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Recent case histories for dam decommissioning in Alberta

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Abstract

In 2018 the Government of Alberta (GOA) released the Alberta Dam and Canal Safety Directive *(ADCSD), including decommissioning, closure, and abandonment of dams and canals (Part 9) and a requirement that public infrastructure and its possible decommissioning should be evaluated when it either becomes a public safety issue or requires rehabilitation.*

Three recent dam removal projects are described in this paper, in terms of how they meet the requirements of the directive, with technical details provided on permitting; design; and construction in the context of each project.

1. *The first project (Klein Lake Dam) is a former water storage dam, constructed to expand a lake for recreational opportunities, which was removed instead of reconstructed after it experienced overtopping failure.*
2. *The second project (Billy Goat Dam) is a mine water diversion dam for a mine pit that will be removed after cessation of mining, as part of long-term mine reclamation plans.*
3. *The third project (Southeast Dyke) is a low consequence dyke for a cooling pond at a thermal generating station with consequences of failure that have decreased over time, due to mining activities modifying the downstream environment.*

These three projects are in different steps – from the process of design to completion of construction – with Klein Lake Dam removal being completed, Billy Goat Dam permitted but not decommissioned, and Southeast Dyke being in the process of obtaining permits to decommission. Additional perspectives from assessment of fish habitat, revegetation, soil nutrients and soil chemistry are also discussed as applicable to illustrate how environmental science informs dam removal design, supports obtaining regulatory permits for dam removal works, and guides construction planning for dam removal.

The application of the ADCSD to dam removal and dam decommissioning projects is presented in this paper, with description of site-specific conditions that lead to selecting the dam removal or dam decommissioning option and discussion on how environmental studies inform design and permitting. The value of detailed environmental evaluations, hydrologic flood routing, assessing downstream impacts on third parties and environmental features, the importance of soil science and vegetation ecology to reservoir bottom revegetation, construction details where applicable, and relationships with regulators will be discussed.

Keywords: *dam removal, decommissioning*

1 Introduction

The Government of Alberta (GOA) owns and manages water dams across Alberta, one of Canada's western prairie provinces that includes the eastern slopes of the Rocky Mountains. The GOA department Alberta Agriculture and Irrigation (AGI) owns, operates, and regulates many of these water dams, while Alberta Transportation and Economic Corridors (TEC) is responsible for their construction, non-operational maintenance, and rehabilitation. AGI also regulates water dams constructed or operated by municipalities or

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private entities for natural resource projects, such as for irrigation, drinking water storage, or hydropower projects.

On 18 December 2018, the GOA released the *Alberta Dam and Canal Safety Directive* (ADCSD or the Directive) (GOA 2018), which contains requirements applicable to the entire life cycle of a dam. The Directive was prepared as part of the regulations that govern dams in Alberta.

The GOA ADCSD dictates that infrastructure, and its possible decommissioning, should be evaluated when it requires rehabilitation or when it becomes a public safety issue. There are also requirements for dam owners, including:

- the use of qualified professionals and qualified individuals
- dam consequence classifications
- the use of risk assessments
- how to design, construct, and operate dams
- required submissions for approval/authorisation and dam safety reporting
- dam safety and emergency management
- decommissioning, closure, and abandonment (in Part 9 of the Directive).

Meanwhile, water dams and tailings dams for mining in Alberta are regulated by the Alberta Energy Regulator (AER). In January 2020, AER released a document titled *Abandonment, Closure, and Decommissioning of Dams at Energy Projects* (AER 2020) which was to supplement the regulation and GOA Directive for tailings dams as, “unlike water dams, which can be breached when they are abandoned, tailings dams store contents for long periods of time.” (AER 2020).

A sample of three projects executed by Klohn Crippen Berger (KCB) between 2013 and 2025 is discussed in this paper:

- Klein Lake Dam removal (dam removal completed in 2020)
- decommissioning of Billy Goat Dam (design completed, permits obtained)
- decommissioning of Southeast Dyke (evaluations completed, design being prepared, regulator advised of owner’s intent to decommission).

The locations of these projects are shown in Figure 1.

Figure 1 Location plan of projects discussed in this paper

Each project is described in the following sections with a summary discussion on key dam removal considerations from the projects discussed in this paper.

2 Case study 1: Klein Lake Dam removal

2.1 Background information and site description

Klein Lake is located 80 km southwest of Sundre, Alberta. In 1965 the GOA constructed the 9.0 m high, 40 m long Main Dam with a 0.45 m diameter gated low-level outlet (LLO) to raise Klein Lake's water level and expand the existing lake. Review of aerial photos and shallow boreholes drilled around the former lakebed indicated that there was a larger ancient lake (a "paleolake") at Klein Lake after retreat of the glaciers. The paleolake was partially impounded by an esker that was naturally breached at the same location where Main Dam was constructed. A temporary cofferdam was used to allow construction of Main Dam in dry conditions.

Significant leakage through Main Dam's esker sand and gravel abutments became apparent shortly after first impoundment. Between 1965 and 1969, the GOA removed the gate from the LLO to leave it permanently open and reconstruct the temporary cofferdam (Cofferdam) to control and maintain the lake level. The Cofferdam was raised to 4 m high between 1969 and 1970, using sand and gravel fill.

Klein Lake is accessed via a trail from the Panther Road. An unnamed outlet creek flows from Klein Lake and flowed beneath Panther Road via a 600-mm-diameter culvert for normal flows and a 900 mm diameter culvert that discharged higher flows. Approximately 400 m downstream of Panther Road the outlet creek discharges into the Panther River.

During the historic June 2013 severe rainfall event and flood, run-off flowed into Klein Lake and overtopped the Cofferdam. The Main Dam, however, retained the flood water, which was then gradually released through the open LLO, minimising flooding impact on the Panther Road and a private development located adjacent to the outlet creek, downstream of Panther Road. The breach of Cofferdam is shown in Figure 2 right after the flood, and in Figure 3 after flood water had passed. The lake upstream of Cofferdam soon after failure is shown in Figure 4.

Figure 2 Klein Lake Dam failure in 2013 showing breach of Cofferdam and Main Dam impounding released water

Figure 3 Cofferdam breach viewed from Main Dam in July 2013

Figure 4 Lakebed upstream of Cofferdam in July 2013

The level of Klein Lake gradually decreased between 2013 and 2020 due to ongoing erosion from lake outflows that naturally eroded Cofferdam fill to foundation level. The former lakebed naturally revegetated with native plant species as the lake level reduced in response to the erosion of the Cofferdam. By the time dam removal started, much of the former lakebed had started to naturally revegetate with native species, and inflow creeks had naturally removed lakebed sediments from pre-impoundment creek channels.

Following Cofferdam failure, the GOA conducted extensive studies to assess the feasibility of dam replacement versus dam removal. Ultimately, dam removal was selected as the most cost-effective and sustainable long-term solution. Additional details for the Klein Lake Dam removal project are presented in Gräpel et al. (2023).

2.2 Environmental studies

Environmental considerations were at the forefront of the project, beginning with an environmental evaluation with biophysical studies to understand the local aquatic and terrestrial ecosystems. Studies identified the presence of Bull Trout, a species listed as threatened under Canada's Species at Risk Act, in Klein Lake, in the outlet creek downstream from Klein Lake, and potentially in the natural inlet creek upstream of Klein Lake. Bull Trout spawning beds were observed in the segment of the outlet creek between Panther Road and the Panther River. The decision to remove the dams offered an opportunity to restore natural connectivity between Panther River, Klein Lake, and habitats further upstream, benefiting trout and other local species. Vegetation and soil science field studies were conducted to assess site conditions and how they would influence revegetation of the lakebed, fill stockpiles, and areas disturbed by construction

2.3 Design

Dam removal design consisted of earthworks modelling with geotechnical information, to assess what the extent of the dam fill was within the existing dams and how the site would be graded after dam removal as part of site reclamation. Stockpiles were located where creek flows would not cause erosion.

The restored channel within the footprints of Cofferdam and Main Dam was designed with gravel armour on the channel bottom and side slopes.

Removing the dams from Klein Lake would significantly decrease flood attenuation offered by Klein Lake, which would result in higher peak flows in the outlet creek than had previously been experienced since 1970. This presented challenges, as private development within the floodplain downstream required protection from potential increases in flow rates following dam removal. The sensitive fish habitat in the outlet creek on the Panther River floodplain also needed to be maintained and protected.

Normal flows in the outlet creek at Panther Road, after dam removal, were accommodated by a precast concrete box culvert (0.61 × 0.61 m), to maintain normal water flow to the valuable fish habitat in the existing outlet creek downstream of Panther Road. However, the increased flow rates from flood events could potentially flood the private development. To address flood management concerns after dam removal, a precast concrete box culvert was installed beneath Panther Road to convey high lows. During construction in the early days of the pandemic, the required high-flow diversion culvert size was not available so a larger, standard-size box culvert (2.4 × 1.2 m) was selected; which provided additional discharge capacity. The high-flow diversion culvert discharges into a high-flow diversion channel, which discharges into an outlet creek downstream of the sensitive fish habitat and the private development. A riprap-armoured diversion berm was constructed upstream of Panther Road to direct flood flows to the culverts below Panther Road. A 1:100-year flood event was used for the design of diversion works. The selection of the dual culvert system avoided the need for land expropriation to construct a diversion berm adjacent to the private development. The regulator provided valuable input throughout the conceptual design of the dual-channel system.

The revegetation design used native species and was based on a review of the species naturally repopulating the exposed lakebed. The design was informed by soil chemistry and nutrient profiles developed by KCB vegetation ecologists and soil scientists; supported by input from government rangeland ecologists. The revegetation design was prepared to augment and complement the natural revegetation that was occurring on the former lakebed. Recognising the potential for erosion of unvegetated surfaces to occur before native species had established ground cover, a sprayed-on erosion control blanket (bonded fibre matrix hydromulch) was used for all exposed soil surfaces and natural soil amendments were added to promote accelerated growth of vegetation. The lakebed a year after completion of construction is shown in Figure 5.

Figure 5 Lakebed in August 2021

2.4 Regulatory permitting and consultation

Provincial Water Act and Public Lands Act approvals were required for the project, which necessitated public engagement and First Nations consultation. Both approvals were obtained with the help of DEMA Land Services. Careful consideration of the potential effects on the aquatic environment and consultation with Fisheries and Oceans Canada supported permitting under the Federal Fisheries Act and Species at Risk Act. Ongoing consultation with provincial regulators (now under the jurisdiction of Alberta Environment and Protected Areas, and Alberta Forestry and Parks) was required to support compliance throughout construction.

Two restricted activity periods (RAPs) for instream works in the outlet creek were defined by regulators to minimise effects on fish during spawning periods. The identified RAPs would have allowed for only a two-week instream construction window in the spring and a two-week instream construction window in late summer. A longer instream construction schedule was accommodated at Klein Lake by blocking the Main Dam LLO to isolate the Klein Lake work area from the downstream environment. Instream work was conducted near Panther Road during the spring two-week instream construction window.

Consultation with Indigenous groups from Treaty 7 and engagement with local stakeholders (e.g. local residents, recreational users, a trapper, a grazing allotment holder, resource companies, GOA lands officers and rangeland agrologists) was critical to understanding how they valued and interacted with the environment at the project site and to answer their questions about the project. Indigenous groups visited the site as part of the consultation process to support their review and input on the project. The input gathered during this process was key information considered in assessing the suitability of the design and its impact on the environment, as the site was returned to an as-created condition as much as practically possible. First Nation consultation was an important step in obtaining regulatory permits to complete the work. Grazing allotment holders and GOA rangeland ecologists identified potential for some salinity in the lakebed soil, as indicated by the presence of horsetail barley which was studied further by KCB's vegetation ecologists in design of seed mixes for lakebed revegetation. Local residents' and GOA lands officer's input was important for understanding how the Klein Lake area was used by tourists and the local residents, so the construction contract could be developed to protect local and recreational interests and avoid work being done on weekends. Timber cleared from the diversion channel area was salvaged for the forestry company who had timber leases in the area.

2.5 Construction

To avoid spring construction delays associated with bird nesting, initial tree clearing work was completed the winter before the tender was released, so that trees within the construction footprint (e.g. Main Dam, stockpile areas, diversion berm, culverts beneath Panther Road and the high-flow diversion channel) were cleared before the start of bird nesting.

The dam removal work was released for tender as part of a public works contract. A set of contract documents with specifications, material quantities and payment terms, an environmental risk assessment letter, all required permits and their conditions, and construction drawings were prepared. Full-time engineering contract administration was provided by KCB. The construction contract included milestone dates to meet regulatory permit conditions and complete key tasks outside of RAPs – such as instream culvert construction or removal of the Main Dam. Additionally, recognising and respecting public use of the area for recreational purposes, the contract included requirements that work not be conducted on Fridays and weekends when recreational activity was highest.

The specified construction period was from early May 2020 when winter conditions were expected to end to mid-October 2020 which was expected to be the start of winter conditions.

To accommodate public use of the construction site safely when work was being conducted, a project information pamphlet was created by KCB with AGI input and distributed to the various adventure tourism outfitters and resorts; so that the public could be kept informed on the nature and goals of the project, as well as the hazards that could be present in the work areas.

Review of the natural ground surface exposed during initial removal of Cofferdam indicated that Cofferdam had been constructed on a ridge of natural ground. The ridge of natural ground below Cofferdam was a remnant of a second esker on site that was partially covered with lakebed sediments from the former paleolake. Confirmatory ground investigations conducted after initial Cofferdam removal verified that all Cofferdam fill had been removed. As a result, a small pond remained upstream of the former Cofferdam location and the former outlet creek channel upstream of Cofferdam did not need to have sediments removed. The regulator was involved in discussions on this matter and visited the site before approving the design change. The final configuration of Cofferdam removal is shown in Figure 6.

Figure 6 Cofferdam removed in September 2020, abutments of removed Main Dam in foreground

Upon field review of the natural armouring of the creek channel and natural vegetation on banks that had established between the downstream toe of Cofferdam and upstream toe of Main Dam, the decision was made by KCB and TEC, in discussion with regulators, not to reconstruct this portion of the channel. The channel had naturally stabilised and was providing a valuable fish habitat, which had developed between 2013 and 2020. The channel left unchanged between the former Cofferdam and Main Dam is shown in Figure 6.

The inlets of the small box culvert and high-flow diversion culvert are shown in Figure 7 and the diversion berm upstream of Panther Road in Figure 8.

Figure 7 Inlet to low-flow culvert below Panther Road that maintains primary channel and fish spawning habitat, with inlet of high-flow diversion culvert in background

A year after construction, a period of high temperature ("heat dome") occurred. Seeding on well-drained sand and gravel soils on the abutments of Main Dam did not germinate due to heat and lack of moisture. Revegetation of these areas has been slower than the rest of the site. The abutments of Main Dam are shown partly in Figure 8.

Figure 8 Diversion berm upstream of Panther Road

3 Case study 2: Billy Goat Dam decommissioning

3.1 Background information and site description

Billy Goat Dam is a 5.5 m high, homogeneous earthfill dam constructed in 1981 at the Highvale coal mine (Highvale Mine) that is owned and operated by TransAlta Generation Partnership (TransAlta). Highvale Mine is located approximately 80 km west of Edmonton, Alberta. Billy Goat Dam was constructed to impound clean water flowing towards Pit 05 of the Highvale Mine and is considered by TransAlta to have a significant consequence classification. The impounded water behind the dam is then pumped to another catchment using a pump and pipeline system with an intake on the right abutment. Billy Goat Dam pond is kept low with regular pumping.

Billy Goat Dam is currently within 250 m of the limit of Pit 05 and within 100 m of a pre-cleared area at the crest of Pit 05. The area between the dam and the pit is land owned by the Highvale Mine and is unoccupied. Billy Goat Dam is shown in Figure 9.

Figure 9 Billy Goat Dam with Pit 05 a short distance downstream

3.2 Environmental studies

Environmental studies were ongoing over several years as part of site operations monitoring, required by site operating permits. An environmental evaluation of dam decommissioning for Billy Goat Dam was conducted using the data collected during the environmental monitoring program.

From a habitat perspective, Billy Goat Dam created an impoundment that would support aquatic and riparian wildlife. Consequently, regulations protecting breeding birds and amphibians were a key consideration when identifying a project schedule for decommissioning the dam, as well as the conditions of TransAlta's existing permits for mining work.

The following points are relevant to the decommissioning design:

- fish are not expected in Billy Goat Pond
- pre-disturbance bird nest and amphibian sweeps would be required if work commenced after 1 April and would remain necessary until 31 August
- bird nest sweeps would be conducted within and adjacent to where habitat removal is required. Ideally work would be conducted after August when bird nesting was complete

Wildlife monitoring work conducted in the area of Billy Goat Dam has shown an increase in the occurrence of western toads over time. Western toads are a species of special concern, meaning the species could become threatened or endangered due to identified threats and biological characteristics. During the last monitoring surveys in 2015, western toads were detected near Billy Goat Pond at monitoring points 1 km to 2 km away, bringing increased probability of toad occurrence or linkage at Billy Goat Pond. However, there are several wetlands in the area providing a range of options for toad habitat, and decommissioning of Billy Goat Dam would not materially affect the habitat availability for toad populations in the region.

Due to the possible presence of eggs and tadpoles of western toads within the pond, it was recommended that the water of the pond should not be drained until the end of August. If project scheduling did not allow for the metamorphosis of tadpoles, it was recommended that effort should be made to capture and relocate the tadpoles to nearby suitable habitats. Adult toads would also be moved to safe habitat if found during work onsite. The requirements for tadpole relocation could potentially be reduced by lowering Billy Goat Pond early in the year and maintaining it at low levels until the notch is excavated.

3.3 Design

Design work for the decommissioning and environmental assessment is presented in a design report submitted to TransAlta (KCB 2020). The decommissioning concept will be a channel excavated through the dam. The channel through Billy Goat Dam was designed to pass the 24-hour, 1:100-year runoff event. A channel base width of 15 m was selected to provide a wider-than-required notch to be conservative. Design details for the notch through Billy Goat Dam are shown in Figure 10.

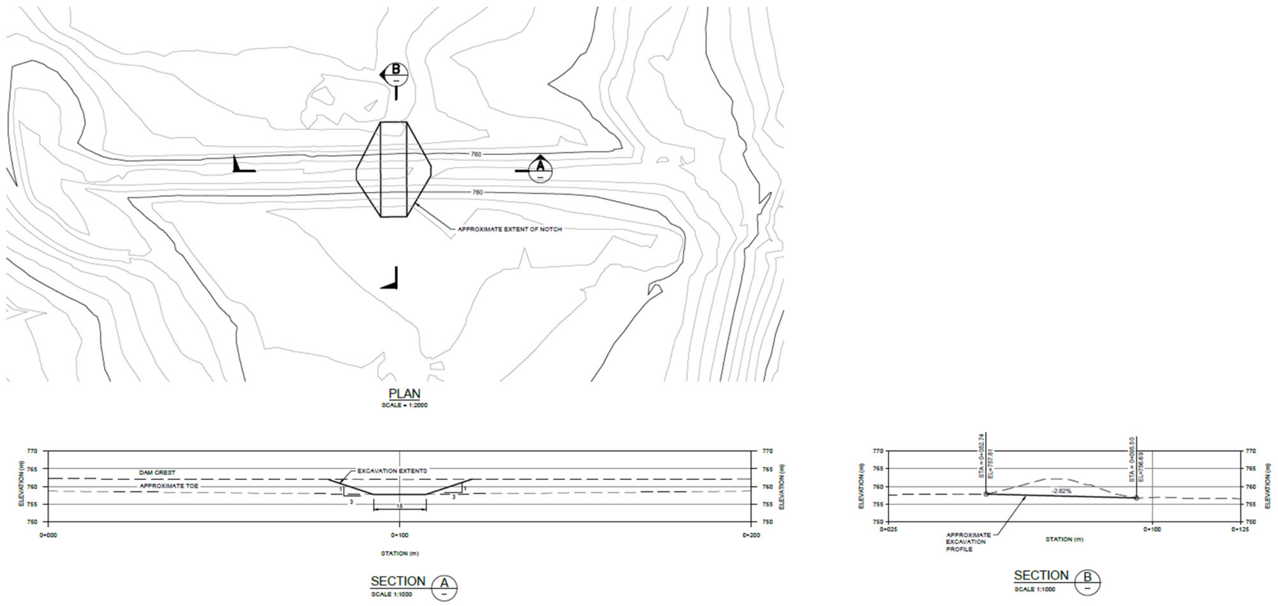

Figure 10 Billy Goat Dam channel details

Channel side slopes of 3H:1V were selected based on the dam being constructed with compacted fill and because the steepest slope on the existing dam is 3H:1V. Review of the available foundation soils and fill information, combined with engineering judgement and experience with fill slopes at Highvale Mine, indicated the channel slopes should be stable at 3H:1V.

After decommissioning, surface water flow that has historically been impounded by Billy Goat Dam will flow through the original channel to a post-reclamation Pit 05 end pit lake area, or will be directed to flow into a nearby pond formerly used for cooling water for thermal power generation.

Quantifiable performance objectives were established during design and included:

- Billy Goat Pond must be kept empty during notch construction
- the channel slopes must remain stable. Fill and foundation conditions should be verified to be stable during channel excavation so that the notch remains open during flood events. Slope flattening should be conducted if necessary and the notch slopes should be inspected regularly
- water must not impound upstream of the channel. If ponding is observed, the channel should be extended into the ponded area to provide drainage
- Run-off could cause erosion of the channel base. Repairs may be required if erosion occurs.

3.4 Regulatory permitting

TransAlta applied for permission to decommission Billy Goat Dam and received all required approvals.

3.5 Construction

The channel through Billy Goat Dam will be excavated no sooner than the fall of 2025. TransAlta will execute this work with its own equipment and crews.

4 Case study 3: Southeast Dyke decommissioning

4.1 Background information and site description

The Genesee Generating Station in Genesee (Alberta) 80 km southwest of Edmonton, Alberta) consists of three thermal generating units fuelled by natural gas. The Genesee Generating Station was formerly a coal-fired powerplant, with coal supplied from an adjacent coal mine (owned by Capital Power and operated by Westmoreland Mining Holdings LLC). Active mining operations ceased in 2023, and land reclamation in the Genesee mine is ongoing. The Genesee Cooling Pond (GCP) is required for thermal power generation. The water license for GCP includes three dykes: North Dyke, Southwest Dyke, and Southeast Dyke (SE Dyke), all with a design crest elevation of 733.4 m. The operation of the generating station is dependent on a managed water elevation within the GCP, with a maximum elevation of 731.5 m and a minimum elevation of 730.5 m (KCB 2020).

The SE Dyke is a homogenous earthfill dyke approximately 2,700 m long and constructed along the south and southeast sides of the GCP. The dyke is generally less than 1 m in height, with a 450-m-long section that is up to approximately 4.5 m high east of Sta. 87 + 60. The design crest elevation is 733.4 m with a crest width of approximately 4.5 m and 3H:1V side slopes. Three floodways were built through the dyke during the original construction, as earth cut channels armoured with riprap, with channel bases at approximately GCP pond elevation. SE Dyke is shown in Figure 11.

Figure 11 East portion of Southeast Dyke. Red arrows indicate areas of erosion and ponded water downstream of the dyke (downstream direction is towards top of photo)

The SE Dyke was originally constructed when mining operations were well to the east of GCP. In the 2000s mining operations switched to the south of GCP and mined overburden dumps were constructed to the south and east of GCP. The natural ground downstream of SE Dyke was always at a higher elevation than GCP and construction of wide, broad and relatively high waste dumps and mine haul roads further changed the downstream area. Water has ponded on the downstream toe area of the SE Dyke and in 2024 was approximately 1 m higher than the pond level in GCP.

The only credible failure mode for the SE Dyke is a breach of the dyke caused by wave erosion. By design, elevated water level in GCP would result in water flow discharging through the floodways into the downstream area. Following dam safety reviews and/or audits completed for GCP between 2002 and 2024 the Southeast Dyke has been assigned a consequence classification of "low" on the basis that there is no consequence of failure from a loss of life perspective, minimal to no consequence of failure on cooling pond operations (socio-economic value), and minimal potential for incremental environmental impacts.

Portions of SE Dyke are currently eroding because of wind-wave action, with erosion at two locations having removed the upstream slope and extended into the crest of the dyke. Failure of the SE Dyke would not result in an uncontrolled discharge of water from GCP. Conversely, due to the higher surface water elevation of the ponded water downstream of SE Dyke, ponded water on the downstream side of SE Dyke would discharge into GCP in response to failure of SE Dyke. The exact amount of water that would be released is unknown, but is not expected to cause water levels in the cooling pond to rise more than 1 cm. Given the limited difference in water levels between the downstream ponds and the cooling pond, a rapid rush of water is not predicted.

Due to the natural high ground downstream of SE Dyke and the redundancy of the SE Dyke created by post-construction modifications to the downstream area, Capital Power wishes to remove the SE Dyke from the listed structures on their water license. Furthermore, access to the eroding areas is limited and repairs will be expensive. It is for this reason that Capital Power selected dam decommissioning with excavation of two notches to drain the ponds on the downstream side of the SE Dyke into GCP. Then the ongoing erosion of the dyke from wind-wave erosion within GCP can continue without need for repair work.

4.2 Environmental studies

Design and environmental evaluation work is presented in KCB (2025). Environmental studies were ongoing over several years as part of site operations monitoring, required by site operating permits. An environmental evaluation was conducted using the data collected during the environmental monitoring program. From a habitat perspective, SE Dyke allowed for creation of aquatic habitat on the downstream side of the dyke where water ponded between the dyke and high ground downstream of the dyke. The environmental evaluation indicated that no significant effects to fish and wildlife habitat were expected for decommissioning SE Dyke. However, the potential for mortality of wildlife species breeding in the downstream ponds was identified which would require mitigation.

The timing of a future erosion failure of the Southeast Dyke driven by wind-wave events is difficult to predict. If a breach of the SE Dyke occurs during the wildlife breeding period, the reduction in water levels within the downstream ponds may lead to a loss of floating migratory bird nests attached to emergent vegetation, floating migratory bird nests built over the water becoming exposed to terrestrial predators, or amphibian eggs being exposed above post-breach water levels.

4.3 Design

Dam decommissioning will be completed with a controlled breach. The controlled breach concept will consist of excavating two channels through the SE Dyke. The design concept currently includes a trapezoid shaped channel with a base width of 2 m, side slopes of 3H:1V, grade of at least 2% toward GCP to promote positive drainage, and seeding to promote vegetation growth. The channels will be excavated where the erosion is located. Due to the low height of SE Dyke at these locations, channel side slopes will be designed on the basis of engineering judgement and experience.

4.4 Regulatory permitting

Based on the current classification of SE Dyke being low consequence, a formal decommissioning, closure, and abandonment plan is not required by the ADCSD for the SE Dyke. According to Section 9.7.1 of the

ADCSD, Capital Power must provide a written statement to the director indicating the intent to undertake decommissioning, closure, or abandonment of their dam and the date on which the undertaking will occur – not less than 14 days in advance of construction commencing. A notification letter is being prepared that will present the proposed design of breach notches, present drawings illustrating the concept, and refer to engineering and environmental studies to support the work so that the requirements of Section 9.7.1 of the ADCSD are met, to obtain permission to decommission SE Dyke in late 2025 or 2026.

4.5 Construction

Permits have not been obtained so construction has not been scheduled yet. When permits are obtained, the timing of the breach work would be in the fall, after October. This time frame for decommissioning will be after the bird nesting season and after amphibian eggs have hatched, but before amphibians start to burrow for hibernation.

5 Key observations

Upon review of the work completed to date on the three projects discussed in this paper, the following key considerations for dam removal or decommissioning projects have been identified:

- Detailed environmental evaluations with field studies are an invaluable part of the process that can inform the designer’s understanding of what species are present and their relative sensitivity or conservation status, inform design decisions, support obtaining permits, identify mitigations to environmental risks during construction, and to understand what RAPs need to be considered to schedule construction work to remove or decommission the dam. In the case of Klein Lake, site-specific environmental studies were completed as part of the design project. For Billy Goat Dam and SE Dyke, ongoing environmental studies as part of site operations were thorough enough to inform an assessment of the decommissioning design work. It was also beneficial that the design team consisted of a group of engineers and environmental scientists from the same firm/office that worked on previous dam removal assignments and also the environmental studies for TransAlta and Capital Power.
- Removal of dams removes hydrologic flood routing capability in a watershed, no matter how small the reservoir. Downstream impacts from elevated flows after dam removal need to be considered from the perspective of third parties occupying lands within the downstream environment, and also the effect of elevated flows on sensitive environmental features such as spawning grounds. In the case of Klein Lake, loss of flood attenuation capacity would eventually result in damage to a sensitive fish habitat and flooding of private development; requiring high-flow diversion while maintaining low flows through the original outlet creek. For Billy Goat Dam, flood routing informed the design, and then the notch was oversized because there were no practical limitations that prevented adopting a conservative design.
- Lakebeds will revegetate naturally, but it takes time in high altitudes with adverse climatic conditions and short growing seasons. Slow drawdown of Klein Lake over several years allowed for progressive natural revegetation as the lake level decreased.
- Studies on soil chemistry and soil nutrient profile allow for selecting plant species that are more likely to germinate and develop good vegetative cover without need for re-seeding, particularly in a remote, relatively high altitude, backcountry environment like at Klein Lake. Ongoing reclamation work at the TransAlta and Capital Power coal mines has developed an excellent understanding on how to vegetate reclaimed areas at those sites.
- Seeding in well-drained areas with high sun exposure may fail in periods of extreme high temperatures, such as the heat dome that occurred in 2021 in Alberta. Riprap or rockfill armouring might be a more reliable solution for remote areas with steep slopes, limited nutrients, and low groundwater table.

- Slow drawdown of Klein Lake as Cofferdam eroded allowed stream flows into the lake to re-establish and remove sediments from pre-impoundment channels, with sediments being deposited in the remaining post-failure lake, not the sensitive Bull Trout spawning habitat downstream.
- If at all possible and appropriate, naturally re-established vegetation and fish habitat should not be destroyed during (de)construction work associated with dam removal or dam decommissioning. At Klein Lake, due to the length of time between initial failure and eventual dam removal, a fish and riparian habitat was naturally restored between the Main Dam and the Cofferdam, and was left as is during the construction phase.
- Good relations with regulators developed years in advance during dam operation and/or during the design phase for dam removal, will be invaluable in permitting the design and also addressing issues that develop during construction. This was especially true for Klein Lake where a high degree of cooperation from the regulators was achieved during all phases of the project.

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