

EXECUTIVE SUMMARY

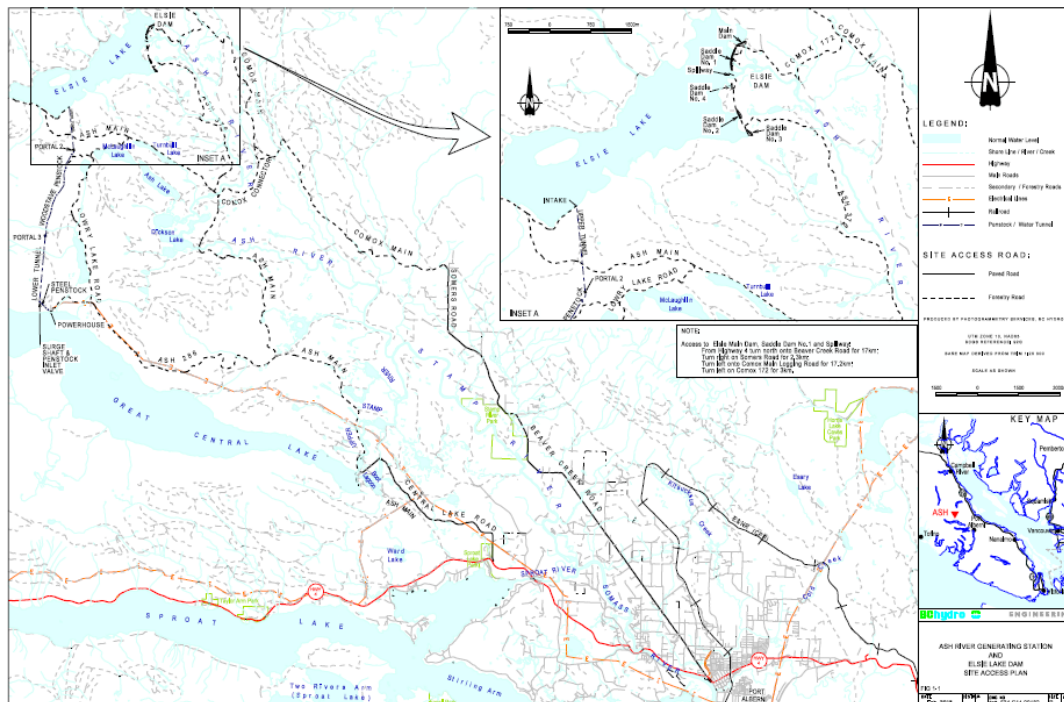
The purpose of this report is to update the Capital Projects Committee of the Board of Directors on key dam risk management activities during the period from July 1, 2015 to September 30, 2015, and to provide reasonable assurance that the safety of dams operated by BC Hydro continues to be managed to the established guidelines and criteria of the Dam Safety program.

The Dam Safety Program has been carried out consistent with its stated objectives throughout the reporting period. The overall Dam Safety risk profile is shown in Figure 1. There is an overall increase in the risk profile this Quarter due to the discovery that the top elevation of the effective impervious core in Duncan Dam is lower than designed.

QUARTERLY FEATURED DAMSITES – ELSIE LAKE DAMS

The Elsie Lake Dams consist of the Main Dam, Saddle Dams 1, 2, 3 and 4, and the Spillway Dam. The dams impound Elsie Lake storage reservoir on Ash River in central Vancouver Island, about 30 kilometers northwest of Port Alberni. The reservoir is approximately 6.6 square kilometers and is used as generation storage for the Ash River Generating Station.

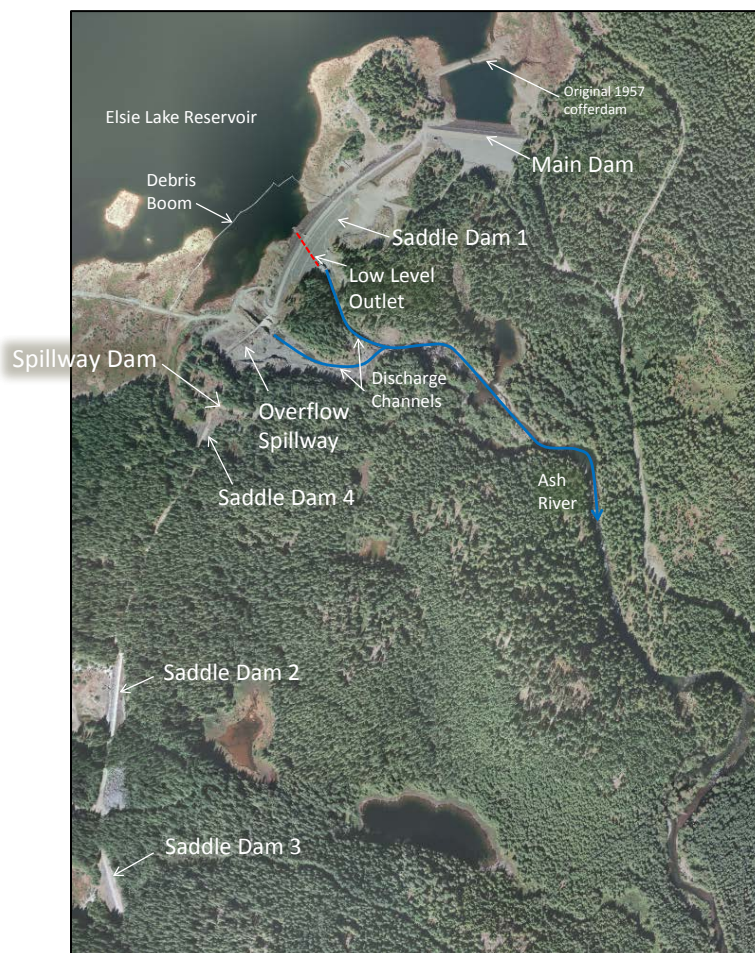
The Elsie Lake Dams were originally constructed in 1957/58. The Main Dam and Saddle Dam 1 are zoned earthfill embankments while Saddle Dams 2, 3 and 4 are homogeneous earthfill structures. The Main Dam is 30.5 metres high, 184.5 metres long and founded on bedrock above a major fault zone. A grout curtain was installed to reduce fault-related seepage. Saddle Dam 1 is 18.3 metres high and Saddle Dams 2, 3 and 4 range from 3 metres to 10.7 metres high. The low level outlet in Saddle Dam 1 provides water releases into the river for fisheries purposes as well as providing emergency drawdown capability.



Location of Elsie Lake Dams

The Main Dam and Saddle Dam 1 are classified as ‘Extreme’ consequence based on dam breach analysis and inundation mapping. Saddle Dam 2 is classified as ‘Very High’, the Spillway Dam is classified as ‘High’, and Saddle Dams 3 and 4 are classified as ‘Significant’. The consequences are based on the varying amount of water that would be released and subsequent downstream inundation for each individual dam failure. Most of the inundation zones are within a defined zone for tsunami risk. All 5 dams are reported as one bar on the Risk Profile.

The intake structure for the generating station is located 4 kilometers southwest of the main dam. From the intake, water is routed 7.9 kilometers through an upper tunnel, a woodstave penstock, a lower tunnel and a steel penstock to the 25 MW powerhouse located on Great Central Lake.



Overview of Elsie Lake Dams

An Investigation for the Elsie Lake Dams was initiated in 1999 to evaluate the earthquake resistance of the Main Dam, Saddle Dam 1, and the Low Level Outlet. In July 2000 interim measures including reservoir drawdown and increased surveillance were implemented to reduce the dam safety risks based on preliminary findings of the ongoing investigation. The free overflow spillway was modified by constructing a 21 metre wide spillway slot to help maintain reservoir levels below a target

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elevation. The investigation was completed in 2001 and confirmed the existence of earthquake and seepage related deficiencies associated with the structures. By July 2001 the project began to implement remedial works. This involved substantial rebuilding of the Main and Saddle Dam 1 and the Low Level Outlet between 2001 and 2005.

During 2001, the Main Dam was excavated down approximately 13 metres from the crest to remove loose, potentially liquefiable layers in the dam. Saddle Dam 1 was also partially excavated to remove potentially liquefiable layers in its upstream shells. Both dams were reconstructed slightly higher than original to provide freeboard for an updated flood estimate. Instrumentation was upgraded and a downstream rockfill berm was later built on the downstream slopes of the two dams to increase their seismic resistance.



Main Dam: Compacting new fill placement (Crest View)



Saddle Dam 1: Reconstruction of dam in 2001

Seismic improvements were also completed on the Low-Level Outlet in 2004. These included removal of the upper portion of the Low Level Outlet Intake Tower, installation of a new slide gate mechanism and construction of a hoist system at the crest of Saddle Dam 1. The Low Level Outlet steel conduit was relined with a new steel pipe and the pipe was extended past the end of the new downstream rockfill berm. A secondary valve was installed to provide emergency closure capability and the hollow cone valve was refurbished and relocated at the downstream end of the new pipe. Remediation of Saddle Dams 2, 3 and 4 consisted of upgrades to the riprap and erosion protection and crest repairs.

Following the Probabilistic Seismic Hazard Assessment Project, the seismic hazard for Elsie Dam almost doubled, and the current withstand is now estimated to be in the order of 1:2000, as compared to an expectation of 1:10000. A review of the requirement for any further rehabilitation will be undertaken on a risk-informed basis, in view of the tsunami risk. A Dam Safety Review for Elsie Dam is in progress.

UPDATE ON OTHER MAJOR DAMS

Mica Dam

Final piezometer upgrades were completed in Q1, addressing the deficiency in regard to the under-instrumentation of this extreme consequence dam. All new instruments are commissioned and in-service. The 2014 construction report and the project completion report will be finalized in Q3.

Revelstoke Dam

Updating of the Marble Shear rock slope geologic model continued in Q2. The new geologic and piezometric information will be used for a stability re-assessment.

The instrumentation installation project for the Left Bank slopes, initiated in F2015, is in progress. The field work, including the drilling and instrumentation installation, was successfully completed in Q2.

La Joie Dam

Progress continues to be made to improve the functionality of the water passages. A few small outstanding items remain and will be addressed during the next available outage window in Q3. Project document continued in Q2.

Terzaghi Dam

Work is in progress to determine the performance of the dam for the updated seismic hazard. The first phase analyses and reporting has been completed. The scope and funding for the second phase of investigations have been approved in Q1. The second phase of the analyses was started in Q2.

WAC Bennett Dam

There are five ongoing dam safety projects:

Condition of the spillway (deterioration of the spillway chute concrete surface)

As previously noted, the second year of construction has been deferred until next year (2016) due to reservoir conditions.

Spillway gate reliability

The project will upgrade selected electrical and mechanical components of the three spillway gates as the first of a multiple stage program to improve the reliability of gate operations. The project is currently in Definition Phase. Issues with some of the gears have been identified, and an interim risk management plan has been put in place.

Long-term performance of the dam core

The work plan for F2016 was approved in Q1. Work continued in Q2 on the failure modes assessment and the review of the seismic geophysical data. The next Expert Engineering Panel Meeting has been scheduled for Q3.

Casing Upgrades

This project was initiated to address the leaky open casings in the core, while retaining their usefulness where applicable. This project will be implemented in phases, and the first part includes the grouting of observation wells and selected drill holes. The Contractor mobilised to WAC Bennett Dam in June, and the grouting work on ten holes was completed in Q2.

Further work is required to address the remaining drill holes and other instrumentation in the dam core. This assessment will start in F2016, continue for the next year, and any construction/remediation work will be carried out in following years.

Condition of the riprap layer protecting the upstream face of the dam

Work continued in the preparation of the Request for Proposal and the BCUC application documents.

Ruskin Dam

In Q2, work continued with the completion of the piers and the assembling of the new Gates 1 and 2. Shotcreting of the spillway surface continued.

It was previously identified that the need for further anchoring of the Spillway would not impact the current construction project scope. In Q2, work continued in the analyses, currently in Stage 1, using simple models. A telephone meeting with the Advisory Board was held in Q2, primarily to present the work plan for the dam analyses and to provide an update of the construction. A full Advisory Board Meeting in person is scheduled for Q3.

Campbell River System

Recent and ongoing work at the three sites is as follows:

Strathcona Dam

The project to construct a new Low Level Outlet is in a preliminary 'needs' phase to identify project requirements. The Project Plan for the Conceptual Design phase was finalized in Q2, and project funding for this phase of the work was approved. Work was initiated with the consultant, including the completion of failure modes assessment workshops.

Ladore Dam

A first draft of the summary report on investigations to assess the seismic performance of the dam has been prepared and reviewed. Preliminary results show that some remedial work will be required. The second draft of the summary report has been prepared and is being reviewed.

John Hart Dam

This project was initiated in F2011 to address the seismic deficiencies associated with the dams. The Conceptual Design Report was completed in Q2, and the first Advisory Board meeting was held. A draft Advisory Board Report has been prepared.

NEW ISSUES

Duncan Dam

An investigation to confirm the elevation of the top of the core of the Duncan Dam was carried out during the Instrumentation Upgrade Project. As noted in the Featured Dam (Fiscal 2015, Q1) description, Duncan Dam is underlain by deep compressible silts and loose sands. This led to significant deformations and the necessity for major design changes being made during construction. One of these design changes altered the characteristics of the material used for the core of the dam from normal water level up to the top of core over a 230 metre section of the dam. Recent investigations have shown that this material does not have the low permeability required to act as an effective water barrier. In addition, the remainder of the core has settled, so that overall, the top of the effective core of the dam is only about 0.38 metres above full supply level. As such, surcharging of the reservoir by any amount cannot be allowed until this situation is remediated. This is now reflected in the risk profile for Duncan Dam in Figure 1. BC Hydro can meet the flood management requirements of the Columbia River Treaty without surcharge, however the inability to surcharge will increase the probability of downstream flooding during freshet water management. Studies will be initiated next quarter to assess the potential damages and likelihoods, in order to better prioritize the necessary remedial work.

WAC Bennett Dam

Two small voids were observed on the upstream slope of Bennett Dam during the semi-annual inspection. They are about 1 metre apart, 1 to 1.5 metres below the crest, immediately upstream from the Sinkhole 1 area. The holes were probed to a maximum depth of about 1.5 metres. In the past, similar holes have been observed elsewhere on the upstream face of the dam. The holes are generally thought to be the result of fine grained material washed down from the crest of the dam being further washed into the voids of the rip rap. The voids were not expected to be an indication of poor performance of the dam; however, given the location of the voids and the past performance of the dam, further investigation was undertaken using a downhole camera to determine the condition of the material surrounding the holes. This indicated that there was no larger void or depression at the base of the rip rap or any other indication of internal erosion. The area will continue to be monitored

until the rip rap replacement project essentially re-builds this area of the dam face. No further specific action will be taken and there is no change to the risk profile for WAC Bennett Dam.

Revelstoke Dam

A crack was observed in the asphalt on the crest of the dam, leading directly downstream from one of the leaky casing installations. The crack is approximately 2.8m in length and ranges from 1 millimetre to 8 millimetres in width. Similar to the WAC Bennett observation, although there was no major concern, due to the location of the crack and previous performance of the casing, further investigation was warranted. A review of the historical photos revealed the crack has been present since at least 2009, similar in appearance to numerous other cracks in the pavement, and indicating that this is not a new issue. Although now more noticeable than in the past, there has been no further development since first reported. The crack will be visually observed weekly, and its width will be monitored monthly to confirm conditions are not changing. The crack will be sealed in the near future to prevent water infiltration. No additional action will be taken at this time. And there is no change to the risk profile for Revelstoke Dam.

GATE MAINTENANCE AND TESTING

During the period of July to end of August 2015, 28 scheduled gate tests at 23 sites were carried out. One gate system failed to operate on demand during testing or normal operations. In another case, gates operated on demand however certain equipment malfunctioned or was found to be in near-fail condition.

As per end of August 2015, operational restrictions were in place on 5 out of 111 flood discharge gates due to known deficiencies (no change from the previous quarter). In addition, 8 out of 111 flood discharge gates were locked out for construction and operational reasons (a small change in the last quarter).

A total of 14 corrective maintenance issues were identified through ongoing testing and maintenance between July and August 2015. A total of 17 new and previous issues were addressed in the same period, for a decrease of 3 issues overall in this reporting period. There has been a progressive decrease in the issue count, which is down from a peak of 77 at the end of May. There are now 68 corrective maintenance issues outstanding at the end of August 2015, compared to 52 as of one year ago.

CIVIL MAINTENANCE

The F2016 program was originally based on a \$4M budget that covers all currently identified items with a Corporate Risk Score of 9.5 and higher. To date 22 of 35 projects are substantially complete. Current spend for the program is \$1,995,000, including \$230,000 for 2 projects that have now been capitalized. There have been five projects deferred or cancelled as mentioned last quarter, leading to a projected program underspend of \$915,000. This has been returned to Corporate.

Completed projects are: Bridge River 1 Penstock inspections; Bridge River 1 tunnel concrete repairs; La Joie Dam face joint repairs; Mica Unit 4 penstock and draft tube inspection; Mica Outlet works inspection (ogee inspection to occur in the fall); Revelstoke Unit 2 penstock and draft tube inspection; Revelstoke 731 block scaling, walkway repairs and access improvements; Downie helicopter pad repairs; Checkerboard creek road repair; Falls River underwater inspection of the dam face; Mica Dutchman and Little Chief road repairs; bridge inspections on Vancouver Island; La Joie debris boom repair; Cheakamus tunnel inspection; Coquitlam tunnel inspection; Wahleach helicopter pad

inspection; Revelstoke Downie road repairs; Falls River penstock saddle repairs; and Spillimacheen rock scaling.

EMERGENCY PREPAREDNESS AND PUBLIC SAFETY

Emergency Preparedness¹

Emergency Action Plans for Hugh Keenleyside Dam and Duncan Dam Canal were updated in Q2 and will be finalized with input taken from the training sessions. The Kootenay Canal Emergency Action Plan was finalized, however updates are ongoing as a result of changing requirements such as the addition of security threat level actions. All Emergency Action Plans are being updated accordingly.

Internal training on Emergency Action Plans were conducted with Emergency Operations Centre staff for three facilities in Q2: Kootenay Canal, Hugh Keenleyside and Duncan Dam. An external agency tabletop exercise was conducted in July for Bridge River.

The Columbia River Basin Emergency Planning Guide is being updated and is planned for issue in Q3.

Public Safety²

Starting in F2016, all Public Safety Management Plans are being reviewed on a three yearly basis. The plan in F2016 is to complete nine Public Safety Management Plans; three were completed in Q1 and Q2 and six are planned for Q3. High risk items identified from the reviews for remediation will be forwarded to Generation Asset Management for consideration and scheduling. The strobe and siren standard is complete and is now being used for design of the new siren/strobe installations at Clowhom, Elko and Puntledge.

COMPLIANCE WITH PROCESSES AND REGULATION

Approval was requested and granted for the Wilsey Dam Instrumentation Upgrades and additional work on the WAC Bennett piezometer remediation projects in Q2.

As required under the Dam Safety Regulation, the provincial Dam Safety Officer for Duncan Dam was notified that the effective core of the dam is lower than designed, as discussed previously, and as such, BC Hydro will not surcharge the reservoir. The Operation, Maintenance and Surveillance Manual for Duncan Dam will be updated to reflect this change. The provincial Dam Safety Officer for WAC Bennett Dam was also notified of the voids observed on the upstream face in the vicinity of Sinkhole 1.

The provincial Dam Safety Officer for Ruskin Dam was notified that repairs to the Ruskin Dam spillway concrete are required before the new spillway gates can be put into operation, and that these repairs are now underway.

¹ Emergency Preparedness is managed by the Strategic Emergency Management team. Dam Safety audits the updating of emergency plans for compliance with the BC Dam Safety Regulation.

² Public Safety is managed by the Public Safety team in Safety Engineering. Dam Safety audits Public Safety activities related to dams.

One Operation, Maintenance and Surveillance Manual (Kootenay Canal) was submitted in Q2. In order to remain within compliance of the regulation, updates to the Mica, La Joie and Terzaghi manuals are required in 2015. These are all in progress, but dependent on personnel availability, may not be finalized before the end of the calendar year. If so, a 3-month exemption will be requested from the Comptroller, and this is not seen to be an issue at present.

Inspections

Overall regulatory expectations were met in Q2 for weekly and monthly dam safety inspections. One of 403 scheduled inspections for Q2 was not completed, due to staffing conflicts.

Dam Safety Reviews

Dam Safety Reviews are a regulatory requirement carried out at minimum intervals of every five to 10 years at high, very high and extreme consequence dams.

Five external Dam Safety Reviews are in progress for F2016 for Buntzen, Falls River, Elsie, Spillimacheen and Salmon River Diversion Dams. Site visits for Falls River, Elsie, Spillimacheen and Salmon River Diversion were carried out and draft reports are being prepared by the consultants for all five Dam Safety Reviews. All findings for the F2015 Dam Safety Reviews will be reviewed and entered into the dam safety issues database over the next few Quarters.

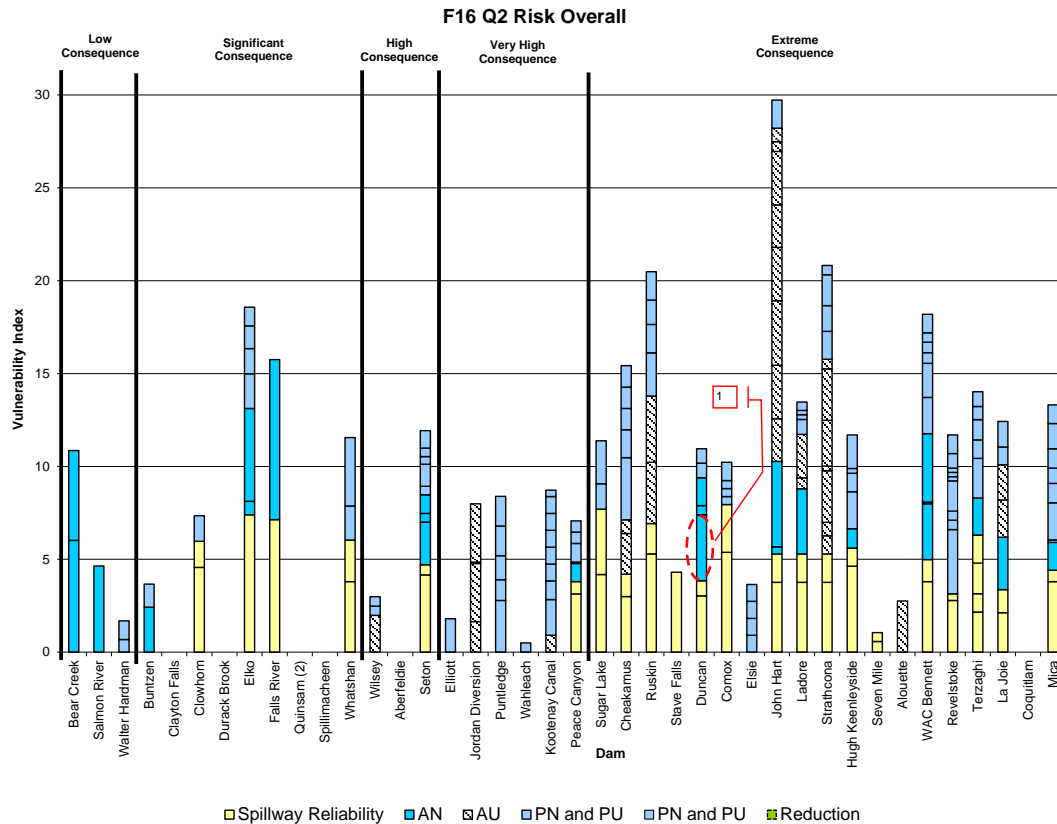
VULNERABILITY INDEX: UPDATE

Changes in Vulnerability Index for actual and potential deficiencies, as outlined in Figure 1, are tracked on a quarterly basis and shown on Figures 2 and 3. This is an indication of the changes in the understanding of the dam safety risk profile.

In Figure 3, the total index is shown (sum of actual and potential deficiencies), as well as separate plots for decreases and increases in the total index. Decreases are due to remediation projects as per the Capital Plan and resolution of issues via Performance Investigations. Increases in the index are due to the recognition of new issues. Existing issues are re-examined on a regular basis, and re-rated as required.

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FIGURE 1 - DAM SAFETY: OVERALL RISK PROFILE



Legend and Summary of Changes:

Increase in Risk

1. Duncan Dam – the core of the dam is lower than designed

Reduction Risk

None.

A – Actual deficiencies have been shown to exist.
 P – Potential deficiencies require further investigation.
 N – Normal Load conditions; associated with daily or short-term operations.
 U – Unusual Load conditions; associated with flood and earthquakes

Consequence classifications reflect current BC Dam Safety Regulations.
 Dam order reflects generally increasing downstream consequences

NOTES:

- Vulnerability Index (Rating) is a qualitative assessment of future dam performance from all causes – the higher the rating the higher the likelihood of poor performance.
- 34 dam sites as identified have reportable risk at present
- This Risk Profile represents only currently known and rated issues. Changes do not necessarily indicate a physical change to BC Hydro assets that increase or decrease risk; rather they often represent a change in knowledge and understanding of the risk. Additionally, many known deficiencies (those without a direct impact on potential dam failure) have yet to be rated.



FIGURE 2 – CHANGE IN VULNERABILITY INDEX

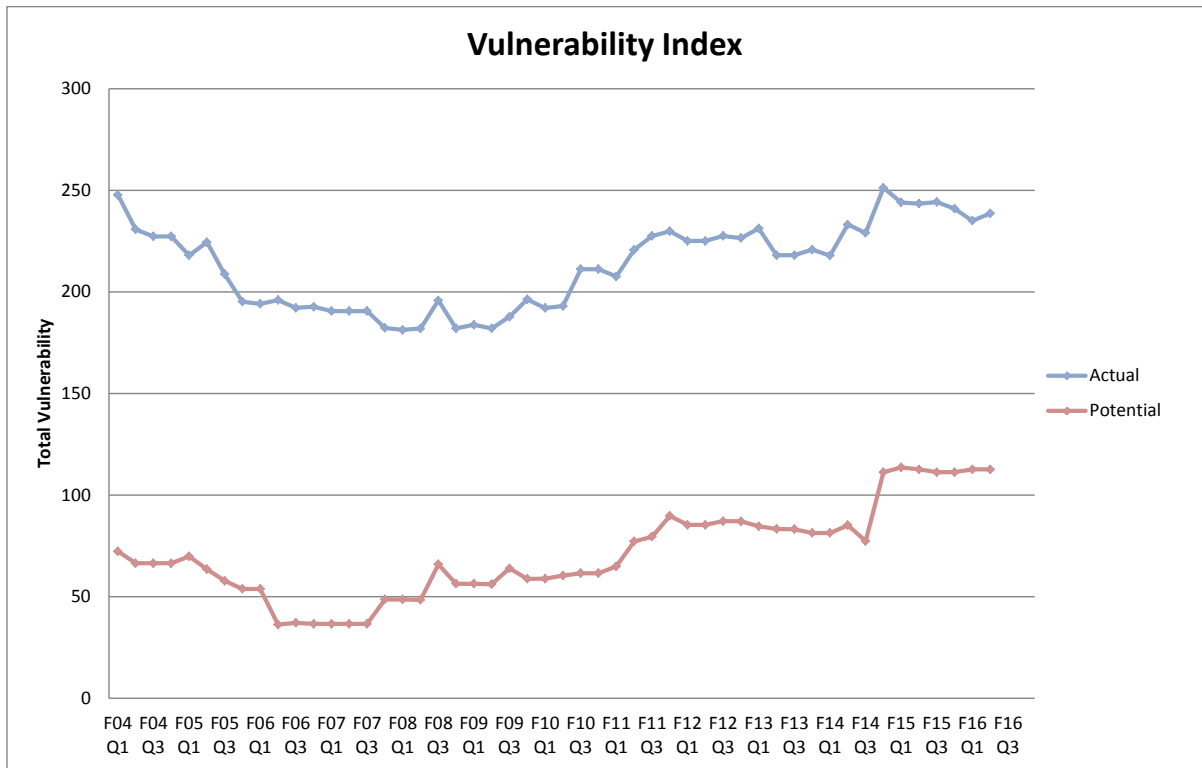


FIGURE 3 – CHANGE IN VULNERABILITY INDEX COMPONENTS

