Dam Decommissioning and Removal

Technical Bulletin

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The Lakes and Rivers Improvement Act (LRIA) provides the Minister of Natural Resources with the legislative authority to govern the design, construction, operation, maintenance and safety of dams in Ontario. The Lakes and Rivers Improvement Act Administrative Guide and supporting technical bulletins have been prepared to provide direction to Ministry of Natural Resources staff responsible for application review and approval and guidance to applicants who are seeking approval under Section 14, 16 and 17.2 of the LRIA. All technical bulletins in this series must be read in conjunction with the overarching Lakes and Rivers Improvement Act Administrative Guide (2011).

Dam Decommissioning and Removal

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1.0 Introduction

1.1 General

This document provides information on dam decommissioning in Ontario, factors to consider, relevant issues associated with decommissioning as well as information about the decision making process relating to dam decommissioning.

This technical bulletin has been prepared to provide direction to Ministry of Natural Resources (MNR) staff who are reviewing proposals, and guidance to applicants who are applying for Section 16 approval as it relates to dam decommissioning or retirement.

For the purposes of this technical bulletin, the term dam decommissioning refers to the full removal of the dam and its associated structures as well as partial removal or lowering the height of the dam. All of these circumstances are considered decommissioning and are subject to the same review and approval process. Retirement of hydroelectric facilities may alter the hydraulic regime of the channel due to the absence of flow regulation, but often the dam and associated structures are retained without alteration. The status of such dams may be considered dam "retirement" as opposed to decommissioning.

Tailings Dams

For the most part and for clarification purposes mine tailings dams generally continue to serve a useful purpose in perpetuity in that they act to contain consolidated tailings or provide water cover over submerged tailings and therefore may not be decommissioned. Where a mine closure plan, under Part VII of the Mining Act has been approved and implemented and there are no further requirements for maintenance and inspection, the mine tailings dam may be approved for decommissioning under Section 16 of the Lakes and Rivers Improvement Act (LRIA). Where mine tailings can be removed and the dam is no longer necessary it can also be decommissioned.

This technical bulletin must be read in conjunction with the Lakes and Rivers Improvement Act Administrative Guide (2011).

1.2 Lakes and Rivers Improvement Act Considerations

Dam decommissioning requires the Applicant to obtain approval under Section 16 of the LRIA for approval of existing works. The types of dam decommissioning works that require approval under the Act is provided in the Lakes and Rivers Improvement Act Administrative Guide (2011).

Applicants seeking approval under the LRIA are required to complete an application and submit it to the appropriate MNR District Office. Further information on this step is provided in the Lakes and Rivers Improvement Act Administrative Guide (2011).

1.3 Case Histories of Dam Decommissioning

Available case histories documenting dam decommissioning have primarily originated in the United States (*Donnelly et al.*, 2001), and can be found in a variety of publications (*MRP*, 2007; *The Aspen Institute*, 2002; *Heinz Centre*, 2003; *ASCE*, 1997). The literature provides practical insights into the benefits, potential pitfalls and lessons learned from dam decommissioning projects including aspects such as:

1. The possible effects of dam decommissioning on upstream and downstream infrastructure, and the need to consider possible repairs, relocations and reconstruction to water intakes, docks, retaining walls, etc., that for some dam removals resulted in significant additional costs.
2. The importance of fully ascertaining the quality and quantity of reservoir sediments that will have to be managed. Lessons learned include making full use of historical information, soil sampling and laboratory analysis, and evaluation methods (e.g., computer modeling) to adequately identify the existing reservoir sediments, and establish a proper sediment management plan for its stabilization and/or disposal.
3. The need to allow for planning flexibility and incorporate cost contingencies for unexpected site conditions. There are several examples of the discovery of contaminated soils and reservoir sediments, unusual dam foundation conditions, and river bedrock outcrops, during construction that necessitated additional on-site mitigation efforts and modifications to the original construction approach.
4. The time and cost saving benefits of using of a well-qualified contractor experienced in structural demolition and in-water construction works as well as having experience with permitting and approvals, sediment management and disposal, and river restoration techniques.

Applicants considering dam decommissioning are advised to review the precedent examples in Canada and the United States.

2.0 Issues Relevant to Dam Decommissioning

2.1 Hydrology, Hydraulics and Geomorphology

The reservoirs of water impounded behind a dam can range from relatively small headponds hundreds of metres in length to very large storage lakes, several kilometers long. Since dams differ in their layout, structures and operation, the degree of impact, in terms of a dam's influence on the magnitude, intensity and duration of high and low flows received downstream can range significantly. For many flood control dams, the reservoir storage capacity serves to control (i.e. attenuate) the release of flood flows which has a direct impact on the downstream hydrology. In contrast, 'run-of-the-river' dams (e.g. overflow weirs) with little appreciable upstream storage will have less effect on flow conditions.

In terms of high flows, for dams that exert a significant amount of peak flow attenuation, the reduction in downstream peak 'channel forming' flows can over time, result in a reduction in the size and morphology of the active channel and floodplain. As such, the

removal of these dams will re-establish increased peak flows to the downstream channel with the following possible results:

1. Channel widening;
2. Increased flooded areas;
3. Altered channel form (i.e. morphology);
4. Altered sediment and nutrient transport;
5. Bank erosion and bank stability issues;
6. Alteration or destruction of fish habitat;
7. Flooding of existing riparian ecosystems;
8. Flooding of public and private properties, buildings, and residences located in re-activated flood plains *(Heinz Center*, 2002); and
9. Increased wetting and drying of littoral edge habitat.

Dams can also alter low flows in the downstream channel, especially when water is stored for supply during more desired release periods as in the case of flood control or water supply dams. The modes of operation associated with such dams effectively replace naturally variable flows with fluctuating discharges and water levels or uniform moderated discharges, resulting in different channel forms and associated aquatic and riparian shoreline habitats.

Dam removal will have the reverse impact on the upstream river channel. Lower upstream water levels generally will reduce the channel width and concentrate the flow within it, increasing velocities and consequently increasing the systems' ability to transport sediment downstream. Previously deposited sediments trapped behind the dam will be especially prone to mobilization and transport downstream. Private and public development near the banks of the former reservoir will most certainly be impacted by the lower water levels (*Heinz Center*, 2002).

Both the hydrological and hydraulic impacts of post-dam conditions will need to be examined over a range of flows and flooding scenarios in order to provide a complete understanding of the potential changes to the river system. This impact assessment needs to take into account both positive and negative changes both upstream and downstream of the dam site.

2.2 Structural

Over the lifespan of a dam, numerous structures may be constructed near the dam reservoir (e.g. roads, bridges, residences, retaining walls, water and sewer lines), or the dam itself (powerhouse, mill). Before a dam is removed and the river channel is re-established, the ground and corresponding foundation stability of the dam and any other affected structures will need to be properly assessed. The results of these investigations may require the dam and/or other structures to be appropriately stabilized, relocated or in some cases reconstructed. Lower upstream water levels and water table elevations may also require the extension or relocation of water intake structures, sewage outfalls, wells, and boat docks and ramps.

2.3 Construction

Site accessibility, in-water work restrictions, and the availability of appropriate disposal sites are three important aspects relevant to the construction works associated with dam decommissioning. If access is limited, temporary easements may need to be established and additional roads and working areas may need to be constructed, often involving vegetation clearing, fill placement and grading works. These works, if required, could result in additional project-related impacts, costs and scheduling considerations as well as possible permitting and approval requirements.

To minimize physical disruption of the river channel and existing habitats, where practical, most or all of the demolition and material removal work may need to be conducted in the dry using cofferdams to divert water around the construction area. Alternatively, floating barges may be used to gain access to the dam structure along its entire length without affecting water passage. The latter option may be more conducive to partial dam removal where only major structural elements of the existing above water portion of the dam are to be removed. In either case, the use of explosives for dam demolition, although possible and usually necessary, warrants special consideration when blasting in or near water due to detrimental effects on fish. The use of mechanical means for dam removal such as a hoe ram is often preferable from both a cost and an environmental perspective.

To the extent possible, all recyclable material (e.g. steel, rebar, mechanical appurtenances, etc.) should be salvaged, re-used or removed to an appropriate re-cycling facility. Any hazardous materials or waste should be transported off-site to an approved landfill or an approved hazardous waste disposal facility. If appropriate and if approved, as an alternative to trucking debris away from the site, non-hazardous, inert material may be used on-site to stabilize newly exposed slopes, to fill in structures or facilities formerly associated with the dam, or to create habitat structures within the channel (*American Rivers et al*., 2002).

2.4 Sediment Exposure

Sediments that settle and become trapped behind a dam structure due to low reservoir velocities constitute an extremely important consideration in the dam decommissioning process. If not properly considered/managed, the released sediments can be transported downstream by re-established channel flows creating turbid waters and degrading fish habitat as well as that of other aquatic animals and plants. These sediments may be deposited in the downstream channel as an island or bar or in the reservoir of a dam structure further along in the system. In some cases, the quality of the reservoir sediments may be unsuitable for release due to the presence of potentially harmful chemical contaminants such as heavy metals and PCBs (*The Aspen Institute*, 2002).

For these reasons it is essential that applicants of dam decommissioning projects ensure that an appropriate level of sediment sampling, analysis and planning is conducted to identify the measures necessary to mitigate the potential for uncontrolled sediment releases once the dam structure has been removed (either in part or in full).

In this regard, past experience has shown that preparation of a proper sediment management plan that details the proposed sediment mitigation measures including sediment stabilization methods and techniques, disposal methods (if required) and site restoration methods, is essential for avoiding adverse downstream effects during, and the years after, the decommissioning. Examples of mitigation measures used to manage reservoir sediments include:

1. Construction timing and staged reservoir drawdown to avoid high flow periods and take advantage of soil stabilization through natural regeneration;
2. Silt trap construction through the use of cofferdams and temporary in-stream berms and flow diversions;
3. Dredging and on- or off-site disposal of (contaminated) sediment;
4. Shoreline stabilization through the use of live-staking, erosion protection mats, rip rap, and vegetative planting, combined with natural regeneration and bio-engineering; and
5. Natural channel design and construction.

2.5 Environmental

The primary environmental benefit/incentive associated with dam decommissioning is to restore the pre-dam natural ecological features and functions of the waterway including the reconnection or enhancement of former migration channels for native fish species, and the generation of fish habitat. In actuality, although the removal or lowering of dam structures from a river channel has the potential to restore and/or enhance fish habitat, this may not necessarily result in a *net* increase in fish habitat due to the sometimes significant changes to the channel form, reduced upstream water levels and increased downstream channel flows resulting from the loss of the storage reservoir.

What can be expected is a change in the type of fish habitat present in the upstream channel from that of open water fish habitat to riverine fish habitat. Consequently, the overall outcomes of fish and riparian habitat impact assessments will be highly dependent on the quality and quantity of existing habitat versus that which can be created both naturally and artificially following the dam decommissioning (full or partial).

Environment considerations also need to include the potential effects to other aquatic animals and plants, birds and terrestrial wildlife which could be affected (both positively and negatively) as a result of the changing water levels upstream and downstream of the dam site. Special consideration should be given to any known species at risk, rare threatened or endangered species that could be affected.

Baseline data of the present conditions must be collected in formulation of the implementation of a decommissioning plan. Any long term monitoring requirements to measure the reconnection and enhancement of the aquatic ecosystem must be identified as part of the decommissioning plan.

Further still, changes to the flow and water level regime can result in changes to important biophysical processes that should be considered in evaluating dam

decommissioning projects from an environmental perspective. These impacts are listed in Table 1.

Table 1 - Biophysical Effects of Dam Decommissioning

Positive Impacts	Negative Impacts
Lower water temperatures	Lower water temperatures
Increased nutrient transport	Elevated nutrient transport and loading
Increased sediment transport	Elevated sediment transport, loading and sediment deposition Increased mobility of heavy metals or other sediment related contaminants
Increased dissolved oxygen levels	Supersaturation of oxygen levels
Return to natural channel flow levels	Loss of ability to control flows for downstream fish spawning Decrease low flows downstream for other uses (fish, assimilation flows, water supply)
Removal of a barrier to fish migration	Increased access of predator species due to barrier removal

2.6 Environmental Assessment Requirements

Dam decommissioning undertakings in Ontario (unless exempt or approved under a previously approved EA) are subject to provincial or federal Environmental Assessment (EA) requirements or both, depending upon the particular circumstances involved.

The issuance of an approval by MNR may constitute a disposition of rights to Crown Resources and trigger the need for the Applicant to either:

1. Conduct an Environmental Assessment, pursuant to MNR's Class EA process; or, if applicable
2. Conduct a different Environmental Assessment (e.g., Municipal Class EA or Conservation Ontario Class EA) – discussed more fully below.

If a dam is located on Crown land, the Ministry of Natural Resources' Class EA for Resource Stewardship and Facility Development Projects (MNR, 2003) applies to dam decommissioning or retirement.

Applicable Environmental Assessments to Dam Decommissioning Projects

It is expected that the majority of dam decommissioning undertakings will be conducted pursuant to one of the relevant Class EA processes. This could possibly be combined with the screening requirements of the Canadian Environmental Assessment Act (CEAA). However, there could be instances where the dam decommissioning project (possibly as determined through the Class EA process) requires an Individual EA pursuant to the Ontario Environmental Assessment Act (EAA) if the project is complex, results in significant net environmental impacts and/or does not meet the specific requirements of a particular Class EA.

1. **MNR Class EA for Resource Stewardship and Facility Development Projects (2003).**

   Would typically apply when MNR is the applicant, or is in partnership with a private sector (non-profit and non-government) group or (for profit) business; or when a dam decommissioning project (private or public) requires a disposition of rights to Crown Resources and there is no other applicable EA coverage.

2. **MNR Class EA for Provincial Parks and Conservation Reserves (2005).** Would typically apply when the dam is located within a Provincial Park or Conservation Reserve and when MNR is the applicant, or is in partnership with a private sector (non-profit and non-government) group or (for profit) business or when a dam decommissioning project (private or public) requires a disposition of rights to Crown Resources within a Provincial Park or Conservation Reserve.

3. **Conservation Ontario Class EA for Remedial Flood and Erosion Control Projects (2002).**

   Would typically apply when a Conservation Authority (CA) is the applicant (or co-applicant with a municipality or other party) and the dam decommissioning works are required to protect human life and property from a potential flood or erosion problem.

4. **Municipal Engineers Association Municipal Class EA (2000).**

   Would typically apply when a municipality and/or private sector developer is the applicant (or co-applicant) and the dam decommissioning works are defined as, or involve municipal infrastructure.

5. **Environmental Assessment Screening pursuant to the Canadian Environmental Assessment Act.**

   Would apply when the applicant is a federal agency and/or when federal lands are involved, federal funding is provided and/or a federal approval or authorization is required to facilitate the dam decommissioning project.

It is the Applicant's responsibility to determine the applicable EA through early consultation with the relevant provincial and federal agencies and then complete the requisite environmental assessment steps, including public and agency consultation, and documentation.

2.7 Social

The safety and stability of an aging dam is intimately linked with the safety of downstream private and public property (and their residents) and thus is of primary importance in the decision-making process of dam decommissioning. Despite these concerns, potential changes to existing public property and infrastructure, recreational and cultural heritage features, and Aboriginal traditional uses resulting from altered river flow regimes and water levels, can raise significant opposition to dam removals by the local public who may have come to recognize that the current ecosystem created by the dam as being of value.

Aspects to be considered include whether upstream residences in proximity to the reservoir will become distanced from the channel following decommissioning, thereby

requiring relocation of shoreline infrastructure such as water intakes, boat ramps, docks and boathouses. Downstream residences that were formerly located outside flood-prone regions may become susceptible to flooding under higher flow regimes post dam decommissioning. In some instances, these changes could have legal implications on property ownership and values.

The social importance of recreational activities such as fishing, boating, swimming, canoeing and kayaking, as well as Aboriginal traditional uses (e.g., hunting, fishing, trapping) and the availability of channel forms that support these activities, both pre- and post decommissioning, can be an important determinant in the social response to the proposed dam decommissioning. In addition, the historical and cultural importance of the dam to the local community can be an over-riding factor in the social response to the proposal to remove or alter the dam from its original form. On the other hand, there may be public support for dam removals, either in part or in full, to provide a more 'natural', aesthetically pleasing, riverine environment.

The ongoing societal benefits (real or perceived) provided by a dam should be sought through public and Aboriginal stakeholder consultation and objectively evaluated against opportunities for dam removal and its potential benefits, including enhanced fish passage, flow restorations and new recreational opportunities (Michigan River Partnership, 2007).

2.8 Economic

Economic issues are an important factor in the decision to consider the alternative to decommission a dam as opposed to rehabilitation. Once the associated costs have been identified through the decommissioning process, the decision to follow through with the decommissioning process will often depend on whether it is identified as the lowest life-cycle cost alternative.

2.8.1 Economic Factors Influencing Dam Decommissioning Prospects

As each dam site is unique, the specific economic factors influencing the decision to decommission a dam will vary from case to case. Regardless of the costs involved, dam owners cannot simply walk away or abandon the dam. The following economic factors need to be considered when contemplating dam decommissioning:

1. Costs associated with rehabilitation or upgrades required to meet present-day dam safety standards;
2. Threat of liability associated with an injury to a member of the public either boating, swimming, or fishing in proximity to the dam;
3. Threat of liability associated with injury or property damage resulting from the failure of an unsafe dam contributing to high insurance premiums;
4. Annual and periodic maintenance costs (life-cycle costs); and
5. Dam operating costs, and in some cases fishway operating costs.

2.8.2 Costs Associated with the Dam Decommissioning Process

Costs associated with dam decommissioning can be categorized as costs associated with the 'assessment process' (i.e. data collection, technical studies, environmental assessment and monitoring) or costs associated with the 'decommissioning process' (engineering design, tendering, construction/removal). These costs are outlined in more detail below.

Assessment Process

1. Data collection and analysis (bathymetry mapping, sediment sampling).
2. Legal surveys (including property ownership, title searches).
3. Environmental field studies (fish, wildlife and vegetation inventories and mapping).
4. Hydrological and hydraulic analysis for low flow to peak flood conditions to evaluate the potential for sediment transport.
5. Identification of potential issues associated with the loss of flood control provided by the dam.
6. Flood plain delineation and mapping in cases where the applicant chooses to partially decommission a dam.
7. Sediment transport analysis (including sediment management).
8. Environmental assessment (including public and agency consultation).
9. Environmental mitigation and habitat creation design/planning.

Decommissioning Process

1. Detailed engineering design, preparation of tender specifications, construction management.
2. Regulatory permits, environmental approvals and authorizations.
3. Site access requirements (roads), temporary easements, construction staging and lay down areas and property requirements.
4. Relocation and/or stabilization of nearby structures (roads, bridges, water and sewer main, buildings).
5. Extension or relocation of water intakes or wells, sewage outfalls, boat docks and ramps.
6. Reservoir/headpond lowering and dewatering including diversion implementation or acquisition of floating barges for construction.
7. Dam demolition and removal of debris (full or partial removals).
8. Dam construction and modification works (partial removal).
9. Material testing for safe disposal and disposal locations (on- and off-site).
10. Channel improvement works including natural channel design (bioengineering techniques).
11. Flood plain stabilization and habitat creation works.

12. Long-term Monitoring and adaptive management.

2.8.3 Cost - Benefit Analysis

To effectively evaluate the economic viability of decommissioning a dam, all of the relevant costs for completing the decommissioning process need to be considered. Coupled with this is the need to recognize and consider the economic benefit of the recreational, environmental, and social improvements/changes to the site by means of an overall cost-benefit analysis.

It is important to note that the costs of some of these benefits are often intangible and not readily quantified. As a result, although the overall costs of decommissioning may exceed that of rehabilitating and maintaining the existing dam, the environmental benefits of decommissioning may outweigh the higher cost resulting in a decision to proceed with the decommissioning alternative. By virtue of this, the decision-making process will require the expertise and judgment of professionals involved in dam decommissioning with the input of government agencies and the public as a means to properly discern the value of the anticipated dam decommissioning benefits compared to those currently associated with the existing dam.

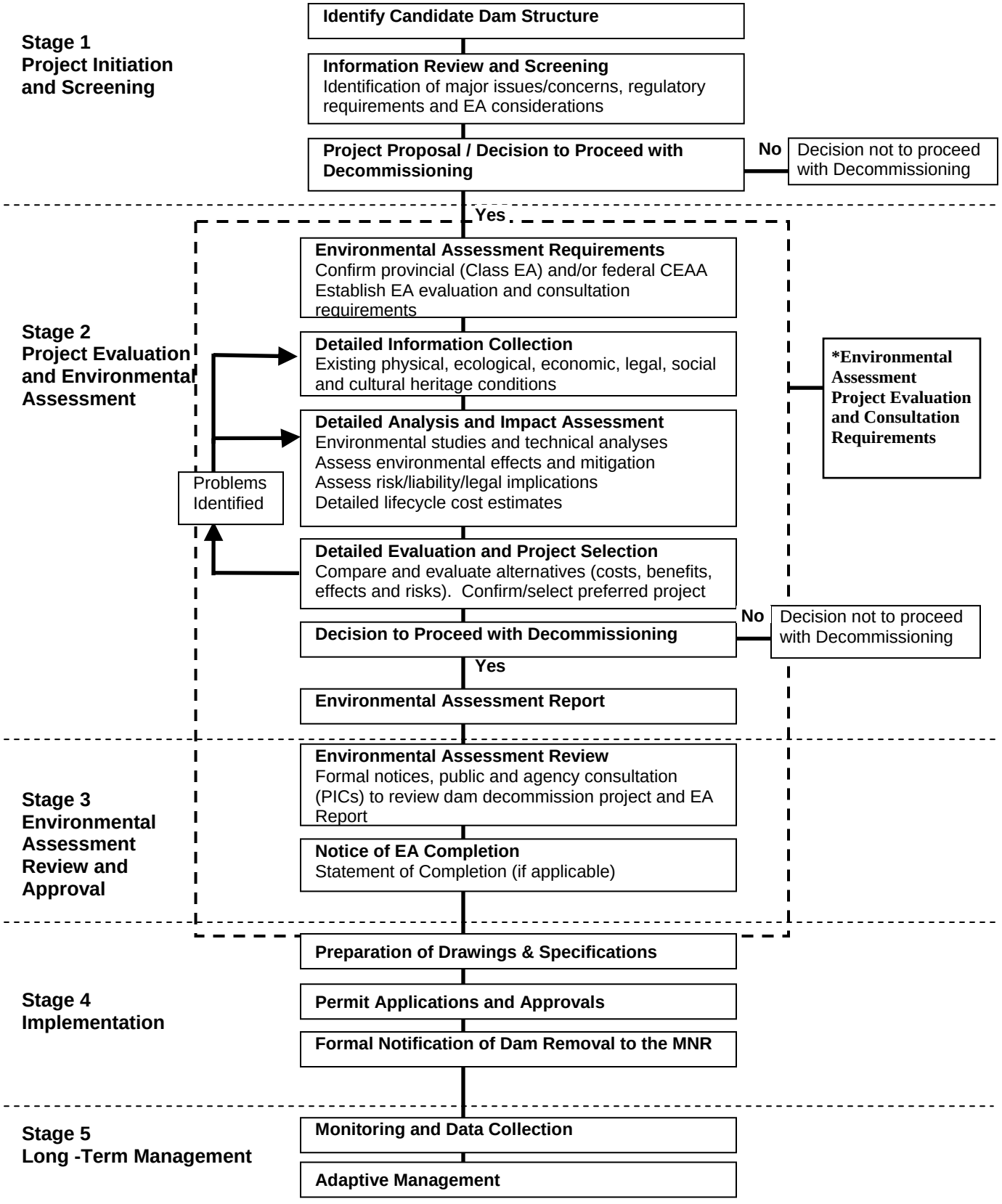
3.0 Decision-Making Framework Process for Dam Decommissioning

In direct consideration of the previously discussed issues relevant to dam decommissioning, a multi-stage decision-making framework process has been developed as a guide for dam owners and MNR staff.

The dam decommissioning process is applicant-driven. The MNR will work with the Applicant to provide support by offering guidance in following the LRIA approval process and MNR's Class EA process (if applicable) where Applicants are contemplating the decommissioning process. Guidance for the steps associated with LRIA Section 16 approval is provided in the Lakes and Rivers Improvement Act Administrative Guide (2011).

A flow-chart outlining the decision making process is presented as Figure 1 and is discussed in more detail below.

Figure 1 - Dam Decommissioning Decision-Making Flowchart



It is important to note that while the framework process makes reference to the Environmental Assessment process, this is for reference purposes only and the actual EA process must be followed. Since many EA processes have prescribed planning, evaluation and consultative requirements, Applicants who are undertaking dam decommissioning are responsible for adhering to the EA requirements and obligated to carry out their decision making assessments (Stages 2 and 3) accordingly in order to avoid duplication.

3.1 Stage 1 - Project Initiation and Screening

This stage involves conducting a screening (i.e., preliminary assessment) of the dam decommissioning proposal to identify the potential environmental effects, preliminary costs and benefits to ascertain whether to proceed with a project to decommission the dam (full or partial) or to abandon the dam decommissioning altogether (i.e. conduct dam repairs instead).

3.1.1 Identify Candidate Dam Structure

Typically, the dam owner who will act as the Applicant will identify a candidate dam structure for possible decommissioning. The desire to identify a specific dam for decommissioning can result from a number of factors including dam safety, economics, environmental or social concerns.

It is expected that at this stage the Applicant will notify the relevant MNR District Office of their intent to consider decommissioning as a possible option for a dam.

3.1.2 Information Review and Screening

Information Review

Involves the collection and review of available dam related information including, but not limited to:

1. dam safety studies, condition assessments, engineer's reports;
2. property ownership maps, land tenure, License of Occupation;
3. natural environment features (fish species, wetlands, ANSIs, ESAs, species at risk, and rare, threatened or endangered species, etc., obtained from files, published sources, agency contacts);
4. current recreational and other uses of the reservoir and waterway (fishing, boating, canoeing, water supply, etc.);
5. potentially 'directly affected' stakeholders (e.g. permanent and seasonal residents, shoreline landowners, First Nations);
6. relevant regulatory agencies (MNR, MNDMF (tailings dams), Ministry of the Environment (MOE), Fisheries and Oceans Canada (DFO), conservation authority, municipality, etc.); and

7. relevant Federal and Provincial Environmental Assessment (i.e., Class EA, Canadian Environmental Assessment Act (CEAA)) legislation, guidelines and requirements.

Screening

Involves conducting a screening of the dam decommissioning proposal to identify the potential environmental features and/ or values that could be affected, preliminary costs and benefits to ascertain whether there are any obvious reasons for completely rejecting dam decommissioning (full or partial).

Table 2 below provides an example framework that could be used to conduct the environmental screening. The assessment of the potential environmental effects should utilize some form of rating system (i.e. 'high', 'medium' or 'low') and consider both positive (i.e. beneficial) and negative (i.e. adverse) effects. Environmental effects are defined as any change to the environment within the defined study area that would occur as result of the project.

At this stage, broad-based as well as any specific project objectives for dam decommissioning, such as reduced operating and maintenance costs, public safety, river restoration and reduced liability should be identified. In addition, public and Aboriginal stakeholder issues, environmental assessment and regulatory requirements should be outlined as best possible and taken into consideration.

An outcome of the screening step could be the rejection of full dam removal as a viable decommissioning option, but retaining partial decommissioning for further assessment.

Table 2 - Example Environmental Screening Table

Screening Criteria	Rating of Potential Net Effect								Comments, Rationale
	–H	–M	–L	Nil	Unk	+L	+M	+H	
Natural Environment Considerations									
Air quality									
Water quality or quantity (ground or surface)									
Species at risk or their habitat									
Significant earth or life science features									
Fish and aquatic species, and habitats									
Natural or human–made hazards									
Recovery of a species under a special management program									
Ecological integrity									
Terrestrial wildlife, habitat linkages and corridors									
Natural vegetation and habitat									
Permafrost									
Drainage, sedimentation or erosion									
Release of contaminants in soils, sediments									

Screening Criteria	Rating of Potential Net Effect								Comments, Rationale
	–H	–M	–L	Nil	Unk	+L	+M	+H	
Create excessive waste materials									
Natural heritage features, areas of scientific interest, or provincially significant wetlands)									
Land Use, Resource Management Considerations									
Access to trails or inaccessible areas									
Obstruct navigation									
Other resource management projects									
Traffic patterns									
Recreational importance – public or private									
Non–renewable resource (e.g., aggregates)									
Noise levels									
Views or aesthetics									
Adjacent uses, persons or property									
Social, Cultural, and Economic Considerations									
Cultural heritage sites, including built heritage resources and heritage landscape features									
Archaeological sites, cemeteries, and areas with archaeological potential									
Displace people, businesses, institutions or public facilities									
Community character, enjoyment of property, or local amenities									
Government services or infrastructure									
Public health and/or safety									
Local economies									
Local businesses									
Tourism values									
Aboriginal Considerations									
First Nation reserves or communities									
Spiritual, ceremonial or cultural sites									
Traditional land or resources									
Aboriginal values									
Lands subject to land claims									

Source: Abstracted from MNR 2003.

3.1.3 Prepare a Project Proposal

A project proposal report must be prepared to summarize the results of the information review and screening. The report will document the principal factors/reasons that have resulted in the Applicant's decision to either proceed with dam decommissioning (full or

partial) or to cease the process. The proposal should assess the decommissioning or alteration of the dam structure and associated activities. Associated activities include but are not limited to:

1. Requirement for construction or upgrading of temporary access to the site; and
2. Location and ownership of a staging area to store equipment and debris prior to transport.

If the Applicant decides to pursue the dam decommissioning proposal further, it is expected that the report would have been sent to the appropriate MNR District Office to initiate MNR's formal involvement in the project. Consistent with MNR's EA scoping requirements, MNR will review the project proposal and confirm to the Applicant the applicable Class EA category as well as any specific EA related project evaluation and consultation steps required.

3.2 Stage 2 - Project Evaluation and Environmental Assessment

This stage involves the collection and review of detailed information and the completion of focused technical studies of the post-dam decommissioning hydrologic and hydraulic conditions (including flows, water levels, sediment transport, etc.) to enable a comprehensive assessment of the expected environmental effects, costs and benefits. The objective of this step is to confirm the decision to proceed with the proposal to decommission the dam (full or partial) or to abandon the dam decommissioning process.

As previously discussed, the decision-making steps associated with this stage are often conducted to meet the project evaluation and consultative requirements of the relevant EA process. Doing so is advantageous for Applicants of dam decommissioning projects and is likely to be required by MNR (or other applicable EA regulators) in order to minimize process and information overlaps, and consolidate consultation activities to reduce confusion and avoid potential project delays.

3.2.1 Environmental Assessment Requirements

This step involves confirmation of the relevant EA process(es) applicable to the proposed dam decommissioning project. General EA guidance for Applicants is provided in Section 2.6 and as noted, it is expected that the majority of dam decommissioning undertakings will be conducted pursuant to one of the relevant Class EA processes, possibly combined with the screening requirements of CEAA.

It is the Applicant's responsibility to determine the applicable EA through early consultation with the relevant provincial and federal agencies and then complete the requisite environmental assessment steps, including public and agency consultation, and documentation.

3.2.2 Detailed Information Collection

This step involves the collection of information pertaining to the existing legal, physical, ecological, economic, social and cultural heritage conditions of the defined study area associated with the dam site. This information will be more detailed than that gathered

in Stage 1 and will be used to review, analyze and assess the environmental impacts (both ecological and societal) associated with the proposed dam decommissioning project.

A listing of the possible data and information requirements is provided below:

1. Historical
    a. Pre-construction dam photos or descriptions
    b. As-built drawings
    c. Property ownership plans, easements, shoreline allowances, etc.
    d. Legal information (water taking rights, access, License of Occupation)
    e. Records of construction methods and costs
    f. Post-construction dam photos (over lifespan)
    g. Operation and Maintenance Records
    h. Upgrades or Rehabilitation drawings
    i. Studies, Dam safety or otherwise
    j. Inspection Reports
    k. Instrumentation and Monitoring Records
    l. Operation and Maintenance Costs
    m. Upgrades or Rehabilitation Costs
    n. Regulatory permits – Applied for and/or approved

2. Hydrologic and Hydraulic
    a. Water Management Plan, dam operating plan
    b. Dam hazard classification
    c. Watershed delineation, contour mapping
    d. Aerial photography (current, historical and pre-dam)
    e. Previous hydrologic and hydraulic models
    f. Surveys: river cross-sections, channel longitudinal profile
    g. Hydrologic records: Rainfall data, snowpack depths, previous flood flow estimates & inflow hydrographs to assess sediment transport issues
    h. Floodplain mapping in the event that the applicant chooses to partially decommission the dam
    i. Stream gauge records and high water marks
    j. Terrain/Channel Assessments for the estimation of roughness coefficients
    k. Reservoir bathymetry mapping (sediment volume, flood storage)
    l. Fluvial geomorphology assessment and stream classification, including inventory of existing erosion sites

3. Geotechnical
    a. Soil classification
    b. Compressive soil strength
    c. Porosity
    d. Ground water elevation
    e. Bedrock elevation

4. Reservoir Sediment
    a. Volume, depth, formation, location
    b. Composition, grain size analysis
    c. Organic content
    d. Chemical content

5. Structural
    a. Local structures inventory (buildings, water & sewer lines, roads, bridges, wells, docks, boathouses, etc.)
    b. Structure foundation details/specifications

6. Environmental
    a. Aquatic species inventory, populations, spawning locations and sizes
    b. Aquatic and terrestrial migratory pathways
    c. Wildlife species inventory, terrestrial habitats, wetland locations and sizes
    d. Critical habitats of rare, threatened or endangered species, species at risk
    e. Fish species passage criteria
    f. Water quality (suspended sediment, water temperature, BOD, COD, etc.)
    g. Riparian shoreline vegetation (species, locations, significance)

7. Social and Cultural
    a. Community character and setting, population, demographics
    b. Visual and aesthetic features, landscapes, values, scenic quality
    c. Land use, infrastructure, transportation routes
    d. Land tenure, property ownership, easement boundaries
    e. Recreational waterway uses and calendar period of use
    f. Commercial, industrial, municipal waterway uses (intakes, marinas, sewage treatment plants)
    g. First Nations, communities, locations, traditional use areas
    h. Native land claims with respect to property and stakeholder assessments, treaty rights, Aboriginal issues
    i. Site history and built heritage assessment for dams, mills and other affected structures with historical significance
    j. Archaeological assessments for construction activities (roads, land clearing, excavation) in areas of high archaeological potential

3.2.3 Detailed Analysis and Impact Assessment

For the proposed dam decommissioning (full or partial), a determination of the specific environment features and values that could be affected will be conducted by the Applicant. The assessment will be more rigorous than that conducted in the Stage 1 screening and should be carried out consistent with the methods and evaluation procedures prescribed by the applicable EA process. In this regard, it is expected that a variety of field study data, technical analyses (i.e., computer modeling), environmental impact assessment methods and professional judgment will be used by experienced practitioners to identify the extent and significance of environmental effects.

Factors to be included in assessing the significance of environmental effects include consideration of the magnitude, extent, duration and frequency of effects as well as other considerations such as likelihood of effect, reversibility and irreversibility, direct and indirect effects and possible cumulative effects. In addition, any public, Aboriginal and agency concerns identified through consultation activities should be considered in the assessment. This process also requires that environmental mitigation measures, required to reduce the severity of impact to acceptable levels, be identified so that the *net* (i.e., residual) environmental effects can be assessed. Also, it is important that any

mitigation measures be identified so that they can be considered in the lifecycle cost estimation for the proposed dam decommissioning.

Evaluative assessments of the anticipated legal, social and risk implications (i.e. dam safety, public safety, liability) should be performed for the 'maintain in place' and dam decommissioning alternatives since these could result in a decision not to pursue the dam decommissioning proposal any further.

Detailed lifecycle costs for the dam decommissioning as well as the 'maintain in place' option should be estimated on the basis of engineering design and construction costs, operating and maintenance costs, environment mitigation measures and other costs (property acquisition, legal, etc.) so that complete appreciation of all costs are incorporated into the evaluation process.

3.2.4 Detailed Evaluation and Project Selection

The evaluation process will consider the extent and significance of net environmental impacts, including requirements for mitigation, lifecycle costs and the benefits associated with the proposed dam decommissioning project. The evaluation should consider the potential risk of and consequences (i.e. costs, liability, environmental impact) resulting from an unexpected dam failure and other issues identified to this point in the process. In addition, consideration should be given to any on-going environmental effects due to the existing dam as well as riparian and land ownership issues (i.e., legal concerns).

To provide an appropriate basis of comparison, the proposed dam decommissioning project should be evaluated and compared against the "Do Nothing" (or Status Quo) option as well as the 'maintain in place' option.

The evaluation should utilize some form of ranking system based on an issue-based (objective oriented) scoring approach with the use of assigned weighting to reflect the decision-making priorities associated with the site-specific environmental sensitivities, risks, benefits and costs. Other factors such as effectiveness, feasibility, public safety, etc., could be included in the evaluation if appropriate.

The following example framework presented in Table 3 should be considered a guide when conducting the comparative evaluation:

Table 3 - Example Evaluation Framework for Dam Decommissioning Alternatives

	Criteria	Weight	Degree/ Severity (0 - 5)	Weighted Total
1	Environmental impacts – natural	20		
2	Environmental impacts – socioeconomic	20		
3	Consequences of dam failure	30		
4	Benefits of decommissioning	15		
5	Lifecycle cost (capital, O&M, environmental)	15		
		100		Total
	(Must total 100)			(Max 500)

Weighted Score = Weighted Total Score ÷ 5) %

1. Environmental impacts – natural (habitat destruction, etc. / more severe, higher rank)
2. Environmental impacts – socioeconomic (recreational usage, etc. / more severe, higher rank)
3. Consequences of dam failure (damages, loss of life, etc. / more severe, higher rank)
4. Benefits from decommissioning (improved habitat, etc. / more benefits, higher rank)
5. Lifecycle cost (capital, O&M, environmental / higher cost, higher rank)

3.2.5 Decision to Proceed With or Abandon the Process of Decommissioning

Based on the results of the evaluation, a decision will be made to proceed with the dam decommissioning project (full or partial) or to abandon the decommissioning process. The final decision will require careful examination of the outcomes of the evaluation exercise within the context of the original objectives for dam decommissioning and reflect any new information gained through the completion of Stage 2.

3.2.6 Environmental Assessment Report

This step involves the preparation of formal EA documentation detailing the steps completed in association with the EA. The EA documentation requirements vary depending upon the particular EA process used and the project category that the project is classified under. Typically for Class EAs (Category C or Schedule C projects), an Environment Study Report (ESR) would be prepared.

As a general guide, the EA documentation should include (but not be limited to) the following information:

1. a description of the proposed undertaking, including the situation or problem to be addressed;
2. a description of the existing environment;
3. a description of the alternatives considered and identification of potential environmental impacts;
4. a comparative evaluation of the alternatives and the rationale for the selection of the preferred alternative;
5. a summary of the consultation activities conducted including individuals, groups and agencies consulted, issues and concerns raised and responses provided;
6. the identification of mitigation measures and methods for avoiding or mitigating negative impacts;
7. information on the construction methods and timing; and
8. proposed effects monitoring.

3.3 Stage 3 – Environmental Assessment Review and Approval

This stage involves the formal notification and review by the public and agencies of the completed EA report for the proposed dam decommissioning project. The outcome of

this step is expected to be a public and agency endorsed dam decommissioning project that can proceed to implementation (Stage 4).

3.3.1 Environmental Assessment Review

This step involves open distribution of the EA report including any technical and evaluative studies completed in Stage 2 for formal review and comment on the procedures, findings, and forecasted implications of the dam decommissioning proposal.

In accordance with the pertinent EA process requirements, the Applicant will provide formal notice(s) (e.g. newspapers, letters, etc.) that the EA of the dam decommissioning project has been completed and that the EA report (and/or other supporting documentation) is available for review. Typically, public information centres (PICs) and/or meetings with directly affected stakeholders, government agencies and the public will be utilized by the Applicant to inform them of the proposed undertaking and obtain comment.

A short list of possible government agency and public stakeholders to be consulted during the EA process is provided below. Stakeholder issues, concerns and comments obtained on the dam decommissioning proposal should be fully documented in the final EA Report (or project file). General acceptance of the project outcomes must be provided by all parties before moving forward to the next step.

Government Stakeholders
Municipal Government Departments i.e. Land Use Planning
Regional Government Departments i.e. Lands & Natural Heritage
First Nations
Ministry of Natural Resources
Ministry of the Environment
Ministry of Energy
Ministry of Culture
Ministry of Northern Development Mines and Forestry
Ministry of Agricultural, Food and Rural Affairs
Ministry of Transportation
Ministry of Aboriginal Affairs
Fisheries and Oceans Canada
Transport Canada
Environment Canada
Aboriginal Affairs and Northern Development Canada
Parks Canada
Conservation Authorities

Public Stakeholders

Seasonal and Permanent Residents (home owners, cottagers, landowners)
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 Canada, Trout Unlimited)

3.3.2 Notice of Environmental Assessment Completion

Following completion of the public and agency consultation on the proposed dam decommissioning project and preparation of a final EA report, the process will culminate with the issuance of a Notice of Completion to all stakeholders, government agencies and the public. The Notice will provide information on the dam decommissioning proposal, where copies of the final EA Report can be reviewed. Typically, a 30-day review and comment period will be provided following issuance of the notice. If no Part II Order (i.e. 'Bump-up') requests are received, the project will be deemed approved and can proceed to implementation (i.e. construction) subject to obtaining all necessary permits and approvals.

While every attempt has been made to ensure consistency of information with relevant documents, applicants should refer the current most recent Reference Manual for MNR Class Environmental Assessments to ensure the current notice, public review, and bump-up protocol is followed, including notification to and consultation with Aboriginal Peoples.

Statement of Environmental Assessment Completion

Specifically for MNR Class EAs, following the 30-day review period, if no Part II Orders are received, a Statement of Completion will be prepared by the MNR District Manager and placed on the project file.

3.4 Stage 4 - Implementation

3.4.1 Preparation of Drawings and Specifications

Involves the detailed engineering associated with the preparation of engineering drawings and specifications for all construction related works associated with proposed dam decommissioning. Typical drawings and association specifications may include (but are not limited to) the following:

1. Site layout, access roads, and construction lay-down areas;
2. Dewatering or diversion plan or floating-barge implementation plan;
3. Erosion control plan;
4. Vegetative clearing;
5. Construction staging;
6. Structure removals and disposal/re-location;
7. Stabilization of remaining structures;
8. Slope stabilization;
9. Reservoir sediment management (i.e. removal) plan (if warranted);
10. Channel restoration and fish habitation compensation/restoration plan (incorporating natural channel design and bio-engineering techniques); and
11. Site restoration and re-planting plan.

The drawings will be utilized for permit application submission to the appropriate agencies (as identified below) as well as for construction tendering, and should therefore be clearly presented for external review. Depending upon the complexity of the dam decommissioning project, preparation of Design Report (or Implementation Strategy) may be necessary to adequately describe and document the proposed construction stages, mitigation measures and monitoring requirements.

3.4.2 Permit Applications and Approvals

The implementation of the dam decommission project may require that several different government approvals be obtained prior to the onset of construction. It is the responsibility of the Applicant to obtain all necessary permits and approvals.

Potential approvals could include, but are not limited to the following:

1. Federal Fisheries Act authorization for the harmful alteration, disruption or destruction (HADD) of fish habitat issued by DFO;
2. Formal approval under the Navigable Waters Protection Act issued by Transport Canada – Marine;
3. Federal Environmental Assessment Screening pursuant to the CEAA;
4. Permit to Take Water issued by Ministry of Environment;
5. Certificate of Approval for temporary sediment settling ponds issued by Ministry of Environment;
6. Stage I/II Archaeological Assessment clearance by Ministry of Culture;
7. Plans and specifications approval under the LRIA; and
8. Permit under Development, Interference with Wetlands and Alterations to Shorelines and Watercourses regulations, issued by the responsible conservation authority.

Concerns to be addressed as part of Lakes and Rivers Improvement Act Approvals

Concerns to be addressed include reservoir draining and/or staged-drawdown, completion of dam removal, disposal of debris, channel and flood plain stabilization and habitat creation works, and re-establishment of channel flows in accordance with the final drawings and conditions of permit approval. Construction should be timed to avoid high flow periods so as to avoid the risk of flooding the work area and subjecting newly exposed/released sediments to erosive velocities. In-water activities (when and where applicable) must be scheduled in compliance with the in-water window that applies to the river system as identified by MNR. Sediment control measures must be implemented and maintained on site throughout the construction period. Vegetation planting must also be timed with the appropriate season to provide adequate growing conditions. In the interim, unstable or un-vegetated surfaces will need temporary protection against erosion.

3.4.3 Formal Notification of Dam Removal to the Ministry

Following completion of the dam removal (full decommissioning), the Applicant will provide formal notification to the MNR that their structure has been removed.

3.5 Stage 5 - Long-Term Management

3.5.1 Monitoring and Data Collection

Monitoring and data collection involves the implementation of construction and post-construction monitoring and analysis programs to evaluate the effectiveness of temporary and permanent mitigation measures. If necessary, remedial action should be taken to repair/replace any erosion control measures that may have failed or are not functioning properly. In addition, monitoring will be used to assess whether the anticipated outcomes of the dam removal are met (i.e. fish migration) and whether any unexpected and possibly detrimental outcomes arise (i.e. excessive sediment transport).

3.5.2 Adaptive Management

Adaptive management involves the periodic scientific evaluation of the 'state of health' of the dam decommissioning site and local environment. Findings of data analyses for selected environmental indicators are evaluated against predicted outcomes and acceptable standards. When undesired effects are detected, a strategy should exist to 'adapt' the original channel design and management plan in an effort to achieve desired effects.

Glossary of Terms

Adaptive Management: Long term decision making process for improving resource management through effectiveness monitoring, study to reduce areas of uncertainty and adjusting to limit failures.

Attenuation: Decrease in amplitude and change in frequency content of the seismic waves with distance because of geometric spreading, energy absorption, and scattering.

Bathymetry mapping: Map to delineate the form of the bottom of a body of water, or a portion thereof, through the use of depth contours (isobars).

Bioengineering: Using natural living materials for bank stabilization, erosion control, and habitat creation, for example, willow plantings, brush layering, or transplanted trees.

Compensation: With regard to fish habitat this term refers to the creation of new habitat or the enhancement of existing habitat to replace habitat loss as a result of the undertaking. Compensation, by definition, implies loss or damage to habitat and should only be considered when mitigation is not possible or inadequate.

Dam: For the purpose of this technical bulletin, a dam is defined as a structure that is constructed which holds back water in a river, lake, pond, or stream to raise the water level, create a reservoir to control flooding or divert the flow of water.

Decommissioning: to retire, abandon, dismantle, or remove from active service, working order, or operation.

Easement: A right or interest or use of passage of persons, vehicles and animals over another person's owned or leased property created through an express registered grant of easement.

Environmental Assessment: process to predict the environmental effects of proposed initiatives before they are carried out. It identifies possible environmental effects, proposes measures to mitigate adverse effects, and predicts whether there will be significant adverse environmental effects, even after the mitigation is implemented.

Fish: Includes parts of fish, shellfish, crustaceans, marine animals, and any parts of shellfish, crustaceans or marine animals and the eggs, sperm, spawn, spat, larvae, and juvenile life stages of fish, shellfish, crustaceans, and marine mammals

Fishway: A combination of structural and/or non-structural conditions, including biological and chemical, which accomplish the safe passage of fish upstream and/or downstream past obstructions in the river.

Fluvial Geomorphology: The study of river processes and resulting channel patterns.

Foundation: The soil or rock upon which the structure or embankment rests. An alternative definition is similar to footing.

Grading: Cut and fill activities designed to increase stability.

Harmful Alteration: Any changes that adversely affect the abilities of the physical habitat to provide the basic life requirements can be considered harmful (Federal Fisheries Act definition).

Height: The height of a dam is the vertical distance between the lowest point of the natural surface of the ground at the downstream toe of the dam and the upper most point of the top of the dam

High Water Mark: A visible demarcation mark made by the action of water under natural conditions on the shore or bank of a body of water which action has been so common and usual and so long continued or that it has created a difference between the character of the vegetation or soil on one side of the mark and the character of the vegetation or soil on the other side of the mark.

Hoe Ram: A hydraulic hammer used in demolition and excavation of solid material such as bedrock.

Hydraulic: Relating to the flow of liquids particularly water.

Hydrograph: The relationship between time and flow, or time and water level, often illustrated on a graph.

Hydrology: The applied science concerned with the waters of the earth, their occurrences, distribution and circulation through the continuous hydrologic cycle of evaporation, transpiration, precipitation, infiltration, storage and runoff.

Lake: includes a pond and similar body of water (e.g. swamp, marsh, bog) if located on a river.

Mine Tailings Dam: A dam constructed to impound an area for the capture of mine waste and process water. These dams may be constructed of mine waste material.

Mitigation: Actions taken during project planning, design, construction, or operation to alleviate adverse effects on habitat.

Porosity: The percentage of void (empty spaces) in earth materials such as rock or soil.

Retaining Wall: A wall built to hold back earth along a river.

Retirement: to cease operation, abandon, decommission, or remove from active service or working order.

Riparian: Adjacent to a river or lake.

River: Includes a creek, stream, brook or similar watercourse with defined bed and banks of a permanent nature.

River Channel: The river or stream channel is defined as that portion of the channel which conveys the mean annual flood and/or which lies between the high water mark on both banks but does not include the overbank flood plain.

Suspended Sediment: Soil particles become suspended in the water as a result of stream erosion or from re-suspension of particles from the bed.

Tailings Dam: A dam constructed to impound an area for the capture of mine waste and process water. These dams may be constructed of mine waste material.

Weir: means a structure in a watercourse intended to raise the water level or partially or totally divert its flow.

Wetlands: Lands that are seasonally or permanently flooded by shallow water as well as lands where the water table is close to the surface; in either case the presence of abundant water has caused the formation of hydric soils and has favoured the dominance of either hydrophytic or water tolerant plans.

List of Acronyms

CA	Conservation Authority
CEAA	Canadian Environmental Assessment Act
DFO	Fisheries and Oceans Canada
EA	Environmental Assessment
ESA	Endangered Species Act
ESR	Environment Study Report
HADD	Harmful Alteration, Disruption or Destruction
MNR	Ministry of Natural Resources
MNDMF	Ministry of Northern Development, Mines and Forestry
MOE	Ministry of the Environment

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