

8.0: Quarterly Dam Safety Report

Executive summary

The purpose of this report is to update the Operations, Planning, Information & Technology Committee of the Board of Directors on key dam risk management activities during the period from April 1 to June 30, 2023 (F2024 Q1) 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 June 30, 2023, but before the completion of this report have also been included.

The key highlights from F2024 Q1 and the beginning of F2024 Q2 documented in this report are:













- The system's aggregated Vulnerability Index decreased by 2.4 through F2024 Q1, with an outlet works operating gate returned to service at Sugar Lake Dam and a number of issues being recharacterized and rerated through database reviews. See page 3.
- The number of Non-conformance issues continued to be reduced, with a net reduction of 21 (6 percent) through Q1. See page 5.
- BC Hydro submitted the Application for the Ladore Spillway Seismic Upgrade Project and the Strathcona Discharge Upgrade Project. See page 6.
- Updates to Operation, Maintenance and Surveillance Manuals and Dam Safety Reviews scheduled for F2024 are progressing to plan. See page 6.
- Surveillance of the dams, reservoirs and reservoir slopes was completed to plan in Q1. Some reservoir slope inspections were advanced ahead of plan to avoid potentially worsening wildfire conditions. See pages 7 and 8.
- Maintenance on the dams continued to be well-delivered. Delivery of preventative and condition-based civil maintenance was ahead of plan through Q1. See pages 8 and 9. Spillway gate maintenance reduced the number of outstanding maintenance tasks from 104 to 94 over F2024 Q1. See pages 8-12.
- Construction on the first stage of the Alouette Headworks Tower and Surge Tower Seismic Upgrade Project commenced. See page 13.
- Small capital projects to stabilize the pier of the access bridge to the Bridge River 2 Intake and to construct a rock berm to prevent fish strandings at Hugh Keenleyside Dam were completed in Q1. See pages 13 and 14.
- The service lives of assets were extended through the completion of recoating of the interiors of the Cheakamus Generating Station's penstocks and refurbishment of the Duncan Dam spillway gates. See page 14.
- The seventy-year-old cruciform followers for Intake Operating Gate 3 at La Joie Dam were replaced. See page 15.

Presenter: Bob Schubak (Director, Dam Safety)

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Dam Safety Program Dashboard

The following dashboard provides an overview of the status of the Dam Safety Program. “Traffic lights” provide a qualitative indication of the status of each of five elements of the Program and trend arrows identify whether the status is improving, deteriorating or unchanged. As referenced, these indicators are supported by more detailed metrics and narratives in the report.

Risk Profile and Issues Management	 	<ul style="list-style-type: none">• Vulnerability Index (pp. 3-4): The aggregated Vulnerability Index was slightly reduced by 2.4 through Q4.• Program Non-Conformances (p. 5): The total number of non-conformances was reduced by 21 (approximately six percent) through Q1.• New and Current Issues (p. 5): No new issues arose in Q1 and existing issues pertaining to white sturgeon entering the low level outlets at Hugh Keenleyside Dam and the rockfall at Revelstoke Dam are being addressed through active projects.
Regulatory Compliance	 	<ul style="list-style-type: none">• British Columbia Utilities Commission (p. 6): BC Hydro submitted the Application for the Ladore Spillway Seismic Upgrade Project and the Strathcona Discharge Upgrade Project.• Operation, Maintenance and Surveillance Manual Updates (p. 6): Manual updates are proceeding to plan.• Dam Safety Reviews (p. 6): Dam Safety Reviews are proceeding to plan.
Surveillance	 	<ul style="list-style-type: none">• Dam Inspections (pp. 7-8): All 411 scheduled routine dam inspections were completed in Q1. Formal inspections and reporting are ahead of plan.• Reservoir Slopes (p. 8): The F2024 program of reservoir slopes inspections progressed ahead of plan, with inspections moved forward to avoid potentially worsening wildfire conditions.
Maintenance and Testing	 	<ul style="list-style-type: none">• Civil Maintenance (pp. 8-9): Civil maintenance progressed slightly ahead of plan in Q1.• Spillway Gates (pp. 9-12): 237 of 236 scheduled gate tests were completed; one extra test was performed. One gate failed to operate on demand, and has been repaired and returned to service. The number of outstanding maintenance tasks decreased by 10 over Q1.
Projects and Investigations	 	<ul style="list-style-type: none">• Capital Projects (pp. 13-15): Construction commenced on the Alouette Headworks Tower and Surge Tower Seismic Upgrade. Construction was completed in: refurbishment of the spillway gate structures at Duncan Dam; replacement of the Intake Operating Gate 3 followers at La Joie Dam; a rock berm to mitigate the potential for fish stranding on the north bank tailrace of Hugh Keenleyside Dam.• Dam Safety Investigations (p. 16): The Peace Canyon Dam Performance Assessment was advanced.
Legend:	     	<p>All areas within the Program element are being implemented to a satisfactory level. Minor, isolated issues may exist but are not deemed to be indicative of deteriorating performance.</p> <p>One or more areas within the Program element exhibit or are at risk of underperformance and are being monitored.</p> <p>One or more areas within the Program element exhibit unsatisfactory performance and require correction.</p> <p>Status of the Program element has improved over the quarter.</p> <p>Status of the Program element was unchanged over the quarter.</p> <p>Status of the Program element deteriorated over the quarter.</p>

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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 higher the value of the Vulnerability Index (scale of 0-10), the higher the likelihood of that deficiency leading to poor performance. The Vulnerability Index for each identified issue at each dam site is shown in Figure 1. Vulnerability Indices for the individual deficiencies are aggregated into stacked bars for each dam, and 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 F2024 Q1 are identified in Figure 1 and described below.

- 1** An **addition** of 1.71 (Potential Unusual deficiency) at **Elsie Dam**.
The seismic withstand of the Elsie Saddle Dam 2 may be inadequate. A seismic analysis concluded that deleterious deformations of the dam may occur under ground motions having annual exceedance frequency of 1/500 compared to a target withstand of 1/10,000 annual exceedance frequency. This issue was recharacterized to a Potential Unusual deficiency from a Non-conformance of Information during a database review in F2024 Q1. A future Dam Safety Investigation is planned to improve upon the calculation and confirm (or obviate) this issue.
- 2** A **reduction** of 0.91 (Potential Unusual deficiency) at **Elsie Dam**.
During the same database review described above, a Potential Unusual deficiency considering that the dam’s concrete spillway may have inadequate seismic withstand was recharacterized from a Potential Unusual deficiency to a Non-conformance Information and the issue’s Vulnerability Index zeroed, as no calculation of the spillway’s withstand has been performed. As for item 1, above, A future Dam Safety Investigation is planned to determine the spillway structure’s seismic withstand.
- 3** A **reduction** of 2.47 (Spillway Reliability deficiency) at **Sugar Lake Dam**.
The F2023 Q4 report described that the screw stem that raises and lowers Outlet Works Operating Gate 2 was bent and the gate removed from service, then subsequently repaired and returned to service early in early April. This issue was closed in F2024 Q1.
- 4** A **reduction** of 0.97 (Actual Normal deficiency) at **Bear Creek Dam**.
The seismic withstand of the Bear Creek Dam – a Low consequence dam – is understood to be less than its target withstand of 1/100 annual exceedance frequency. As part of a recent database review, this issue was reviewed and the Vulnerability Index was recalculated downward.

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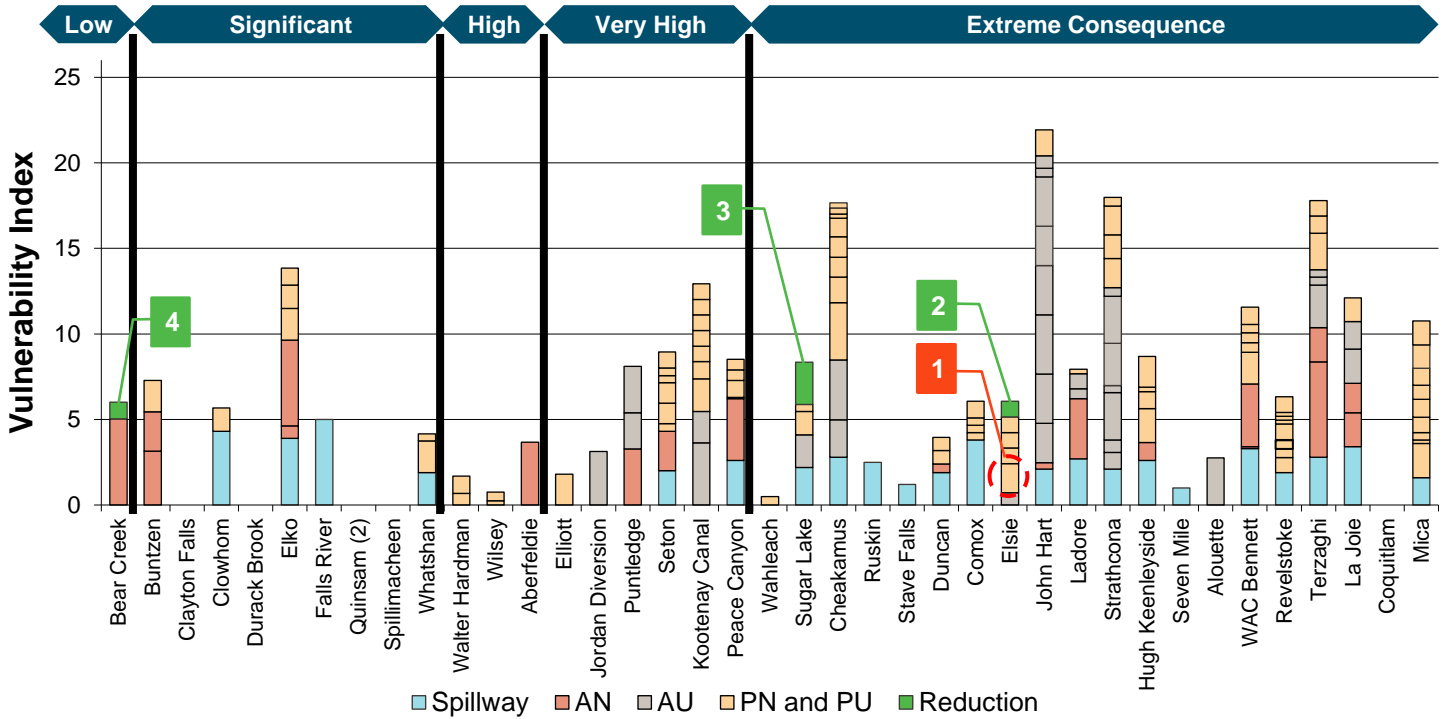


Figure 1 Dam Safety overall risk profile at the end of F2024 Q1, as represented by the Vulnerability Index. Changes this quarter are indicated by the numbered boxes.

- AN** Actual deficiency (demonstrated to exist) under *normal* load conditions
- AU** Actual deficiency (demonstrated to exist) under *unusual* load conditions
- PN and PU** Potential deficiency (requiring further investigation to demonstrate existence) under either normal or unusual conditions
- Spillway Reliability** Deficiency related to operational reliability or serviceability of the dam's spillway and/or other flood discharge systems

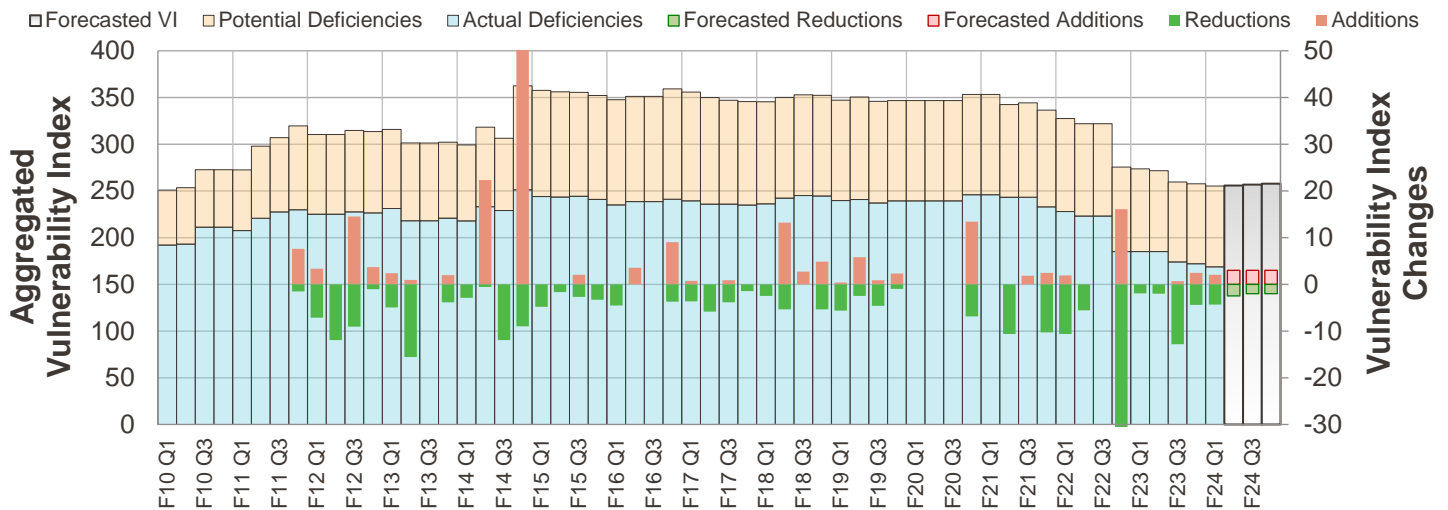


Figure 2 Historical and forecast changes and trends in the Vulnerability Index aggregated across the BC Hydro system.

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Over the last several years, new issues have added to the aggregated Vulnerability Index at a rate of approximately 12 per year. To prevent deterioration of the overall risk position, reductions in Vulnerability Index through resolved issues should occur at the same pace or faster. Table 1 below confirms that Vulnerability Index reductions have far exceeded additions over the past four quarters. Vulnerability Index reductions through F2024 are forecast to fall just short of the target, however.

Table 1 Trends and forecasts for Vulnerability Index changes in F2024.

		Actual / Forecast	Target
Dam Safety Vulnerability Index	Reductions - Last 4 quarters	23.5	12 ✓
	Reductions – Fiscal Year	10.9	12 ✗
	Additions - Last 4 quarters	5.2	

Non-Conformances in the Dam Safety Program

Activities to identify, review, resolve and close Non-Conformance issues continued through F2024 Q1. A total of eight memoranda were issued documenting changes to the Dam Safety Issues Database. As a result, 24 Non-Conformance issues were completed and three new issues were identified.

There are currently 329 outstanding Non-Conformance issues in the database. Since the start of F2019, when resolution of such issues was made a priority within the Dam Safety Program, the number of Non-Conformance issues has been reduced by just over 40 percent. Figure 3 below shows the continuing progress in reducing the number of Non-Conformance issues.

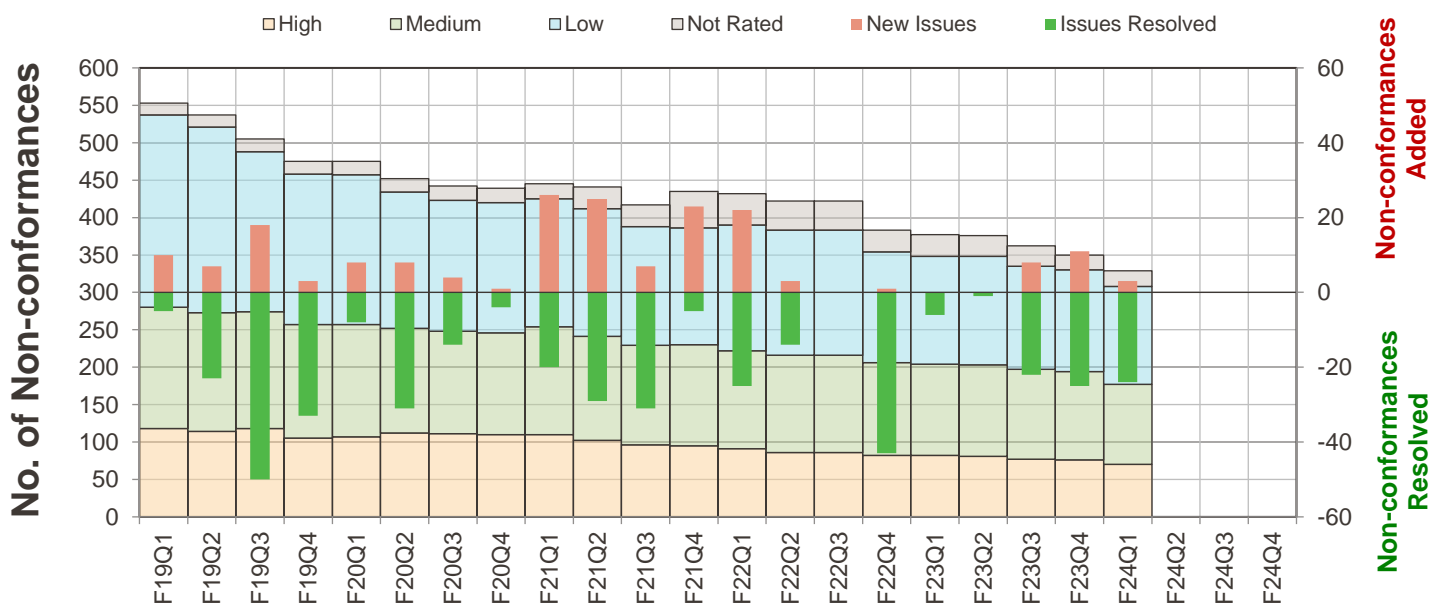


Figure 3 Changes and trends in the total number of Non-Conformance issues (characterized by level of importance) within the Dam Safety Program.

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New Issues

No new issues arose in F2024 Q1.

Update on Existing Issues

Hugh Keenleyside Dam – White Sturgeon in Low Level Outlets

As reported previously, white sturgeon have been observed entering the dam's low level outlet ports and swimming up the operating gate slots to access the tops of the gates during the summer months. To avoid injury or mortality to these fish, which is an Endangered Species under the Federal Species at Risk Act, BC Hydro is continuing to monitor for the presence of white sturgeon before any operation or testing of the gates. An engineering solution to prevent sturgeon from entering the gate slots has now been developed. Material has been ordered for a prototype to be installed on one gate to evaluate the effectiveness of the design and to ensure that it doesn't interfere with gate operation.

Compliance with Processes and Regulations

Regulatory Communications – British Columbia Utilities Commission

As described in last quarter's report, the Commission issued its Decision and Order G-107-23 for the John Hart Dam Seismic Upgrade Project, accepting that the project and associated expenditure schedule are in the public interest.

BC Hydro submitted the Application for the Ladore Spillway Seismic Upgrade Project and the Strathcona Discharge Upgrade Project under Section 44.2 of the *Utilities Commission Act* on 14 June 2023.

Regulatory Communications – Comptroller of Water Rights

One submission was made to the Provincial Dam Safety Office in Q1 of F2024, requesting authorization to alter the spillway and increase discharge capacity at Elko Dam. Approval for this work is still pending.

Operation, Maintenance and Surveillance Manuals

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

The updated Manual for Cheakamus Dam was completed and issued in April. Six Manual updates are planned for F2024, for which work commenced or continued essentially to plan in Q1.

Dam Safety Reviews

Dam Safety Reviews are independent, systematic reviews and evaluations of all aspects of a dam's physical condition, design, construction, operation, maintenance, processes, and other systems affecting the safety of the dam. Performed by external consultants, they are carried out at minimum intervals of every five to ten years for dams that are classified in accordance with the Dam Safety Regulation as High, Very High, and Extreme consequence dams.

Seven Dam Safety Reviews are planned for completion in F2024. In Q1, work on the Ruskin Dam Safety Review continued on plan and contracts for reviews at Comox, Cheakamus, John Hart, Stave Falls, WAC Bennett, and Wilsey Dams were issued.

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Surveillance

Key activities comprising dam safety surveillance include inspections, monitoring of instrumentation and quality control of data, and characterization of dam performance. Table 2 below provides key metrics regarding these activities, which are described in the following sub-sections of the report.

Table 2 Dam safety inspections and surveillance activities.

		Quarter Q1		Year-to-date	
		Actual	Target	Actual	Target
Routine dam inspections	Completed	411/411 = 100%	100%	411/411 = 100%	99.5% ✓
	Missed	0		0	
Formal (annual and semi-annual) dam inspections	Field work completed	33	20	33	20 ✓
	Reports issued	11	0	11	0 ✓
Instrumentation data checks		189/195 = 97%	97%	189/195 = 97%	97% ✓
Reservoir slopes inspections	Field work completed	9	4	9	4 ✓
	Reports issued	0	0	0	0 ✓

Routine Dam Inspections

Routine weekly and 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 of the scheduled routine inspections were completed this quarter.

Formal Dam Inspections

Formal inspections of the dams are regulatory inspections completed by Dam Safety Engineers on a semi-annual or annual frequency, as dictated by each dam's Consequence Classification. These inspections include a comprehensive visual inspection, a review of the monitoring data and an assessment of the condition of the water containment and conveyance structures. The Dam Safety Engineers are required to complete 71 of these inspections and reports annually. The Dam Safety Engineers completed the field work for 33 facilities and issued the reports for 11 of these inspections, well ahead of plan.

Instrumentation and Monitoring

Dam Safety Surveillance collects, checks, and assesses about two 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. Even though most of the data is checked automatically it is essential that qualified staff review the data regularly to ensure the systems

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are functioning as expected. The Dam Safety Technologists in each region regularly check instrumentation data plots for all dams to ensure the Automated Data Acquisition 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. 189 of the 195 planned checks were completed in Q1, which met the target of 97% completed.

Reservoir Slopes

Reservoir Slopes inspections are completed on a frequency ranging from semi-annually to once every 10 years depending on the assessed hazard of the slope. They are typically carried out by the Reservoir Slopes Geologist and the Specialist Dam Safety Engineer for the Upper Columbia Region. Each inspection generally consists of a review of all monitoring data, a visual inspection completed from helicopter with boots-on-ground assessment of identified areas of concern, and documentation by a sealed engineering report. The field work for nine of the slopes inspections was completed in Q1; well ahead of target. These inspections were moved forward to avoid potential delays, cancellations or other impacts due to wildfires, as have been experienced in the past.

Unusual Events or Observations

The Dam Safety On Call Person responded to 86 calls in Q1, which typically includes instrumentation alarms, operational inquiries, operations notifications during high inflows and earthquake notifications. This number of calls and responses is about typical.

Civil Maintenance

Civil maintenance on Dam Safety and Generation assets progressed well in F2024 Q1, per Table 3.

Table 3 Dam Safety and Generation Civil Maintenance for F2024.

		Quarter Q1		Year-to-date	
		Actual	Target	Actual	Target
Corrective and Condition-Based Maintenance	Spend (\$k)	707	792	707	792
	Work Orders Completed	2	1	2	1
Preventative Maintenance	Tasks Completed	125	121	125/121 = 103%	

Preventative Maintenance

In Q1 of F2023, Stations Field Operations and Engineering Services completed 125 preventative maintenance tasks against a plan of 121.

Corrective and Condition-Based Maintenance

The corrective and condition-based civil maintenance program was underspent at the end of Q1 by \$85k, due to several projects starting later than planned. Forecasted spend for the year is currently close to target, with Program & Contract Management working to reduce the uncertainty in estimates for projects that have not yet started.

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A significant project completed in Q1 was the repair of a crack running all the way down the centerline of the concrete spillway at Mica Dam, part of a multi-year program of repairs to the spillway. This crack was observed to extend through the slab to the drainage gallery below. With this configuration, the crack could lead to excessive uplift forces in the chute slab panels during a spill event.

Construction Services Vernon performed concrete repairs along the crack following procedures provided by BC Hydro Engineering and the repair material vendor, incorporating lessons learned from previous repairs in the same area. The repair procedures were designed to minimize the risk of future cracking in the repaired area.

Other work completed in Q1 included shotcrete repairs at La Joie Dam and detailed planning and preparation for repairs to the spillway steps at Ruskin Dam.



Figure 5 The Mica Dam spillway with repairs to the centerline crack underway.

Spillway Gate Testing and Maintenance

Spillway Gate Testing

During Q1 of F2024, 237 of 236 scheduled gate tests were completed, including annual gate tests of 29 gates. The single extra test was performed in June to align the maintenance schedule for the devices at La Joie Dam. Table 4 below provides key metrics related to spillway gate testing.

Table 4 Spillway gate testing results for F2024.

		Quarter Q1		Year-to-date	
		Actual	Target	Actual	Target
Monthly Tests	Completed	237/236 =100%	100% ✓	237/236 =100%	98% ✓
	Missed	0		0	
Gates Failing to Operate on Demand during Testing	No. of failures	1		1	
	Failure rate	1/235 = 0.4%		1/235 = 0.4%	

The single gate failure to operate on demand occurred on one of the two Revelstoke Dam outlet works maintenance gates, where the motor failed during the test. The motor has been replaced and the gate returned to service. In addition, the hoist system for the two gates was designed with the ability to cross-connect (use the east motor to lift the west gate and vice versa) which would have allowed the gate to operate despite the failed motor, but instructions to do so were not

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available and so that function was not tested as part of the maintenance and testing program. The field maintenance engineers have now developed and tested a cross-connection process and we are adding it to the program as a quarterly test.

While not resulting in a failure to operate since crews were able to open the gates, several malfunctions occurred during testing of the spillway gates at the WAC Bennett Dam in May. Upgrades to these gate systems were commissioned approximately three years ago, but the project is still active to complete backup power supply scope and address deficiencies. The project team is currently troubleshooting and correcting the issues that led to the malfunctions. In addition, the field maintenance engineering team is leading a root cause analysis to more fully understand the event and identify potential corrective actions beyond the immediate repair.

Exceptions to Gate Testing Program

Gate testing scopes were reduced to exclude gate movements at some dams, as described below:

- In April, certain gates at Mica Dam, Duncan Dam, WAC Bennett Dam, and Peace Canyon Dam were not operated due to freezing conditions. At Hugh Keenleyside Dam, one of the eight low level outlet gates was not operated due to a maintenance outage.
- At Mica Dam in May, one of the spillway gates was not operated due to birds nesting in the gate.
- At La Joie Dam in May, one valve was not operated due to a conflict with ongoing project work.
- At Duncan Dam, in May and June, the low level outlets were not operated due to construction of a fish weir downstream.
- At Hugh Keenleyside Dam in June, the low level outlets were not operated due to a restriction for high differential head.
- At Peace Canyon Dam in June, the five spillway gates were not operated due to a conflict with construction work replacing gate seals and springs.
- At WAC Bennett Dam in June, the three spillway gates were not operated pending investigation and repair of the issues identified in May, described above.

Gates Out of Service or Under Restricted Service

The availability of flood passage devices is a key measure of our ability to pass high inflows and manage reservoir levels. As at the time of writing this report, all spillway gates and flood passage devices are in service.

Spillway Gate Maintenance

Spillway gate maintenance results are shown in Table 5 on the following page. Work on planned tasks was slightly ahead of plan in Q1, with fourteen of the planned tasks completed compared to a plan of twelve. Additionally, three emergent tasks were completed for a total of seventeen planned and emergent spillway gate maintenance tasks completed in Q1.

The number of outstanding gate maintenance tasks is shown in the chart in Figure 6 on the following page. Through Q1, the total number of outstanding maintenance tasks was reduced from 104 to 94.

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Table 5 Spillway Gate Maintenance Results for F2024.

Corrective and Condition-Based Maintenance Tasks	Quarter Q1		Year-to-date
	Completed	Planned	
Planned Tasks	14	12	14/12 = 117%
Emergent Tasks	3		3

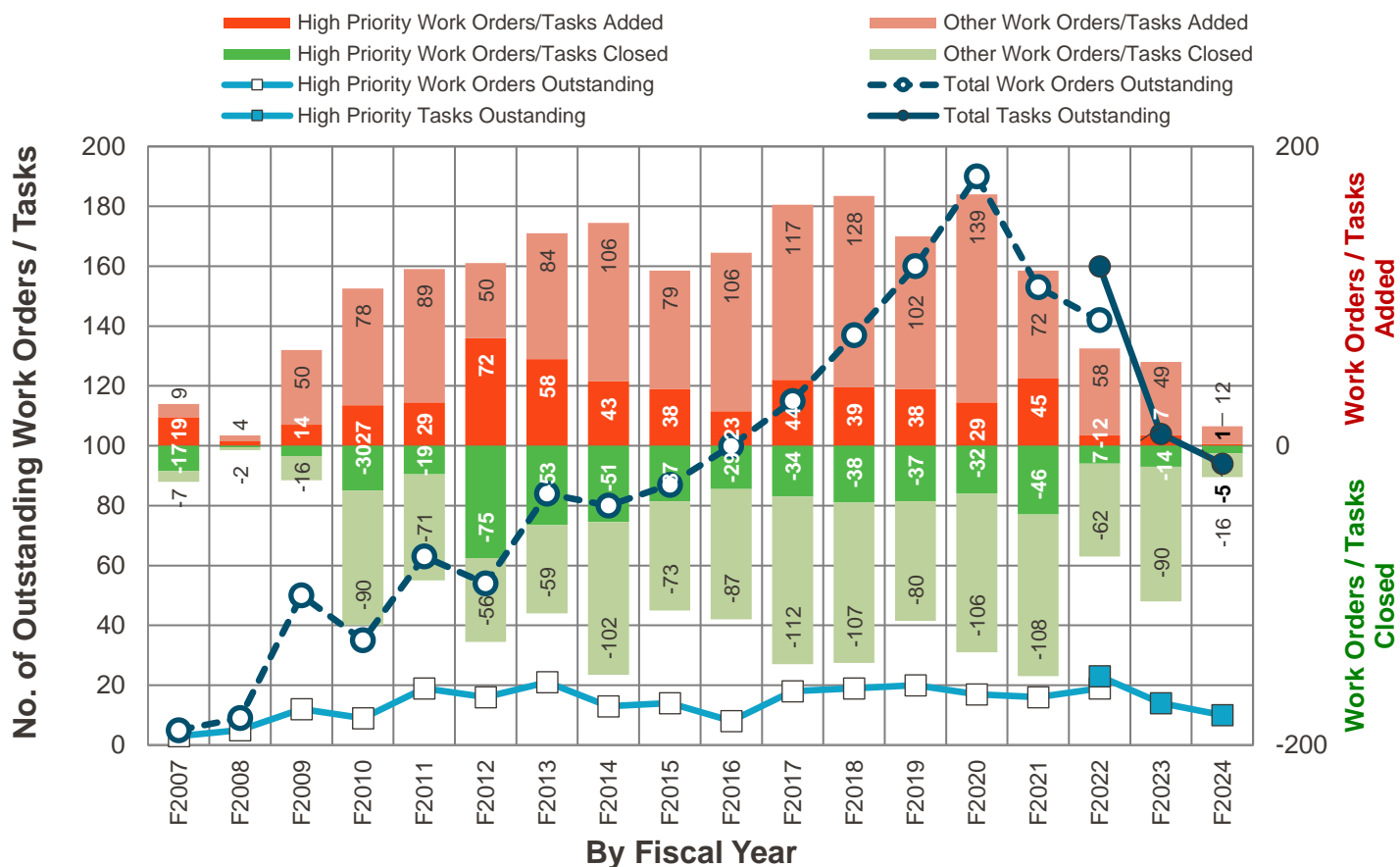


Figure 6 Number of outstanding corrective and condition-based spillway gate maintenance work orders and tasks, new work orders and tasks added, and work orders and tasks closed as at the end of each previous fiscal year.

Notes:

1. At the conclusion of F2022 moving forward into F2023, figures were restated as outstanding tasks instead of outstanding work orders to align with Operations reporting.
2. Work Orders / Tasks Added includes new work orders / tasks created in the year and identified with the gate reliability work group. It does not include work orders / tasks from previous years that were recategorized with the gate reliability work group.
3. Work Orders / Tasks Closed includes work completed through the annual maintenance program. It does not include cancelled work orders / tasks or work orders / tasks that were recategorized out of the gate reliability work group.
4. Due to notes 2 and 3, above, the net change in the number of Outstanding Work Orders / Tasks will not always equal Work Orders / Tasks Added less Work Orders / Tasks Closed

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“High priority” maintenance tasks are those where the asset shows moderate to severe signs of deterioration and/or its ability to perform its intended function may be compromised and failure of the asset could lead to loss of reservoir control, albeit with a long intervention time available. There were no new high priority tasks entered into the system in Q1, while four high priority tasks were completed, and as a result the net number of outstanding high priority maintenance tasks was reduced from 14 to 10 through Q1 of F2024.

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 Dam Safety Regulation as part of annual 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 the Quarterly Safety & Emergency Management Report, submitted to the Operations, Planning, and Information & Technology Committee, for updates on emergency preparedness and public safety.

Site C Clean Energy Project

Dam Safety, Generation System Operations and the Site C Clean Energy Project team are engaged in ongoing collaborations to integrate the Project’s design and construction activities and the eventually constructed facilities into BC Hydro’s Dam Safety Program. In Q1, these activities were focused on ascertaining that the Project had sufficiently progressed on construction and that conditions were amenable to closing and converting Diversion Tunnel 2 in preparation for reservoir filling.

Personnel from Dam Safety collaborated with Stations Asset Planning, Engineering Services, Stations Field Operations and the Site C Clean Energy Project team to plan and prepare for the project acceptance processes that will begin with tailrace filling and reservoir filling.

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Capital Projects

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

Alouette Headworks Tower and Surge Tower Seismic Upgrade

The objective of this project is to ensure that operation of the tunnel that diverts water from the Alouette Lake Reservoir to Stave Lake can be relied upon after a major earthquake. The components of the tunnel’s discharge facilities include the headworks tower and shaft, the surge tower and shaft, the headworks operating gate, the slopes adjacent to these structures, the power tunnel concrete lining, and mechanical, electrical, protection and control, and communications equipment for remote operational capability.

The first stage of construction comprising upgrades on the Stave Lake end of the tunnel and discharge facilities is now underway. The contractor mobilized to site and commenced construction in Q1. In-tunnel work to refurbish concrete structures and anchor the surge shaft walls is scheduled for this summer’s tunnel outage. Installation of new backup power and communications systems for post-earthquake operability and general reliability improvements is scheduled for next year. The in-service date for the first stage scope is October 31, 2024.

Bridge River 2 Generating Station – Intake Access Bridge Pier Stabilization

Located 4 km upstream of Terzaghi Dam, the Bridge River 2 intake is a free-standing structure that diverts flows from Carpenter Lake to the Bridge River 2 Generating Station via a concrete-lined tunnel. The intake is accessed by a bridge which is supported by a concrete pier anchored into the foundation slope. The intake houses a single Intake Operating Gate that can only be operated locally.

Undermining of the Bridge River 2 intake structure’s access bridge pier foundation was observed during preventative maintenance inspections in May 2021. A subsequent investigation in June 2021 carried out by members of Generation Stations Civil Engineering determined that the structural integrity of the bridge was satisfactory, but that further destabilization of the rock slope could lead to a loss of support of the pier foundation. An ex-plan project was initiated to address this issue and an adjacent slope stability issue on the intake tower access road. The bridge pier stabilization work, which included anchoring of rock blocks and shotcreting to prevent further erosion, was completed in May 2023.



Figure 7 Stabilization of a bridge pier at the Bridge River 2 Generating Station intake tower.

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Cheakamus Generating Station – Recoat Unit 1 and Unit 2 Penstocks (interior and exterior)

The overall scope of this project is to strip the old, failed coatings on the exterior and interior surfaces of the two penstocks and steel lined tunnel at Cheakamus Generating Station and recoat them to prevent further corrosion and extend their service lives. Supporting scope includes the installation of hatches and fall arrest systems on the penstocks and construction of a new road and vegetation removal for improved access to the penstocks.

In F2024 Q1, the project completed the interior recoating scope, including repairs and deficiencies, during a scheduled outage in May 2023. The direct exterior recoating activities commenced on completion of the interior scope. Erection of scaffolding and placing of containment to facilitate the exterior recoating of the middle third of the penstocks commenced in June 2023.

Duncan Dam – Refurbish Spillway Gates

Following an earlier project that upgraded the electrical and mechanical components of the spillway gate system, including power supply and distribution, protection and control, hoists and drives, this project was initiated in 2017 to address the degradation and extend the service life of the existing spillway gate structures through limited selective refurbishment. The refurbishment of the gate structures was completed in F2024 Q1.

Hugh Keenleyside Dam – Tailrace North Bank Modification

In 2020 and 2021, several sturgeon fatalities were discovered along the north bank of the Hugh Keenleyside tailrace. The sturgeon that had injuries consistent with being stranded amongst the north bank riprap material. Subsequently, a flat section of the north bank – a “bench” – was identified as being a potential contributor to the sturgeon strandings.

This project was initiated to modify the geometry of the north bank to eliminate it as a potential cause of fish strandings and fatalities. In F2024 Q1, the Project constructed an elevated berm along the north bank to act as a barrier preventing fish from being pushed onto the existing bench through wave action and fluctuating water levels. The effectiveness of the berm will be monitored over the summer of 2023 to determine if any further modifications are required to minimize impact to sturgeon and other aquatic species.

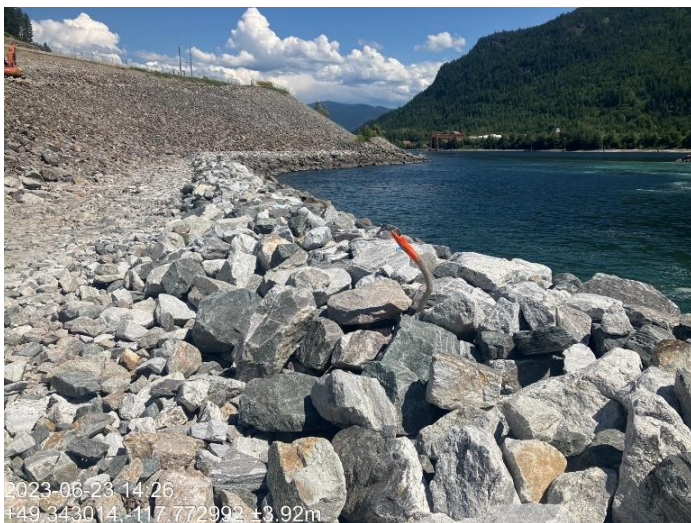


Figure 8 Hugh Keenleyside completed tailrace north bank modification. A berm has been constructed in front of the flat bench to prevent fish stranding.

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La Joie Dam – Intake Operating Gate and Follower Replacement

While raising Intake Operating Gate 4 on March 23, 2021, the uppermost cruciform follower (part of the Intake Operating Gate lifting mechanism) failed and dropped the intake operating gate approximately five feet to the sill. See the Quarterly Dam Safety Reports from F2021 Q4 and F2022 Q1 for additional information regarding this incident.

This project was subsequently initiated to replace the followers in all four intake gates and replace the gate bodies of Intake Operating Gates 3 and 4, all of which are of original construction from 1951. The project scope includes a like-for-like replacement to ensure that the gates can be reliably operated to pass flows, provide isolation, and manage Downton Reservoir until the extensive upgrades to the dam in the La Joie Dam Improvements Project can be completed.

Replacement of the Intake Operating Gate 3 followers was completed in May and June of 2023. (The followers on Intake Operating Gate 4 were replaced in 2022. See the F2022 Q4 report.) Construction activities included helicopter work to bring equipment on and off the intake tower, removal of the old followers, installation of the new followers and refurbishment of the intake gate guides. The followers for Intake Gates 1 and 2 will be replaced in spring of 2024.



Figure 9 Replacement of Intake Operating Gate 3 cruciform followers at La Joie Dam. Heavily corroded followers that were removed are shown above; newly fabricated and installed followers at right.



Lake Buntzen 1 – Coquitlam Tunnel Gates Refurbishment

The Coquitlam Buntzen Tunnel Inlet was built in 1903 and modified in 1911. It is constructed in natural rock with all gates installed in fixed locations 27 metres underground. The original facility had one maintenance gate that was partially refurbished in 1955 and two downstream operating gates that were original from 1911, and has had a history of mechanical problems resulting in reliability issues. This project is to replace those original gates and upgrade the intake's structures and equipment so as to ensure the reliable operation of the intake operating gates for management of Coquitlam reservoir elevations and water conveyance for generation at Lake Buntzen 1 Generating Station.

Intake operating gate underground civil works are now substantially complete. Stability upgrades to the slopes at and approaching the access adit are currently underway with planned completion in August 2023. The new Intake Operating Gates will be installed from July to September of 2023. Finally, permanent power and local control buildings will be installed and commissioned in November 2023.

Dam Safety Investigations

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

Peace Canyon Dam Performance Assessment

The overall objective of this Dam Safety Investigation is the assessment of the stability of the concrete dam at Peace Canyon in conjunction with the evaluation of scouring and erosion of the rock immediately downstream of the spillway, an area known as the plunge pool. The overall scope of the Investigation includes:

1. Characterizing future spills that would exacerbate scouring at the plunge pool that potentially reduces the stability of the dam’s spillway, and determining if interim risk reduction measures are required;
2. Assessing the strength parameters of bedding planes within the dam’s rock foundation that are relevant to the stability of the dam, with external expert input as required;
3. Assessing the stability of the dam for normal and unusual load conditions by assuming various drain deficiencies and the determined strength parameters; and
4. Determining if any the future upgrades are required to ensure the long-term satisfactory performance of the Peace Canyon Dam and developing a high-level cost estimate and schedule for the leading alternative upgrade.

A plunge pool bathymetric survey was conducted in April 2023, using vessel-mounted multibeam sonar augmented by sonar conducted from a remotely operated vehicle to survey areas not reached by the surface bathymetry (either through geometry or turbulence). Located through the global navigation satellite system, the survey produced a high-resolution point cloud that describes the underwater surface of the plunge pool, as illustrated in Figure 10. This was the most recent in a series of surveys through which the progression of scouring is being measured.

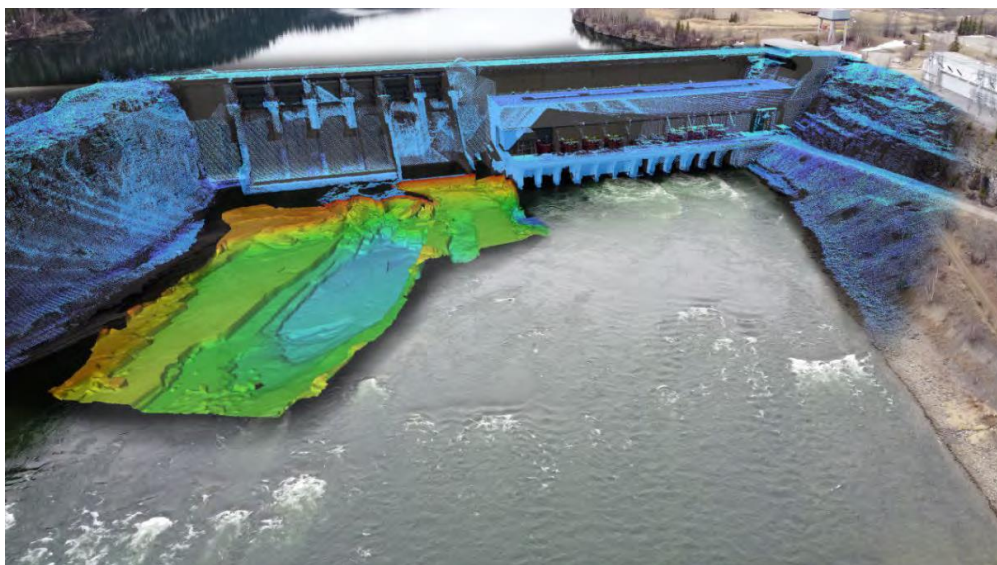


Figure 10 Point cloud survey data overlaid on drone imagery of Peace Canyon Dam.

In June, a site visit to Peace Canyon Dam was carried out by Dr. George Annandale and Dr. Michael George, who are leading international experts in the erosion of rock spillways. Dr. Derek Martin completed a review of the bedding plane geotechnical parameters and issued his final report. The project team also commenced development of a three-dimensional model of the dam to support hydraulic and stability analyses that are planned to follow.