

B.C. DAM SAFETY PROGRAM ANNUAL REPORT 2019/20

EXECUTIVE SUMMARY

The B.C. Dam Safety Program Annual Report for 2019/20 summarizes the achievements, challenges and ongoing initiatives of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development's (FLNR's) Dam Safety Program. Under the Dam Safety Regulation (Regulation), *Water Sustainability Act (WSA)*, 2016, the program's mandate is to mitigate loss of life, damage to property and damage to the environment from a dam breach. The *WSA* requires dam owners to inspect their dams, undertake proper maintenance on them and ensure that their dams are compliant with ongoing engineering standards. This mandate is realized through the Dam Safety Program's 4 objectives:

1. Providing formal and informal training to dam owners and dam safety professionals.
2. Ensuring dam owner compliance with the Regulation.
3. Reviewing project plans for dams to ensure consistency with Canadian Dam Association Guidelines and other industry standard practices.
4. Supporting dam safety emergency planning and response.

Dams throughout the province can serve many purposes, including:

- Power generation
- Municipal and domestic water supply
- Irrigation and livestock watering
- Fish and wildlife enhancement
- Industrial use
- Flood control

The dam safety program has been successful in several areas this year including:

- Stakeholder engagement by Dam Safety Staff and designated Dam Safety Officers (DSOs) has grown due to increased training events arranged and facilitated by the dam safety training coordinator.
- Dam safety staff participated in professional development provided internally by FLNR and externally by other jurisdictions, professional associations, and industrial partners such as BC Hydro.
- Dam Safety staff ensure that adequate consultation is conducted with First Nations and Indigenous communities on a case-by-case basis through the FLNR Water Authorization Section.
- The BC Oil and Gas Commission (OGC) continue to be the lead dam safety regulator, in close working relationship with FLNR's Dam Safety Program, for oil & gas related dams.
- Dam Emergency Management planning and training exercises for dam owners continues to be developed.

- In 2019/20 the target date to receive 90% of the required annual dam status reports improved by 5 months from 2018/19, which was the first year the E-Licensing and FrontCounterBC's request/submission method was used [i.e. 90% received by November (2019) and 90% received by June (2020)]. This improvement is a result of significant training efforts, funding to enhance E-Licensing, improved stakeholder engagement, and the assistance of FrontCounterBC.
- Dam owners now have access to online introductory self-directed learning on BC Dam Safety Management at the B.C. Dam Safety website.
- Dam Safety Staff continue to improve the number of dam failure consequence classifications listed in e-Licensing.
- The British Columbia Extreme Flood Project, which seeks to provide evidence-based information from meteorological data to more precisely predict extreme flood events suitable for the design of dams in all failure consequences, is nearing completion. While specific to British Columbia and surrounding areas, the methodology and applications of this study will be influential beyond our provincial borders. Project rollout, led by Senior Dam Safety Engineer Robert McLean and an international, multidisciplinary team, is expected in 2021.

The dam safety program continues to work toward addressing the following challenges:

- DSOs, working closely with water authorization staff, continue to ensure owners of unauthorized dams are discovered and their dams meet the requirements of the Regulation & WSA.
- Dams with a failure consequence classification of low are addressed by DSOs on a reactive or complaint-driven basis. The program is exploring opportunities for additional capacity to proactively engage with owners of low consequence dams, such as formal and informal training sessions.
- Some local governments are not adequately resourced to respond to dam emergencies in a timely manner.
- Some dam owners are having difficulty paying for the cost of dam ownership such as routine maintenance, site surveillance, formal inspections, normal operation of their dam as well as cost to comply with the Regulation such as hiring technical experts to undertake dam safety reviews, prepare Operation, Maintenance and Surveillance manuals and Dam Emergency Plans, and undertaking dam rehabilitation and site assessments (i.e. archeological investigations). The dam safety program is exploring funding mechanisms to help address these gaps.
- Smaller communities have a shortage of qualified professional engineers with experience in dam design, construction, or management. Owners of dams in these areas may find dam engineering services to be limited or unavailable and it can be costly to bring in outside expertise.

The following table quantifies the 2019/20 Dam Safety Program statistics and achievements:

2019/20 Dam Safety Program Statistics & Achievements

Staffing	
Dam Safety Officer (DSO) - Full Time Equivalents	11.75
Dam Safety Support Staff - Full Time Equivalents	5.2
Dams	
Regulated Dams	1879
Unregulated Dams	189
Audits	
Dams Audited for Regulation compliance	142
Education & Awareness	
Dam Inspection and Maintenance workshop attendees	113
Dam Safety Management workshop attendees	108
Engineering	
Dam construction, rehabilitation or decommissioning plans reviewed	93
Dam construction, rehabilitation or decommissioning monitored	34
Documentation	
Dam Operations, Maintenance and Surveillance manuals reviewed	73
Dam Emergency Plans reviewed	86
Dam Safety Review reports assessed and accepted	16
Dam Incidents	
Dam breach response	2
Dam incident response	6

Contents

EXECUTIVE SUMMARY.....	1
INTRODUCTION	5
British Columbia’s Dam Safety Program	5
History and Regulatory Framework	5
Program Delivery and Operations.....	5
Regulated Dams in B.C.	6
2019/20 PROGRAM ACTIVITIES.....	7
DAM OWNER COMPLIANCE	7
Education and Awareness.....	7
Communications and Engagement	9
Annual Dam Status Report – Self-Reporting by Owners.....	10
Dam Safety Reviews.....	11
Dam Safety Database	11
Dam Safety Audits.....	12
DAM SAFETY PLANS REVIEW, CONSTRUCTION AND APPROVAL	13
Reviewing Plans and Monitoring Work in Progress or Completed.....	13
Operational Reviews	13
PROGRAM MANAGEMENT.....	14
Program Administration.....	14
Outreach and Professional Development	14
Other Dam Safety Program Highlights	15
Climate Change	16
DAM EMERGENCY PLANNING AND RESPONSE.....	16
Dam Breach (Breach of dam imminent, in the process of breaching, or has breached)	16
Dam Incidents (Conditions NOT requiring immediate intervention to avert breach)	20
No Dam Incidents (Conditions NOT impacting safety of the dam (verify as appropriate))	26
PROGRAM CHALLENGES AND OPPORTUNITIES	28

INTRODUCTION

The B.C. Dam Safety Program Annual Report for 2019/20 summarizes the achievements, challenges, and ongoing improvements to the Ministry of Forests, Lands, Natural Resource Operations and Rural Development's Dam Safety Program for the period of April 1, 2019 to March 31, 2020. The publication of an annual *Dam Safety Program Report* meets a key public accountability commitment made by the B.C. Government following the 2010 Testalinden Dam failure.

British Columbia's Dam Safety Program

The aim of the Dam Safety Program is to promote the safety of water storage dams in B.C. by:

1. Providing formal and informal training to dam owners and dam safety professionals.
2. Ensuring dam owner compliance with the Regulation.
3. Reviewing project plans for dams to ensure consistency with Canadian Dam Association Guidelines and other industry standard practices.
4. Supporting dam safety emergency planning and response.

History and Regulatory Framework

B.C.'s dam safety program began in 1967 in response to the rapid development of large hydroelectric dams in B.C. At that time, dams greater than 15 metres in height were inspected by government engineers under the authority of the *Water Act*. Over time, the program expanded to include smaller dams. Inspections focused on ensuring the dams were designed, constructed, operated, and maintained to acceptable standards for public safety.

The first B.C. Dam Safety Regulation under the *Water Act* came into effect in 2000 based on recommendations from an independent program review of the 1995 Cannon Creek Dam failure. The regulation placed legal responsibility for the safety of dams on dam owners; thus, requiring owners to operate, maintain, and inspect dams to minimize risk to the public, the environment, and the economy. In addition to the new regulation, the program reviews recommended enhancements to the dam safety program to improve rigour, consistency, accountability, and to ensure adequate resources were present to deliver the program across the province. The review also recommended that the program follow the guidelines of the Canadian Dam Association (CDA).

Further improvements were made to the regulation and the program in response to the Deputy Solicitor General's recommendations following the 2010 Testalinden Dam failure. These include developing a comprehensive database of dams in the province, requiring signage at dams, updating the dam failure consequence classifications, and making education and awareness a key pillar of the program.

On February 29, 2016, the Dam Safety Regulation, *Water Sustainability Act* came into effect replacing the former B.C. Dam Safety Regulation, *Water Act*.

Program Delivery and Operations

The Dam Safety Program is delivered by the Dam Safety Section in Victoria, DSOs from FLNR resource regional or district offices, and DSOs from the BC Oil and Gas Commission (OGC). The Dam Safety Section in Victoria is responsible for overall administration of the program, in close collaboration with FLNR Regional DSOs and OGC DSOs. This includes leading development of legislation, policies and procedures, coordinating delivery of education/training sessions, reporting progress on program objectives, meeting the program's information system's needs and leading the dam safety community of practice. DSOs in the Dam Safety Section in Victoria are also responsible for regulating most water supply dams greater

than nine metres in height (also known as major dams). FLNR Regional DSOs are responsible for dams that are less than or equal to nine metres high. OGC DSOs are responsible for all oil and gas related dams that are authorized by the OGC. The program also receives support from FLNR's compliance and enforcement branch and partner agencies such as Emergency Management BC.

DSOs undertake the following activities while administering the dam safety program:

- Conduct periodic audits of dam owners' dam safety management systems to ensure that dam owners are compliant with the Regulation and their dam safety management systems are consistent with both government and CDA guidelines.
- Review annual dam status reports submitted by dam owners summarizing their dam safety activities, as required by the Regulation.
- Assess formal dam safety reviews completed by an engineer on behalf of the dam owner, every 7 to 10 years for high, very high, and extreme consequence dams.
- Monitor dam owners' progress on addressing any potentially hazardous conditions at their dams, as identified through dam safety reviews, audits, regular inspections or any other means.
- Review plans for dam construction, rehabilitation, replacement, and decommissioning to ensure consistency with CDA guidelines.
- Review new and modified Dam Emergency Plans as well as Operation, Maintenance, and Surveillance Manuals for consistency with government and CDA guidelines.
- Review failure consequence classifications for new dams or changes to failure consequence classification for existing dams. Failure consequence classification determines the regulatory requirements that apply to a dam. Higher classification dams are subject to higher levels of regulation and oversight.
- Educate dam owners about regulatory requirements, government and industry guidelines, and best practices in dam safety.
- Respond to dam safety emergencies. This can involve a range of activities from overseeing a dam owner's response to hazardous conditions at a dam or, if a dam owner does not respond, undertaking the work necessary to help respond to and mitigate the hazard.

Regulated Dams in B.C.

A wide range of dams are authorized under the WSA and subject to the Regulation. These include some of the largest dams in Canada associated with hydro-electric power generation (e.g. the Mica Dam), as well as dams used for agricultural irrigation, industrial use, municipal water supply, domestic use, and flood control. As of February 6, 2020, there were a total of 2,068 active dams in B.C. of which 1,879 are regulated by the Dam Safety Program. Table 1 provides an outline of the regulated and unregulated dams based on their Failure Consequence Classification, which is determined by the level of downstream and upstream impacts resulting from the unlikely failure of the dam or its appurtenances. Schedule 1 of the Regulation provides information on how to determine a dam failure consequences classification. Table 2 shows the distribution of these dams across the regions of BC.

Table 1: Active regulated & unregulated dams under Regulation, WSA (as of March 31, 2020)

Failure Consequence Class	Regulated Dams	Unregulated Dams	Total
Extreme	43	0	43
Very High	86	1	87
High	231	0	231
Significant	593	13	606
Low	825	103	928
None	0	10	10
Unclassified ¹	101	62	163
Dam Totals	1,879	189	2,068

Table 2: Active Regulated Dams – Consequence Classification by Administrative Unit

Consequence	Dam Safety Section	West Coast	South Coast	Cariboo	Thompson	Okanagan	Kootenay	North Area	BC OGC	Total
Extreme	43	0	0	0	0	0	0	0	0	43
Very High	48	11	1	2	3	17	3	1	0	86
High	54	19	16	30	55	37	9	4	7	231
Significant	59	110	43	80	139	69	24	46	23	593
Low	9	121	15	228	174	97	39	131	11	825
Unclassified	0	0	0	33	0	6	1	61	0	101
<i>Total</i>	<i>213</i>	<i>261</i>	<i>75</i>	<i>373</i>	<i>371</i>	<i>226</i>	<i>76</i>	<i>243</i>	<i>41</i>	<i>1,879</i>

2019/20 PROGRAM ACTIVITIES

The activities of the dam safety program in 2019/20 are grouped into the following areas:

- Dam owner compliance
- Dam safety plans review, construction and approval
- Program management
- Dam emergency planning and response

DAM OWNER COMPLIANCE

Education and Awareness

The advent of the B.C. Dam Safety Regulation in 2000 placed the burden of responsible dam management solely with the dam owner. To assist the dam owner, the Dam Safety Program promotes and provides dam safety education and awareness initiatives. Namely, the Dam Safety Program has employed a full time Dam Safety Training Coordinator who leads the education and awareness pillar of

¹¹ Unclassified Consequence refers to active dams whose consequence have not yet been determined. The seemingly high number is because these dams are very small and do not fall within the threshold of where the entire regulation applies (in terms of storage and height) and were considered non-regulated prior to the 2016 Regulation amendment. These dams are therefore a low priority for the Dam Safety Program and consequence assessments/verification has not been undertaken. Also, there have been several new dams built in the Northeast Region for oil & gas and agricultural purposes and consequence classifications determination is pending following field assessments.

dam safety and delivers dam safety workshops in provincial regions throughout the year. These workshops are available to all owners of dams and are sponsored, in part, by the Ministry of Agriculture (AGRI), Water Supply Association of BC, and the BC Water & Waste Association (BCWWA).

Furthermore, published resources are also available to current and prospective dam owners and stakeholders, including the new 2019 BC Dam Safety Pocketbook. This resource provides a quick overview on common issues found in earthen embankment dams and includes recommended actions to assist in the inspection and maintenance of these dams. This Pocketbook is included in all workshops run by the program and is available upon request. Also new for 2019 is a free online training program that is publicly available as an introduction to the Regulation and dam safety requirements.

Additionally, every audit a DSO conducts with a dam owner includes a dam site visit and the opportunity to discuss specific dam safety issues and concerns. It is imperative that dam owners fully understand their dam safety responsibilities as per the Regulation and the importance of maintaining a safe dam. Dam safety staff have also delivered dam safety education and awareness training to other provincial staff members. For example, staff have been trained to assist DSOs with rapid dam assessments during emergencies. Additionally, staff who are responsible for provincially owned dams (such as dams licenced to BC Parks, Fish & Wildlife, Crown Land Restoration Branch, etc.) have also been trained to undertake their dam owner responsibilities as per the Regulation.

FLNR staff supported development of the Agriculture Knowledge Transfer Resource; a dam safety education program targeted specifically at owners of agricultural dams. The project was made possible with support from the BC Agriculture & Food Climate Action Initiative, Ministry of Agriculture, Agriculture Canada, and the BC Cattlemen's Association. The Dam Safety Section has added this new initiative into its education program in the form of a dam management workshop. Through the partnerships above, the dam safety section runs many one-day workshops, all free of charge, across the province.

Table 3 provides a list of the workshops which have been offered in various locations across B.C. in 2019 along with the attendance records. The attendance was 211 compared to 138 last year, an increase of 53%. This increase in attendance was due to having a full-time dedicated training coordinator on staff. The workshop types include Inspection and Maintenance of Dams (DIM) and BC Dam Safety Management (BCDSM).

Dam safety education continues to be an important part of the BC Dam Safety Program and is key to ensuring dam owner compliance. Refer to the BC Dam Safety website at www.gov.bc.ca/damsafety for future offerings in [dam safety training](#). The Dam Safety Program has also released a new online [self-directed course on dam safety in BC](#), which provides basic dam safety concepts and information on how dams are regulated in B.C.

Table 3: Dam Safety Program 2019 Workshops

Date	Location	Number of Attendees	Sponsor	Type
December 2, 2019	Prince George	8	BCWWA	DIM
November 29, 2019	Kelowna	24	BCWWA	DIM
November 20, 2019	Colwood	13	BCWWA	DIM
November 13, 2019	Duncan	16	AGRI	BCDSM
November 7, 2019	Penticton	15	WSA	DIM
November 4, 2019	Nanaimo	9	BCWWA	DIM
October 29, 2019	Kamloops	17	AGRI	BCDSM
October 23, 2019	Ladysmith	24	AGRI	BCDSM
October 21, 2019	100 Mile House	13	AGRI	BCDSM
October 1, 2019	Fort St John	16	AGRI	BCDSM
September 19, 2019	Smithers	10	AGRI	BCDSM
September 17, 2019	Vanderhoof	12	AGRI	BCDSM
May 31, 2019	Dawson Creek	8	BCWWA	DIM
May 30, 2019	Dawson Creek	9	BCWWA	DIM
May 3, 2019	New Westminister	8	BCWWA	DIM
May 1, 2019	New Westminister	9	BCWWA	DIM

Communications and Engagement

In addition to formal and informal education, the dam safety program communicates regularly with dam owners and communities of interest. Dam safety staff participated in the following communications and engagement activities in 2019/20:

- OGC and FLNR dam safety staff made a presentation to the oil and gas industry dam owners in Fort St. John in February.
- OGC staff reinforced the necessity of dam emergency planning in a presentation to the Canadian Association of Petroleum Producers.

- FLNR dam safety staff provided on-site training on the responsibilities of a dam owner for the Krestova Improvement District.
- FLNR staff presented a technical paper, titled “Safe Operation of Agriculture Dams in the Thompson Region of B.C.”, at the 2019 CDA Conference in Calgary.
- FLNR staff met with BC Hydro and Rio Tinto representatives for annual and semi-annual dam safety meetings, respectively.
- FLNR staff notified owners of high, very high and extreme failure consequence dams in early April ensuring their dams are maintained and operating properly to allow the safe discharge of possible flood flows during spring freshet.
- FLNR staff participated at a desktop emergency planning group meeting for Site C Stage 2 river diversion and cofferdam.
- FLNR staff delivered a dam safety presentation to the annual Thompson Regional EMBC Spring Emergency Preparedness workshop for first responders.

Annual Dam Status Report – Self-Reporting by Owners

Each year, the Comptroller of Water Rights requests owners of dams with high, very high and extreme failure consequence classifications to complete and submit an annual dam status report. DSOs use the information in annual dam status report to assess compliance between dam safety audits, ensure information in the provincial dam database is current, and help dam owners address any emerging dam safety issues. Dam safety officers may contact dam owners to request more information or arrange a meeting to discuss dam safety concerns. The reports request the status of the following:

- Formal inspection(s) and regular site surveillance
- Dam safety review completed by a qualified professional engineer
- Operations, maintenance, and surveillance manual
- Dam emergency plan and emergency contact information
- Submission of dam emergency plan information to local emergency authority
- Changes to downstream land-use that might affect the failure consequence classification of the dam
- New dam safety concerns that have not previously been reported

Starting in 2018 the annual dam status reports were requested online through FrontCounterBC, rather than through regular mail. Annual Dam Status Reports were requested for the second year in the 2019 with a return of 75% by March 5th and 92% by June 24th. Most of the late returns required follow-up by staff who encouraged the use of online reporting. If a dam owner was not able to use the online system, they were required to complete a paper report and submit via email, fax, or regular mail.

A total of 328 dam status reports out of a total 357 requested (92%) were returned in 2019/20. If a dam owner does not submit a report for three consecutive years, enforcement action may be initiated. Like previous years, a high degree of compliance continues with dam owners conducting annual formal inspections and frequent site surveillance of dams. Of the 328 submitted reports, 92% had undertaken their required annual formal inspection and 97% had undertaken regular site surveillance.

The Regulation requires owners of significant, high, very high, and extreme failure consequence classification dams to provide local emergency authorities with dam emergency plan information. Owners of existing dams were given until March 31, 2020 to meet this requirement. For the 2019/20 reporting period, approximately 80% of dam owners reported that they had complied with this requirement. DSOs will continue to work with dam owners and local authorities to ensure that all parties are aware of the new requirement.

Owners of high, very high and extreme failure consequence dams were further asked questions about dam safety training. 82% of these dam owners indicated that they had taken some form of dam safety training.

Dam Safety Reviews

Under the Regulation, owners of high, very high and extreme failure consequence classification dams are required to retain a qualified engineer to conduct a dam safety review every seven to ten years, depending on the dam’s consequence classification. The engineer evaluates the safety of a dam and the dam owner’s safety management system and prepares a report, which is provided to the dam owner and the DSO. The dam owner is then responsible for addressing deficiencies identified in the review.

There are 317 dams requiring a dam safety reviews every ten years and 43 dams requiring a dam safety reviews every seven years. See Table 4 below for the status of dam safety reviews as reported by DSOs for 2019/20.

Table 4: Status of dam safety reviews in progress, as reported by DSOs for 2019/20

Dam Safety Review	FLNR/OGC Administrative Units									
	Dam Safety Section	West Coast	South Coast	Cariboo	Thompson	Okanagan	Kootenay	North	OGC	BC
Dams with Dam Safety Reviews										
How many dams are overdue in dam safety reviews?	31	8	7	3	9	3	1	3	0	65
How many dams are undergoing dam safety review?	31	8	2*	5	2*	2*	1	0*	0	51
Review of Dam Safety Review (DSR) documents by DSO (including version reviews)										
How many DSRs were reviewed in 2019/20?	13	3	2	1	9	3	1	0	0	31
How many DSR documents were accepted?	8	2	0	1	2	3	0	0	0	16
How many DSR documents were rejected (that is, sent back for more info)?	5	1	2	0	7	0	1	0	0	16

* Conversations are in progress with dam owners regarding outstanding required DSRs

Dam Safety Database

Accurate information about B.C. dams is important for DSOs to manage their portfolio of dams, report on the state of dams, and for quick access to information during emergencies. The dam safety database is comprised of two separate but linked digital information systems:

- E-Licensing - houses text-based data records for each dam, and
- BC Dams geographic dataset - provides geospatial data.

E-Licensing is the interface used by DSOs and is available to authorized internal users. Key information from eLicensing for each dam is available to the public in a geospatial layer that can be viewed on [DataBC's iMap service](#).

To improve the quality of data in e-licencing an engineering co-op student was hired in the summer of 2019 to gather data and update contact information for owners of all significant failure consequence classified dams, comprising 31% of the regulated active dams in B.C.

Accurate location information of a dam is required for spatial representation in mapping applications and GIS. Of the total number of active dams recorded in the dam registry, 82% have associated geospatial information that can be displayed. Some of the 367 dams in the database missing geospatial data have location information that exists but is not accessible to be used for display. This discrepancy is currently being corrected by FLNR and Ministry of Environment staff who are improving connectivity between the E-licensing system, which supports the dam registry, and the BC Government Warehouse repository of the geospatial data. For the remainder that do not have spatial data, DSOs will continue to obtain spatial data for these dams during routine site visits conducted as part of dam safety audits or other opportunities.

Through the Water Information Systems Project funding program, several more upgrades were made to E-licensing focusing on improving workflows associated with dam audits and managing dam incidents. This undertaking was a collaborative effort between FLNR Dam Safety and Water Business staff to streamline and integrate processes used in the workflows and make communications with dam owners more efficient. Several rounds of user acceptance testing was conducted by Water Business staff with Dam Safety staff participation to verify improvements. After E-Licensing changes were finalized, Water Business staff provided training to DSOs to go over how to use the updated system.

Dam Safety Audits

DSOs meet with dam owners and conduct dam safety audits at least once every five years for all regulated high, very high and extreme failure consequence classification dams, and at least once every ten years for regulated significant failure consequence classification dams. Each DSO has an individualized annual target of audits to ensure that all dam audits are completed within the required time frame. The audits are an opportunity for DSOs to meet with dam owners to review records, conduct site visits, and to help identify deficiencies. These audits help confirm whether the dam owner is aware of and is carrying out the requirements of the Regulation. If deficiencies are found, DSOs provide information to help dam owners understand requirements and resolve issues. When necessary, DSOs follow up with owners to ensure that any identified deficiencies are corrected.

In 2019/20, DSOs completed a total of 142 audits. See Table 5 for the number of audits conducted by DSOs in 2019/20:

Table 5: Number of audits conducted by DSOs in 2019/20 (by administrative unit)

Administrative Unit (FLNR/OGC)	Dam Audit Target for 2019/20	Dam Audits Completed*
Dam Safety Section	40	28
West Coast	14	12
South Coast	7	11
Thompson	26	25
Cariboo	17	26
Kootenay	4	0
Okanagan	18	15
North	10	13
OGC	0	0
Total	136	130

*In some units, dam audit targets were not met due to reduced dam safety staffing (i.e. retirements, parental leave, etc.).

DAM SAFETY PLANS REVIEW, CONSTRUCTION AND APPROVAL

Reviewing Plans and Monitoring Work in Progress or Completed

The Regulation requires dam owners to submit plans for construction, alteration, or decommissioning of a regulated dam. The DSO must evaluate the plans before the dam owner can commence work. DSOs review these plans for consistency with the Regulation and CDA guidelines and may conduct periodic site visits to monitor construction while the work is underway. DSOs also provide professional advice to other statutory decision makers to coordinate requirements under WSA authorizations (e.g. issuing a leave to commence construction under a water licence), and when a statutory decision maker is issuing an order under the WSA for work related to a dam.

In 2019/20, DSOs reviewed a total of 16 project plans for new dams, 63 for dam rehabilitations, and 14 for dam removals. DSOs monitored 7 construction projects for new dams, 16 dam rehabilitation projects, and 11 dam decommissioning projects of which 7 were completed.

Operational Reviews

The Regulation requires owners of dams, other than those with a low failure consequence classification, to periodically review and revise, if necessary, their Operations, Maintenance, and Surveillance (OMS) manuals as well as their Dam Emergency Plans (DEP). Any revisions and/or updates are submitted to the DSO. This is required at least every ten years for significant and high failure consequence dams and every seven years for very high and extreme failure consequence dams. The annual dam status report includes questions on the status of the OMS and DEP, while serving as a reminder to dam owners of their obligation to maintain these documents. In 2019/20, DSOs reviewed more than 73 new or revised OMS manuals and more than 86 new or revised DEPs.

The Regulation also requires owners of dams to review downstream conditions and notify a DSO of any changes that may impact a dam's failure consequence classification. These reviews help ensure that dams are subject to appropriate regulatory requirements and oversight. In 2019/20, DSOs reviewed more than 24 requests for changes to failure consequence classifications.

PROGRAM MANAGEMENT

Program Administration

In 2019/20, a total of 11.75 Full Time Equivalents (FTE) designated DSOs administered the B.C. Dam Safety Program across the province at the FLNR Water Management Branch office, the various FLNR regional or district offices, and OGC offices in Fort St John and Kelowna (Table 6). Dam safety staff have an additional 5.2 FTEs of support staff, which includes administrative support, water licence authorization, and managerial program guidance.

Table 6: BC Dam Safety Program Staffing by Administrative Unit in 2019/20 (FTE)

Work	FLNR/OGC Administrative Units (FTE)									
	Dam Safety Section	West Coast	South Coast	Cariboo	Thompson	Okanagan	Kootenay	North	OGC	BC
Dam Safety	4.3	0.75	0.9	1.0	0.85	0.8	1.0	1.15	1.0	11.75
Support	1.4	0.40	0.3	0.7	1.40	0.3	0.2	0.30	0.2	5.2
Unit Total	5.7	1.15	1.2	1.7	2.25	1.1	1.2	1.45	1.2	16.95

Outreach and Professional Development

To stay up to date on the technical aspects of dam safety, many dam safety staff participated in various conferences and professional development committees including the CDA, the Association of State Dam Safety Officials (ASDSO), and the International Commission on Large Dams (ICOLD). These opportunities provide a broader base of knowledge to dam safety staff and allows staff to proficiently discuss dam issues with dam owners, consultants, stakeholders, First Nations, and regulators.

In 2019/20, dam safety staff continued to collaborate with their counterparts in other jurisdictions, agencies, industry, and professional associations on developing and improving dam safety best practices.

With funding from EMBC and Public Safety Canada's National Disaster Mitigation Program, the dam safety program initiated the B.C. Extreme Flood Project, a compendium of three studies to develop guidance regarding probable maximum precipitation and flood requirements for dams in BC. This project is one of the first of its type in the world, and many jurisdictions are interested in the results of this project. So far, two technical papers on this initiative have been presented and published at the proceedings of the 2020 United States Society on Dams (USSD) Conference held in Denver, Colorado.

Two dam safety staff represented B.C. at the 2019 International Commission on Large Dams (ICOLD) Conference in Ottawa, and four dam safety staff represented B.C. at the 2019 Canadian Dam Association (CDA) Conference in Calgary. Staff attending the CDA conference also attended several workshops including a risk assessment workshop and an emergency management workshop while one staff member gave a presentation. Two staff members are on-going members of the CDA Dam Design and Construction Working Group, the Emergency Management Working Group, and the Regulator's Committee. These staff assisted in the preparation of the Design and Construction and Emergency Management working groups' technical bulletins and the facilitation of workshops at the conference.

Dam safety staff from FLNR and the OGC participated in a technical workshop hosted jointly with BC Hydro and its dam safety staff at their office in Vancouver on November 24th and 25th of 2019. This workshop provided an opportunity to share technical dam safety information to dam safety staff and collectively improve the current state of knowledge. DSOs benefit from the technical knowledge imparted to make accurate and accountable decisions on a range of different dams with varying technical attributes and ownership arrangements. The workshop covered areas related to:

- Dam break analysis and inundation mapping,
- Public safety around dams,
- Risk informed decision making related to the operation of reservoirs under flooding conditions,
- Concrete issues and technology,
- Operations planning of hydropower systems,
- Dam data instrumentation, and
- The use of independent environmental professionals for the Site C project.

The workshop was complemented with a tour of the Northwest Hydraulics Consultants laboratory in North Vancouver where a multitude of testing and modelling is completed for dams. Attendance at the biennial technical workshop, along with the annual dam safety community of practice (COP) meeting, is required by all DSOs to maintain their designation under the WSA.

Additional outreach from the dam safety staff also included the following:

- Staff participation on the dams and reservoirs committee of the Okanagan Basin Water Board.
- Continued staff participation with Engineers and Geoscientists BC on practice advisory on dam safety.

DSOs participated on various technical webinars provided by the Association of State Dam Safety Officials, Engineers and Geoscientists B.C., and Natural Resources Canada. Internally, DSO training was offered in 2019/20 to several new regional dam safety staff, one from the North Region, one from the Cariboo Region, and one from the Kootenay Region, as well as two staff from the OGC. All new dam safety program staff are required to receive a basic program orientation overview and undertake audits under the supervision of an experienced DSO before receiving a DSO designation. This, along with attending monthly conference calls, the annual community of practice meeting and biennial technical training, helps ensure that staff have the skills necessary to fulfill their role as DSOs. It also promotes consistency in the application of the program and Regulation across the province.

Other Dam Safety Program Highlights

Other notable Dam Safety Program accomplishments in the past year include:

- Dam safety policy has been drafted regarding minor dams, dams exempted from the regulation, designation of a dam owner, immediate vicinity, information disclosure, DSO role on site visit, and dam owner designation.
- Information on the [dam safety program website](#) is regularly updated to ensure dam owners have access to current information on the Regulation, policies, and other guidance and best practice documents on dam safety. This year the Dam Safety Program created a new section on [education and training](#).

Climate Change

The Dam Safety Section recognizes that a changing climate will have effects on the safe operation of facilities. Variable projections in greenhouse gas emission's effect on climate, combined with a highly variable topography in British Columbia means that climate effects will have high degrees of variability throughout the province. However, overall, downscaled climate projections for BC predict that there will be warmer average temperatures resulting in more rain during the winter and more seasonal droughts in the summer months. As a result, the need for dam-based reservoirs are generally anticipated to amplify when considering hydropower initiatives and the role that reservoirs play in regulating streamflow in periods of water abundance and scarcity.

Risk of dam failure is also anticipated as climate change will cause an increase of high flow events filling reservoir structures during certain periods, followed by more prolonged drier periods drawing down reservoir levels. This will result in more stress on dams potentially due to surficial erosion, internal erosion due to larger groundwater gradients if the dam was not constructed properly, and increased static and potentially dynamic loads during extreme weather.

Because of these changing circumstances, the Dam Safety Section initiated the B.C. Extreme Flood Project (as mentioned above), which will provide evidence-based information from meteorological data, allowing a more precise prediction of extreme flood events suitable for the design of dams in all failure consequences. This project will aid the Dam Safety Program in many ways including; assisting FLNR staff analyse hydrotechnical assessments for such things as reservoir inflow design floods, and for improving data used by qualified professionals for issues such as re-evaluating existing hydrological data to ensure a dam will perform adequately during significant weather events. While advancing the metrological data that informs these assessments is still an evolving process, the Dam Safety Program is committed to continued research and data collection, working with our partners to mitigate the risk of climate change and maintain the stability and safety of British Columbia's dams.

DAM EMERGENCY PLANNING AND RESPONSE

When an incident relating to a dam is reported to the province, a DSO or other FLNR staff person will follow the Dam Emergency Response Plan and immediately respond, occasionally with support from regional compliance and enforcement staff. The dam owner is contacted and depending on the situation, Emergency Management BC and other agencies may be involved. Although not all reported incidents are an emergency or even an issue related to a dam, each one is followed up on and a Dam Incident Report is created and filed. The following is a list of the dam incidents reported in 2019/20.

Dam Breach (Breach of dam imminent, in the process of breaching, or has breached)

There were two dam breaches reported in 2019/20.

1. Dam Name: Valley Pond (Upper) Dam
DFile: D810560-00
Date: March 27, 2019
Consequence Classification: Low
Location: Near 150 Mile House

On March 27, 2019 on a site visit requested by the dam owner, FLNR staff discovered Valley Pond (Upper) Dam with ten centimetres of freeboard and debris and ice partially blocking the spillway (Photo 1). The owner was directed to remove the debris and install large volume pumps to draw down the water level in the reservoir. Another visit by helicopter the next day revealed the dam

overtopping and large ice debris again partially blocking the spillway. MOTI, the Cariboo Regional District and EMBC were notified by FLNR of a potential breach. The FLNR assistant water manager, through a written order, required the owner to make the dam safe. The owner notified downstream residents and complied with the FLNR directions resulting in the prevention of overtopping. The dam embankment was in poor condition because of the erosion and slumping. The owner was required by FLNR to retain the services of a qualified professional and complete the repairs as soon as possible.



Photo 1: Overtopping and erosion of the Valley Pond (Upper) Dam embankment

2. Dam Name: Dugout dam near Hallis Lake Community Pasture
DFile: None
Date: May 7, 2019
Consequence Classification: Unclassified minor dam
Location: Vicinity of Quesnel

Between April 1st, 2019 and May 7th, 2019, a 50m-by 50m- by 3m dugout dam breached at the spillway pipe, releasing water and debris to the pasture below the dam (Photo 2). Although the dam crest was three metres wide, the piping at the spillway pipe was enough to cause the dam to fail as it was poorly constructed in 2018 during rainy weather and not compacted because the material was too wet.



Photo 2: Minor dam failure due to piping around spillway pipe near Hallis Lake Community, Quesnel

Dam Alerts (Abnormal conditions requiring immediate action to avert breach)

A dam alert occurs when an abnormal condition is observed at a dam or a dam performs abnormally, and without swift and effective intervention, failure may occur.

There was one dam alert reported in 2019/20.

1. Dam Name: Upper Buse Lake Dam
DFile: D120125-00
Date: April 16, 2019
Consequence Classification: Low
Location: Robbins Range area, southeast of Kamloops

On April 16, 2019, FLNR staff discovered and contacted the owner of the poorly constructed dam with minimal freeboard and seepage at the toe of the dam. FLNR staff met at the site with the owner who was siphoning the reservoir with a 150mm pipe (Photo 3) as the existing spillway pipe was grossly underperforming. The owner was instructed to maintain surveillance of the dam and use a pump to draw down the reservoir rapidly as possible. The owner was also advised to add more material to heighten the crest of the dam and broaden the crest width and downstream side of the dam to flatten the slope of the dam. Should the dam breach, the content would spill onto the adjacent hay field, which was not a concern.



Photo 3: Siphon installed by owner to drain full-supply reservoir of the Upper Buse Lake Dam

Dam Incidents (Conditions NOT requiring immediate intervention to avert breach)

A dam incident occurs when an abnormal condition is observed at a dam or the dam performs abnormally but the condition is not expected to lead to a failure of the dam.

There were six dam incidents reported in 2019/20.

1. Dam Name: Cannell Lake Dam
DFile: D410102-00
Date: February 3, 2020
Classification: High
Location: North of Steelhead near Stave Lake

On February 3, 2020, FLNR received a request from EMBC to assess the damage done to the spillway of the dam owned by the City of Abbotsford, resulting from increased inflows because of intense rainfall from a recent storm event. FLNR and municipal staff visited the dam later in the week to assess the spillway. The reservoir levels had already receded, exposing the damage done to the spillway channel bed (Photo 4). FLNR informed EMBC that timely repair to the spillway channel was required to prevent further damage at the onset of a similar storm in the future. The municipality is working with its consultant on producing remedial options for the spillway and in the meantime was managing the lake level daily to reduce any further damage to the spillway outlet condition daily.



Photo 4: Erosion of the spillway channel of the Cannell Lake Dam

2. Dam Name: Hugh Keenleyside Dam
DFile: D350003-01
Date: January 13, 2020
Classification: Extreme
Location: West of Castlegar

On January 13, 2020, BC Hydro notified FLNR of damage to the left floating guide wall upstream of the Hugh Keeleyside dam, because of overnight storms. The guide wall was discovered to have two of its six pontoons, near where the debris boom was anchored, slowly being submerged into the water. If the debris boom were submerged, it would have impacted the operation of the discharge facilities by blocking the water passage or impacting the gates to open or close. BC Hydro has reduced the discharge to reduce the load on the debris boom. A tug was brought in to remove the accumulated debris from the debris boom. An around the clock site coverage was undertaken to ensure no further problems ensued. The owner was in the process of evaluating the guide wall damage and reviewing options to temporarily relocate the debris boom anchor.

3. Dam Name: Duck Meadow Dam
DFile: D130167-00
Date: April 15, 2019
Classification: Significant

Location: Northwest of Monte Lake

On April 15, 2019, FLNR was notified by the dam owner that cattail islands had been dislodged upstream of the dam and the debris had moved down to the dam outlet, potentially causing blockage if not removed and raising the water level in the marsh. Movement of cattail debris occurs periodically during freshet. The owner brought in an excavator to remove the debris and a site visit by FLNR staff three days later confirmed the operation was performed (Photo 5).



Photo 5: Removal of cattail debris upstream of the Duck Meadow dam

4. Dam Name: Skins Lake #2 Dam
DFile: D620001-03
Date: March 11, 2020
Classification: Extreme
Location: South of Burns Lake on the Nechako Reservoir

On March 12, 2020, the owner of the dam notified FLNR that the day before one of the radial gates of the spillway would not be operating at its designed flow rate due to a damaged flat belt (Photo 6) used for the actuation of the radial gate. This would be a problem in passing freshet flows. Rio Tinto (dam owner) staff planned submerged replacement of the flat belt of the gate, which was in place holding water. The repairs were completed and the radial gate was made operational.



Photo 6: Damaged flat belt used for the actuation of the spillway radial gate with the Skins Lake #2 Dam

- 5. Dam Name: Seton Dam Power Canal
- DFile: D110002-02
- Date: November 26, 2019
- Classification: High
- Location: Vicinity of Lillooet

On November 26th, 2020, BC Hydro reported to FLNR that the Seton Dam powerhouse canal was dewatered for water cooling upgrade and maintenance work on November 3rd. Upon refilling eighteen days later, the canal weir instrumentation showed high water flows up to 3400 litres per minutes causing the weir to spillover and flood the ground of the weir building (Photo 7). This happened because of sub-zero temperatures affecting water flow in the area two days before re-watering. Typically, elevated water flows occur when the powerhouse is brought back to service. This event was atypical as the weir flows were much higher causing leakage. By November 23rd, the

weir flows had returned close to normal with no water leakage. BC Hydro dam safety staff were onsite to assess the excess water flows and other site conditions the day before.



Photo 7: Leakage from the Seton Dam Power Canal weir inside the building

6. Dam Name: Gaspard Lake Dam
DFile: D810321-00
Date: July 8, 2019
Classification: High
Location: South of Hanceville

On July 8, 2019, FLNR staff, during aerial reconnaissance of the Big Creek flooding event, observed highwater in the lake and high flow rate through the spillway of the Gaspard Lake dam, damaging the spillway (Photo 8).



Photo 8: Damage to the spillway bank of the Gaspard Lake dam

Informed by FLNR, the dam owner worked on reducing the water level in the reservoir by opening the lower level outlet of the dam. The owner and their engineer had submitted a plan to make emergency repairs to the spillway. The spillway has been re-armoured for the 2020 freshet.

No Dam Incidents (Conditions NOT impacting safety of the dam (verify as appropriate))

This term is used for reports that are initially received as dam incidents but do not impact the safety of a dam. It could refer to an erroneous report, or a report about an abnormal condition that could be interpreted as a threat to a dam.

There were two reports classified as “no dam incident” in 2019/20.

1. Dam Name: Aberfeldie Dam
DFile: D320000-00
Date: May 3, 2019
Classification: High
Location: East South East and upstream of Bull River

On May 3, 2019, BC Hydro reported to FLNR that a washout of fill material was found 265m downstream of the dam adjacent to the penstock (Photo 9). Presuming leakage, action was taken earlier beginning April 29 to prevent further erosion by dewatering the penstock. No seepage from the penstock at the site was observed. Issues with the durability of welded joints on the penstock and the structure of the pipe were previously identified in 2017; however, neither contributed to any observed leakage from the penstock at that time. BC Hydro has since repaired the leak and is continuing monitoring of the penstock.



Photo 9: Washout looking upstream towards Aberfeldie Dam

2. Dam Name: Willan Lake Dam
DFile: D810140-00
Date: June 10, 2019
Classification: Low
Location: South of Alexis Creek

Following a significant rain event, the dam weir was observed by FLNR staff during aerial reconnaissance on June 10, 2019 close to overtopping with high water flow scouring the toe of the steel weir and left abutment causing damage. Promptly after being informed by FLNR, the dam owner repaired the dam. A follow-up on July 23 by FLNR staff revealed the placement of a large rock at the left toe of the steel wing of the dam to reinforce (Photo 10), looking downstream.



Photo 10: Rock reinforcement of the Willan Lake weir dam

PROGRAM CHALLENGES AND OPPORTUNITIES

The B.C. Dam Safety Program continues to make progress in addressing the recommendations of the 2010 Deputy Solicitor General's report on the Testalinden Dam failure. Program staff is working to address several challenges:

- DSOs, working closely with water authorization staff, continue to ensure owners of unauthorized dams are discovered and their dams meet the requirements of the Regulation & WSA.
- Dams with a failure consequence classification of low are addressed by DSOs on a reactive or complaint-driven basis. The program is exploring opportunities for additional capacity to proactively engage with owners of low consequence dams, such as formal and informal training sessions.
- Some local governments are not adequately resourced to respond to dam emergencies in a timely manner.
- Some dam owners are have difficulty paying for the cost of dam ownership such as routine maintenance, site surveillance, formal inspections, normal operation of their dam as well as cost to comply with the Regulation such as hiring technical experts to undertake dam safety reviews, prepare Operation, Maintenance and Surveillance manuals and Dam Emergency Plans, and undertaking dam rehabilitation and site assessments (i.e. archeological investigations).
- Smaller communities have a shortage of qualified professional engineers with experience in dam design, construction, or management. Owners of dams in these areas may find dam engineering services to be limited or unavailable and it can be costly to bring in outside expertise.

B.C. Dam Safety Program
Ministry of Forests, Lands and Natural Resource Operations and Rural Development
December 2020