Ministry of Forests, Lands, Natural Resource Operations and Rural Development

Dam Decommissioning Guidelines

Dam Safety Program

Ministry of Forests, Lands, Natural Resource Operations and Rural Development

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Definitions

Attenuation: the reduction in the peak of a hydrograph as it moves downstream, resulting in a broader, flatter hydrograph.

Crown land: land, whether or not it is covered by water, which is vested in the government.

Dam:

(a) a barrier constructed for the purpose of enabling the storage or diversion of water diverted from a stream or an aquifer, or both, and
(b) other works that are incidental to or necessary for the barrier described in paragraph (a).

Decision maker, in relation to a decision under the *Water Sustainability Act*:

(a) the person authorized to make the decision, and
(b) if more than one person is authorized to make that decision, the person who is making or has made that decision,

whether on application or on the person's own initiative.

Dam decommissioning: to take a dam out of service permanently.

Engineering professional:

(a) a professional engineer as defined in the *Engineers and Geoscientists Act*, or
(b) a holder of a limited licence under the *Engineers and Geoscientists Act* that permits the person to practise professional engineering and who is acting within the scope of the limited licence.

Full dam decommissioning: the removal of the entire dam and appurtenant structures to the original stream bed level and to the original abutment surfaces outside the stream channel.

Breach: the construction of an opening in the dam for the purpose of removing the ability to store water within the reservoir. Typically, the breach will extend fully vertically to the original stream channel elevation, but may be limited horizontally.

Partial dam decommissioning: the construction of a breach to allow for the reduction of reservoir storage.

Stakeholder: a person with a specific interest or concern in the outcome of a decision.

Stream:

(a) a natural watercourse, including a natural glacier course, or a natural body of water, whether or not the stream channel of the stream has been modified, or
(b) a natural source of water supply,

including, without limitation, a lake, pond, river, creek, spring, ravine, gulch, wetland or glacier, whether or not usually containing water, including ice, but does not include an aquifer.

Stream channel: the bed of the stream and the banks of the stream, both above and below the natural boundary and whether or not the channel has been modified, and includes side channels of the stream.

Storage purpose: the impounding and retention of water for subsequent use for a water use purpose.

List of Acronyms

Acronym	Definition
DFO	Department of Fisheries and Oceans Canada
DSO	Dam Safety Officer
DSR	Dam Safety Regulation
EAO	Environmental Assessment Office
EGBC	Engineers and Geoscientists British Columbia (formerly the Association of Professional Engineers and Geoscientists BC - APEGBC)
FLNRORD	Forests, Lands, Natural Resource Operations and Rural Development
IDF	Inflow Design Flood
PCL	Permit over Crown land
QPE	Qualified Professional Engineer
SDM	Statutory Decision Maker
WSA	*Water Sustainability Act*

List of Websites

BC Environmental Assessment Office: www.eao.gov.bc.ca

Canadian Environmental Assessment Agency: www.ceaa-acee.gc.ca

FrontCounter BC: www.frontcounterbc.gov.bc.ca

B.C. Dam Safety: www.gov.bc.ca/damsafety

Engineers & and Geoscientists British Columbia (EGBC): www.egbc.ca

Chapter 1: Introduction to Dam Removal

In BC, the Dam Safety Regulation (DSR) identifies any of the following as a "restricted activity" under Section 17 of the Regulation:

(a) Removing all or a significant part of a dam
(b) Decommissioning a dam
(c) Deactivating a dam, or stopping the normal operation of a dam, for a period longer than one year

Prior to undertaking a restricted activity, an owner of a dam must provide written notice to a Dam Safety Officer (DSO) of their proposed work. This is the first step in a process that may include various phases of planning, consultation and reporting prior to receiving approval to begin work.

The purpose of this guideline is to assist the dam owner in the regulatory process of dam decommissioning.

Chapter 2: Exploring the Option of Dam Decommissioning

The decision to decommission a dam can be complex, with many factors and a wide range of effects to consider. A dam owner may not need the storage, or may find that the cost of continued operation and maintenance of the dam outweigh the benefits. Often the dam has reached the end of its life cycle and without significant rehabilitation is, or will soon be, unsafe.

There are both benefits and drawbacks to removing a dam, including environmental, social, and economic considerations.

2.1 - Environmental:

- Hydraulic changes to the stream after dam removal may result in erosion, bank instabilities, and the loss of flood attenuation capabilities.
- Potential release of excessive sediment impounded in the reservoir and upstream of the dam. The sediment may contain toxic materials and excessive nutrients.
- Passage may be restored, both upstream and downstream, for fish and aquatic organisms.
- Vegetation changes along stream, especially upstream in former reservoir area.

The hydrological impact of dam removal varies depending on the characteristics of the stream, dam, and reservoir. Removing a larger dam and reservoir may reduce flood attenuation capabilities, therefore re-establishing peak flows through the channel system. The opposite is also true, with the lost ability to manage for seasonal low-flows. These changes can affect channel morphology, including the potential for increased erosion and flooding occurrences. Removal of dams with small reservoirs will have less effect on flow conditions.

In some instances, a dam can trap sediments (photos 1 and 2) that would usually be transported through the river system. Once the dam is removed and flows are re-established, the built-up deposit is usually transported downstream due to increased stream flow velocities and reduced channel width in the former reservoir area. This material can be downstream and may carry with it excessive nutrients

and pollutants, depending on the natural conditions, industry and other human activities occurring within the watershed area.

Photos 1 and 1: Sediment deposited behind Tunnel dam.

Dams are usually a barrier to fish passage and migration if not installed with a functional fish passage system. The removal of the dam restores the ability for fish and other aquatic organisms to migrate both upstream and downstream. This may be both positive and negative, depending on the species and whether they are considered invasive. As the reservoir area reverts back to channelized stream flow there can be a significant loss of aquatic habitat. The newly-exposed former reservoir bottom is also susceptible to invasive vegetation. It can be beneficial to drain the reservoir area slowly over a few years leading up to the dam removal, to allow local vegetation to establish as the

water recedes. Transportation and navigation on the river system is also restored when the dam is removed.

2.2 - Social:

- Public safety and impacts to downstream infrastructure and property
- Government regulator enforcement actions
- Recreational use and aesthetics value reduction due to loss of the reservoir
- Cultural or heritage values

Dam owners are responsible for the safe operation of a dam, which is directly linked to the safety of, and risk to, the downstream infrastructure and population. Public safety is a paramount consideration in the decision-making process of dam removal. Ultimately, the dam owner has the right to remove the dam, or transfer ownership of the dam if there is a party willing to accept the liability and potential upgrades required to ensure the safe operation of the dam. This situation may be expedited if the DSO, or overseeing regulatory body, identifies the dam as an unacceptable safety risk. An enforcement action or order may be issued to the dam owner to quickly rectify the unsafe situation.

Impacts to the former reservoir area should also be considered from an aesthetic, recreational, and property impact point of view. If there has been infrastructure added and associated recreation enjoyed by residents around the reservoir, there is potential for a negative response to the dam removal. There may also be cultural or heritage values associated with the dam structure or reservoir, which may pose additional challenges. For more information, see Chapter 5 on Public Consultation, Agency Referrals and First Nations Consultation.

2.3 - Economics:

- Liability issues related to unsafe dams or dam removal
- Site restoration costs post-dam removal
- Potential changes in property values
- Costs associated with dam removal or dam upgrades and restoration

A dam owner is liable for any damage resulting from the failure or improper maintenance or operation of a dam, even if the water licence authorizing the dam has been cancelled (see sections 29 and 122 of the *Water Sustainability Act* [WSA]). This liability remains after dam removal, especially if a partial breach was chosen over a full removal.

Awareness of these liabilities, combined with a comprehensive cost-benefit analysis, can help to move the dam decommissioning decision process forward. A comprehensive cost-benefit analysis involves not only those items which are quantifiable in dollar values, but also attempts to include the above-mentioned liabilities, even if only in qualitative terms. Please refer to the paper "*Economic Analysis of Dam Decommissioning*" (Bureau of Reclamation, 2003) for more details on conducting a comprehensive cost-benefit analysis.

While the loss of one type of recreational and scenic resource may decrease value to some, to others the restored natural river flow, improved water quality, increased potential for navigation, and added open space increases the value of the site. Preliminary studies have shown that property values in some cases may actually increase long-term following dam removal, but every case is site-specific. According to a study of small dam removals in Wisconsin (Socioeconomic and Institutional Dimensions of Dam Removals: The Wisconsin Experience, Born et al, 1998) the costs of dam repair averaged three times the

cost of dam removal. As well, there are often significant costs associated with disposing of (and recycling) materials produced from removing a dam.

Chapter 3: Authorization Basics

In B.C., the decision to decommission a dam is largely owner-driven and may result from concerns related to public safety, owner liability, end of lifecycle, poor cost/benefit ratios, or environmental restoration. Aside from the obvious technical considerations for the dam's removal, many owners may be unaware of the costs, referrals and time associated with the authorization process. The intent of this section is to provide a roadmap to assist dam owners and their consultants in understanding what government approvals may be required, so that the process can be completed in an efficient and timely manner. Figure 1 provides a flowchart to assist in the decision-making process.

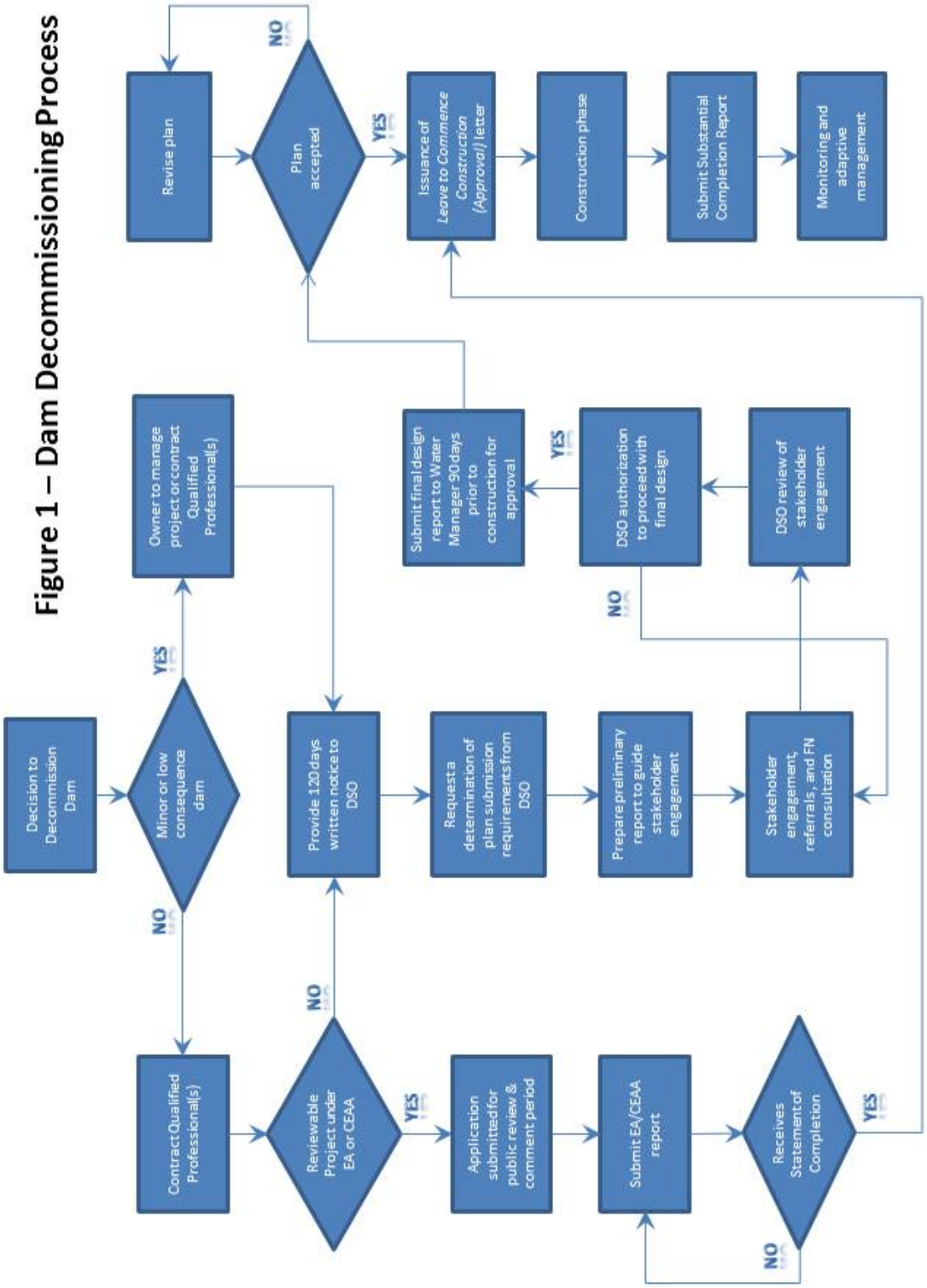
3.1 – Environmental Assessment Processes

Every dam and reservoir is unique. Many factors can influence decommissioning decisions, and each project will be faced with its own set of engineering challenges. Similarly, the variability of authorizations and permitting requirements can be significant. A first step in any dam decommission project is to establish if the project is reviewable under either the federal or provincial environmental assessment processes. This process is generally reserved for larger dams.

An assessment may be required under the B.C. *Environmental Assessment Act* if the proposal is to dismantle or abandon a facility that was previously permitted under the WSA (or former *Water Act*) to impound $\geq$ 10 million m^3 of water. For more information, please contact the BC Environmental Assessment Office (EAO) sector lead responsible for water management projects: www.eao.gov.bc.ca

For information on federal review requirements, please contact the Pacific and Yukon regional office of the Canadian Environmental Assessment Agency: www.ceaa-acee.gc.ca

Figure 1 – Dam Decommissioning Process



3.2 – Water Sustainability Act

The Water Management Branch and the Regional Resource Authorization units of the Ministry of Forests, Lands, Natural Resource Operations and Rural Development (FLNRORD) administer the WSA and DSR for the licensing and operation of freshwater dams in B.C.

3.2.1 – Water Licensing

When a dam owner decides to decommission their dam, they are required to abandon their associated water licence. In B.C., abandonment of water rights must be made by written application through FrontCounter BC to a FLNRORD Water Manager. Approval of the abandonment of all or part of the rights may be issued subject to terms and conditions, which may include requiring the dam owner to complete the decommissioning of the dam and related works to the satisfaction of the Ministry. This process is managed by the water allocation division of FLNRORD and is separate to that of the regulatory requirements under the Dam Safety program. The applicant should anticipate that their application to abandon their water licence will be held in abeyance until decommissioning work is completed. In addition, the water licence may not be cancelled until an environmental monitoring program has been completed and demonstrates that there likely will be no unforeseen adverse impacts related to decommissioning of the dam. Monitoring programs may be as short as one year, or extend upwards to 10 years.

For more information on the process, please visit www.frontcounterbc.gov.bc.ca, or call, email, or visit the FrontCounter BC office in your region.

3.2.2 - Dam Safety Regulation

The BC Dam Safety Program regulates approximately 1,900 dams across the province. Each regulated dam has a DSO who is responsible for monitoring dam owners' compliance with the regulation. A list of DSOs and program staff is available on the Dam Safety Program website at www.gov.bc.ca/damsafety.

Separate to the requirement to make application for the abandonment of a water licence, a dam owner is required to follow the direction provided under section 17 (2) of the DSR:

> (a) at least 120 days before the date on which the owner expects to begin work on the restricted activity, give to a dam safety officer written notice of the proposed restricted activity, and
>
> (b) at least 90 days before the date on which the owner expects to begin work on the restricted activity,
>
> (i) prepare a plan, in the form and with the content specified by a dam safety officer, in relation to the activity, and
>
> (ii) submit the plan to a dam safety officer for acceptance by the dam safety officer.

Prior to preparing and submitting a plan as per Section 17 (2) of the DSR, the proponent should contact their DSO to request a determination of plan submission requirements. Based on a conceptual design provided by the dam owner, the DSO will identify what analysis, assessments or information will be required for submission in preparation of a preliminary decommissioning plan design report that will be used in leading stakeholder engagement, Ministry referrals and First Nations consultation. Chapter 4

provides more detail on the possible elements to be addressed in an assessment, which may include engineering, hydrological, hydraulic, environmental, social and economic considerations.

3.3 – Additional Legislation

In addition to the requirements under the DSR, a proponent may need to seek permitting or approvals authorized by other provincial or federal government agencies. These permits or approvals will be required prior to commencement of decommissioning work. Appendix A provides an overview of possible permits and approvals that may be required. It is the responsibility of the proponent to ensure all legislative approvals and permits are obtained.

For information on possible additional provincial requirements, please contact FrontCounter BC.

The following are examples of permitting requirements under various statutes typically encountered when working in and about a stream.

3.3.1 – *Land Act*

Where the dam owner has acquired land tenure for the dam(s), improvements (powerhouse, penstock, intakes, etc.) and/or flooding of the land, the site must be decommissioned as per the terms and conditions of the tenure document. If no tenure exists or if the tenure document does not establish conditions for site decommissioning -such as may be the case with a Permit Over Crown Land (PCL) - then the dam owner is responsible for restoring the surface of the land as nearly as may reasonably be possible to the same condition as it was prior to development of the dam and associated works.

Dam decommissioning may require development of a road where previous access was limited or inadequate to allow for heavy equipment to be brought to the site. In such instances a road permit may be required from the Land Tenures Branch. Applications for Crown Land Tenure can be submitted through FrontCounter BC.

3.3.2 – *Federal Fisheries Act*

In instances where the federal *Fisheries Act* applies, the dam owner is required to avoid causing serious harm to fish unless authorized by the Minister of Fisheries and Oceans Canada (DFO). The *Fisheries Act* applies where the dam is associated with a waterbody that supports fish that are part of a commercial, recreational or Aboriginal fishery. For additional information, the proponent is encouraged to seek advice from a qualified environmental professional or contact a Fisheries Protection Office in their area.

3.3.3 – *Wildlife Act*

A salvage permit may be required in situations where the proposed decommissioning work may necessitate the capture and relocation of fish and wildlife. Pursuant to section 19 of the *Wildlife Act* and the Permit Regulation, a regional manager may issue a permit authorizing a person to trap, possess, transport and release live wildlife.

3.3.4 – Provincial Park Use Permit

If the dam site is partially or wholly within a Provincial park boundary, a Park Use Permit will be required. A copy of the application can be obtained from the FrontCounter BC website under “Application Forms.”

3.3.5 – Easement Agreements

In some instances, the dam may be located on private property not belonging to the dam owner. Typically, an easement registered on the land title or a less formal agreement would provide direction as to requirements for the decommissioning of the dam. If no easement or agreement exists, the dam and property owners will need to reach an understanding prior to starting work on the decommissioning. It is appropriate to inform the DSO of the terms and conditions of the agreement; however, FLNRORD has no standing in the decision process.

Chapter 4: Project Scoping and Preliminary Design Development

Upon completion of the feasibility study and development of a conceptual design for dam decommissioning, the next step in the process is to identify what technical studies must be undertaken to identify potential adverse effects of the project. Consideration of environmental issues, public safety, historic value, aesthetic, archeological, societal, and First Nations interests is required to prevent or mitigate potential impacts related to the dam's removal and site rehabilitation. The results of this assessment will help guide the public comment and referral process.

Dam owners should be aware of the timeframe for a project and plan accordingly. Scheduling for a small, off-stream dam located on an owner's property where there is limited stakeholder engagement or First Nations consultations, may be completed within one year (photo 3). However, for larger and more complex dam sites (photo 4), the process may take two to three years before actual work commences.

Photo 3: Decommissioning of small off-stream dam.

Photo 4: Decommissioning of BC Hydro's Coursier dam.

4.1 – Level of Effort

In most cases, the level of rigor in developing a decommissioning plan will be commensurate with the size and complexity of the dam. Decommissioning a large, long-established dam will be more challenging than a small structure. For example, large reservoirs may contain significant volumes of accumulated sediment that may require removal, stabilization, or an engineered release. Each of these options comes with different costs and operational challenges that will require detailed analysis. Conversely, a small off-stream dam that can be safely drained to allow for construction activities to occur in the dry will require limited analyses/assessments and result in lower removal costs.

4.2 – Initial Consultation with Regulator

In order to minimize costs and project duration, and facilitate the preparation/submission of preliminary design plans, it is important that the dam owner(s) understands the Ministry's expectations.

The Provincial Dam Safety Program's objectives for decommissioning a dam include:

- Removal of all potential hazards associated with the dam
- Restoration of the dam site to a safe, stable and maintenance-free condition
- Restoration of Crown lands to a usable state
- Restoration of natural functions and processes to stream hydrology, channel morphology, and ecosystems

During the meeting with a dam owner, the DSO's role, in part, will be to assist the dam owner in navigating through the process in an efficient manner. Discussions may also include:

- Meeting regulatory requirements
- Identification of known issues or possible concerns related to decommissioning of the dam
- Reservoir, dam site and stream restoration options
- Fisheries-related issues
- Public safety concerns
- Stakeholder identification, notification and level of involvement
- Performance monitoring and mitigation

In advance of decommissioning the dam, all anticipated impacts should be clearly identified. Impacts can be positive, such as in the removal of a fish barrier, or negative, such as an increased likelihood of downstream flooding.

4.3 – Multiple Dam Owners

On application in writing by the holder of an authorization (dam owner), Section 31 of the WSA – Abandonment of rights under an authorization –provides that the Statutory Decision Maker (SDM) may require arrangements respecting responsibility for decommissioning of the works with one or more persons.

If the dam has two or more owners, it is expected that all owners are in agreement with decommissioning the dam. Should any owner not wish to abandon their water licence and decommission the dam, then further discussions on how the project will proceed would be required. It may be that water licences could be transferred from one or more licensee(s) to the remaining owner(s) with the remaining owners choosing not to decommission the dam. Another possible option could be for some licensees to abandon their rights. The reduction of licenced storage could be addressed by reducing the reservoir level through operational means or by excavating the spillway sill elevation. In all

scenarios, the remaining dam owner(s) would assume full responsibility for the dam, including operation, maintenance, surveillance, and other regulatory requirements.

To simplify discussions, dams with multiple owners should appoint an owners' designate as described in Section 22 of the DSR. The dam owner who is designated should arrive with a conceptual plan to help scope out what assessments and analyses will be needed to shape the development of the design process. The location of the dam site can also play an important role on deciding on the style of decommissioning. Dams located on private property generally have fewer governmental requirements for material disposal, site remediation and level of public engagement. Conversely, dams situated on Crown land, within a park, or within an urban setting may require a higher level assessment and/or consultation.

4.4 – Partial or Full Decommissioning

An important consideration is whether to fully remove the dam, or breach only a portion of the dam. With a breach, the reservoir level will still be reduced to pre-dam elevations without removing the entire dam. This may be advantageous in that the costs of decommissioning can be significantly reduced. However, issues surrounding public safety, long-term operation and maintenance, and stakeholder support would need to be adequately addressed. From a liability perspective, damage resulting from the remaining works rests with the dam owner as per Section 122 of the WSA. As an example, if the breach was to become blocked (Photo 5) and the reservoir allowed to refill, a failure of either the blockage or remnant dam could result in damages of which the dam owner could be found liable. Therefore, to mitigate potential hazards from the remnant dam structures, long-term monitoring of the site may be required. The dam owner is encouraged to undertake a thorough cost-benefit analysis to assist in choosing the preferred option.

Photo 5: Park Lane Dam 20 years after partial decommissioning.

If the decision is made to partially decommission the dam, an owner is required to restore the outlet channel to pre-dam construction elevation and ensure that the breach is of an adequate size. Additional information on appropriate breach sizing can be found in Appendix B.

If the reservoir has captured a large amount of sediment during its operation, sediment management may be required. Options can include mechanical removal (excavation or dredging), in-situ stabilization, stream erosion, or a combination of these methodologies. The proponent will need to undertake an assessment of the risks, costs, and environmental impacts for each method prior to meeting with the DSO.

Discussion may also involve expected timing or phasing of the decommissioning work and the safety management of the dam, prior to and during decommissioning activities.

Upon concluding the scoping meeting, the dam owner should come away with expectations for the preliminary report development. The dam owner and/or design engineer should have an understanding of:

- The roles and responsibilities of the various participants, and
- The specific tasks and technical components that should be considered in developing the preliminary design report

For smaller projects, a preliminary plan may not be required and the design engineer can instead begin preparing the final design drawings and report.

4.5 – Services of Qualified Professionals

Decommissioning of a dam and related works can be a complex undertaking involving knowledge in many fields of engineering, geoscience and biology. The consequences of a sudden release from the reservoir can be severe, and the owner may be liable for any and all damages affecting public safety, property, and the environment. Therefore, for all dams except those with a “low” consequence of failure classification or where dams/reservoirs are off-stream and located completely on the dam owner’s property, FLNRORD will require that the dam owner contract the services of a professional engineer who is registered in BC and has the appropriate education, training and experience with regards to the design and construction of dams.

FLNRORD also recommends that those proponents who have a dam with a low consequence also seek the services of a professional engineer. Engineers and Geoscientists British Columbia (EGBC), the organization responsible for the licensing and conduct of professional engineers (P.Eng.) and professional geoscientists (P.Geo.) in B.C., has published the guide, *Advice on Hiring a Professional Engineer or Professional Geoscientist in BC* - APEGBC, March 2007, to assist the public when engaging a professional.

The role of the professional engineer is to develop a decommissioning plan, manage and/or supervise construction activities, document the process, and submit a completion report. The professional engineer should also assist the dam owner by:

- Obtaining all relevant information
- Providing notification to the client as soon as reasonably possible if specialty services or changes in the scope of work are required

- Ensuring that the conclusions and recommendations in the decommissioning plan submission are supported by the appropriate level of analysis, clear rationale, and that any assumptions are clearly stated
- Providing summaries of all design calculations
- Submitting to the client a signed, sealed and dated copy of the decommissioning plan

Depending on the complexity of the dam, the professional engineer may require the assistance of other specialists that could include:

- Engineers with expertise in specialty areas such as blasting, concrete, structural, electrical, etc.
- Environmental engineers to test for chemical contaminants within the reservoir sediments
- Geoscientists and hydrologists (geologists, fluvial geomorphologists, and hydrogeologists) to characterize the impact on:
    - channel stability
    - sediment transport
    - bank stability
    - groundwater
- Hydrologists to provide analysis on changes to stream discharges
- Biologists to identify:
    - potential adverse environmental effects (e.g. species at risk)
    - appropriate work timing windows
    - planting material for site remediation
- Surveyors
- Agrologists

4.6 – Preliminary Design Report

The role of the preliminary design is to provide information to stakeholders, First Nations and referral agencies with the goal of facilitating meaningful dialogue leading to general support for the project. The report should contain all information listed in Section 1.0 of the "*Decommissioning Plans Checklist*" found in Appendix C that was identified by the DSO during the scoping meeting. Dam owners should be open to concerns expressed by stakeholders, First Nations and referral agencies. The owner should be prepared to consider alternatives to the preliminary design and make accommodations whenever it is in the public interest. More information on the consultation process can be found in Chapter 5.

4.6.1 – Data Collection and Review

Data collection is essential to developing an appropriately detailed preliminary design. Data collection should include information related to the dam such as design and service records. EGBC's *Professional Practice Guidelines - Legislated Dam Safety Reviews in BC* (2013) presents a detailed list of possible information related to dam design and service records. Much of the information will likely be already held by the dam owner. Where this is not the case, the DSO may be an alternate source.

Additionally, information to determine potential effects related to the decommissioning of the dam will be required. This may include:

- Hydrologic and hydraulic data (rainfall/snowpack data, stream flow data, floodplain mapping, channel assessment, etc.)
- Geology, slope stability, river processes, river geomorphology, etc.
- Environmental (biogeoclimatic zones, potential rare or endangered species, fisheries, instream work timing window, etc.)

- Social and cultural information (site history, aesthetics, archeological, First Nations interests, etc.)
- Legal information (water licencing, easements, land status)
- Economic information (e.g. local businesses, tourism, etc.)

4.6.2 – Field Review

Once the data has been compiled, field work including, but not limited to, invasive investigations may be necessary to fill in any outstanding information gaps. For the identification of potential downstream effects due to channel morphological changes, sediment transport or flooding, a field review should include all reaches of the stream that may be susceptible to dam removal impacts. Often, impacts will extend to the entire stream and could include the receiving waters beyond the downstream confluence with the stream under study. Studies that may be required include:

- Topographic/bathymetric surveys of the dam site, channel and reservoir as required
- Stream channel assessment downstream of the dam to assess potential impacts to anticipated changes in the hydrologic regime
- Characterization of reservoir sediments (volume, composition, contaminants, etc.)
- Environmental reviews (inventory of aquatic/terrestrial wildlife and plant/plant communities at risk

4.6.3 – Form and Content of Preliminary Design Report

Following the data collection and field review, analysis of the data can begin to assess project impacts and develop alternative options where required. This information will be used to both identify stakeholders and guide future discussions with them.

To allow for informed dialogue between stakeholders, First Nations, regulators and the dam owner, a preliminary design report must be prepared that succinctly summarizes the proposed project and identifies possible concerns. The report should be structured and written in a manner that is easily understood by the general public, refraining from technical jargon where possible, but should have an appropriate amount of detail to address questions that may arise. The author is expected to present conclusions and recommendations that "*are supported by the appropriate level of analysis, clear rationale and that any assumptions are clearly stated" (Professional Practice Guidelines - Legislated Dam Safety Reviews in BC (APEGBC, 2013)*.

Chapter 5: Public Consultation, Agency Referrals and First Nations Consultation

Consultation is an important component of the dam removal process, and is based on the principle that those affected by proposed projects should have an opportunity to provide input. While consultation is not an explicit requirement of the DSR, it is a well-established policy in provincial natural resource management. The guidance in this chapter is consistent with EAO legislation and policies.

5.1 - Consultation Objectives

Many dams and their associated reservoirs provide benefits to British Columbians beyond the beneficial use of water authorized in the water licence. Removal of the dam may have a negative effect on the local population and some projects may have a significant impact on environmental values in the

stream. Therefore, before proceeding with a dam removal project, the owner must take into account potentially significant adverse environmental, social, economic, health and heritage effects. Once identified, prevention or reduction strategies may be developed. Opportunity should be provided to anyone who might be willing to take ownership of the dam.

> *"The Ministry is responsible for consulting and appropriately accommodating First Nations when a decision could affect asserted or established Aboriginal rights and title or treaty rights. While the Province is responsible for ensuring adequate and appropriate consultation and accommodation, it may involve the proponent in the procedural aspects of consultation."*
> (Guide to Involving Proponents When Consulting First Nations, Province of British Columbia, 2014)

> *"Consultation is intended to ensure that opportunities exist for the public to understand the proposed project and to have their comments appropriately considered."*
> (Environmental Assessment Office, Public Comment Policy)

5.2 – The Province's Role

The Province leads both First Nations consultation and government agency referrals.

5.2.1 – First Nations Consultation

Although the duty to consult rests with the Crown, in certain cases the dam owner may be expected to:

- Involve First Nations in relevant studies
- Incorporate community and traditional knowledge into baseline studies
- Identify First Nation interests that may be affected by a proposed project
- Identify and develop measures to prevent, avoid or mitigate any potential significant adverse effects on First Nations' interests

5.2.2 – Government Agency Referrals

To aid in the facilitation of the consultation process, the Province will identify and make initial contact with government agencies that may have an interest in the proposed project. For example, both the Ecosystems and Fisheries & Wildlife branches are typically provided an opportunity to review dam removal projects to determine if the project may pose a risk to species or ecosystems. It is possible that certain conditions may be requested of the dam owner following reviews by referral agencies.

5.3 – Dam Owner's Role

If public engagement is required by the DSO, it is the dam owner's responsibility to identify and engage public individuals or groups who may have an interest in the dam removal project prior to commencement of the project. Smaller projects may only require the dam owner to conduct a public consultation program that is acceptable to the SDM.

5.3.1 - Identifying Stakeholders

The first step is for the dam owner to consider who may be potentially impacted by the project. Key stakeholders will include landowners or residents living adjacent to the reservoir and the river downstream of the dam. Other interest groups may include:

- A riparian or landowner whose land is likely to be physically affected by the project
- Business owners (resort and marina owners, outfitters, etc.)
- Municipalities (planning departments, local health departments, utilities)
- Sport, fishing and recreational clubs
- Not-for-profit environmental organizations (Ducks Unlimited, Trout Unlimited, etc.)

In any case, a DSO or SDM may direct that the proponent notify any person(s) whom they consider advisable.

5.3.2 - Public Notice

The Public Consultation Policy Regulations (PCPR) under the *Environmental Assessment Act* describe requirements for giving public notice. The Dam Safety Program recommends that the dam owner review Sections 4, 5, 6 and 7 of the PCPR as appropriate guidance for undertaking public engagement. It is also

recommended that a dam owner consult with their DSO to confirm requirements for their specific project.

Notice requirements are described in Section 14 of the Water Sustainability Regulation. Posting of a public meeting should contain information on how to access background documents for review to provide for an informed engagement/discussion process. Postings must also indicate time(s) and location(s) of meetings, and timelines for public comment periods.

5.3.3 – Public Engagement

It is the Dam Safety Program's general policy that at least one formal comment period, between 30 and 75 days, be established. Early, frequent communication will help lead to building project support, and it is advisable that the dam owner is receptive to the public's concerns and reasonable requests for concessions.

Community interest or concerns in the project should be assessed as early as possible. This initial assessment of the interest level will help guide the dam owner in developing the community engagement strategy. The scope of the project and its location will help guide the owner to determine how the assessment should proceed. A small dam removal project may be able to address local concerns with a door-to-door discussion between the owner and nearby residents. Larger projects may require a community meeting.

In all instances, the dam owner should come prepared to provide a design that presents "before" and "after" renderings of the dam site. The dam removal plan, be it a preliminary or final design, will be used in the stakeholder comment process. Therefore, it should be adequately detailed to provide a description of the site conditions following decommissioning, as well as possible impacts to the public, environment or infrastructure. There should also be an accounting of all identified pros and cons associated with the project.

The dam owner should anticipate and prepare responses for questions such as:

- What will the footprint of the remaining lake, wetland or stream look like following dam removal?
- How will this affect fishing in the lake?
- Will there be an increased risk of flooding of my downstream property?

A more thorough listing of common questions can be found in *Removing Small Dams in Maine: A Basic Guide for Project Managers* produced by Maine Rivers (2011).

5.3.4 – Appropriate Level of Consultation and Accommodation

Stakeholder engagement can take many forms and cover a broad range of activities. A public meeting initiated by the dam owner to describe the project may or may not be sufficient to address all concerns of interested members of the community. Depending on the public interest in the project, this phase may take several months to complete. In some cases, public engagement has lasted 12 to 18 months.

Proponents should consider ways to address concerns or mitigate impacts to stakeholder interests. The BC *Guide to Involving Proponents When Consulting First Nations* provides the following examples for accommodation which can be equally applied to stakeholders:

- Avoiding the impact to the identified stakeholder

- Modifying the proposal to mitigate potential impacts to stakeholder interests (e.g. altering the footprint or location of the proposed activity)
- Changing the timing of proposed activities
- Requirements for impact or environmental monitoring
- Other mitigation strategies

Stakeholders who are strongly opposed to the removal of the dam may wish to consider a transfer of appurtenancy or apportionment of rights under a water licence. If this option is available, the stakeholder(s) would become the dam owner and assume all the rights and obligations as defined in the WSA and DSR.

Dam owners are encouraged to provide an opportunity for stakeholders to remain engaged throughout the project through regular communication and consultation.

5.3.5 – Documenting Comments

Upon completion of the public engagement process, the dam owner will present a summary of comments received, the name and contact of the commenter, and evaluation of all public input. It is important that stakeholders' concerns and comments are accurately recorded and documented during the engagement period. A summary and evaluation of the comments is required as part of the final design report. The SDM will refer to this information when making a decision to accept the plan and provide approval for commencing the construction phase of the project.

5.3.6 – Objections

If a person who has been given notice of the dam decommissioning has concerns that cannot be accommodated by the dam owner, they may submit their objection to the SDM who will decide whether or not the objection warrants a hearing. Additional details can be found under Section 13 of the WSA.

5.3.7 - Ministerial Decision to Proceed

The DSO will assist the proponent and interested parties to resolve outstanding concerns wherever possible. This may include securing further commitments or modifications to the proposed project. However, it is important to note that although there is an expectation for the dam owner to consult, the Dam Safety Program supports a dam owner's decision to remove a dam, consistent with legal requirements.

Once the SDM is satisfied that all reasonable accommodations and objections have been addressed, the dam owner will be notified that they can move forward with the final design report.

Chapter 6: Final Design Report

With the completion of the stakeholder engagement process, preparation for the final design can begin. A final design report is required to be submitted to the DSO for acceptance prior to issuance of SDM approval to begin work. The submission will incorporate much of the content of the preliminary design with amendments, where required, resulting from recommendations received during the First Nations consultation, government agency referrals, and stakeholder engagement.

The assigned DSO will review the submitted information to ensure the proposed project will be constructed in a manner that provides the appropriate level of protection to public safety, property and

the environment. This review is undertaken to determine if the submitted information conforms to accepted practices, the *WSA* and its regulations.

Documents which contain deficiencies will be identified to the owner and/or the project engineer. Changes may be required to conform to accepted practice. Where differences of opinion arise on the suitability of certain practices - and cannot be readily resolved - the burden of proof will rest on the owner and/or project engineer to demonstrate the suitability of the proposed plan or action.

All revisions to plans or drawings previously submitted for review must be accompanied by a complete detailed list of revisions made, specifying where the revisions are located. The DSO will make every effort to ensure that plans are reviewed in a timely manner and contact the proponent directly as soon as possible.

The final design report contains the various engineering investigations and pertinent project information. It forms an important element of the project design documents and supports the development of the plans and specifications. Final design reports shall be comprehensive in description of the various investigations and analyses. The report will include all design, environmental, and safety factors considered with the project and must bear the seal and signature of the project engineer.

Details on the general contents of a final report can be found in Appendix C. Should the final design differ from the preliminary plan, it may be necessary to review the previous analyses, assessments and impacts.

Chapter 7: Project Approval

Once the final design report is submitted and approved, consent to proceed is issued by the SDM in an authorization, change approval or order. The proponent is required to provide the DSO at least 30 days' notice prior to initiation of full or partial dam removal, and must ensure that the project proceeds as per the approved plan. Downstream notifications may also be required, whether for consumptive water users or for streamside inhabitants. If it is determined that the dam poses an immediate risk to public safety, the decision-making timeline and approval process should be condensed.

The proponent is obligated to contact the DSO if substantial changes to the project arise. Unpredictable elements such as adverse weather, equipment failure, and unexpected subsurface conditions should be considered and contingencies built into the project. Essential components may include compliance with timing windows, environmental monitoring during construction, and documentation of the activities. For example, the dam may be located off-stream, therefore instream work windows consideration would not apply. Best Management Practices for instream works must be followed in all cases where applicable. Refer to the following website link for more information regarding Instream Work Windows and Best Practices:

www2.gov.bc.ca/gov/content/environment/air-land-water/water/water-licensing-rights/working-around-water

Chapter 8: Project Completion

The DSO may assess the site during or after the removal of the dam. The freshet occurring after the removal of the dam is an optimal time to assess the site for performance and stability. Also, as per S.9(5) of the DSR, the dam owner may be required to undertake further actions that the comptroller or water manager considers necessary to alleviate any adverse consequences to any person, the infrastructure or works, or other property or the environment that may be affected by any work performed on the dam. This is a reasonable time for the DSO to recommend the water licence abandonment process continue (or not) based on the result and performance of the site after the full dam removal or (partial) breach.

8.1 - Residual Works

Residual works that remain are a continued liability for the landowner requiring ongoing monitoring of the site for hazards that may occur. Responsibility remains for the stability of, for example, an excavated breach and any possible future blockage that may occur in the channel. *"The concern is that blockage, caused by such things as a beaver dam, debris from the lake or sloughing of the slopes of the excavated dam material could create a dam safety concern"* (Seyers et. al. 2004). Photo 6 provides an example of beavers damming an excavated breach, which is a relatively common issue in B.C.

Photo 6: Beaver dam constructed in breach of dam.

8.2 - Completion Report and Post-Removal Monitoring

8.2.1 – Construction Completion Report

A completion report, prepared by an engineer or dam owner (low consequence dam), is to be submitted within 60 days upon substantial completion of the project. The contents of the report shall confirm that

dam decommissioning has been completed as per the plan submissions or identify where deviations have occurred, and, as a minimum, include the headings listed below:

- Photos documenting stages of the dam removal
- Updated as-built drawings of former dam location and/or remaining dam sections
- Descriptions of the main components of the dam removal, including the applicable portions of the Final Design Report
- Other design and construction records

The reader is referred to Appendix C for additional detail.

8.2.2 - Performance Monitoring

In many cases, a dam owner will be required to conduct an appropriate level of post-removal site surveillance and monitoring, depending on site characteristics. Monitoring of the site post-decommissioning should consider both biological and physical stability elements and typically would be in place for one to five years post-construction.

The biological component of the monitoring plan, designed by a qualified environmental professional, should, for example, consider species at risk and the sensitivity of the surrounding ecosystem. Quick re-establishment of the native vegetation may be an important consideration if invasive weeds are a concern. The owner should respond accordingly to adverse conditions noted at the dam location. Post-project monitoring may include, but isn't limited to, revegetation success/mortality and the presence of invasive plant and/or animals.

The physical stability of the site (constructed breach, stream channel – at the dam site and down-stream, reservoir slopes, etc.) also will require surveillance and monitoring. Elements to consider include:

- Beaver presence and impacts
- Erosion issues and sediment stability/mobility issues
- Residual public safety risks

Design of a performance monitoring plan of the physical attributes should be undertaken by a suitably qualified engineer or geoscientist.

For smaller off-stream dams located on the dam owner's property, this would likely not be required.

Chapter 9: Additional Resources and Reference Material

The following references may provide useful information to consider when assessing a dam removal project. Many of the reports are available online.

American Rivers, Friends of the Earth and Trout Unlimited. 1999. *Dam Removal Success Stories: Restoring Rivers Through Selective Removal of Dams that Don't Make Sense*.

BC Environmental Assessment Office*. 2015. The Role of Public Consultation in Environmental Assessments: Phase One Report*. EAO, December 2015.

BC Environmental Assessment Office*. Fairness and Service Code.*

BC Environmental Assessment Office. *Public Comment Policy.*

British Columbia Ministry of Aboriginal Relations and Reconciliation. *2014.Guide to Involving Proponents When Consulting First Nations*.

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Congressional Research Service. 2006. *Dam Removal: Issues, Considerations, and Controversies*. November 2006.

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International Commission on Large Dams Dam Decommissioning Guidelines. ICOLD Bulletin 160.

Main Rivers. 2011.Removing Small Dams in Maine – A Basic Guide for Project Managers. December 2011. http://mainerivers.org/wp-content/uploads/2009/05/Dam-Project-Manager-GuideME-copy.pdf

Minnesota Department of Natural Resources. 2010. *Reconnecting Rivers: Natural Channel Design in Dam Removal and Fish Passage.* January 2010.

National Oceanic and Atmospheric Administration. *Relics and Rivers: Dismantling Dams in New England* – video produced by the National Oceanic and Atmospheric Administration.

New Hampshire Department of Environmental Services. 2003. *Guidelines to the Regulatory Requirements for Dam Removal Projects in New Hampshire.* Revised 2007.

O'Connor, J.J, J.E., Podolak, C.J., Keith, M.K., Grant, G.E., Spicer, K.R., Pittman, S., Bragg, H.M., Wallick, J.R., Tanner, D.Q., Rhode, A., and Wilcock, P.R., 2012: *Geomorphic response of the Sandy River, Oregon, to removal of Marmot Dam* Major. U.S. Geological Survey Professional Paper 1792, 64 p.

Ontario Ministry of Natural Resources. 2011. *Dam Decommissioning and Removal – Technical Bulletin.* August 2011.

Oregon Watershed Enhancement Board. *2008. Small Dam Removal in Oregon – A Guide for Project Managers*. December 2008.

River Alliance of Wisconsin and Trout Unlimited. *Dam Removal: A Citizen's Guide to Restoring Rivers*. *2000*

The Aspen Institute. 2002. Dam Removal – A New Option for a New Century.

The Heinz Center. 2002.Dam Removal – Science and Decision Making.

U.S. Fish & Wildlife Service. October 2015. *Guidance for Decommissioning U.S. Fish & Wildlife Service Low Hazard Dams.*

Trout Unlimited, American Rivers, River Alliance of Wisconsin, Natural Resources Council of Maine, and Atlantic Salmon Federation, in cooperation with the National Park Service, Rivers, Trails and Conservation Assistance Program. *Taking a Second Look: Communities and Dam Removal* – video produced by Trout Unlimited, American Rivers, River Alliance of Wisconsin, Natural Resources Council of Maine, and Atlantic Salmon Federation, in cooperation with the National Park Service, Rivers, Trails and Conservation Assistance Program.

US Department of the Interior – Bureau of Reclamation. 2003. *Economic Analysis of Dam Decommissioning.*

U. S. Society on Dams. 2015. Guidelines for Dam Decommissioning Projects –comprehensive document for U. S. owners engineers and others to help guide decision-making.

W.C. Seyers, S.J. Garner, and H.M. Matthews. 2004. *Dam Safety Case for the Decommissioning of Coursier Dam*. BC Hydro Engineering.

Appendix A: Permitting and Approvals

In British Columbia, it is the responsibility of the proponent (dam owner) to ensure that they acquire all permits and approvals prior to commencing construction activities associated with decommissioning their dam. Working around water often requires authorization under both provincial and federal legislation. The following is a brief description of other authorizations commonly required for dam decommissioning projects.

In addition to the required approval issued by the Dam Safety Program, the following provides descriptions of other common permits/approvals. A more complete listing of possible permits/approvals can be found in Table 1.

Land Act:
Where the dam owner has acquired land tenure for the dam(s), all improvements (powerhouse, penstock, intakes, etc.) and/or flooding of the land, the site must be decommissioned as per the terms and conditions of the tenure document. If no tenure exists, or if the tenure – as in the case of many permits authorizing the occupation of Crown land (Permit Over Crown Land) – does not establish conditions for the site decommissioning, then the dam owner shall restore the surface of the land as nearly as may reasonably be possible to the same condition as it was prior to development of the dam and associated works. Any significant variance must be approved by a lands manager.

The process of decommissioning may require the development of a road where previous access was limited or inadequate to allow for heavy equipment. In such instances a road permit may be required from the Land Tenures Branch. A Crown Land Tenure electronic application can be submitted through FrontCounter BC[1]. A list of authorizations offered through FrontCounter BC, as well as links to application forms, is available at www.frontcounterbc.gov.bc.ca.

Federal Fisheries Act:
In instances where the federal *Fisheries Act* applies, the dam owner is required to avoid causing serious harm to fish unless authorized by the Minister of Fisheries and Oceans Canada. The *Fisheries Act* applies where the dam is associated with a waterbody that supports fish that are part of or support a commercial, recreational or Aboriginal fishery. For additional information, the proponent is encouraged to seek advice from a qualified environmental professional or contact a Fisheries Protection Office in their area.

Wildlife Act:
A salvage permit may be required in situations where the proposed decommissioning work may necessitate the capture and relocation of fish and wildlife. Pursuant to section 19 of the *Wildlife Act* and the Permit Regulation, a regional manager may issue a permit authorizing a person to trap, possess, transport and release live wildlife. Applications can be found and submitted online through FrontCounter BC.

Additional Permitting/Authorization:
Separate from the requirements under the DSR, a proponent may need to seek permitting or approvals authorized through other government agencies. Table 1 provides an overview of possible permits and approvals that may be required. It is the responsibility of the proponent to ensure that all legislative approvals and permits are obtained.

[1] FrontCounter BC is a single window service for clients of provincial natural resource ministries and agencies.

Some permitting that may apply to your project can include:

- A parks use permit (required if the dam is located within a BC Park)
- Local government bylaw permits for activities such as soil removal/deposit tree and landscaping policies and watercourse protection
- Access through private land

Easement Agreements:
In some instances, the dam may be located on property not belonging to the dam owner. Typically an easement registered on the land title or a less formal agreement would provide direction as to requirements for the decommissioning of the dam. If no easement or agreement exists, the dam and property owners will need to reach an understanding prior to commencement of decommissioning the works. It is appropriate to inform the DSO of the terms and conditions of the agreement; however the Ministry has no standing in the decision process.

Table 1 – Partial Listing of Permits / Approvals

Permit / Approval Name	Level of Government	Agency	Applicable Legislation
Pre-Construction:			
Environmental Assessment Certificate	Provincial	BC Environmental Assessment Office	*BC Environmental Assessment Act,* Reviewable Projects Regulation
Decommissioning Plan	Provincial	FLNRORD	*Water Sustainability Act*, Dam Safety Regulation
Abandonment of Water Licences	Provincial	FLNRORD	*Water Sustainability Act*
Dissolution of Water User Community	Provincial	FLNRORD	Sections 51 through 61 of the *Water Users' Community Act*
Licence of Occupation	Provincial	FLNRORD	*Land Act*, Temporary construction use areas
Licence to Cut	Provincial	FLNRORD	*Forests Act*
Mines Act Permit	Provincial	Ministry of Energy and Mines	*Mines Act*, for use of existing quarry
Amendment to Certificate of Public Convenience and Necessity	Provincial	BC Utilities Commission	*Utilities Commission Act*

Permit / Approval Name	Level of Government	Agency	Applicable Act
Federal Minister's decision	Federal	Canadian Environmental Assessment/DFO	*Canadian Environmental Assessment Act 2012*.
Parks permit	Federal	Parks Canada Agency	*Parks Act*
Fisheries Act Authorization & Permits for Schedule 1 aquatic species	Federal	DFO	*Fisheries Act*
Scientific Fish Collection – Fish Salvage General Permit Application	Provincial	FLNRORD	*Wildlife Act*
Permits, Agreements and Exceptions	Federal	Environment Canada - Environmental Stewardship Branch	• *Species at Risk Act* (SARA) • Permits Authorizing an Activity Affecting Listed Wildlife Species Regulations
Approved, permitted or designated works	Federal	Transport Canada	*Navigation Protection Act*
Park Permit	Provincial	BC Parks	*BC Park Act*
Construction Related:			
Oversize/Overweight Permit	Provincial	Ministry of Transportation and Infrastructure	*Commercial Transport Act*
Storage and Dispensing of Fuels Permit	Provincial	Office of the Fire Commissioner	*Fire Services Act*
Explosives Licence (to break down concrete) structures)	Federal	National Research Council	*Explosives Act*
Transport and disposal of hazardous waste	Provincial	Ministry of Environment	*Environmental Management Act* & Hazardous Waste Regulation
Soil Removal and Deposit bylaws, Tree and Landscaping policy & bylaws, Watercourse Protection bylaw	Local Government		*Local Government Act*
Private Property Owner Approvals			
Easement, agreements, and approvals			

Appendix B: Minimum Design Standards and Considerations

1.0 General

This Appendix applies to regulated dams in B.C. undergoing either full or partial decommissioning. The requirements described here on are intended as the ***minimum*** acceptable design standards. For all but the simplest dam decommissioning projects, it is expected that a *qualified professional* engineer (QPE) will be retained to prepare a design plan. The QPE should apply their own considerations, judgements and professional skills when developing decommissioning plans and not rely entirely on the design standards provided herein.

Deviations from the minimum standards described in this Appendix will only be considered under special circumstances (i.e. where it can be justified, and where safety issues are not compromised). A written request containing justification for all deviations must be submitted to the DSO with a complete list of works that would not meet the minimum standards, the reasons why, and how they would be addressed. A decision will be made and owners will be informed in writing as soon as possible.

For all dam decommissioning projects, owners are required to ensure that the site is left in a state that is safe for the public and the environment.

Reviews of past dam decommissioning that was undertaken prior to these guidelines has noted obvious public safety hazards (photo 1). In some instances, public safety hazards are less obvious – as described in the following case study of the Dennett dam.

Photo 1:

Partial decommissioning of the Park Lane dam, B.C. Note the loose concrete and exposed rebar posing a public safety hazard.

Photo 3: Partially decommissioned dam (2016)

Case Study - Dennett Dam Decommissioning

Built in 1933, this low-head dam was located on the lower Tuolumne River in Modesto, California. The dam partially failed twice in the 1930s and was condemned by the state of California in 1947. Years later, the Department of Fish and Wildlife constructed a mid-channel breach to facilitate fish passage at low flow.

Although the remnants of the dam appear innocuous, they pose a significant safety hazard, causing three drowning deaths between 2006 and 2009. Plans are underway for the complete removal of the dam.

2.0 Structural Removal Limits of Dam

The decision to either fully or partially decommission a dam and appurtenant structures will dictate the structural removal limits. In either case, to authorize the abandonment of water rights (water licence) in accordance with Section 31(1) of the *WSA*, no storage of water (beyond natural storage) may remain.

The structural removal limits are based on a wide variety of factors, including:

- Type of dam (e.g. concrete vs. embankment, control dam vs. saddle dam)
- Property status (private property vs. Crown land)
- Public safety and liability issues
- Environmental issues (i.e. fish passage)
- On-stream or off-stream location of the dam and reservoir
- Historical and cultural issues
- Sediment management issues
- Economics
- Operation and maintenance requirements
- Aesthetic factors
- Use and landowner/stakeholder preference
- Potential land use and development

The reservoir outlet shall be re-established at/near the original channel location, unless an operational or stability issue justifies a change. The extent of removal required for the safe decommissioning of a dam should be assessed by a qualified professional.

2.1 Full Decommissioning

Full decommissioning implies that all ***visible*** elements of the dam shall be removed from the site. The owner may choose to remove subgrade elements completely, or leave foundational material buried. In some cases, it may be acceptable to leave concrete sills at grade level to improve channel stability. If any material is left in the subgrade, long-term ownership and maintenance must be considered.

For most small dams, removal to a minimum depth of 0.5 metres below the streambed may be sufficient. However, for dynamic river systems or for larger dams, a qualified professional will be required to determine the depth of removal to ensure the structure is not exposed in the future.

Restored channel banks shall be designed to pass a 100-year flood without causing significant erosion or failure. Excavation beyond original dam abutments may be required to ensure slope stability. In either case, the embankments should include natural-looking ground contours following full dam removal.

The final design specifications should include provisions for erosion protection. Scour holes within the reservoir may be backfilled or allowed to fill naturally depending on the scope of the project.

2.2 Partial Decommissioning

Partial dam decommissioning allows some structures – or portions of structures – to remain in place. At the breach cross-section, the dam shall be excavated, at a minimum, down to the natural ground level to ensure no evidence of the original structure is visible.

2.2.1 Breach Design

The type of dam will determine the extent of removal of the structure to ensure the long-term stability of the site.

For embankment dams, the breach for low or significant consequence classification dams shall be of sufficient width to pass the 24-hour, 100-year flood event while maintaining a minimum one metre of freeboard. The bottom width of the breach shall be the width of the original natural channel measured at top of bank, but not less than four metres. Decommissioning of high, very high and extreme classification dams shall be of sufficient width to pass the inflow design flood (IDF) with a minimum one metre of freeboard and shall take into consideration passage of woody debris.

The breach sideslopes for earthfill embankment dams with heights of less than nine metres shall be designed for long-term stability and may not be steeper than 1.5:1 (horizontal : vertical). For embankment dams with heights greater than nine metres, a slope stability analysis that provides an adequate factor of safety shall govern the design, but in no case shall the slopes be steeper than 2:1.

In all cases, the breach shall be designed and constructed to accommodate anticipated flow velocities and shear forces to ensure the prevention of erosion and downstream transportation of embankment material.

A concrete or masonry dam can generally be removed to achieve a designed geometry by methods that include controlled blasting, mechanical demolition, or diamond-wire saw cutting. Other less common methods include the use of chemical expansive agents, flame-cutting or hydroblasting. The breach may be vertical (photo 4) or inclined, but in either case the remaining structure must be able to withstand all physical loads including seismic.

Timber crib dams are generally removed entirely due to the difficulty of ensuring long-term stability. A detailed analysis confirming long-term stability would be required in cases where a partial decommissioning is proposed.

2.3 Special Design Considerations

Generally, requirements for off-stream reservoirs are more relaxed given the limited ability of the reservoir to be refilled. The diversion works on the source stream and/or the groundwater well(s) must be removed and the site properly rehabilitated, ensuring that possible refilling of the reservoir cannot occur. For partial decommissions on property that is accessible to the public, all remaining structures must not represent a potential safety hazard.

Dam decommissioning projects that have saddle dams, spillways, appurtenant structures, sensitive fish habitat, extreme sediment buildup in the reservoir or extreme flow velocities may require special considerations to be incorporated into the final design specifications.

Photo 4:

Partial decommissioning of the Utopia dam, B.C., using an excavator mounted pneumatic hammer drill.

To provide for safe construction during the dam removal, special design considerations may require the use of one or more special measures – such as upstream and downstream aprons, grouting, cut-off walls, temporary structures for stream flow diversion during dam removal, drainage systems, and permanent protective works for remaining portions of the existing dam and appurtenant structures.

Long-term ownership and maintenance of any structures must be included in the final design specifications.

2.3.1 Saddle Dams

Typically, saddle dams are shorter in height than the control dam, and may be located some distance from the naturalized reservoir perimeter following decommissioning. In many cases, there may be no need for any decommission of the saddle dams; however, where required by the DSO, design standards as presented above may apply.

2.3.2 Water Conveyance Structures

Pipelines, penstocks, flumes, spillways, canals and tunnels must all be considered during decommissioning. For partial dam decommissioning projects, these structures will need to be assessed to ensure natural drainage systems are restored. It may not be necessary to removal all or parts of these structures for re-establishing natural drainage; however, if located on Crown land the Province may require their removal. Spillways, for the majority of earth embankment dams, are located off the dam and excavated in natural ground. The decision to remove the spillway will be based on site characteristics, the need to ensure adequate flood mitigation post-decommissioning, and risk to public safety.

Disconnection of outlet works such as intake towers and outlet pipes require special design consideration. Outlet pipes may be infilled with concrete; however, it is recommended that dam owners consider their individual situation to determine if alternative technical aspects should be investigated.

2.3.3 Appurtenant Structures

Generally, power houses, ancillary buildings, and transmission and distribution lines located on Crown land must be removed. In some instances, the Province may allow some or all structures to remain for historic preservation or other interests.

Removal of part or all of instrumentation and monitoring equipment and any other mechanical and electrical equipment must be incorporated into the management and maintenance regime.

2.3.4 Channel Reconstruction/Rehabilitation

The expectation is that the stream channel is normally restored to its original alignment and grade, with natural-looking ground contours provided on the dam abutments following full removal (*USSD Guideline for Dam Decommissioning Projects, 2015*). Material used in the reconstruction of the channel will be appropriately sized and sorted. It is expected that the channel bed be constructed to a thickness that would allow for some natural erosion without the underlying soils being exposed.

The requirement of a grade control structure may be necessary to maintain a stable bed elevation through the breach and to provide fish passage. The *Fish Passage Design for Road Crossings* manual published by Caltrans[2] is one of a number of available guidance documents that provide assistance in the design of a grade control structure. The need for fish passage should be discussed with provincial fisheries staff. Where there is a need to accommodate fish passage, the breach design shall consider the natural range of flows. In some instances there may be a desire to restrict the passage of all or certain fish species. See Fish and Wildlife website for more information: http://www.env.gov.bc.ca/fw/.

Numerous guides on the design of riprap revetment to be used as channel bank protection and channel linings on larger streams and rivers can be found in the literature including the Riprap Design and Construction Guide found at:
http://www.env.gov.bc.ca/wsd/public_safety/flood/pdfs_word/riprap_guide.pdf

2.3.5 Streamflow Diversion

Temporary diversion methods are used to reroute water from a stream, or to restrict flows to a designated portion of the stream channel to allow for construction activities to take place in the stream, along the banks or beneath the active channel. Temporary diversion methods should occur on a project- and site-specific basis and shall prevent stream flow from entering the work area. For large streams, a temporary diversion may consist of berms, ditches, dewatering wells or coffer dams constructed within the stream to confine flow to one side of the stream while work progresses on the “dry” side of the berm. For smaller streams, a temporary diversion method may divert the entire waterway. Scour protection shall be provided to prevent flow re-entering the stream channel from mobilizing streambed

[2] California Department of Transportation [CA DOT] 2007. Caltrans fish passage design for road crossings – Appendix K hydraulic design option rehabilitate structure with rock weir. May 2007.

and embankment sediments. For off-stream dams, a pump and/or bypass pipe may serve to dewater the reservoir.

If temporary diversion works in and about a stream are required during construction, the owner should apply appropriate, general best-management practices to fulfill the WSA and associated regulations. If the construction of temporary diversion waterways are used to isolate successive parts of construction at the worksite, ensure they are designed by a professional engineer and constructed in accordance with that design. Design the natural channel, remaining outside of the cofferdams, to adequately pass the one in 10 year maximum daily flow during the period of construction.

2.3.6 Reservoir Sediment Management

Removing a dam is likely to lead to the movement of sediment, and possibly the restoration of a more natural river flow. However, there are risks associated with releasing sediment. If the quantity and quality of sediment released could have adverse consequences on water quality and biodiversity, then the method of decommissioning will require a sediment management plan such that its downstream transportation does not significantly impact aquatic life or destabilize the downstream channels.

Depending on the scope of the instream management methods, project sediment removal and disposal methods or in-situ remediation can be used to manage sediment. Instream management methods allow the river to naturally redistribute the impounded sediment downstream while forming its own natural channel through the former impoundment, or while flowing through a newly constructed channel. This method may not be approved depending on the stream and the quantity of sediment to be redistributed downstream. Project removal and disposal methods may be to use mechanised removal to manage the sediment. Another option may be to contain reservoir sediment storage by leaving a reinforced concrete weir/sill in place. Consultation with the right expertise may be required in preparing a sediment management plan.

In cases where significant sediment has deposited in the reservoir, reconstruction and rehabilitation of the riparian may be required some distance upstream of the dam.

2.4 Emergency Response Planning

There is an expectation that during decommissioning, water impounded in the reservoir area shall be released in a controlled manner that will not endanger lives or damage downstream properties. There may be occasions where it is not possible to empty the reservoir prior to decommissioning of the dam. For projects that necessitate the rapid release of water from a reservoir, or where there exists a potential of an uncontrolled release, an emergency response plan will be required. The plan would, in part:

- Provide inundation mapping for the worst-case flood and an evacuation plan that identifies local emergency authorities for the areas potentially flooded
- Identify necessary closures of transportation corridors
- Define the communications system to be employed, complete with testing exercises
- Describe the public meetings to inform downstream residents of the risk

Case Study – Park Lane Dam Decommissioning

The 12-metre-high concrete slab and buttress Park Lane dam was constructed in 1922 to supply water to the Britannia Creek mine and townsite. Following the closure of the mine in 1974, the dam was abandoned.

An engineering study commissioned by the Province of B.C. in 1988 concluded that the dam represented a hazard to public life and property. This led to the planned partial decommissioning of the dam by the Province the following year. The method chosen was controlled blasting using high-velocity explosives.

Given the potential of an uncontrolled release, the Province developed an evacuation plan based on the worst-case scenario of the dam entirely collapsing during the controlled blast. Additionally, a major highway and railway line were closed prior to detonation.

On May 29, 1989, explosives designed to create a hole in the slab were detonated. Unbeknownst to the design engineers, the buttresses had no vertical reinforcing steel and were constructed with horizontal cold joints, which were hidden by gunite. This resulted in a larger than expected blast hole and the subsequence failure of adjacent buttresses. Although not the worst-case scenario, the release ($255 m^3/s$) was much greater than the expected flood volume. Damages were relatively minor and included the loss of three resource road bridges, two foot-bridges, water and sewer lines.

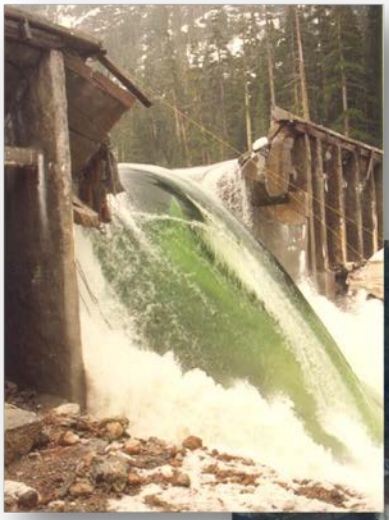
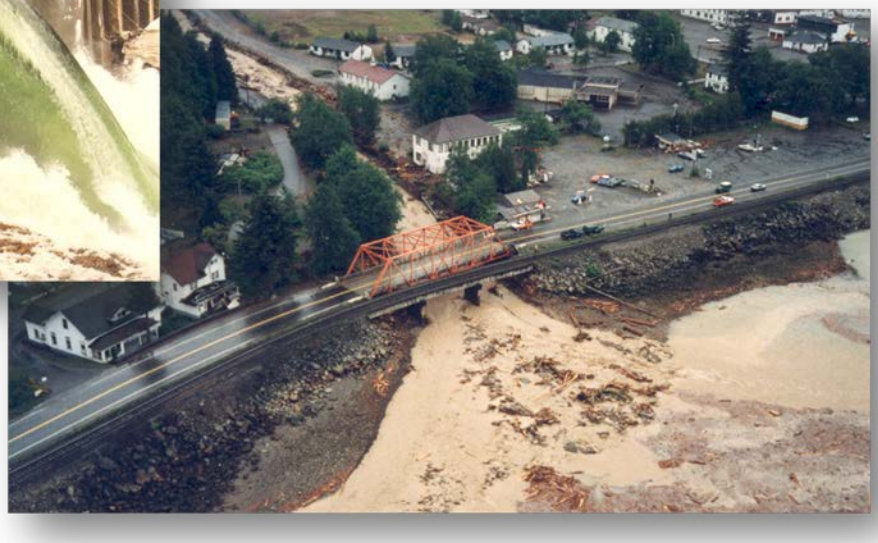


Photo 5 – Breaching of dam.

Photo 6 – Downstream debris flood.



- Provide a plan for a possible recovery phase required in the unlikely event of an uncontrolled release

The Park Lane dam case study provides an example of where an emergency response plan was activated during the course of the dam decommissioning.

2.5 Performance Monitoring

Once decommissioning is complete, it is important to assess whether the aims of the project have been achieved. A performance plan should include maintenance of the channel and embankment stability, target levels of regrowth survival, the minimizing of invasive species, and any other site-specific issues. The goal of the performance plan is to monitor the site to ensure that the management and maintenance regime is followed and project objectives continue to be met. Monitoring can extend beyond the site to include impacts such as water quality, river aggradation or scour, and wind-blown sediments.

One to five years of monitoring with the completion of annual inspection reports are required for most dam decommissioning projects to monitor physical changes on the site. Depending on site-specific issues, annual monitoring may extend beyond the proposed term.

Based on the results of the performance monitor, adaptive responses may be required and may include the following:

- Restore water quality through treatment (e.g. settling ponds or treatment plants)
- Increase efforts for the revegetation of exposed soils
- Mitigate for local flooding and bank erosion
- Enhancement of wetland features critical to aquatic species
- Replace undersized infrastructure (e.g. culverts)

Appendix C: Decommissioning Plans Checklists

This Appendix is intended to provide a general overview of the content for the submission of preliminary and final design plans and post-construction reporting, as required in the decommissioning of a regulated dam in British Columbia.

These guidelines are meant to apply to dams of all sizes and complexity. For smaller projects, plan requirements may be minimal, whereas for larger projects, much of the guideline elements may be requested. Recognizing the unique nature of each dam, it is expected that the proponent meet with a DSO to identify relevant background information, analyses, assessments, and design elements for their specific project. As per Section 17 of the DSR, the dam owner must prepare a plan, in the form and with the content specified by a DSO for acceptance.

1.0 Preliminary Plan

The preliminary design plan is meant to present all stakeholders with enough background on the potential effects of the project to allow for informed discussions to occur. These subsections of the preliminary plan are intended to be very general, because each dam will have different site-specific engineering and environmental concerns. In some cases, not all of these steps will be necessary, especially for decommissioning of low-consequence classification dams. It is advised that the dam owner evaluate each section and subsection when designing the preliminary plan.

1.1 Introduction

The introduction should define the purpose of the plan and provide a brief description of the dam location, ownership, and licensing information.

- ☐ Dam name, provincial dam file number, and consequence classification
- ☐ Location map and UTM coordinates
- ☐ Dam owner(s) and associated water licences
- ☐ Total constructed storage volume and purpose(s)
- ☐ Description of proposed decommissioning and rationale for the project

1.2 Background Information

1.2.1 Description of the Dam:

This section should provide a general description of the dam and related structures including the history of construction and subsequent alterations or improvements.

- ☐ Dam type (e.g. timber, earthfill, concrete, masonry, or combination thereof)
- ☐ Dimensions (e.g. height, length, width)
- ☐ List of all appurtenant structures
- ☐ Representative photographs of the dam, reservoir and appurtenant structures

- ☐ Construction date
- ☐ Purpose (e.g. hydropower, irrigation, water supply, land improvement)
- ☐ List of significant alterations or improvements that occurred during the life of the dam

1.2.2 Description of the Reservoir:

Review of the reservoir circumference is required to identify hazards and slopes which could become unstable in time. The terrain adjacent to reservoirs, particularly in mountainous regions of British Columbia, can be very steep and susceptible to landslides. Rapid drawdown can destabilize slopes leading to landslides, liquefaction and major slope displacements (*APEGBC, 2014*).

- ☐ Map illustrating:
  - Outline of the reservoir rim
  - Reservoir location (on or off river)
  - Contributing watershed area
- ☐ Operating range elevation
- ☐ Surface area
- ☐ Total live and dead storage
- ☐ Bathymetry mapping

1.2.3 Description of Land Status:

It is important to identify land ownership, both from the perspective of public engagement and legal access/trespass concerns.

- ☐ Prepare property ownership maps
- ☐ Prepare legal surveys showing footprints of buildings and docks around the reservoir

1.2.4 Identification of Water Rights Holders

- ☐ Current water licensees that may be affected (e.g. loss of diversion structure, clogged intakes from increased sedimentation, low flows at certain times of the year
- ☐ Loss of the reservoir could affect the surrounding aquifer(s) recharge and flow paths causing lowering of the groundwater elevation necessitating deeper wells

1.2.5 Identification of Stakeholders:

Stakeholders, at a high level, include any persons/groups that could potentially be impacted by the decommissioning of the dam.

- ☐ Identify seasonal and permanent residents proximal to the reservoir (e.g. homeowners, cottagers, landowners)
- ☐ Identify downstream upland riparian landowners

- ☐ Identify business owners (resort and marina owners, water sports rental suppliers, outfitters, etc.)
- ☐ Identify local government(s) proximal to dam/reservoir or downstream that could be impacted (planning departments, local health departments, utilities)
- ☐ Identify sport, fishing and recreational clubs
- ☐ Identify not-for-profit environmental organizations (e.g. Ducks Unlimited, Trout Unlimited)
- ☐ Identify water licensees on the source or with groundwater wells nearby

1.3 Site Characterization and Field Assessments

A complete and thorough understanding of the existing site conditions is important to the success of the project. Data should be collected for all structures within the impoundment, as well as all upstream and downstream structures that may be impacted by the removal of the dam. After collecting all available engineering data, additional field work may be required to confirm the site conditions.

Additional field work should be designed to fill in any information gaps required to perform the proposed assessments included in the project scope. This could be gathering information regarding the design of the dam and appurtenant structures, property boundaries, reservoir impoundment limits, wetland limits, ground surface contours, river cross-sections, upstream dams and affected structures, threatened and endangered species and habitats, inundated lands, sediment thickness within the reservoir, geological site conditions, hydrogeological site conditions, and the presence of contaminated sediments.

1.3.1 Geotechnical/Structural Assessment

When a dam is to be partially decommissioned, it is important to ensure that the remaining portions of the dam(s) will not pose a hazard to the public or environment in the future.

- ☐ For embankment dams, an assessment of the abutments, remaining upstream dam face and reservoir rim slopes may be required to determine stability during reservoir drawdown and following dam removal or breach
- ☐ For concrete dams, an analysis of the static and seismic stability of any remaining portions of the structure will be required

1.3.2 Hydrogeological Assessment

Lowering the reservoir level may have an impact on the surrounding aquifers. An understanding of the potential effects on groundwater wells is required for public engagement.

- ☐ Mapping of known groundwater wells
- ☐ Analysis of potential groundwater effects following decommissioning
- ☐ Identification of groundwater wells potentially influenced by reservoir

1.3.3 Preliminary Sediment Management Assessment

The following information will be required to prepare the appropriate sediment management plan:

- ☐ Characterization of all stored sediments (volume, size distribution, chemistry, mobility, etc.)
- ☐ Calculations of the annual sediment yield
- ☐ Documented results from bathymetry mapping and sediment sampling

1.3.4 Hydrology Assessment

Often the dam that is proposed to be decommissioned will have been in place for many years. Downstream development may have benefitted from the dam's regulated flows. An increased risk of flooding may be possible in a post-dam scenario. In addition, the post-dam construction flow environment may have had an effect of channel morphology and aquatic habitat, both of which may be impacted by the dam's removal.

- ☐ Hydrological analysis for five-day low flow, two, 10, 100 and 200-year return inflow hydrographs
- ☐ Analysis of the potential impact that the loss of peak flow attenuation from reservoir will have on downstream flooding of public and private properties, buildings, and residences located in re-activated flood plains
- ☐ Establish floodplain elevations for the appropriate return period inflows downstream of the dam
- ☐ Delineation of expected high-water mark around the reservoir following decommissioning

1.3.5 Fluvial Geomorphology Assessment

Dams can profoundly influence fluvial processes and stream morphology at all lifecycles, including decommissioning. Beginning with construction and continuing throughout the operation of the dam, changes in flow regime and sediment transport can cause adverse effects on stream morphology, impacting aquatic habitat. Over time, a new equilibrium develops along the river system, possibly resulting in a change in aquatic communities. The decommissioning of the dam could once again disrupt conditions.

Some areas to consider for analysis include:

- ☐ Altered sediment and nutrient transport
- ☐ Channel widening
- ☐ Bank erosion and bank stability issues
- ☐ Altered channel form (e.g. morphology)
- ☐ Aggradation or degradation (leading to meandering stream, loss of channel capacity, etc.)
- ☐ Dominant channel pattern (e.g. single thread, braided, compound)
- ☐ Sediment transport analysis (including sediment management)

1.3.6 Assessment of Environmental Concerns

An environmental assessment, when required, must be carried out by a qualified environmental professional or a team of qualified environmental professionals. Potential adverse environmental effects identified in the environmental assessment must be mitigated or avoided. Once decommissioning of the

dam is completed, a surveillance and monitoring program must be developed to monitor the effectiveness of the mitigation measures and ensure that the objectives outlined in the decommissioning plan have been achieved. Items to consider include:

- ☐ Description of natural environmental features (e.g. fish and other aquatic animals, birds and terrestrial wildlife, wetlands, Areas of Natural Science Information (ANSIs), Environmentally Sensitive Areas (ESAs), species at risk, and rare, threatened or endangered species, etc.)
- ☐ List of areas within the flow regime at risk for alteration or destruction of fish habitat
- ☐ List of areas within close proximity to the site that are at risk for increased wetting and drying of littoral edge habitat
- ☐ List of species identified to be at risk due to environmental changes induced by the decommissioning of the dam (e.g. plants, invertebrates, reptiles, amphibians, fish, birds and mammals)
- ☐ List of terrestrial and aquatic flora and fauna
- ☐ List of biophysical effects (e.g. water chemistry changes, water temperatures, nutrient transport, dissolved oxygen, etc.)
- ☐ Description of the proposed undertaking, including the situation(s) or problem(s) to be addressed
- ☐ Description of the measures and methods for avoiding or mitigating negative impacts to areas identified to be at risk (e.g. invasive species)
- ☐ Description of proposed monitoring plans
- ☐ Description of proposed enhancement opportunities

1.3.7 Economic and Social Impact Assessment

Social

- ☐ Description of potential changes to navigation on the stream and/or reservoir
- ☐ Description of aesthetics concerns
- ☐ Description of control methods for minimizing dust generation (e.g. nuisance following removal of the Condit dam in Washington)
- ☐ List of cultural heritage sites, including built heritage resources and heritage landscape features (previously inundated cultural and archaeological sites may become exposed and subject to erosion or human disturbance, *ICOLD Bulletin 160*)
- ☐ List of archaeological sites, cemeteries, and areas with archaeological potential
- ☐ List of potential loss of recreational opportunities (e.g. fishing, boating, swimming, camping, etc.)

First Nations Considerations

- ☐ List of First Nation reserves or communities
- ☐ List of spiritual, ceremonial or cultural sites
- ☐ List of traditional land, subsistence resources, or other values
- ☐ List of lands subject to land claims

Economic

- ☐ List of potential loss of business (commercial fisheries, fishing lodge, tourism, etc.)
- ☐ List of land uses around the reservoir
- ☐ List of property values

Infrastructure

- ☐ Description of water intakes, water main or wells, storm and sewage outfalls, boat docks and ramps, roads, bridges, culverts, buildings, bridge piers, retaining walls, dikes, dry hydrants, and buried utilities
- ☐ List of downstream dams
- ☐ List of additional services provided by the dam (e.g. does the dam provide road access to isolated communities?)

1.4 Preliminary Design Plans, Drawings and Specifications

For more complex projects – including projects with fish passage – determining the minimum breach dimensions may require developing a hydraulic model using computer programs to compute the maximum increase in reservoir depth during passage of the peak 200-year flood, and to compute flow depths and velocities for determining the need to armor the breach opening. Final design specifications may need to account for backwater influence from downstream channel or other structures, including bridges, and attenuation of the inflow hydrograph created by the remaining embankment and upstream reservoir area.

For low and significant consequence dams, the need for watershed modeling may be eliminated by either removing the entire dam or by designing the breach opening to conservatively accommodate the peak 100-year inflow, assuming no attenuation of the inflow hydrograph.

Hydraulics encompasses the flow characteristics around and through hydraulic structures such as bridges, culverts and weirs. For the decommissioning of a dam, it also includes the behavior of flows through the breach and reservoir outlet channel.

- ☐ Assessment of possible changes to the downstream flow regime and impacts to infrastructure (e.g. downstream culverts undersized)
- ☐ Analysis of the impact using grade control structures (such as a riffle/weir) to minimize downstream sediment transport

☐ Drawdown release capacity, drawdown rate limitations

☐ Preliminary design of any grade control structures

For the partial decommissioning of a dam:

☐ Calculate the sizing of the required breach that will safely pass the 200-year flood without erosion of the remaining embankment.

☐ Identify any hydraulic jumps created following construction of the breach, and provide design controls to prevent head cutting.

☐ Calculate the tractive forces on the breach side slopes and provide the appropriate sizing of riprap to resist bank erosion.

2.0 - Final Design Report

The final design report follows on the findings from the public engagement process, government referrals and First Nations consultation processes, as appropriate. The final design should consider stakeholder comments and identify where any accommodations have to be made. Final drawings and specifications will be of sufficient detail that they can be used to tender the construction work, and should include a description of the specific methods expected to be employed throughout the project.

The contents of the final design report will include changes to the design presented in the preliminary design report as a result of consultation in addition to the following:

- Summary of Stakeholder Engagement
- Engineering Design Plans, Drawings and Specifications
- Site and Channel Rehabilitation Plan
- Environmental Management Plan
- Construction Supervision Plan
- Performance Monitoring and Adaptive Management Plan

2.1 Summary of Stakeholder Engagement

☐ Mitigation plans regarding any potential losses of recreational facilities (fishing, boating, canoeing, water supply)

☐ Mitigation plans regarding any potential losses to businesses

☐ Mitigation plans regarding any potential losses of property value

2.2 Engineering Design Plans, Drawing and Specifications

Plans shall be drawn up to detail the configuration and specifications of the dam following the proposed decommission and any remaining associated works. The plans and specifications must contain sufficient detail to totally depict the proposed construction work and shall be submitted to the DSO for review and acceptance.

☐ Project location and vicinity maps

- ☐ Site map of dam and reservoir area showing unique and natural features, property boundaries, full supply contour, normal water level contour following dam removal, and appurtenances at a scale of 1:1000 or larger (e.g. 1:500 is larger)
- ☐ Sectional view along longitudinal axis of dam (1:250 or larger) identifying abutment and foundation contacts
- ☐ For partial removals, cross-sectional views of dam at location of maximum height adjacent to breach (1:75 or larger)
- ☐ Spoil disposal areas
- ☐ Riprap to extend up the breach sideslopes to a minimum height of the 200-year flood elevation
- ☐ Riprap sizing (based on hydraulic analysis), angular/round, gradation, bedding thickness and volumes
- ☐ Geosynthetic product descriptions
- ☐ Seismic stability analysis for any remaining structures (e.g. tower-like structures and notched concrete dams)
- ☐ Details of embedded metalwork, drainage systems, core wall, etc.
- ☐ Inventory of mechanical and electrical equipment
- ☐ Drawdown method and rate limitations
- ☐ Temporary cofferdam and diversion methods
- ☐ A description of the demolition method (e.g. excavation, drill/blast, hammer, diamond-wire sawcutting, chemical, etc.)
- ☐ Location for disposal of dam materials
- ☐ Staging areas identified
- ☐ Access routes identified

2.2.1 Sediment Management Plan

This section is intended to build on the initial assessment undertaken in the preliminary plan submission and the consultation processes, and provides results of any additional analysis or modelling required to assess future channel stability, both at the dam/reservoir site and downstream, and including possible ecological impacts. Typical options for the management of sediment include:

- ☐ No action required as there is limited sediment storage
- ☐ Engineered rapid release of sediment (e.g. Condit Dam, 2.4 million cubic yards in 90 minutes)
- ☐ Mechanical removal (e.g. clamshell excavation, hydraulic dredging, excavator and barge)

☐ Stabilization of sediment

☐ Combination of the above

Information to collect could include:

☐ Volume estimates of stored sediment in the reservoir that would be removed and/or released

☐ Computer modelling of large-volume sediment releases and/or highly sensitive streams/aquatic ecosystem to simulate
- Breaching
- Road crossing options
- Channel modifications
- In-channel detention basins

☐ Details on downstream sediment trap(s) and operation plan

☐ Sectional view of the channel showing sediment detention basin profile, if required

☐ Project time frame

2.2.2 Channel Reconstruction

Reconstruction of a stable channel through the reservoir and dam will require consideration of alignment, grade control, and bed materials. The design will need to be considered in conjunction with the sediment management plan.

☐ Self-adjusting, naturalized channel requiring no long-term maintenance or monitoring

2.3 Site and Channel Rehabilitation Plan

On Crown lands, the owner will be required to leave the site in a condition that is safe and does not alienate the property for future use or enjoyment of the public. In environmentally sensitive areas, it may be important to ensure that revegetation of disturbed soils occurs in a manner that precludes the establishment of invasive vegetation.

Consideration should be given to the provision for recreational facilities. This may include new buildings, trails, or boating facilities. Depending on the layout of the site and the decommissioning plan, provisions for public safety may also be required.

☐ Public safety

☐ Details for re-contouring of site

☐ Identification of spoil areas

☐ Revegetation

2.4 Environmental Management Plan

Those projects deemed to have significant environmental impacts during the construction may require a separate plan detailing how the impacts to the environment will be monitored. Depending on the scale of impacts, a requirement of the leave to commence construction or licence will be to retain an acceptable person to implement and manage the accepted Environmental Management Plan.

The Environmental Management Plan must be based on the environmental assessment undertaken in the Preliminary Design report and include the following:

- ☐ Site inventory of species at risk
- ☐ Sensitive areas mapping
- ☐ Species salvage plan
- ☐ Environmental monitoring requirements
- ☐ Water quality monitoring
- ☐ Timing windows provided
- ☐ Mitigative activities and methods for avoiding impacts
- ☐ Site restoration and replanting plan
- ☐ Planned compensation
- ☐ Weed and invasive plant management
- ☐ Sediment and erosion control plan
- ☐ Emergency procedures

2.5 Construction Supervision Plan

For all dams, a plan shall be submitted to the DSO describing how adequate and competent construction supervision will be provided. The Construction Supervision Plan may include:

- ☐ Construction methods (Concrete: drilling and blasting, diamond-wire sawcutting, mechanical demolition, or other. Embankment: common earth-moving equipment)
- ☐ Sequence of activities
- ☐ Emergency response plan (for a project where an uncontrolled release might occur)
- ☐ Site access and mobilization (need for road construction or improvements, helicopter support for remote locations, etc.)
- ☐ Reservoir drawdown methodology (low-level outlet release, siphon and/or pumping), rate and limitations
- ☐ Protection of existing structures and utilities
- ☐ Public protection requirements

- ☐ A description of construction management organization and responsibilities
- ☐ Details for stream diversion, dewatering, work area isolation. The site diversion shall be capable and safely passing the construction design runoff (1:10-year flood to 1:200-year flood based on consequence classification)
- ☐ Details for providing flow to the downstream channel for ecosystems, fish life, water users and water quality
- ☐ A listing of construction activities related to critical project elements and planned inspection efforts including staffing level, responsibilities, frequency and duration of site visits
- ☐ A description of the quality assurance testing program which describes the type of test, general frequency, acceptable results, handling of deficient materials and the individuals responsible for overseeing the testing
- ☐ Description of the technical records handling and the content and frequency of construction progress reports
- ☐ A detailed construction schedule showing the proposed start dates and duration of construction activities
- ☐ A description of planned engineering supervision
- ☐ A description of planned instrumentation to be employed or other pertinent information
- ☐ Stabilization of remaining structures
- ☐ Burial of material
- ☐ Information on the construction methods and timing

2.6 Performance Monitoring and Adaptive Management Plan

- ☐ Monitoring objectives, methods, locations and duration discussed
- ☐ Condition Assessment Report criteria for one-year warranty inspection
- ☐ Proposed effects monitoring
- ☐ Frequency of post-construction monitoring
- ☐ Acceptable mortality for vegetation
- ☐ Compensation

3.0 Post-Construction Report

- ☐ As-built drawings
- ☐ Photographs showing removal and final product

☐ Other design and construction records

☐ Information regarding site stabilization, including revegetation activities

☐ Refined Performance Monitoring and Adaptive Management Plan