management of generation water passages (penstocks and power tunnels) and their associated flow control devices (intake gates, penstock inlet valves). Consequently, oversight of capital projects relating to these assets has been transferred to Dam Safety. The first project below describes one of these newly transferred projects.

Bridge River 1 – Strip and Recoat Penstocks 1-4

The coatings on the Bridge River 1 Penstocks are reported to be failing, with significant defects throughout the surfaces. Without intervention the steep penstocks will progressively corrode, resulting in metal loss, which may ultimately undermine the structural integrity and safety of the penstocks. Failure of these high-pressure penstocks would impact downstream infrastructure, including the CN railway line, public access road, BR1 Powerhouse, and the BR1 switchyard.

The project was initiated by Stations Asset Planning but in Q3 Dam Safety took over as the planning organization. The scope of the project, which is now in Feasibility Design, is to strip and recoat both the internal and external surfaces of the four penstocks

Bridge River 1 – Mitigate Surge Spill Hazard

This project was initiated following the BR1 Penstock Leak Detection Project in which a penstock leak detection system and a penstock inlet valve auto-closure system were installed to automatically close the valves upon detection of a penstock leak. Rapid closure of the Bridge River 1 penstock inlet valves, however, would lead to pressure surges in the upstream tunnel and potential overtopping of the surge shafts at the top of the penstocks. This project will construct structures around the surge shafts to contain spills from overtopping of the shafts. This will enable the auto-closure system to be commissioned and facilitate a future project to upgrade the penstock inlet valves to be capable of closure under the flow of a full penstock rupture. Preliminary Design was completed in Q3 and Partial Implementation was advanced to allow for vegetation removal outside of the bird nesting period without impacting the project schedule. The project has completed Definition Phase and has obtained funding approval for Implementation Phase.

Board briefing – DAM SAFETY QUARTERLY REPORT**Bugaboo Diversion Dam Decommissioning**

The Bugaboo Creek Diversion was constructed to provide water to the Spillimacheen Generating Station but has been abandoned since the 1957 freshet washed out the spillway control structure. As BC Hydro derives no benefit from this facility and there is no financial justification to re-establish the diversion into the Spillimacheen River, this project was released in 2016 to decommission the Bugaboo Diversion Dam and diversion works. On completion of the Identification Phase, partial removal by lowering the dam to meet the criteria of a “Minor Dam” in the Dam Safety Regulation was confirmed as the Preferred Alternative. This gave the benefit of allowing the retention of a wetland in the dam’s forebay with minimal ongoing requirements for monitoring and reporting.

Partial removal commenced in F2021 Q2 and was completed in Q3. Engineering Design Conformance Records have been issued and the dam’s existing Conditional Water License will be changed to a Conservation License.



Figure 7 (Left) On commencement of dam crest removal. (Right) On completion.

Duncan Dam – Refurbish Spillway Gates

This project will extend the service life of the existing spillway gate structures by limited, selective refurbishment. During Conceptual Design, the project developed a refurbishment scope that includes locally strengthening the bottom girder webs, improving drainage at the bottom girder, replacing bolts in critical areas, and removing and replacing failed coatings where necessary. The project completed Conceptual Design Stage during Q3. The project gained approval to proceed to a combined Feasibility and Preliminary Design Stage given the limited scope of design work.

Hugh Keenleyside – Floating Guide wall Pontoon 4 Armouring

This project was initiated in Q3 to restore armouring to the end of the floating guide wall at Hugh Keenleyside after pontoons 5 and 6 sank earlier in 2020, as described in the F2020 Q4 quarterly report. The end of Pontoon 4 is currently unarmoured and exposed to marine impacts. Significant impacts could lead to cracking of the concrete, causing the pontoon to sink. The debris boom is connected to the end of Pontoon 4 and could be either disconnected or pulled underwater. Failure of the debris boom could lead to blocking of the spillway gates and a loss in discharge capacity. The

Board briefing – DAM SAFETY QUARTERLY REPORT

project will recover armouring panels from Pontoon 6 and install them on Pontoon 4 or fabricate new armouring panels for Pontoon 4 to protect it from damage.

Dam Safety Investigations

Dam Safety Investigation Projects (“DI”s) are generally performed to either refine knowledge regarding potential issues or non-conformances of information recorded in Dam Safety’s Issue Database or to perform precursor work for planned capital upgrade projects. This section provides descriptions of newly launched DIs and updates for those DIs where significant developments have occurred or where milestones were achieved.

Stochastic Modelling of Extreme Floods – Columbia River

This investigation was launched in F2017 to develop a stochastic (probabilistic) flood model for the Canadian portion of the Columbia River System, which will be used to assist BC Hydro Dam Safety in understanding the flood risk of the Columbia River System as it impacts the safety of the dams and the downstream communities, and to develop management strategies (e.g., operational changes, upgrades) to address this risk. Development of continuous probability distributions of various flood characteristics (inflow, outflow, peak reservoir level) for eight modelled projects – Mica, Revelstoke, Keenleyside, Whatshan, Kootenay Canal, Duncan, Sugar Lake and Libby – is forecast to be complete by the end of Q4.

In Q3, Dam Safety added scope to incorporate random gate spillway failures into the stochastic flood modelling, using estimated gate failure rates from historical testing records. The goal of the analysis is to investigate – in an approximate way – the sensitivity of the flood withstand in the system to random spillway gate failures, providing insights to which dams are most vulnerable to gate reliability issues during flooding.

Aberfeldie Penstock DI

Slope erosion was observed along the Aberfeldie HDPE penstock right-of-way in late-April 2019. The subsequent inspection identified that the ground disturbance was caused by a penstock leak through the split factory weld at bend PI6. Further defects on additional bends were discovered and repaired between May and November 2019. Please refer to the F2020 Q1 through Q3 reports for additional information.

A subsequent investigation documented the deformation and out-of-roundness of the pipe, which the consultant noted could have occurred during construction or could be a result of slope movement. This DI was initiated to identify any additional weld deficiencies on the HDPE Penstock and to carry out a high-level review of the penstock slope. A penstock interior inspection and pressure testing of the elbow fittings was carried out in Q3. The inspection identified additional minor weld defects at three locations that were during the subsequent penstock inspection. The pressure test proceeded as expected and pressure gain was attained in all cases. The slope review will take place in F2022.

Additionally, scope for investigation of options to permanently remediate the defective penstock elbows is being developed for inclusion in this DI.