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EXECUTIVE SUMMARY

The end of the 20th century has seen the emergence of an important new trend relating to dams. This entails the decommissioning of impoundments that no longer serve a useful purpose or provide only marginal benefit. Many of these same dams are expensive to maintain, have unacceptable levels of impacts and in some cases pose a public safety threat. ‘Momentum for river restoration is accelerating in many countries and many of these efforts revolve around relatively old, small dams that have been, or are likely to be decommissioned.’ (WCD Report, November 2000)

Experience in North America and in Europe shows that decommissioning dams has enabled the restoration of fisheries and riverine ecological processes. While decommissioning efforts have generally received public support to date, there have also been some valuable lessons learned from these initiatives. Most importantly, there is a need for a cautious and risk adverse approach to the decommissioning of dams or ‘other dam management strategies’. If these efforts are well conceived and executed, there is every reason to believe that we can restore the overall health of our rivers.

In this regard, the current decommissioning of the Theodosia dam is seen as a positive case study in which risk adverse strategies are being undertaken. Conversely, the removal of the Illecilewaet dam in 1985, while well intentioned, was plagued by stabilization problems. Had this endeavor been undertaken in a staged, more risk adverse manner and additional efforts been made to contain sediment loads, many of these problems could have been avoided. Learning from our mistakes as well as our successes is critical to the future success of decommissioning projects. Raising awareness on these experiences and promoting more effective dam management strategies is ultimately the goal of this project and the BC Outdoor Recreation Council (ORC) report.

This report provides a general review of decommissioning lessons from abroad, examines issues and experiences that are unique to the province, and evaluates options as well as opportunities associated with the range of dam management strategies that are available for river recovery in British Columbia. The report examines dam management options such as removal and decommissioning, as well as alternative management strategies for dams that continue to serve a useful function, such as modification, water use planning guidelines, and owner divestment or partnership schemes. Such practices are currently being used in British Columbia to help reduce impacts from dams and improve the health of our rivers.
There are approximately 2500 dam structures in the province that are officially known to provincial agencies. Of these, approximately 400 dams have been classified as high or very high hazard where loss of life or property may occur should the dam fail. (MoELP, Water Management Branch, 1995). According to the US Association of Dam Safety Officials, the average life expectancy for an un-maintained dam is approximately 50 years. (Donnelly et. al., 2001) It is currently estimated that roughly half of our dam structures are already of this age or greater. Within the next ten years, it is estimated that this number is likely to reach approximately 75 percent of our licensed or operational structures.

It is unknown how many of our remaining operational dams are either redundant, obsolete, or provide only marginal benefit, but it may be as high as ten percent. In fact, it is unknown how many dam structures in total have reached the end of their economic or structural life cycle in British Columbia. Over the last century, approximately one hundred licensed dams have been abandoned by their owners. Although the Ministry of Environment has removed or safeguarded nearly half of these over the last several decades, the number of abandoned dams is expected to increase in the near future given the fact that many of the remaining dams are expected to reach the end of their economic and structural life cycle in the next few years. This does not include the number of illegal dam structures that exist within the province. Furthermore, it has been estimated from random surveys that the number of smaller diversion or impoundment structures that are not classified as dams by provincial agencies, may equal if not exceed the total number of licensed dams. This is a problem many communities can no longer afford to ignore.

More studies and further resources are currently required to address the specific needs of individual river systems as well as more effective management strategies for existing dam structures. As the stock of older dams increases significantly and the life expectancy of these dams is becoming more of a safety concern, our management choices between decommissioning and refurbishment are only likely to increase with time. Due to the significant costs and risks that will be associated with upgrading or replacing many of these structures, many communities are now learning that removal or decommissioning is a viable solution. For dams that still serve an important function, most of these can also be operated more effectively than they are at present.

The report includes a component on the identification and systematic evaluation of nearly 100 dam candidates from around the province. This was carried out in order to explore the range of issues and options associated with dam management and to encourage further government action or initiatives towards addressing some of these outstanding issues and options. A ‘primary candidate list’ of nearly 40 dam structures was created based on an evaluation of operation, institutional, and biological concerns. Of these, a ‘candidate short list’ of a dozen structures was selected based on a more rigorous ranking scheme. This short list highlights some of the structures where decommissioning or alternative management schemes have the greatest potential for occurring in the very near future.
The prioritization of candidates was based on three main factors. These factors included: (i) their **Operational status** (whether or not a dam serves a useful safety, economic, social, or environmental function), (ii) **Institutional concerns** (such as public safety, water license concerns, agency support, etc.), and (iii) the **Biological potential** for each candidate (the dam candidates that appear to have the greatest potential from a fisheries enhancement or restoration perspective).

Of the twelve primary candidate structures that were selected, six of these candidates were chosen for potential removal or decommissioning management options based on their ranking and unique characteristics. This includes the following dam structures:

<table>
<thead>
<tr>
<th>Removal or Decommissioning Candidates</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kitsault dam,</td>
<td>Kitsault River, Skeena region</td>
</tr>
<tr>
<td>Jennis Lake dam</td>
<td>Drury Inlet, Vancouver Island region</td>
</tr>
<tr>
<td>Chonat Creek dam</td>
<td>Quadra Island, Vancouver Island region</td>
</tr>
<tr>
<td>Coleman Creek dam</td>
<td>Burrard Inlet, Lower Mainland region</td>
</tr>
<tr>
<td>Surf Inlet dam</td>
<td>Princess Royal Is., Skeena region</td>
</tr>
<tr>
<td>Tunnel dam</td>
<td>Britannia Creek, Lower Mainland</td>
</tr>
</tbody>
</table>

This list is not meant to be all-inclusive. There are many other candidates that are not included in the short list that received strong agency support for removal or decommissioning for safety related reasons, but there may have been other agency concerns or limited potential benefit associated with fish or wildlife values. For a more comprehensive list of these primary candidates, please refer to the report.

It is important to note that, while removal or decommissioning strategies have been, and will continue to be, a viable option for alleviating impacts and risks of dams, the BC Outdoor Recreation Council (ORC) is not calling for the removal of all, or even most dams. Rather, the goal of the council is to ensure that the viability and need for certain dams is regularly reviewed and that every effort be made to restore our rivers and lessen dam related impacts on our waterways. If removal or decommissioning is not a viable option for a particular dam structure, river restoration and the rejuvenation of local fisheries can be achieved by using a multitude of other management techniques, ranging from water use planning to structural modifications, without losing any significant amount of benefit that many of the province’s dams continue to provide.

There were six other candidate dams that were selected for the ‘candidate short list’ that still served a useful function, but were selected for **alternative dam management** strategies such as **modification** techniques (such as fish ladders, fish diversion channels, etc.), **water use planning** flow operational changes (allowing for controlled management of water flow regimes), and innovative **water management partnerships**. In some cases, two or more management strategies were identified as potential options for an individual structure.
Alternative Dam Management Candidates   Location

<table>
<thead>
<tr>
<th>Alternative</th>
<th>Location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cleveland Dam</td>
<td>Capilano River, Lower Mainland</td>
</tr>
<tr>
<td>Coquitlam Dam</td>
<td>Coquitlam River, Lower Mainland</td>
</tr>
<tr>
<td>Eneas Dam</td>
<td>Findlay Creek, Southern Interior</td>
</tr>
<tr>
<td>McIntyre Dam</td>
<td>Okanagen River, Southern Interior</td>
</tr>
<tr>
<td>Elsie Lake Dam</td>
<td>Ash River, Vancouver Island</td>
</tr>
<tr>
<td>Fulford Dam</td>
<td>Salt Spring Island, Vancouver Is.</td>
</tr>
</tbody>
</table>

While some of the above structures are conducive to modifications, they can also be managed for water use planning, and/or multi-partnership alternatives. Furthermore, while this list is made up of candidates that are well suited for action in the short term, there are many other dams that should be considered for modification or water use planning in the intermediate period. For example, BC Hydro is committed to developing water use plans for all of its structures over the next several years. While this is a positive development, BC Hydro’s structures make up only a small percentage of the total number of dams in the province. Consequently, the ORC hopes the water use planning process will be further explored for candidates that lie outside of BC Hydro’s umbrella.

Regulatory mechanisms, public pressure, and financial incentives have proven to be the most effective tools in motivating dam owners to improve operations, to increase societal or environmental benefits, and to reduce the negative impacts associated with existing dams. The report includes some basic recommendations on these subjects. In general, better evaluation mechanisms of dam management strategies are required so they can be applied in a more timely and optimal manner for each river system. This will mean improving existing data collection, planning, implementation, and monitoring efforts that are associated with these strategies. In addition, there are a number of other issues related to dam management that will need to be addressed if we are going to promote the recovery of our river systems. This includes issues such as the regulation and evaluation of water licenses, water consumption trends, public input and awareness campaigns, more up to date and integrated baseline information and monitoring programs, and the greater allocation of human, technical, and financial resources towards these programs.

Various provincial agencies, BC Hydro, and stewardship groups are to be commended for their hard work and efforts to date on addressing some of these issues. However, it is obvious that the provincial agencies responsible for dealing with dam management, have limited resources to deal with all of these issues effectively. There is a legitimate concern about the limited human, technical, and financial resources that are currently being allocated to the existing management of our dams and the health of our rivers. Furthermore, additional funding will be required in the very near future to deal with the growing number of potential problems that are likely to arise from dam structures that will have reached the end of their life cycle or that are likely to be abandoned due to the costs associated with upgrading.
We are reaching a point where the risks associated with the multitude of safety, economic, social, and environmental concerns is becoming dangerously high. The Outdoor Recreation Council hopes the province will take appropriate action to allocate greater resources to appropriate provincial agencies to deal with these concerns before it is too late. By continuing to selectively remove or decommission those dams that do not make sense, (‘including those that have been abandoned, have excessive costs related to benefits, or pose a safety hazard’), we can begin to restore the numerous benefits associated with healthy free-flowing rivers.
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1. INTRODUCTION

1.1. Background

The province of British Columbia is home to some of the world’s greatest rivers and it is one of the wealthiest areas in the world in terms of its natural reserves of fresh water and wild spaces. As countries around the globe face water shortage crises, poor water quality, the extinction of local fish populations and the degradation of habitat, British Columbians are gaining a greater awareness of the importance of our rivers and streams.

We are beginning to understand that our social and economic health depends upon the integrity and future of our environment. This realization is an important source of the growing public concern that calls for the reassessment of past and current water management techniques. This includes questioning the rationale behind current dam management practices and evaluating the impacts of our dam structures.

New information has become available and technology and techniques have become more sophisticated. These are all important reasons to revisit existing dam structures to determine whether or not they continue to serve a beneficial function to society and if they can be managed in a more optimal manner to improve the economic, social, and ecological values associated with our river systems.

1.2. Goals and objectives of Project

While volumes have been written on the construction of dams and to a lesser extent on campaigns opposing construction of dams, little information is available on the history of decommissioning these structures. (Donnelly et. al., 2001) No comprehensive review of dam decommissioning experiences exists. There are currently limited and in most cases dwindling resources that are available to the government, corporate, or private stakeholders for dealing with dam management and water use issues effectively.

The primary goal of the River Recovery project is to raise awareness on some of the main issues, options, and opportunities for dam decommissioning and other dam management techniques that are available for restoring the health of rivers in British Columbia. The project intends to seek out and promote some of the most promising dam candidates from around the province, examine management options, review lessons learned from past experiences, and discuss some of the constraints and opportunities that are available at this time for restoring British Columbia’s rivers.

The first part of the report deals with some of the common trends as well as unique issues within British Columbia that are associated with the decommissioning process. The second part of the report provides an overview of dam management strategies and some experiences with these strategies to date. This includes options such as removal and/or decommissioning strategies for dams that no longer make sense. In addition, it reviews alternative dam management strategies such as modifications, water use planning, and divestment or partnership options for structures that still serve a useful function. A short list of potential decommission candidates as well as candidates for alternative management schemes have been selected, evaluated, and examined in this section. The third part of the report discusses some of the river recovery schemes that are underway in British Columbia, available funding opportunities, and recommendations on the multitude of issues and opportunities related to dam management within B.C.
1.3. The BC Outdoor Recreation Council

The BC Outdoor Recreation Council has taken the initiative with the River Recovery Project to work with the existing agencies, corporations, conservation and stewardship groups, as well as with private owners to help raise awareness about some of the core issues, lessons, and opportunities that BC rivers face today with respect to dam decommissioning.

By raising awareness through the River Recovery Project report and web site, BC ORC hopes to bolster and promote greater public support for the allocation of greater resources towards these issues so that we can move forward towards the more effective and comprehensive management of our rivers and streams. The Outdoor Recreation Council of BC is a non-government organization that represents over 40 provincial outdoor recreation organizations and conservation groups that together have more than 120,000 members. The mission statement of the ORC is to ‘promoting and enhance the quality and diversity of outdoor recreation opportunities in British Columbia. ORC is responsible for coordinating BC Rivers Day, and compiling BC’s Most Endangered Rivers list.

The Outdoor Recreation Council strives to build better communication between stakeholders and government agencies, to advocate wise management of our natural resources and wild spaces and research issues affecting outdoor recreation. The Council has taken the initiative with the River Recovery Project to work with the existing agencies, corporations, conservation and stewardship groups, as well as with private owners to help raise awareness about some of the core issues, lessons, and opportunities that BC rivers face today with respect to dam decommissioning.

1.4. A history of dams in British Columbia

Dams have been constructed in British Columbia for over a century. The majority of these dams were typically small structures, constructed for irrigation and water supply purposes. Today, there are five types of dam structures in BC including earth fill dams, concrete arch dams, gravity dams, masonry dams, and timber crib dams. BC has approximately 2200 licensed dams that are currently operational.

These dams serve a variety of purposes such as flood control, erosion control, low flow augmentation, water supply, recreation, and hydroelectric power. About 196 dams are considered major dam structures, as they are higher than nine metres in height. The remaining dams are considered to be minor structures because they range between one metre to nine metres in height and they are capable of impounding a minimum volume of water. (Water Management Dam Safety Regulations, March 2000) BC dams range in size from small privately owned irrigation dams, to B.C. Hydro’s 242 metre high Mica Dam.

The period of greatest dam building activity occurred in the 1950’s and carried on through to the 1970’s. It was an era of aggressive large scale dam construction. Construction was justified on the basis of the prevailing mandates of the various ministries, economic interests of various public and private corporations, and the social demands of British Columbian’s.
Things began to change in the 1970’s as residents witnessed the serious environmental and social costs associated with dams. The decline of fish stocks and the drowning of productive farmland, forests, scenic canyons, recreational playgrounds, and townships, fueled a growing public opposition to new dams. During the 1980’s, grass roots lobbying blocked the construction of new dams on the Skagit, Stikine, and Peace rivers.

As a result of the available technology and changing perceptions in both dam safety and environmental issues, one of the most promising alternatives for addressing issues and impacts associated with the deterioration of aging dams was to consider some kind of decommissioning or retirement for the structures. In the United States, this process of dam retirement has become well advanced. There are numerous case histories and formal ASCE guidelines in place. The earliest case of dam retirement occurred in 1912. Since that time, over 495 dams have been retired. Most of these cases have occurred relatively recently. (ASCE, 1999)

1.4.1. Adaptive Water Management Plan Process

The Theodosia River is located near Powell River and it affected by a dam built in 1955 approximately 13 kilometers upstream of the river outlet in the Theodosia Inlet. Thanks to the efforts of Pacifica Papers, the Department of Fisheries and Oceans, BC’s Ministry of Environment, the Sliammon First Nations, the Steelhead Society, and the BC Outdoor Recreation Council, the Theodosia dam is the first documented example in Canada and BC of a major dam structure that is to be decommissioned or disarmed (in the sense that the proposed alterations would change the dam’s original function and operations) with restoration of the river’s health as a main objective. The Theodosia River Adaptive Water Management Plan (AWMP), developed in 1999, entails following a formal, structured adaptive management process that includes a partnership between government, corporate, and private stakeholders.

1.4.2. Water Use Planning Process

British Columbia Hydro Corporation (BC Hydro) is also to be commended in conjunction with the various federal and provincial agencies and public stewardship groups for its efforts to develop and implement river recovery strategies through a water use planning (WUP) process that was first developed on the Alouette River dam in Maple Ridge, in the mid 1990’s. BC Hydro began its first documented case following a formal, structured water use planning WUP process on the Stave River and Puntledge River dams following the official adoption of the WUP guidelines in 1998.

Although these efforts are to be commended, British Columbian’s currently faces a new set of challenges with respect to the limited financial, technical, and human resources that are available to deal with the numerous remaining dam structures and management issues that potentially threaten many of our valuable heritage and salmon bearing rivers.

1.5. Current status of dams in British Columbia

While many dams continue to serve important functions, there are numerous abandoned, potentially hazardous, and obsolete dams that may cause more harm than good. There are over 2500 dams currently registered or known to provincial agencies in British Columbia. Over 90 percent of these dams are considered to be ‘minor’ in size. In most cases, smaller dams do not pose as great a hazard as larger dams. It is important to note
that the probability of smaller dams failing can be much higher due to the lack of owner resources and appreciation of the severe consequences of a dam failure on people, property, or the ecological health of a river system.

The Water Management Branch notes that there are approximately 400 dams that have been classified, as high or very high hazard where loss of life may occur should the dam fail (Water Management, Public Safety Report, 1995). It is estimated that of these 2500 dams, roughly one hundred have been abandoned over the last century. As many as ten percent of the total number of these dams provide no or marginal benefit, and/or they are presently considered a liability to people, property, and to the ecological health of our rivers. At the present time, many of the dams in British Columbia are also reaching an age where more frequent and costly maintenance or upgrading is necessary. According to the US Association of Dam Safety Officials, the average life expectancy for an unmaintained dam is approximately 50 years. (Donnelly et. al., 2001) It is currently estimated that roughly half of our dam structures are already of this age or greater. Within the next ten years, it is estimated that the number of operational dams expected to be greater than 50 years of age is likely to reach approximately 75 percent.

This does not include the multitude of unlicensed or illegal dam structures that remain standing in the province. These unlicensed structures include operational dams that were never registered or older remote dams built for mining, logging, irrigation, or water storage functions that have since been abandoned. There are also many structures that do not fall within the “dam classification” scheme of Water Management due to their smaller size or impoundment capacities. Many of these minor storage structures still remain standing and are negatively impacting our river systems. Nobody really knows how many illegal or abandoned structures there are, but the random surveys carried out to date indicate that the total number of unlicensed impoundment or diversion structures that remain in the province may even exceed the total number of operating or licensed dam structures (Correspondence and interviews with DFO, MoELP, and environmental consultants, 2001).

1.6. BC’s dam decommissioning experience to date

Although the Ministry of Environment has removed or safeguarded nearly half of the abandoned dams in our province over the last several decades, the number of candidates for decommissioning is expected to increase in the near future given the fact that many of the our dams are approaching the end of their economic and structural life cycle in the next few years. Removal or decommissioning options should also extend to those dams that incur greater social, economic, and environmental costs to society than benefits.

This includes minor impoundment or diversion structures that are not classified as dams, but continue to block and harm the health of our rivers and streams. As the stock of older dams increases significantly and the maintenance of these structures is becoming more of a safety concern, our management choices between decommissioning and refurbishment are only likely to increase with time.

Typically, there are three management options to choose from for these dams. We can (i) change how they operate, (ii) upgrade and repair structures, or (iii) we can remove them. Often repairs or upgrading can be three times as expensive as the one time cost of removing a dam, and replacing a dam is usually even more expensive. (River Alliance Of
Wisconsin et al., 2000) In light of the fact that dam removal or retirement has become recognized as a viable and sometimes profitable option for communities, the decommissioning idea is gaining momentum across the province and around the world. For dams that continue to serve an important function, most of these can be operated more effectively with less negative impacts than at present.

2. **RATIONALE FOR DAM DECOMMISSIONING**

Although some dams can provide important economic, social, and environmental benefits, dams can also cause negative economic and social impacts to the community and to the ecological health of a river system.

2.1. **The Impact of Dams On River Systems**

There are many ways dams affect physical processes essential for sustaining a healthy river ecosystem – but the problems of river management and restoration can be broken up into three important pathologies (International Rivers Network Presentation entitled ‘Reviving Living Rivers’ delivered by Williams, P.B, 2000):

1. **Diversions.**

   The impacts of reductions in flow due to water supply diversion are more widely understood. The greatest impacts occur in the low flow seasons and in some semi-arid regions, the downstream river channels may completely dry up. For many years, returning flows to river habitat has been a focal point of environmental restoration efforts, and more recently, this has been extended to restore freshwater flows to sustain major estuaries like the Fraser River Basin.

   This has led to the formulation of minimum ‘in-stream’ flow requirements for fish under the federal and provincial Fish Protection and Water Protection Acts. Some dams have now changed their operation to release a fraction of their inflow to provide such flow releases, with their proponents claiming this action alone will mitigate downstream ecological impacts. These claims are at best unproved. Restoring minimum flows, by themselves, does nothing to sustain and replenish critical habitats created by floods and flow variability.

2. **Elimination of the flood flow pulse.**

   Typically, large reservoirs are operated to store seasonal high flows to release water for power generation or irrigation later in the year. This has the affect of greatly reducing flow variability downstream of the dam by capturing smaller frequent floods in the reservoir. Impacts of large, less frequent and hazardous floods are less affected by dams as they tend to fill the reservoir and spill uncontrolled downstream at the flood peak.

   These changes in flow variation and flood frequency have major adverse impacts on key processes. For example, they typically eliminate regular floodplain river ecologic interactions without eliminating flood hazards; they eliminate natural periodic disturbance essential for rejuvenating wetland habitats; they prevent pulses of freshwater that sustain estuarine ecologic processes, and they reduce the capability of the river to move the sediment downstream and allow choking of the channel with riparian and emergent vegetation.
Recent attempts have been made to release small flood pulses from some reservoirs to mitigate these adverse affects. Such measures alone are unlikely to be more than marginally useful however, if they do not also restore the flow of sediment to the river.

3. Trapping sediment.

Large reservoirs capture almost all of the sediment carried by a river. Until the reservoir completely silts up, water releases downstream are ‘clear water’ flows that erode the bed and banks of the river channel until the natural sediment transport capacity of the river has been regained – which may be tens of kilometers downstream. The impacts on river system habitats are profound. Lowering the channel bed isolates the floodplain from ecologic interaction with the river channel as effectively as if it were dyked and channel lowering lowers the water table, drying up floodplain, wetlands, and woodlands. Silts and mud no longer replenish floodplain soils; the complexity of habitats in the river channel is simplified into a single uniform thread.

Further downstream, organic debris no longer replenish estuaries and deltas, sands are no longer delivered to beaches, thus degrading estuarine and coastal habitats. So far in the history of large dam operation, there has been no effective way to engineer passage of sediments downstream, unless most of the reservoir capacity is allowed to silt up. This means that this major impact of large dams on key geomorphic processes that sustain the ecosystem simply cannot be mitigated without complex or costly efforts.

2.2. Reasons For Decommissioning Dams

Clearly dam removal or disarmament is not appropriate for all or even most of the dams in the province. Many dams continue to serve public or private functions. This does not mean however, that rivers should continue to be heavily impacted by these dams. Most dams across the province could be operated in a fashion that reduces their current negative impacts on rivers. In many cases, our provincial agencies are working hard to improve the operations of functional and economically viable dams through active participation in the water use planning and regional compensation schemes.

However, there remains a large number of dams that are either abandoned, serve only a marginal economic benefit, or have outlived their usefulness. Some dams cause such significant environmental damage that no amount of re-operation or habitat enhancement will alleviate the environmental harm they create. For these dams, where the environmental impacts of the dam outweighs its benefits, dam removal or decommissioning strategies are a reasonable and viable solution for restoring the ecological health of our rivers.

Dams all across the province have been and will be removed or decommissioned for three primary reasons: economic, social, and environmental. Most decisions for decommissioning involve a combination of all three of these reasons.

2.2.1. Economic Reasons For Removal Or Decommissioning

Financial issues are often a significant factor in the decision to remove a dam. As a dam ages, it becomes less efficient and continued operation may not be cost-effective. Further, dam operation and maintenance costs increase as a dam gets older and a dam owner or operator is aed with on going significant, ever increasing costs. To maintain
the dam in compliance with regulatory standards, owners and operators must make operations and maintenance investments, structural upgrades, and modifications. These costs, combined with potentially lower revenue generated by the dam, can make retirement or decommissioning the most cost-effective alternative for a dam owner. Add this to the potential financial liability of a dam failure and the economic reasons can provide a very persuasive argument for the removal or decommissioning of a dam. In many cases, dam removal or decommissioning may cost less than the maintenance or structural repairs for an aged or unsafe dam. This is especially true for dams where the benefits of the dam are marginal. In the United States, an examination of small dam removals showed that removal or decommissioning typically cost two to five times less than the estimated safety repair costs. (Trout Unlimited. Sept. 1999) Even if the costs are comparable, dam removal eliminates the future cost of continued maintenance and repairs.

2.2.2. Social or Safety Reasons For Removal Or Decommissioning
Dams are built to block or divert up to a few million litres of water. Resultant stress causes structural deterioration over time and ultimately limits the life of a dam. When structural integrity of a dam is fails or breaks down; the danger of failure is an immediate and serious concern. The failure of a dam can cause damage to private and public property, threaten lives and have devastating downstream ecological impacts. Dam failures are not unknown in British Columbia. There have been a number of failures since the turn of the century to as recently as 1995. One examples is the failure in 1912 where a small water supply dam servicing the coal shipping port of Union Bay on Vancouver Island failed, killing a man and causing extensive damage to downstream property. Another failure occurred in 1941, a 10 metre high dam located above the town of Penticton failed resulting in severe damage to downstream areas. If that dam had failed today, with the current population living downstream of the dam, economic and environmental damage and the risk to the community would be much higher. The most recent failure occurred in May 1995. A six-metre high earth filled irrigation dam failed and caused approximately half a million dollars damage. The 1995 failure and consequent release of storage water from the reservoir killed 48 head of cattle, destroyed 1.5 km of a public road, and damaged 100 acres of farm land as well as introducing 700,000 cubic metres of sediment into the Quesnel River.

From a social perspective, dams can reduce or eliminate economic activities or recreational opportunities. Dams block free flowing river systems forming an impediment to public access and the migration of people and goods. Dams can hinder recreational opportunities such as fishing, boating, or other activities downstream and they tend to have a negative impact on the aesthetics and character of a natural setting. Because dam owners often own large parcels of land above and below dams, significant sections of rivers are often effectively inaccessible to members of the public.

2.2.3. Environmental Reasons For Decommissioning
While dams benefit society economically, socially and sometimes even ecologically, there is much evidence to support the argument that many dams cause considerable harm to rivers, fish and fish habitat. Dams change the chemical, physical, and biological processes of rivers and adversely affect fish and wildlife populations. By blocking free-
flowing river systems, dam structures hinder the flow of nutrients and sediments and impede fish and wildlife migration.

Upstream of dams, stagnant reservoir pools and altered flow timing confound the reproductive cues and behaviors of many fish species. Dams alter water temperatures and oxygen levels critical to species survival Resultant flooding can eliminate or significantly limit unique or threatened wildlife habitat.

Fish are often killed in power turbines as they try to migrate up or downstream. Further, dams can cause a delay in the time that it takes for juvenile migratory fish to be flushed to the ocean by turning traditionally fast flowing rivers into slow moving reservoirs. This delay is very harmful to the fish as their bodies undergo physiological changes that prepare them to survive in salt water. Stagnant reservoirs also expose young fish to predators and disease and often lethally high water temperatures. (American Rivers et al., 1999)

Studies show that fish populations in rivers impacted by dams and water diversion projects have declined drastically from historic levels. In particular, dams have harmed migratory fish such as salmon, steelhead, sturgeon, herring, and cutthroat trout. Salmon runs that numbered in the millions before the era of dam building have now dwindled to only hundreds in a few systems, an in many instances have been completely been wiped out. The drop in fish stocks is not solely due to dam construction of course but it is a startling statistic when one considers that up to 80 to 95% percent of the Columbia River salmon are killed by the series of dams located on the river’s main stem and reservoirs. (NW Energy Coalition and the Columbia and Snake Rivers Campaign. 1998)

3. DAM DECOMMISSIONING EXPERIENCES AND ISSUES

In a review of case studies taken from the United States and Canada’s decommissioning experience, there were a number of common issues with the dams that have been removed or decommissioned to date including the following:

Typically, dam structures that have been selected for removal or decommissioning share some common characteristics. They are usually older structures, ranging in age from 60 to 140 years old, under 15 metres in height, and they usually have smaller reservoirs that are typically less than 30ha. (Donnelly, C.R et al, in a paper entitled ‘The Process of Decommissioning Dams in Ontario.’ presented in 2001)

Some common reasons for removal are inadequate structural stability; obsolete purpose or the structure provides a marginal benefit to the owners. More recently, dams are being removed due to fish and fish habitat concerns.

3.1. Experiences from Canada and the United States

1. Baseline Inventories, evaluation and monitoring

Dams can contribute extensive benefits and prosperity to regions. Unfortunately for ecological systems, cost/benefit analyses are usually estimated based on assumptions and the information available at the time of the dam design and in the past rarely entailed a comprehensive environmental impact assessment.

In a global review done by the World Commission on Dams, it was found that there is few instances where the operations of dams were analyzed several years after
implementation to ensure these benefits were actually achieved. (WCD Options Assessment IV, March 2001) The study concluded that the key to improved management of regulated rivers is in the collection of data and the interpretation and conversion of this data to knowledge. Despite the potential adverse impacts of dams, there appears to be no systematic methodology for monitoring the ecological responses to dams.

It is not widely known how or even if dam removal or decommissioning will improve the overall health of a river system. Documentation and evidence of the decommissioning experience is surprisingly scarce as is the case with virtually all ecological restoration efforts. (Stanley, E.H. 1999) It is for these reasons that a systematic process of evaluation and documentation of these cases is required.

Decision support systems centred around real time data, integrated multi-agency and stakeholder adaptive management schemes, as well as consistent monitoring mechanisms can provide opportunities for effective decision making based on agreed upon policies, current data, and appropriate optimization techniques. Monitoring alone could justify the original investment by developing knowledge that could be used in other projects. With consistent monitoring and evaluation mechanisms we can adapt dam management or operational rules to minimize adverse impacts and maximize benefits.

2. Public demands on power or water

Dams are built to manage water, but they cannot manage the demands for water. Together with the decommissioning, modification, and operational tools that are available for the dams, legislation, environmental restoration, and education programs targeting the demands and water use of the general public must be part of the package. Society must continue to move toward curbing consumption of our water.

3. Liability issues

When considering the possibility of removal or decommissioning, it is recognized that the liabilities associated with dam ownership do not only arise as a result of accidents or negligence in exercising care and duty in the operation and maintenance of the dam. Liability can also arise if the decommissioning or management strategy results in a long-term negative impact.

Methods to ensure a controlled release of accumulated sediments within the reservoir represents an important example of dam removal liabilities. In many cases, inadequate or no mitigation measures were implemented. This sometimes led to long term adverse downstream effects, with adverse impacts reported for many years after construction. These include negative impacts on downstream aquatic life do to the sudden flush of the sediments accumulated in the reservoir.

4. Public input and reaction

In a review of recent decommissioning case studies across North America, the reaction of the local public was initially opposed to dam removal, usually citing issues such as historical and recreational importance as well as initial loss to fish species and habitat. (Donnelly, C. et al., 2001) Although initial concerns were usually outweighed or compensated by benefits such as additional habitat created for improved fish passage, opposition remained entrenched. Such opposition usually led to the requirement to
undertake an environmental assessment with associated delays and increases in costs to the projects.

More recent cases have shown that thru public hearings and workshops, the public can get access to the facts, voice concerns, and educate themselves on the benefits of decommissioning. In most cases, this led to a re-establishment of public trust. (Trout Unlimited et al., video entitled: “Taking a Second Look…”, 1999) Democratizing risk management schemes will become important to successful public involvement in local or regional water management decisions.

5. Costs

The cost to remove a dam varies as drastically as the characteristics of the rivers on which dams are located. In a review of a number of case examples, Pansic et. al, (1998) determined the following cost breakdown for a typical decommissioning project:

- Infrastructure removal or disarmament costs: 30%
- Environmental engineering or enhancement: 22%
- Sediment management: 48%

The capital costs are only a fraction of the total costs that one might expect when a decision is made to decommission a dam. Who pays for dam removal or decommissioning projects is equally varied.

3.2. Dam decommissioning issues in British Columbia

British Columbia faces many of the same general experiences and issues from abroad. Regulatory mechanisms, public pressure, and financial incentives have proven to be the most effective tools in motivating dam owners to improve operations, to increase societal or environmental benefits, and to reduce the negative impacts associated with existing dams. This next section deals with the constraints and problems our province is facing in having to deal with some of these issues.

3.2.1 Data Collection and Monitoring Requirements In BC

Without adequate baseline information on the integrity of our river system, fish stocks, wildlife, and impacts of dam structures on the ecosystems, it is not possible to manage water use or dams in an optimal manner, or make informed decisions about what is best for the river system.

In terms of the status and trends for fish, wildlife, or the ecological health of our rivers in British Columbia, baseline information is scarce. The status of 43% of the salmon stocks in British Columbia is unknown. Of the 5,476 stocks that could be classified, 3% (142 stocks) are extinct, 13% are at moderate to high risk of extinction and 4% are of special concern. (BC MoELP, Report on Trends In BC, 2000) An additional 22% of the unknown stocks may be at high risk or extinct, but the existing information is inconclusive.

Cutthroat trout has the greatest percentage of extinct stocks (13%), as well as the highest proportion (80%) of stocks whose status is unknown. Although Steelhead has the lowest proportion of stocks at moderate to high risk, 32% are classified “of special concern” and the status of 48% is unknown. Eighteen percent of Coho and 13% of Chinook stocks are at moderate to high risk of extinction. Chinook stocks are most at risk on southwest
Vancouver Island, while Coho stocks are most at risk on the Central Coast. The population of stream spawning Kokanee in Okanagan Lake has declined by 98% since 1971 and Bull Trout populations are declining in 41%, and have unknown status in 16% of the 183 watershed groups that historically contained this species. In British Columbia, Bull Trout is classified as a vulnerable species, in the US; some Bull Trout populations are listed as threatened in the *Endangered Species Act.*  

It is widely recognized by the provincial agencies that dam operation and construction on our rivers is an important factor contributing to habitat loss as well as declining fish stocks and wildlife species in our province. (BC MoELP, Report on Trends In BC, 2000)

Under the provincial *Fish Protection Act,* it requires water licenses to be assessed for fish values. Currently, provincial water management evaluations take fisheries values into consideration by allocating approximately 10% of the mean annual discharge as the minimum level of water required for fish stocks based on a modified “Tennant Method”. This methodology is used across the province by water management and fisheries branches to try and compensate for fisheries values. There are some assumptions in this methodology however, that raise some legitimate concerns for fish stocks. First, it assumes the precipitation levels, topography, and fish behavioral patterns are all uniform across the province, which they are not. It also assumes that the water flows will be consistent over time, which we know is not always the case. Therefore, the question remains as to whether this is an adequate measure for ensuring healthy fish water level values in our river systems.

Comprehensive or timely monitoring and evaluation of our rivers is also missing in many removal or decommissioning projects that have taken place, so how will the province ensure that these decommissioning projects are beneficial to the ecological health of the river system and how can we learn from these projects without thorough and timely documentation of the decommissioning process?

### 3.2.2 Decision making and evaluation mechanisms for dam management

There are two formal processes used in the province of British Columbia for evaluating impacts and reviewing dam management strategies. The first process involves an evaluation and prioritization process used by the Water Management Public Safety Branch to review the majority of our dams. It is described in the British Columbia Dam Safety Regulations under the *Water Act,* Regulation 44. The MoELP Public Safety Branch evaluates all dams using this process unless they fall under the jurisdiction of the provincial Water Use Planning WUP guidelines. The WUP process constitutes the second formal process for dam review and management. Currently, the first planning process is used to evaluate over 90 percent of our existing dams including the abandoned, marginal use or obsolete structures, and dams with few or minor water use conflicts.

**Dam Safety Regulations and Responsibilities**

The Provincial Dam Safety Program has two management focuses—regional and provincial. Dam Safety Officers in the provincial office are responsible for monitoring and auditing 176 major dams across the province. A major dam is one that is greater than nine metres in height. The remaining 2300 dams are the responsibility of the regional safety officers and all are minor or regional dams with a height of less than 9 metres.
The province has approximately one dam safety officer responsible for each region. The province is divided into seven regions and they are defined as: (1) Vancouver Island; (2) Lower Mainland; (3) Southern Interior; (4) Kootenay; (5) Caribou; (6) Skeena; and (7) Omineca/Peace (see figure 1). Given that there are approximately 2300 dams in the province and seven regions with only one or two dam safety officers per region, it is unrealistic to expect that all dams in the province can be systematically and effectively reviewed and evaluated every year.

Under the policy and procedures manual for MoELP Public Safety programs, dam safety officers should prepare a comprehensive yearly assessment for each dam in their region. These yearly assessments focus on structural integrity, operation, and potential downstream safety hazards, economic costs, and environmental consequences should a dam failure occur. Dam officers are also required to monitor and advise on changes in “consequence of failure” and “probability of failure”. This requires the review of dam inspection and safety reports, dam audits and follow-up audits, operational, maintenance and surveillance reports. A dam officer must also track downstream development, land/property ownership changes, any dam up-grading programs, structural inadequacies, and maintenance shortcomings.

Without adequate human, technical, and financial resources available to carry out these reviews and evaluations, the provincial agencies will continue to administer licenses and review only the most critical of cases that provide immediate risk to people and property. Monitoring and review of beneficial water use and environmental impacts are not possible without a commitment on the part of the provincial government to adequately fund and staff the water management branch.

Public safety mandate and prioritization process

One of the prime concerns for dam management in British Columbia is safety. The majority of decision-making frameworks and evaluation assessments are geared towards whether or not a dam meets provincial safety standards. Environmental and social issues are given cursory review at best or they are ignored entirely. Once it is determined that a dam meets safety standards, a licensee can continue to operate with few incentives thereafter to monitor, evaluate, or mitigate the environmental impacts of dams on our rivers. Moreover, the monitoring and evaluation that is done may not reflect the various economic, social, and environmental concerns associated with the community.

Safety procedures used in 1986 by the Ministry of Environment outlined a dam classification system that was based solely on the consequences of a failure. Current safety procedures also focus on the consequences of a failure but include the probability of a failure. The consequence and probability of failure are evaluated in a table to assess the hazard level associated with each dam structure over time. The evaluation for the consequences of a failure assess the loss of life, property and environmental impacts should a sudden failure occurs. Given the large number of dams in BC, safety officers must often rely on information provided to them by the dam owners to make their assessments.

Due to the limited time and resources, evaluations are typically restricted to safety concerns. Dams located in remote areas where there are low hazard ratings due to low population density or undeveloped land, will receive a low priority in the review process.
and a low priority rating for removal or decommissioning. Subsequently, the negative ecological, social or potential economic impacts (i.e. fisheries or recreational values) of these dam structures are often ignored. Similarly, the potential social, economic, and environmental benefits associated with potential removal or alternative dam management practices are not sufficiently addressed.

Although the federal Fish Protection Act and provincial Fisheries Act require instream structures to be assessed for their impact on fish and fish habitat values, there are currently limited means or mechanisms of incorporating or enforcing these requirements into the dam management process. The current regulatory mechanisms and management programs of the province do not address historical fish or wildlife values or the ongoing negative ecological impacts associated with dams. Nor do they encourage or support evaluation of future environmental benefits that are often associated with removal or decommissioning.

Life Cycles And License Renewal

The question that needs to be asked is ‘should water licenses be issued in perpetuity to dam proprietors?’ The argument of this report is that there needs to be an expiry date or limited time frame on water licenses so they can be systematically reviewed and evaluated to determine whether the water could be used in a more beneficial manner.

There are many factors that limit the operational lifetime of dam including the amount of silt buildup behind the dam, basic construction materials simply wear out, and many dam simply are no longer cost effective due to the high maintenance or upgrade costs required to keep the dam up to standards. In the United States, the Federal Energy Regulatory Commission (FERC) or its state equivalent licenses most dams on a 40-year period (Pacific Coast Federation of Fishermen’s Associations, 1999). At the end of that period, each dam has to be re-evaluated. If the dam no longer serves a useful function, they are often retired.

The life cycle of a dam should not be determined by structural integrity alone, it must also be determined by economic, social, and environmental considerations that are likely to change with time. By issuing a finite time frame on a license, government agencies can re-evaluate the operations and impacts of a dam. The re-evaluation of a water license could help to determine whether or not there are greater benefits to the community and the health of the river system if a dam structure should be retired or if changes are required in the operation of a dam. It has been proven in many cases that restoring free flowing rivers in developed areas can act as a catalyst for further economic benefits derived from activities such as land reclamation, aesthetic improvements to the river system, and recreational opportunities that arose from dam removal (Trout Unlimited et al., Taking a Second Look 1999).

In British Columbia, water licenses are issued to dam owners in perpetuity as long as the owners continue to meet safety requirements of the Water Act and Dam Safety Regulations. An exception to this rule is when there is an objection is raised about the license is not being “used beneficially” by the licensee. The plaintiff is responsible for proving that the dam is not being used beneficially. This is an expensive and difficult thing to prove legally and consequently, no groups has ever been successful in attempting to do so. A dam license has never been revoked or taken away for failing to use water
beneficially despite the fact that there are a number of cases in BC where a dam owner has retained the rights to a water license for a dam structure that is not providing beneficial use as defined in the water license. In the some cases, dams have not been used beneficially for many decades.

A good example of a dam that has not been used beneficially for many years is the Surf Inlet dam located on Princess Royal Island in the Skeena region on the mid-coastal region of BC. The dam is owned and licensed to a Rupert Resources, a mining company. The dam was built to create a reservoir for the purposes of transporting mineral ore to the Surf Inlet area. The dam was built in the early 1940s and remains in place despite the fact that there has been no mining in the watershed since 1943. The mine owners retain the rights to the water license because they have maintained the dam to meet provincial safety standards. The owners are holding onto the license for potential future use and compromising both present and future environmental values. The dam impedes the passage of sockeye stocks to prime habitat areas in the upper reaches of the river.

As it stands, the dam safety regulations do not encourage the review of beneficial use or competing beneficial water use potential into the evaluation process. Dam safety officers are not required to actively monitor the use of water licenses, and it is left to the owner to decide if the maintenance of the dam is worth their investment. The only other option is for a third party to raise the issue and, as discussed earlier, there has been little success to date of third party grievances.

**The Water Use Planning WUP Process**

The second formal planning process or assessment strategy used in the province to evaluate dam management strategies is the Water Use Planning WUP guidelines. In 1996, the province announced the creation of a “water use planning” process in order to revisit provincial water management in light of changing public values and environmental needs. Water Use Plans are intended to clarify the rights with regards to water resources and recognize the social and environmental values associated with water resources.

A Water Use Plan can be required under the British Columbia Water Act as part of the licensing procedure for reservoir facilities. A WUP defines operating parameters and a management strategy that recognizes multiple water use values and for multiple users and objectives. Aquatic habitat, flood control, power generation, First Nations issues, land development, water supply, forestry, irrigation, navigation, recreation and cultural value are a few of the issues that may influence and direct a Water Use Plan.

The WUP process is carried out as part of the licensing procedures of the BC *Water Act*. The WUP process was originally designed by BC Hydro for its major power and control facilities. WUP process was applied to large BC Hydro facilities where operations were complex and affected interests are significant and diverse. Water use plans are prepared via a collaborative effort involving the existing or prospective licensee, government agencies, First Nations, local stakeholders and the general public.

**Public Involvement And Input**

Public involvement in various forms has been a feature of the North American political landscape for decades. It is clear that policy for risk management involves public resources and public values, so it is easy to argue that judgments by the public should be
used to help guide such decisions. On the other hand, risk management decisions are
enormously complex, replete with technical uncertainties and perplexing value tradeoffs.
Therefore, it is important to set the stage with a clear and systematic methodology for
including various stakeholders in the decision making process so they can provide their
input, comments, and concerns in a manner that contributes constructively to the final
outcome or decision.

The WUP process includes for the purposes of designing public involvement with groups
of stakeholders, the following questions into its decision making process:

- What ends are important to achieve in selecting a management
  alternative for the question at hand?
- What alternatives can be constructed to achieve these objectives?
- What information is needed to characterize the impacts of these
  alternatives, in terms of measures for the states objectives?
- What tradeoffs arise in selecting among the alternatives?
- What alternatives can the participants afford to support?

From the experiences of BC Hydro and MoELP to date, it was agreed that building
consensus amongst partnership groups is at best a partial criterion for success in a public
decision making process. (McDaniels, T.L. et al., Risk Analysis, 1999) The main
objective of public involvement is to provide insight to decision makers, not to resolve a
dispute. Public involvement could take many forms, ranging from surveys to extensive
deliberative processes. The goal of the public involvement component is that participants
will gain more insight and thus provide better informed recommendations. Anything
more than this, is a bonus.

WUP Process Evaluation Steps

The following steps provide an overview of the Water Use Planning (WUP) process:

Step 1. Request and Announcement: the licensee or other interested parties may
request or trigger a WUP process where dam facility operation is to be
changed beyond the terms and conditions of existing licences. The
proponent must issue a public announcement of the process.

Step 2. Preliminary Work Determining Issues: scope water issues and interests

Step 3. Determine consultative process

Step 4. Define water use issues and objectives

Step 5. Gathering Information: Collect data on water use impacts

Step 6. Creating and Evaluating Alternatives: Assess tradeoffs between
alternatives

Step 7. Determine and document areas of consensus and disagreement and prepare a
consultation report

Step 8. Documenting: licensee prepares draft WUP and submits it for regulator
review.

Step 9. Provincial Review and Decision

Step 10. Federal Review: DFO reviews plan for regulatory and policy implications
Step 11. *Monitoring and Compliance Assessment*: comptroller and regulatory agencies assess compliance with authorized WUP

Step 12. *Periodic Plan Review*: scheduled periodic review, as specified in WUP. The review can be triggered by new water use issues, application for a new or amended license, etc.

The WUP process provides great opportunities for the development of dam management strategies. Unfortunately, it is being used to address less than 5 percent of the total number of dams in the province. BC Hydro currently operates 30 hydroelectric facilities and 31 reservoirs in 6 major river basins and 27 watersheds.

The WUP process was not designed for abandoned, obsolete, or marginal use dam structures in remote areas. Nor does the WUP process incorporate strategies for dealing with removal or decommissioning of structures. Regardless of the original design or limitations of water use planning, many of the innovative principles behind the process can be applied to many of the dam structures that are not under the management of BC Hydro. The adaptive management style of the WUP process has proven to be an effective means of addressing both minor and major structures.

3.2.3 Public Consumption and Water Use Management Concerns

British Columbia has 25% of the flowing fresh water in Canada. Ongoing monitoring, protection, and careful management of these water resources are of critical importance. When the demand for water licenses exceeds the capacity of a water supply, the provincial government places restrictions on the further use of that water body. The number of restrictions registered against streams in British Columbia was seven times higher in the 1990s than in the 1960s. The dramatic increase in restrictions in recent decades indicates the increase in the number of rivers and streams that are reaching maximum capacity for water use. Over half of the restrictions are in five of the 43 water districts in the province: Nelson, Kamloops, Victoria, Cariboo, and Vernon. (BC MoELP, Report On Environmental Trends In BC In 2000.)

River or stream restrictions are used as a management tool to ensure that water supply in the province is maintained. Restrictions may range from including minimum fish flow clauses in a water license, to suspending the issuance of any further licenses on a water body. The number of restrictions on BC rivers and streams is indicative of the intensity of water use in the province, pressures on water supply, and the intensity of water management that is required to maintain that water supply. Water has numerous and often competing users. These include: agriculture, recreation, industry, domestic uses, and fish and wildlife. Water quantity or water quality affects not only everyone that uses the water, but also the plant and animal life that depends on that water for survival.

**Who Are The Fresh Water Users In British Columbia**

The total amount of surface water licensed in the province doubled between 1960 (326 billion cubic metres) and 1990 (646 billion cubic metres). Power production, including storage for power production, is the largest use of surface freshwater in the province. Just under 632 billion cubic metres are now licensed for these purposes, or over 97% of the total volume of water licensed in British Columbia. The remaining 3% of water licensed is for consumptive uses such as industrial/commercial, drinking water or
agriculture. It should be noted that water licenses specify the maximum volumes of water that may be used for a given purpose – the actual amount of water used may be less.

**What Is Being Done To Protect And Manage Water Resources In BC**

The BC Water Protection Act (1995) prohibits large-scale diversions between watersheds and new licenses for the export of bulk water. In a March 14, 2001 judgment, the Federal Court of Appeal ruled that the National Energy Board (NEB) decision to issue export permits to BC Hydro was “not reasonable” because the original BC Hydro applications for permits did not properly address the potential of “significant adverse environmental effects” arising from its hydro electric facilities. Consequently, the courts ruled in the favour of the Sierra Legal Defense Fund, the Steelhead Society, and the BC Wildlife Federation.

Other initiatives in BC include the Fresh Water Strategy for BC (1999) that consolidates provincial initiatives into one cohesive strategy. Initiatives include: designating sensitive streams under the Fish Protection Act, which restricts the approval of new water licenses; implementing a three year Drinking Water Strategy; and investigating economic and social approaches to promote water conservation through programs such as education and appropriate pricing. Recently, BC’s provincial government responded to public opinion by legislatively protecting important salmon rivers against future dams under the Fish Protection Act. In addition, BC has embraced two important programs – the BC Heritage Rivers System and the Canadian Heritage Rivers System – which officially commemorates BC rivers that represent outstanding values of provincial and national significance. These values include culture, ecology, economy, history, and recreation.

In addition to legislation, and environmental programs, demand management warning for residents in drought or low snow pack years and education programs such as BC Hydro’s “Power Smart” program are good attempts to educate the public about wise energy use. These types of programs will hopefully reduce the rate of future demand.

**3.2.4 Legal framework and liabilities of dam owners**

In all cases, the dam owners are responsible for the safe operation and maintenance of their dams. This requires the dam owners to operate and maintain their dams in accordance with dam safety regulations or any order that is made under the *Water Act*. Under Regulation 44, section 10 of the *Water Act*, a dam owner must, if requested by a dam safety officer, provide various construction records, operation manuals, inspection reports, design plans, safety reports, and in some cases emergency plans in order to evaluate the condition or hazard potential of a dam. The extent and frequency of evaluation obligations of a dam owner depend on the potential consequences of the dam if a failure were to occur. Where consequences are classified as high or very high, inspection reports may be required on a semi-annual basis while safety review reports may only be requested once every ten years. In some cases, if a complex issue needs to be resolved, the comptroller or water manager may require a dam owner to retain an expert, satisfactory to the comptroller or regional manager to submit a report. Most often however, the responsibility associated with data collection and evaluation lies with the owner.
Currently the province does not have a mechanism for providing adequate training, technical assistance, or a standardized approach for dam owners to proceed with the collection or evaluation of baseline information. Safety regulations on minor structures do not include meeting seismic safety standards and many of the major dams have not yet upgraded their structures to meet current seismic standards in British Columbia. Furthermore, there are currently no legislative requirements or incentives for owners to evaluate or monitor the short term or long-term impacts associated with the physical footprint and the operation of their dams on the health of the river system.

**Liabilities and lessons associated with decommissioning**

Under the Water Act, a past licensee or property owner can be responsible for liability issues associated with accidents or negligence in the maintenance and operation of a dam structure. Under civil law, the responsibility may lie with the original builder or liability can also arise if a proponent chooses to remove or decommission a dam that stakeholders have come to rely on in the past. In some cases, stakeholders may object to the current owner devolving or passing on responsibility for a structure to an individual or agency that the stakeholders believe may not safeguard their interests in the future.

There are a number of cases in British Columbia where the removal of dams was done too hastily and/or the implementation was poorly conceived resulting in damages to property and negative impacts to the environment. In most liability cases, dams were removed or decommissioned without adequate testing and analysis of the structures and sediments behind the dams. In some cases, due diligence was shown but unusual circumstances led to unfortunate results.

1. **Parklane Dam**

   A good example of a case involving good preparation and planning but poor response includes the 1989 Parklane Dam case on Britannia Creek. In this case study, the Ministry of Environment was attempting to partially breach a potentially hazardous and high risk structure. Preparations were made beforehand to deal with a potential emergency situation by ensuring that precautions such as road closures, community awareness programs, access restrictions etc. were in place. The breach exercise resulted in an unexpected partial dam failure. Consequences included some property damage, severe erosion to the downstream stream banks, and scouring of spawning grounds from the substrate released downstream. The cause of the failure was later determined to be a structural flaw within the foundations of the dam that had not been detected before the breach exercise took place.

   The Ministry of Environment took full advantage of its lesson and recorded the event on videotape in order to create an educational piece from it. The two main lessons to be learned from this case study was the importance of being prepared for such an event as well as the importance of a careful evaluation before commencing work.

2. **Illecilewaet Dam**

   The Illecilewaet dam near Revelstoke was decommissioned in 1985. It is a good example of liability following the removal of a dam. BC Hydro, in partnership with the city of Revelstoke, and local stewardship groups, helped out on a community project in an attempt to remove a local dam. Unfortunately, the removal of the dam allowed the upstream bedload material to sweep downstream, elevating the river bed.
and subsequent ground flows which resulted in channel instability and flooding problems for downstream residents. Although it was not BC Hydro’s dam and they were involved in a voluntary capacity, they were held to be partly liable for their involvement in the removal. Since then, they have been responsible for helping to maintain and stabilize the downstream channel. In this particular case, the impacts from the removal were not well conceived. This resulted in a costly lesson for BC Hydro and the other partners that were involved.

While BC Hydro is to be commended on its efforts for helping out with the decommissioning, the lesson to be learned from this case study is that a carefully planned out and multi-staged approach to these types of projects is often essential. An adaptive management strategy for dealing with unexpected circumstances should be incorporated into any decommissioning project.

3.2.5 Costs associated with dam management

Dams are not free. They need to be financed, constructed, and constantly maintained and operated – sometimes at great cost to society. In some instances such as in the Columbia Basin, there are also costly long-term mitigation efforts, such as hatcheries, smolt transportation, and habitat compensation programs that must be taken to protect the same species being destroyed by the dams. These mitigation costs tend to grow over time.

Net Social Benefits

Costs associated with dams can vary significantly. These costs are not always economic. In fact, some dams provide minimal social benefits at a huge social cost. The real test is to determine a dam’s ‘net social benefit’. (The Pacific Coast Federation Of Fisherman’s Associations, 1999) This is defined as the sum of its gross social benefits minus its other environmental and social costs, ongoing operations and maintenance costs, and environmental mitigation costs (including the eventual costs of removal or decommissioning after its term of service is over). Often that equation will shift over time – a project that once made economic sense in the past is not guaranteed to make sense in the future. This becomes increasingly true as a dam reaches the end of its life cycle and operational as well as mitigation costs increase dramatically.

Each dam should be judged on its net social benefits and if its costs (including environmental damages) outweigh its benefits, there is a justification for potential removal or decommissioning.

Budget Requirements

Given the numerous information gathering, planning, design, implementation, and monitoring requirements as well as costs that are associated with successful dam decommissioning cases to date, the existing financial resources the provincial government has allocated to these components is nowhere near sufficient. Currently, the provincial agencies are having troubles trying to meet the needs of their own dam structures.

The main sources of funding are becoming fragmented due to the increasing number of competing agencies and groups trying to get financial assistance, or they have been dwindling in other cases due to the low prioritization that has been given to dams and water management issues. If agencies and stewardship groups alike are having to cut
serious corners to minimize costs and meet budgets, this in turn jeopardizes optimal water management programs for many of our rivers and increases the likelihood of potential hazards or liabilities associated with the numerous safety, economic, social, and environmental concerns related to dams.

Old Forebay dam is located on the Jordan River on Vancouver Island. BC Hydro currently owns the structure but was willing to remove or decommission the dam because it no longer served a useful function and it was becoming a safety concern. The MoELP Fisheries Branch had been stocking the upstream reservoir with trout so they regarded the protection or maintenance of the dam as a benefit to the environment. From a safety viewpoint, the Water Management Branch were concerned about their liability unless a responsible party was able to take over the responsibility of the dam. Although BC Hydro was willing to pay for the removal of the structure or put the equivalent sum of money towards maintaining the structure if another stakeholder such as MoELP Fisheries Branch was willing to take on the responsibilities of the dam, the provincial agency did not have enough money to ensure they could ensure responsibility for the structure in order to further protect their fisheries investment.

**Long Term Accountability**

Financial assistance should be provided to dam owner that take the initiative to help remove, decommission, modify, or upgrade their structures. Since dams or their life cycle are potentially finite, removal or decommissioning is also more likely to become more of an issue in the future. However, the costs for decommissioning to date have not been considered as part of the life cycle costs of dams. Decommissioning has not entered into benefit and cost calculations that establish the feasibility of new projects. How can the province budget for decommissioning in the future? Perhaps some of these costs should be incorporated into the existing water use license fees. The fees could also be scaled based on the negative impacts the dams are likely to have on the health of the river.

BC has many old mining sites where tailings ponds were built to serve the mining operation. Dams associated with tailings ponds do not fall under the jurisdiction of the Water Management Branch; they are the responsibility of the Ministry of Mines. Most of these tailings ponds contain dam structures that have since been abandoned and are reaching the end of their finite life cycle. The costs of cleaning up these sites however, has become prohibitive in most cases. The cumulative costs associated with the mitigation measures or the compensation required for clean up after a mining operation should be included in the cost of the license.

The Twin creek tailings dam is located on a tributary to the Kettle River. It is the last remaining dam structure that exists on the Kettle River and it no longer serves any economic service or function. There is an existing water license on the dam that belongs to a mining company. Upstream of the dam, there is an abandoned mine site and the dam currently blocks the residual tailings or debris from the mine from entering into the lower reaches of the creek. The province and MoELP Fisheries Branch are reluctant to remove or decommission the dam because of the potential detrimental value of the tailings to the fish downstream. The costs associated with cleaning up the mine are prohibitive and the owner is not able to afford the mitigation costs. As it stands now, the fisheries value may be better off with the tailings structure in place.
Who Is Responsible For Costs Associated With Decommissioning

The proprietor(s) that is responsible for dealing with costs can vary as much as the costs themselves. For dams that are still operational or that have one or more licenses, the bulk of the responsibility will lie with the proprietor. This may range from federal, provincial, regional, and local government entities to corporate or private dam owners. In most cases where a dam has been abandoned or there is an illegal structure, the owner’s are no longer around, or they are not capable of meeting the costs associated with mitigation or decommissioning. In these cases, the province can either pursue legal action that can itself be quite expensive, or it may assume the financial responsibility for removal or decommissioning. In some cases, divestment opportunities are available where a willing stakeholder or partnership may be entered into in order to share some of these costs. Costs associated with decommissioning or modification of dam structures and the reclamation of watersheds are immense. Financial obstacles cannot be overlooked without jeopardizing future dam decommissioning and modification initiatives.

Most dams have been built without planned funds or investments for their removal or the reclamation of affected watersheds and fish populations. Indeed, the concept of dam removal, modification, or water use planning with fish habitat as a prime objective, is a relatively new concept. For the most part, private dam owners are unprepared for the associated costs and processes necessary to efficiently and effectively identify a dam decommissioning candidate, study the structure and river system, identify stakeholder issues, remove or modify the dam, and monitor effects of alteration to structure and river hydrology.

It is imperative that dam owners are not targeted as eco-culprits or as the sole monetary source for dam decommissioning initiatives. Dams serve, or in some cases served, a purpose and though the purpose may have changed or become obsolete, the contribution of the dam must be acknowledged if the process of decommissioning and consultation is to begin at all.

4. DAM MANAGEMENT AND RIVER RECOVERY STRATEGIES

Though river restoration is relatively new to British Columbia, there are numerous examples of BC rivers being restored through dam management techniques. For dams where removal or decommissioning is not an option, regulatory mechanisms and public pressure have proven to be effective in motivating dam owners to provide modifications or improve operations using a variety of techniques to increase social and environmental benefits and reduce the negative impacts from the existing structures and/or the operation of the dams. The following section reviews and demonstrate a few of the main alternatives that are being used to restore our rivers.

4.1. Dam management strategies

In general, an optimal solution for managing a dam structure requires addressing the particular characteristics of each river system, the structural footprint and/or operation of each dam structure, the goals or objectives of the various stakeholders, and the human, technical, and financial resources that are available for each program or project.
For the purposes of this project, dam management options focused on five main management alternatives. The alternatives are generally selected depending on the operational and institutional concerns, as well as the potential social and biological benefits or opportunities that are likely to occur for each river system. The five management options discussed in this report include the following:

(i) Dam Removal or dismantling
(ii) Disarmament or decommissioning;
(iii) Structural Modifications;
(iv) Water use planning or operational techniques;
(v) Divestment of ownership or partnerships

4.1.1. What is meant by dam removal or dismantling
This is the most dramatic option, involving the complete dismantling of all physical barriers to stream flow. The intention here is to fully restore the natural flow of the river, including peak flows and seasonal flooding. The ultimate objective of dam removal is to partially or fully restore natural flow to the river and to allow for the free transport of substrate or organic debris as well and to restore upstream or downstream passage to fish, wildlife, and people. Dam removal can sometimes be immediate, but more often it is staged in a cautious, risk-averse way to avoid unwanted release of the sediments that typically accumulate behind older dams.

Usually dam removal does not require extensive engineering after a structure has been removed, nature will take care of itself. An exception to this is where landscape is so disturbed that extensive restoration is needed. Instead of traditionally engineered channels that pipe water and sediment through waterways, meandering channels can help restore stable flows and lost habitat. These channels put water and sediment back into the land and restore fisheries, wildlife, and wetland habitat. They can also reduce scouring and erosion from the movement of substrate and sediment in high flows that naturally occur every year.

Dam removal can sometimes be immediate, but more often it is staged in a cautious, risk-averse way to avoid unwanted release of the sediments that typically accumulate behind old dams. A good example of a staged dam removal is the Chetwynd dam in the Omineca Peace region near Prince George. This case involved the staged removal of a dam that was being taken out for safety reasons by the MoELP Water Management Branch. The dam was removed using a staged approach. Taking into consideration the fish habitat downstream, a meandering channel was designed, constructed and maintained in order to mitigate against scour from the substrate released from above the dam site that would have had a negative impact on the downstream habitat. This is an example of a very successful case, where a well thought out and cautious approach was taken.

4.1.2. What is meant by disarmament or decommissioning
Dam decommissioning has taken on a multitude of different definitions and meanings over time depending on who is using or defining it. The decommissioning option usually alters the dam structure in some way, restores flow to some degree, and permanently changes the original function of the dam. However, some of the dam may be left intact,
recognizing that complete removal of dams may not always be the best option for a river system. For example, remnant structures may serve to stabilize reservoir sediment, or provide a limited buffer against flooding. Also partial alteration helps to avoid the expense of complete removal. Dam decommissioning or disarmament can provide all these benefits while still achieving the ecological objective of improved fish passage and greater instream flows.

There is no generic approach to dam decommissioning just as there is no generic approach to river restoration. It is often safety issues and economics or finances that dictate the ‘how’ and ‘when’ for decommissioning. Decommissioning is usually an economic option if it is determined that the costs of further operation outweigh its ongoing benefits – that is, the dam has gone beyond its useful life. The process for decommissioning a dam structure can sometimes be very costly depending on the size and complexity of the dam or river system. A formal decommissioning process usually includes initial consultation with stakeholders, designing and planning the best alternative for the decommissioning, evaluating assessments and approvals, implementation, monitoring, as well as the related enhancement and/or rehabilitation works that are required after a dam structure has been decommissioned.

The Theodosia River is a salmon-bearing river near the town of Powell River on BC’s mainland coast. The Theodosia was once one of the most productive rivers in the Strait of Georgia, with runs that included 100,000 pink salmon, 50,000 chum, and 10,000 coho. Another dam built on the river’s main stem in the 1950’s diverted up to 80% of the Theodosia River’s flow for hydroelectric power, causing damage to the salmon habitat downstream. Today, the Theodosia dam produces only marginal power, and a coalition of groups are making plans to decommission the dam and restore the river. These groups include the BC government, Pacifica Papers Ltd., the BC Outdoor Recreation Council, the Sliammon First Nations, the Steelhead Society, and the Federal Department of Fisheries and Oceans.

The Theodosia River represents a major step forward in the restoration of rivers that have been damaged by dams. Baseline studies are being carried out on the river with ongoing plans for further modification with the goal of decommissioning the structure in mind. Modifications of the dam will begin in September 2001 that will include designs for releasing greater water flows down stream into the salmon bearing sections of the river. Decommissioning of the Theodosia will provide BC and Canada with an inspiring model for the restoration of river habitat through the gradual decommissioning of a dam structure using a formally documented adaptive management process.

4.1.3. Alternative dam management strategies

While removal or decommissioning strategies is a viable option for dams that no longer make sense, many dams continue to serve public or private functions where dam removal or decommissioning is not an appropriate solution. This does not mean however, that rivers should continue to be heavily impacted by these dams. Many dams across the province could be operated in a fashion that reduces their current negative impacts on rivers. In many cases, our federal and provincial agencies are working hard to improve the operations of viable dams with modification and water use planning techniques, or more comprehensive water management strategies involving partnerships and divestment opportunities. The following management tools are used across the province on
operational dam structures to try and minimize their negative impacts and maximize the benefits of the river systems.

4.1.4. Dam modifications

Modifications provide a range of options that have little or no impact on dam function or operations, allowing existing dams to continue providing societal benefits such as electrical power, drinking water, flood protection, etc. Examples of modifications include fish ladders or diversion channels that can improve fish access to spawning or rearing habitat above and below the dam structure without altering the function of the dam itself.

The Puntledge River dam serves as an excellent example of modifications that can be created to overcome some of the negative impacts from dams. Chinook and coho salmon and steelhead trout migrate each year from the Georgia Strait to the Puntledge River near Courtenay. When the Puntledge dam was expanded in the 1950’s, populations of these species declined. A partial solution to this problem was the construction of a fish ladder over the dam and into Comox Lake, which allowed adult salmon to spawn in the tributary streams. Half the juvenile salmon that tried to swim down past the dam were killed as they passed through the turbines.

After extensive research, BC Hydro installed state of the art fish screens at the dam in 1993. The new screens cost an estimated $4.7 million dollars to build. The fish screens guide fish through by-pass tubes that lead to the bottom of the dam and then are released to the river below unharmed. Today, 99 percent of the young salmon pass through safely. BC Hydro received two prestigious awards for its design from the Electrical Power Research Institute and BC Engineering Society.

4.1.5. Divestment of Ownership Or Partnerships

While much of our work focuses on redundant, obsolete, or functional structures, there are some dams that still provide social or environmental benefits that fall outside the limited mandates and financial resources of the MoELP Water Management Branch. There is a growing number of dams which no longer meet the safety standards of the Dam Safety Branch, or they are no longer required by their owners for the purpose of fulfilling the primary economic objectives of their respective water license obligations. However, some of these structures serve local interests. They may be desired or required for the benefits they provide to the social well-being of the community or the biological health of the river system.

Efforts toward divesting the ownership or management of these structures to other agencies or willing stakeholders who would derive benefits from the reservoirs or downstream sections is what this management tool is all about. Over the past couple of decades, the province and some private owners have successfully divested operation and/or maintenance of some structures to willing and able partners. Divestment is becoming increasingly more difficult however, as the availability of partners and funding is reduced. Case studies from across North America show that many dam candidates fall into this management category.

An excellent example of project that fall into this category include the hundreds of restoration projects that conservation groups such as Ducks Unlimited have carried out with private dam structures that were originally used for irrigation purposes. By sharing
the water or upgrading the structures, Ducks Unlimited were able to protect or restore threatened wetland, fisheries, and wildlife values to the river system. They have been involved with over 600 small structures in British Columbia alone trying to create new habitat.

With the funding and technical assistance provided from the Fraser River Action Plan, the Columbia Basin Trust Fund, Columbia Kootenay Fisheries Renewal Partnership Fund, FRBC programs, The Real Estate Foundation of BC, Habitat Conservation Trust Fund, and through partnerships with federal and provincial agencies, Ducks Unlimited has been able to assist private owners with partial or complete divestment of ownership and the economic liabilities associated with maintaining or upgrading the structures.

Through partial divestment strategies, property acquisition, and/or water license partnerships, Ducks Unlimited have been able to protect or restore wetlands by maintaining or refitting dams to provide more optimal conditions for surrounding fish and wildlife. This included enhancement opportunities such as providing nesting tunnels, floating islands for nesting, nest boxes, and riparian protection schemes.

An excellent example of the great work Ducks Unlimited has been carrying out throughout the province includes the Interior Wetlands Program which began as part of the Fraser River Action Plan in 1992 to develop demonstration projects and encourage the stewardship of British Columbia’s wetlands. Some of the more successful projects under this program include the Peter Hope Lake project, the Fallis Pond Conservation project, the Buckskin Marshes project, McDonald Creek Conservation project, Duck Meadow Wetland Restoration project, and the Alternative Livestock Watering Facility program. Other successful examples of divestment projects that have taken place in the last ten years involving Ducks Unlimited include the Creston Valley Conservation Project in partnership with the Creston Valley Water Management Authority, and the Kootenay Trophy Case project.

4.2. Evaluation and weighting methodology for candidates

The evaluation of dam candidates from around the province was carried out after extensive consultation with various federal and provincial agencies, BC Hydro, private dam owners, and public stakeholders involved with the operation and/or decommissioning of dams in order to highlight some of the most promising candidates from across British Columbia. In order to rank and identify the primary list of operational candidates from each of the seven provincial regions, a systematic evaluation of nearly 100 candidates was carried out from around the province.

The study was designed to help identify primary dam decommissioning and/or management candidates from around the province. The evaluation and review was also designed to help raise awareness on some of the management strategy issues related to potential river restoration opportunities.

4.2.1. Evaluation methodology

The evaluation strategy used in this project was designed by adapting existing selection and evaluation methodologies developed internally by BC provincial agencies, BC Hydro Corporation, and outside agencies such as Ontario’s Ministry of Natural Resources. The selection and evaluation process involved a number of interviews and meetings that took
place with individuals from the Departments of Fisheries and Oceans Canada, provincial agencies such as MoELP Water Management and Fisheries Branches, BC Hydro, major conservation groups such as the BC Steelhead Society and Ducks Unlimited, local stewardship groups such as the Alouette River Management Society, stream keeper groups, ecological societies or fish and game clubs, as well as with private dam owners. In addition, an interactive web site was designed and set up to encourage people from around the province to send in a list of potential candidates for evaluation.

The criteria for evaluating and selecting candidates and potential decommissioning options in this project was developed based on the high degree of attention the criteria receive from government agencies, funding agencies, stewardship groups, and other stakeholders who are involved in the decommissioning process. In general, the selection process involved examining the following three factors:

1. **Operational Significance**: the safety, economic, societal, or environmental values or benefits associated with the existence or operation of the dam structure.

2. **Institutional Concerns**: government agency, corporate, or private owner has significant concerns about factors such as the structure being abandoned, maintaining safety standards, the economic viability, social or environmental limitations or damage associated with the ecological footprint or operation of the dam structure.

3. **Social Or Biological Improvement Potential**: what are the potential economic, social, or ecological benefits for the river system (upstream or downstream of the dam structure) if the structure is considered as a candidate for decommissioning.

If a dam structure was a good candidate for two or more factors, then they were automatically selected for the primary candidate list. Thirty-eight dams were selected for the primary candidate list. Candidates from the primary candidate list were then evaluated based on the individual criteria described hereafter and prioritized according to their weighted score.

4.2.2. Dam Evaluation Classification

After consultation with provincial agencies, BC Hydro, private dam owners, and other stakeholders from across the province, dam structures were systematically divided up into several classes depending on the range of management strategies that were determined to be best suited for them. Each of the candidates were evaluated and ranked based on a set of weighted criteria to determine the relative priority that each structure received.

The candidate dams must meet one or more the following criteria to belong to a specific class. Each criterion is assigned a weighting of one point. If a dam structure meets the criteria condition, then it receives a score of one point. A maximum score of nine is possible for each class. If a dam structure did not meet a specific condition, it received a score of zero. If a condition was unknown, then it received no score in order to stay on the side of caution, but it remained open for further study. The higher the score, the higher the ranking of the dam structure in terms of priority. The *Class Criteria* are as follows:

Class I.
The *First class* was created to include dam structures that serve no or marginal benefit to anyone, are a potential liability, are too costly to maintain or upgrade, and would provide an opportunity for economic, social, or environmental improvements to a river system if they are removed or decommissioned.

Criteria for abandoned, marginal benefit, or obsolete dams with potential for disarmament or removal: (max. score of 9)

- Abandoned or the owner agrees to decommissioning option;
- Potential safety liability or fails to meet current safety standards and is not likely be upgraded in the near future;
- Fails to fulfill its original function or provides no or marginal economic, social, or environmental benefit to the owner;
- Dam is not cost effective to operate and maintain the short term costs for decommissioning are justified to eliminate long term operation, upgrading and maintenance costs;
- Dam is not required by others;
- Decommissioning or removal would provide greater economic, social, or environmental benefits to the overall river system;
- There is financial support or technical assistance available for decommissioning or removal opportunities;
- Current loss or significant deterioration of nationally or provincially important fisheries\wildlife or habitat, commercial species, unique landscapes, or sites of cultural significance;
- River recovery would occur with time without restoration.
Class II.

The Second class includes dam structures that are operational and provide some kind of safety, economic, social, or environmental benefit to the owner or community. The operation of these structures can be improved to provide greater economic, social, and environmental benefits to the river system by utilizing more innovative water use planning techniques or through structural modifications.

Class II. Criteria for operational dams with potential for modifications or improved water use planning techniques (WUP): (max. score of 9)

- Dam is operational and has one or more legitimate water licenses attached to it
- Dam provides an essential safety, economic, social, or environmental benefit to the owner or community
- Dam is cost effective and is capable of meeting legal obligations and water license standards
- There is a legal obligation to improve or upgrade the dam using either restoration, modification, or WUP techniques
- There is agency and/or owner support for modifications or water use planning techniques to help restore or improve the economic, social, or environmental values of the river
- There are significant tangible/intangible economic, social, or environmental benefits associated with potential modifications or WUP improvements to the dam structure
- There is financial support and/or technical assistance available to work with potential modification or WUP techniques
- Current loss or significant deterioration of nationally or provincially important fisheries/wildlife or habitat, commercial species, unique landscapes, or sites of cultural significance.
- River recovery would occur with time without restoration if either of these techniques were used.

Class III.

The Third class was designed for dam structures that currently provide no or marginal economic benefit and may be considered a potential safety liability. However, these structures do provide some other important social or environmental benefits. This type of dam structure currently provides greater social or environmental benefits to the river system if it remains protected, is restored and/or maintained by willing and able stakeholders (maximum score of 9).

Class III. Structures that require divestment of ownership or a partnership in order to ensure a dam structure continues to provide existing and/or other potential social or environmental benefits to a river system.

- Dam does not meet core business needs or function of the owner but there are other substantial social or ecological benefits to retaining and/or maintaining the dam
- The owner is willing to divest ownership of the structure to another willing stakeholder which will reduce the long term costs and liabilities of the original owner
- Dam is currently or potentially able to provide greater tangible/intangible economic, social, or environmental benefits if it is maintained or reconstructed rather than being removed
- There is some financial support and/or mechanism available to acquire and maintain the structure for the long term
♦ The dam currently or potentially could provide significant protection or restoration opportunities for improving the health of the upstream or downstream ecosystem
♦ There is provincial agency approval / support for the transfer of ownership or partnership
♦ The dam is not a safety hazard or liability
♦ There is no current loss or significant deterioration of nationally or provincially important fisheries/wildlife or habitat, commercial species, unique landscapes, or sites of cultural significance.
♦ River recovery would occur with time without restoration if either of these techniques were used.

The candidate dams are ranked in the table below. A short list of dams for decommissioning or removal and for modification or water use planning is in the following section.

Table 1. Candidate List For Dam Management Strategies

<table>
<thead>
<tr>
<th>Dam Name</th>
<th>Owner</th>
<th>Dam Size</th>
<th>Location</th>
<th>Water License</th>
<th>Potential Management Options</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Region 1: Vancouver Island</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elsie Lake Dam</td>
<td>BCH</td>
<td>Major</td>
<td>Ash River</td>
<td>Y</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Bear Creek Diversion</td>
<td>BCH</td>
<td>Minor</td>
<td>Tributary to Jordan River</td>
<td>Y</td>
<td>II or III</td>
<td></td>
</tr>
<tr>
<td>Chonat Creek Dam</td>
<td>Private</td>
<td>Minor</td>
<td>Quadra Island</td>
<td>N</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>China Creek Dam</td>
<td>Abandoned</td>
<td>Minor</td>
<td>Port Alberni Inlet</td>
<td>N</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Old Forebay Dam</td>
<td>BCH</td>
<td>Minor</td>
<td>Jordan River</td>
<td>N</td>
<td>I or III</td>
<td></td>
</tr>
<tr>
<td>Heber Diversion Dam</td>
<td>BCH</td>
<td>Major</td>
<td>Campbell River</td>
<td>Y</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Puntledge River. Dam</td>
<td>BCH</td>
<td>Major</td>
<td>Vancouver Island</td>
<td>Y</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Fulford Creek Dam</td>
<td>Private</td>
<td>Minor</td>
<td>Salt Spring Island</td>
<td>Y</td>
<td>II and III</td>
<td></td>
</tr>
<tr>
<td>Glen Lion River Dam</td>
<td>Abandoned</td>
<td>Minor</td>
<td>Port Hardy</td>
<td>N</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Lookout Brook Dam</td>
<td>Municipal</td>
<td>Minor</td>
<td>Victoria</td>
<td>Y</td>
<td>I or III</td>
<td></td>
</tr>
<tr>
<td>Magarrigle Creek Dam</td>
<td>Municipal</td>
<td>Minor</td>
<td>Nanaimo</td>
<td>Y</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Jennis Lake Dam</td>
<td>Private</td>
<td>Minor</td>
<td>Drury Inlet</td>
<td>N</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Region 2: Lower Mainland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tunnel Dam</td>
<td>Corporate</td>
<td>Major</td>
<td>Britannia Creek</td>
<td>Y</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Alouette Dam</td>
<td>BCH</td>
<td>Major</td>
<td>Alouette River</td>
<td>Y</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Cleveland Dam</td>
<td>GVRD</td>
<td>Major</td>
<td>Capilano River</td>
<td>Y</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Coquitlam Dam</td>
<td>BCH</td>
<td>Major</td>
<td>Coquitlam River</td>
<td>Y</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Stave /Ruskin Dam</td>
<td>BCH</td>
<td>Major</td>
<td>Stave River</td>
<td>Y</td>
<td>II</td>
<td></td>
</tr>
<tr>
<td>Caribou Dam</td>
<td>GVRD</td>
<td>Minor</td>
<td>Brunette R.</td>
<td>Y</td>
<td>I or II</td>
<td></td>
</tr>
<tr>
<td>Coleman Creek Dam</td>
<td>Municipal</td>
<td>Minor</td>
<td>District of North Vancouver</td>
<td>Y</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Noons Creek Dam</td>
<td>Abandoned</td>
<td>Minor</td>
<td>Port Moody</td>
<td>N</td>
<td>I</td>
<td></td>
</tr>
<tr>
<td>Dakota Creek Dam</td>
<td>Abandoned</td>
<td>Minor</td>
<td>Howe Sound</td>
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4.3. Introduction to short list dam candidates

A ‘primary candidate list’ of nearly 40 dam structures was created based on an evaluation of operation, institutional, and biological concerns. Of these, a ‘candidate short list’ of a dozen structures was selected based on a more rigorous ranking scheme. This short list highlights some of the structures where decommissioning or alternative management schemes have the greatest potential for occurring in the very near future.

4.3.1. Dam removal or decommissioning candidates

Twelve short listed candidate structures were selected from the table above. Six of these candidates were chosen for potential removal or decommissioning management options based on their unique characteristics and circumstance. The six dam candidates are listed on the following pages.
1. **Kitsault dam**

The Kitsault dam is located on the Kitsault River in the Skeena region near the community of Alice Arm. The dam is still licensed but is left over from an abandoned mining operation. The owner is currently willing to support removal or decommissioning options if the province can provide financial and technical assistance. It is a log crib dam about 6 metres high and is a safety concern to the provincial agencies. It is located upstream of the Alice Arm community which is surrounded by a deteriorated dyke. If the dam was to fail, it is felt the dyke would probably not hold consequently jeopardizing the community of Alice Arm. Therefore, from an institutional perspective, there is strong support for the removal or decommissioning of this structure. From a potential biological perspective, the existing dam provides a barrier to fish passage for numerous salmon stocks. The decommissioning of this dam would also provide significant restoration opportunities.

![Figure 2. Upstream view of Kitsault dam on Kitsault River, Skeena Region. (Source: MoELP)](image)

2. **Jennis Lake dam**

The Jennis Lake dam is located near Drury Inlet approximately 45 km northeast of Port Hardy and flows into the Queen Charlotte Strait. A remnant 44-metre long and 2 to 6.7 m high stone and timber splash dam at the outlet of Little Jennis Lake has impounded a lake surface of about 4.3 hectares. Historically, the lake was used as a “log pond” whereby logs were temporarily stored in the pond and release at high water levels through a sluiceway into Huaskin Lake. The dam is no longer operational, is abandoned and partially breached.

Little Jennis Lake has been identified as a restoration opportunity whereby the removal of the dam and the resultant lowering of the reservoir would improve fish access and return the currently inundated fish habitat. Historical coho access to Huaskin Lake was confirmed by the DFO. The structure currently poses a barrier to the coho salmon runs and the upper lake is filled with debris. This project has community and industry partnership potential and could be restored by a trained group of forestry and fisheries workers under the supervision of an interdisciplinary team made up of river engineers, hydrologists, and biologists. Due to the complexity of the project, it is essential that the specialist team provide construction supervision. FRBC originally had plans to support this project, but they ran out of money and it was shelved. Design and implementation plans have also been developed for the project. The project currently proposes for the removal of the structure with restoration of the
creek channel and mitigation measures for sediment impoundment. This candidate received strong support from provincial agencies for removal or decommissioning.

![Figure 3. Upstream view of Jennis Lake Dam at outlet of Little Jennis Lake, Vancouver Island Region. (Source: MoELP)](image)

3. **Chonat Creek dam**

Chonat Creek dam is located in Chonat Bay on Quadra Island in the Vancouver Island region. The structure was built in the early 1920’s and has since been abandoned. It is a concrete aggregated structure that is approximately eight metres wide and two metres high with a partial breach. Because it is located in a narrow section of the creek, it has become a focal point for beaver activity and debris jams that consequently impede fish passage. Removal of the dam would create an opportunity for greater fish passage to chum, coho, and sea run cutthroat stocks. In addition, it would provide for improved riffle pool habitat without the structure.

Technical assistance has been offered by a multitude of different stewardship groups. This includes a logging outfit that has offered to provide technical expertise and equipment to remove the structure, the Grant B. Culley Foundation which is a private education and research group that has been involved with fish enumeration related work on the river system, and the Pulton Bay stewardship group that has been continuing to try and enhance the river system. This project is likely to be carried out in the near future if the province can assist with any costs incurred. No picture is available for this dam.

4. **Coleman Creek dam**

Coleman Creek is a tributary to the Burrard Inlet, located on the Lynn Valley area of the Lower Mainland. The dam is a two metre high wooden structure that is in bad condition. The project involves a dam owner who took the initiative to identify an illegal structure that had been used for landscaping purposes. With a partnership involving the North Shore Streamkeepers, the Morten Creek Salmon Enhancement Project, MoELP, and the landowner, the dam has the potential for decommissioning, modification, and ownership divestment opportunities.

The province has agreed to take on the responsibility of a water license for the structure so that it can be modified in order to create a series of weirs allowing for easier fish passage to coho, steelhead, and cutthroat stocks. The local stewardship groups carried out fish enumeration surveys on the system. In addition, they have also agreed to continue to monitor and enhance the surrounding area to facilitate the recovery of this river system.
5. **Surf Inlet dam**

The Surf Inlet dam is located at the end of Cougar Lake on Princess Royal Island about 70 km south east of Prince Rupert. It is a concrete buttress structure about 18 metres high and 127 metres in length. It was originally constructed for power to the Surf Inlet Power Co. Ltd. in 1916. Since then it was reconditioned in 1934 and the water license has been taken over by a mining company. The Surf River and Cougar Lake have traditionally been host to a variety of fish stocks including 5,000 spring, 20,000 coho and lots of sockeye, pinks, and chum salmon. Today there are a few sockeye, resident kokanee, cutthroat trout, sculpin, and sticklebacks that use the upstream and downstream sections of the river. (BC MoELP Fisheries, Fish Wizard Database)

Although the dam is currently licensed to a mining company, Rupert Resources, which has maintained the dam to meet provincial standards, the owner has not carried out any mining activity in this watershed since 1943. The mine owners continue to retain the rights to the water license because they have maintained the dam to meet provincial safety standards. The owners are currently holding onto the license for potential future use. The dam however, currently impedes the passage of sockeye stocks to upper reaches of the river. There are obviously competing interests on this river system, but the fish have no means of recourse without some kind of assistance from either decommissioning, or modifications to the structure from a willing stakeholder or partnership opportunity.
6. **Tunnel dam**

The Tunnel dam is located approximately 4 kilometers east of Britannia Beach near Howe Sound in the Lower Mainland. It was constructed in 1916 by a mining company as a diversion structure used for power. It is a concrete gravity dam approximately 32 metres high and 212 metres long. Minimal rehabilitation has been done for the dam since construction. It is currently owned and operated by Copper Beach Estates and used to supply water to the town of Britannia Beach. The dam is considered a safety hazard and that is the major reason for its inclusion on this list. The downstream sections of Britannia Creek are presently seriously polluted by acid rock drainage from an old copper mine that closed in 1974. Acid run-off results from the exposure of sulfur bearing waste rock to both air and water – and this is becoming an increasingly severe problem at a number of old mine sites across British Columbia. For this reason Britannia Creek was recently deemed to be British Columbia’s most endangered river and the decommissioning of the dam is part of the overall reclamation plan for the creek that the ORC is asking the government to undertake in the very near future. It should also be noted that healthy resident fish stocks continue to exist in the upper part of the watershed.

![Upstream view of Tunnel Dam on Britannia Creek, Lower Mainland Region (Source: MoELP)](image)

4.3.2. **Alternative Dam Management Candidates**

If removal or decommissioning is not a viable option for a particular dam structure, river restoration and the rejuvenation of local fisheries can also be achieved by using a multitude of other management techniques. There were six other candidate dams that were selected for the ‘primary candidate list’ that still served a useful function, but were selected for alternative dam management strategies such as **modification** techniques (such as fish ladders, fish diversion channels, etc.), **water use planning** techniques (allowing for controlled management of water flow regimes), and innovative **water management partnerships**. In some cases, two or more management strategies were identified as potential options for an individual structure.

7. **Cleveland Dam**

The Cleveland dam owned and operated by the Greater Vancouver Water District (GVWD), is located on the Capilano River in North Vancouver, approximately six km upstream of the Burrard Inlet. Construction of the 91 metre high concrete dam was completed in 1954 and it was built as a reservoir for the supply of drinking water for the surrounding area. It is currently used as an auxiliary structure for water supply.
The dam impounds a reservoir extending 4.5 km to the north, where the Upper Capilano River flows into the lake.

The GVWD is proposing to install a seepage control blanket and cut off wall over the next couple of years to upgrade the dam for safety related reasons. The GVWD considers the seepage control project necessary for dam safety reasons and the hydraulic gradients through the soil abutment must be reduced in order to lessen the rate of erosion.

Currently, the Capilano Fish Hatchery produces 1 million Coho, 2.5 million Chinook, and between 10 to 20,000 Steelhead annually into the Capilano River system. The GVWD is already working very closely with the federal Department of Fisheries and Oceans, provincial agencies, and the Capilano Fish Hatchery staff on designs for improving water use planning as well as modifications and enhancements for the Capilano River. In addition to well-staged mitigation measures for the upgrading of the structure, the GVWD is considering a number of post construction compensation schemes. This could potentially include temperature controls, flow controls, revitalization of side channels, riparian revegetation plans as well as nutrient and gravel additions

![Aerial view of Cleveland dam on Capilano River, Lower Mainland Region.](image)

8. **Coquitlam Dam**

The Coquitlam dam is located on the Coquitlam River, 15 km upstream from its confluence with the Fraser River near the city of Port Coquitlam. The Coquitlam dam provides additional storage and flows that are diverted via a tunnel to Buntzen Lake and then to the Buntzen Generating Station. Coquitlam Lake is also used for domestic water supply to the Greater Vancouver Water District through an intake located 300 metres above the dam on the east shore of the reservoir. The dam is a hydraulic fill embankment structure that is approximately 31 metres high with a crest length of 290 metres. Coquitlam Lake covers 1100ha and contains Dolly Varden char and cutthroat trout. Spawning and rearing habitat are present in the upper Coquitlam River, which flows into the northern end of the lake. There are also extensive fisheries values in at least two smaller tributary streams. Downstream of the dam, the Coquitlam River provides 17 km of habitat for five species of sport fish including coho and chum salmon, cutthroat and steelhead trout, and Dolly Varden char. The primary spawning habitat is
located downstream of the dam for 5km. Below this point, the river has been channelized and sediment loads are high due to inputs from gravel pit operations. Unlike other BC Hydro reservoirs, Coquitlam reservoir does not provide a sport fishery because it is located within a GVRD watershed that serves as one of the domestic water sources for the Lower Mainland. However, Coquitlam River is of high local importance from a fisheries perspective but current production is limited by channel modifications and sediment inputs. Because BC Hydro has already increased flows into the river from the dam, additional benefits from further modification may be minimal. Sediment issues however, are critical and the influence of existing flow regimes and gravel operations on salmon habitat located downstream should be investigated. Ramping concerns are also important due to the length of the river and the significance of the local fishery. Further consideration should therefore be given to where and when water is released. The construction of off channel habitat below the dam has also had a positive influence on the fishery and opportunities to undertake similar projects in the future should be further explored.

![Figure 8. Upstream view of Coquitlam Dam on the Coquitlam River, Lower Mainland Region. (Source: BC Hydro)](image)

9. **Eneas Lake Dam**

The Eneas Lake Dam is situated on Findlay Creek approximately 12 km west of Peachland, in the Southern Interior region of BC. The dam is located next to the Eneas Lakes Provincial Park, in the headwaters of the Findlay Creek watershed. The watershed upstream of the spillway consists of a series of three lakes connected by a series of “canoe-able” channels. Downstream of the spillway, consists of approximately 150m of Findlay Creek and a small lake/wetland area. At present, trout are prevented from traveling upstream though the concrete spillway from Findlay Creek to Eneas Lake, particularly during low flow conditions.

The Eneas Lake dam is currently licensed to Summerland for irrigation and as a waterworks license. The Peachland Sportsman’s Association (PSA) considers the Eneas Lakes Provincial Park area to be a valuable fishing site. The PSA wants to work with local and provincial agencies to ensure that this local fisheries resource is sustained. Background fisheries information found the reservoir to rate high on the regional lakes priority list due to the high aesthetic values and presence of naturally producing rainbow trout populations.
With funding provided by the Okanagan-Similkameen Boundary Fisheries Partnership, the PSA, and the district of Summerland, they would like to implement the WUP strategy to allow for adequate water levels in the reservoir and improve flows for fish downstream. In addition, the PSA is proposing modifications to the dam structure such as lowhead baffles being placed on the spillway to allow for easier migration for trout over the structure. There is currently a tradeoff between maintaining the structure for biological and recreational benefits while meeting the economic and social needs of the community. Working in partnership with all these groups and with the funding opportunities that are available, this project has great potential.

10. McIntyre Dam

The McIntyre dam is located near Vaseaux Lake in the headwaters of the Okanagan River in the southern interior region of BC. The dam is currently used for flood control and to facilitate the diversion of water to Oliver for irrigation. The dam was rebuilt in the 1960’s to exclude exotic species such as pumpkinseed, perch, and bass. This in turn excluded salmon stocks from migrating upstream and nutrients migrating downstream. Because of the high fisheries values associated with the river system, discussions are underway by the Okanagan Basin Technical Working Group (OBTWG) to address these issues.

This group includes members from the federal DFO, BC MoELP, and First Nations representatives. So far, this group has used the WUP process to review the optimal management of the dam and river system. The project has already carried out baseline inventories of habitat and fish species upstream and downstream of the dam structure and identified restoration options. Studies carried out for the Okanagan River includes two reports designed to facilitate discussions between Canadian and US parties interested in improving conditions for fish within this trans-boundary river system.
The McIntyre Dam project includes numerous opportunities for potential fisheries enhancement, restoration of habitat, and water use planning strategies for the river. Potential modifications may include construction of a potential spawning channel, and several habitat restoration initiatives including riffle/pool construction, setback dyking, and re-vegetation programs for the streambanks.

Furthermore, the project is considering modified flow releases using WUP techniques during spawning and migration periods, as well as providing temperature controls to accommodate different fish species. Some of the issues that are unique to the McIntyre dam include fish access for sockeye salmon stocks that are currently impeded by the structure, disturbance to the existing native stocks from potential diseases being carried by downstream stocks, or the introduction of exotic fish species such as bass into the system. The McIntyre dam candidate, is an excellent example of why a well conceived and cautious adaptive management approach is necessary before any action takes place on a river system.

11. **Elsie Lake Dam**

The Elsie Lake Dam is located on the Ash River about 40 km northwest of Port Alberni in Vancouver Island. A power intake on the south shore of Elsie Lake Reservoir sends the water through a tunnel from the reservoir and diverts it about 7.4 km to a powerhouse on Great Central Lake. The Elsie dam itself is an earthfill structure about 30 metres high and 189 metres long.

Elsie Lake, the reservoir impounded by the dam has a total surface area of 1106 ha at full pool and a mean depth of 8 metres. Sport fish species present in the lake include rainbow and cutthroat trout, while steelhead have been stocked in the lake since 1982. Based on FRBC survey, there are also significant fish resources in the downstream sections of the Ash River. The 25 km reach to its mouth supports a number of species such as coho and chum salmon, as well as steelhead, rainbow, and cutthroat trout.

The Electric System Operations Review (ESOR), conducted by BC Hydro in 1993/94 identified several concerns that the public and agencies had regarding the operations of the Ash River Project. Those related to fish included concerns about high water temperatures and low instream flows in the Stamp/Somass systems during the late summer. Other concerns related mainly to restricted recreational opportunities on the reservoir due to drawdowns and the resulting stumps and mudflats along the shoreline.

The Ash River has already under consideration by BC Hydro for the WUP process. This dam is a valuable operational structure and the WUP process can help to create a
balance in the need for power, recreation, and high fish values. In addition, this structure currently impedes fish passage to fish stocks in the Ash River. Therefore, some kind of modification such as a diversion channel or fish passageway should be considered for the Elsie Lake dam.

Figure 11. View of Elsie Lake Main Dam from right abutment, Ash River, Vancouver Island Region (Source: MoELP)

12. **Fulford Creek Dam**

Fulford Creek dam, located on Salt Spring Island is a great example involving the integration of the water use planning process, partnerships, and modification options. The Fulford Creek dam is a minor dam structure that is still operational but was failing to meet safety standards. The structure is 5 metres high, with erosion problems and a spillway that impeded fish passage and required upgrading. Through a multi-level partnership between the DFO, local stream keeper members, and the private owner, they were able to implement modifications such as fish passage around the structure, use habitat enhancement, and oversee alterations to water flows for healthier fish habitat. This is a great example of how we can utilize the WUP process along with water use planning and modification techniques for smaller dam structures.

Figure 12. Fulford Creek dam structure, Saltspring Island, Vancouver Island Region. (Source: MoELP)
5. OPPORTUNITIES AND RECOMMENDATIONS FOR BC

In researching the experiences of dam management strategies in British Columbia, the authors utilized a variety of sources for information. Initially this was problematic because there is no single, centralized repository of records or data on dam removals, decommissioning, or alternative management experiences for the province. While MoELP offices in Victoria maintains an archive for existing and operational “major” dams throughout the province, there is no comparable database on either “minor” or removed dams. Information that was available was often limited to the specific interests of the agency involved and was not inclusive. Very little of the data on past experiences is computerized or otherwise organized in an easily accessible format. It is often scattered among various locations or agencies, and in some instances has been lost.

5.1. Water Management Plans And Opportunities For BC

As a result, this section represents an attempt to bring together existing information on a few of the successful dam management experiences the province has had to date.

1. Whiskey Creek Dam Removal

Whiskey Creek is a tributary to the Little Qualicum River on Vancouver Island. The concrete aggregate dam was built at the turn of the century and was originally intended to function as a water reservoir for the local Qualicum residents but it was never utilized. The dam was approximately six metres high and 20 metres in crest length. Sediment impoundment had built up over the years to the point where it had reached halfway up the height of the dam and was backed up for 75 metres upstream. Although cutthroat and brown trout used the reservoir, the dam obstructed anadromous fish passage to Coho and Chum salmon as well as steelhead and sea run cutthroat trout stocks.

Because it was not ranked as a high safety concern by water management, stewardship groups had to resort to other agencies for technical advice and funding sources. With financial assistance provided by the Habitat Conservation Trust Fund and technical assistance provided by the Urban Salmon Habitat Program, MELP Fisheries, and the Qualicum Beach Streamkeepers, the removal of the dam became a success story. It took two more years of hard work by the local stewardship groups to remove the majority of the sediment that had become imbedded behind the dam. Mitigation and enhancement activities during this time have also included monitoring, re-grading the bank slopes, large woody debris placement and habitat complexing for the fish.
This case study is an excellent example of how government and stewardship groups can work together through innovative partnerships to achieve their goals. Provincial fisheries staff and community members are to be commended for their hard work and entrepreneurial spirit. There are other examples of these kinds of partnerships across the province and the ORC hopes that there will be greater opportunities for the growing number of structures that are likely to become well suited for removal or decommissioning in the near future.

![Replanting embankment at Whisky Creek (Source: Faye Smith)](image)

Figure 13. Replanting embankment at Whisky Creek (Source: Faye Smith)

2. The Okanagan River Basin

For decades, the Okanagan River has been damaged by channelization, water extraction, urban encroachment, and riparian habitat loss through the building of dams and weirs. A growing awareness has accompanied this degradation, of the declines in kokanee and sockeye salmon in the Okanagan basin that has led to recent intense efforts to rebuild stocks and protect and restore aquatic habitat. The Okanagan drainage is one of the most complex resource management problems in BC as population growth, ecological values and transboundary issues compete for water. (A. Caverly, MoELP background report. 2000) The Okanagan Lake Action Plan was started in 1996 to address some of the issues in the basin. However, the history of the changes in the Okanagan goes back well over 50 years. Much of this is documented in the Okanagan Basin study.

A dam located at the outlet of Okanagan Lake levels regulates lake levels. The drawdown regime is determined by the Water Management Branch of the MoELP and guided by the Okanagan Basin Agreement. For many years the main priority has been flood control and irrigation and this priority has often been at the cost of aquatic fauna and habitat. This is slowly changing with the assistance of the water use planning process intended to help protect the diverse interests of the local communities, First Nations, fish and wildlife, and the ecological health of the river.

The Okanagan River is heavily channelized as it passes out of Okanagan Lake, through Skaha Lake. There are two more dams and a series of drop structures en route to the US border and the Columbia River100 km to the south. Sockeye ascend the river and spawn in sections retaining remnant natural habitats. The sockeye salmon run is one of only two substantial runs remaining on the Columbia (reports are that 56,000 sockeye have migrated past the Wells dam in the US this past summer, potentially destined for the Okanagan). The sockeye are currently at risk from flow fluctuations, the most harmful fluctuations occurring during winter salmonid egg incubation.
Salmon are not the only fish that use and depend on the habitat and water in the Okanagan River. A number of other fish species inhabit the Okanagan River. These include both native and non-native species. The river flows through a rare semi-desert ecosystem, unique in the province as well as in Canada. Numerous wildlife species live here, including many that are found nowhere else in B.C.

Channel modifications for flood control (including channelization, dyking, and vegetation removal) in the late 1950’s virtually eliminated fish habitat from many section of the Okanagan River. A technical committee consisting of federal, provincial, and first nations representatives are working at developing a long term plan for restoring the river’s indigenous fish populations. The first order of business has been to launch a major initiative to improve understanding of fish requirements and to implement selected habitat restoration strategies based on acquired knowledge.

Funding for the Okanagan River Basin has been provided by the Habitat Conservation Trust Fund, Fisheries Renewal BC, and the Douglas County Public Utility District. A variety of projects will be completed within the next two years and these include:

- Channel complexing (riffle construction)
- Bank re-vegetation
- Flow modifications to redirect water back into the original river channel at select sites
- Determining optimum flow management strategies for fish
- Sockeye spawning channel feasibility study
- Investigating potential sources of adult sockeye mortality

Based on the current level of support, and the potential for long-term financial commitments from various funding agencies, the prognosis for Okanagan River is good.

With the return of over 35,000 sockeye this past year to the Okanagan River system, these figures also reinforce the potential for such a program.

3. **The Columbia Basin Trust Water Management Plan**

The Columbia River Treaty was ratified by the governments of B.C., Canada and the U.S. in 1964 to control flooding in the Columbia River Basin and to generate electricity. Canada agreed to build Mica, Keenleyside, and Duncan Dam and the U.S. constructed the Libby Dam. The B.C. government created BC Hydro to build and operate these dams and reservoirs. Some of the power would be used locally, but most electricity was routed to major urban centers outside the region, creating a significant revenue source for the Province.

Prior to the ratification of the Columbia River Treaty, there was little or no consultation with the residents who had been displaced by Columbia River Treaty dams and projects. Even though the residents were the ones who stood to lose the most from the project, they were excluded from the decision making process. Landowners were faced with diminishing resources and degradation of their surrounding environment. This resulted in lost economic and social opportunities for hundreds of families. In 1995, local governments and tribal councils in the Basin coordinated their efforts and formed the Columbia River Treaty Committee to pressure
the Province to allocate funds for social, economic, and environmental development in the region. This led to the creation of the Columbia Basin Trust Act and the Columbia Basin Management Plan.

Water management objectives under the management plan include the following:

- Optimizing the benefits from dam management practices including fisheries, recreation, and aesthetics.
- Advocating on behalf of those residents whom the Columbia River Treaty affected and who still has justifiable compensation claims.
- Resolving water management issues which have not been satisfactorily addressed by conditions of existing water licenses including debris management and public access to reservoirs and other waterways.
- Establishing a process for receiving and commenting on significant applications made under section 10 of the Water Act to help ensure regional managers give adequate consideration to the Columbia Basin Management Plan.

In 1996, the Columbia Basin Fish & Wildlife Compensation Program (CBFWCP) was created to conserve and enhance fish and wildlife populations affected by BC Hydro dam related activities in the Columbia Basin. Funding of $3.2 million in perpetuity is provided from BC Hydro as a part of the crown corporation’s water license agreement. The Hugh Keenleyside, Mica and Revelstoke dams significantly altered the river system and created the Arrow Lakes. Fish populations and habitat were severely impacted. The dams flooded river, lake and tributary habitat; created greater water level fluctuations; killed fish in turbines; blocked spawning migrations; impounded nutrients upstream, and changed the volume, speed and direction of water flows that circulate nutrients.

Little research was conducted on resident species in order to better understand their biology, behavior and habitat requirements. Consequently, the impact of dams was not assessed or considered prior to their construction. The decline in fish productivity in the lakes became unavoidably evident in 1994 when fisheries biologists noted an alarming trend of smaller and fewer kokanee, the main food source for larger sport fish species. By 1998, Upper Arrow kokanee returning to spawn had plummeted to 60,000 from the 550,000 recorded in 1988, a 90% decline in numbers. (BC MoELP et al., Creating a Balance..., 2000)

An experimental fertilization project and proposed restoration plan for the Arrow Lakes Reservoir was initiated in the 1998. The Compensation Program is also delivering other related projects including the monitoring of over 21 tributaries and the researching of key fish species such as bull trout and rainbow trout to better understand the species and their habitat losses. These projects are being monitored to determine their effectiveness and to provide direction for the future.

The Columbia Basin Trust is currently working with the Columbia Power Corporation in a joint venture partnership. The partnership venture will focus on the development of a number of power projects, community consultation programs, parks development programs, environmental protection initiatives through water use planning strategies.
and land acquisition, lake fertilization programs, reclamation plans, and educational programs to address terrestrial ecosystem restoration and conservation needs in the Basin.

5.2. Funding opportunities for dam management strategies

There are generally two major types of funding opportunities associated with the dam management process in British Columbia. The first type deals with the impacts or ecological footprint of a dam structure on a river system. This usually involves a form of habitat compensation, environmental mitigation strategies to deal with sediment impoundment, or modifications to the structure. The second type of funding is associated with the maintenance of, or improvements to, existing dam operations. This includes operational modifications to water flow regimes such as the WUP strategies.

The Fisheries Renewal Fund Of British Columbia (FRBC) and the Flood Protection Assistance Fund from the Provincial Emergency Program (PEP), as well as internal funding has traditionally been the largest source of funding for provincial projects related to dam management strategies. The budgets for this program however are dwindling and there are fewer opportunities for provincial agencies to use this fund than before.

BC Hydro has initiated several compensation programs to address fish and wildlife impacts that resulted from the construction of BC Hydro’s facilities. The Bridge Coastal Fish and Wildlife Restoration Program (BCRP) include watersheds in the Fraser Valley, Vancouver Island, Coastal, Bridge River and Shuswap areas. The BCRP includes the public and First Nations in the decision making process to determine which projects receive funding. In addition, BC Hydro has two other compensation programs in the Peace Williston and Columbia Basin areas.

The Water Use Plan (WUP) Program has been active since 1996. The objective of the WUP program is to review and modify water management practices in light of changing public values and environmental needs. BC Hydro intends to develop plans for each of its major facilities and has put approximately $25 million aside for this purpose.

BC Hydro’s Power Supply Environmental Management System (EMS) was created to ensure that its limited resources are applied effectively to activities that create the greatest environmental risk. The program cost two million dollars to implement and a further $500,000 per year to maintain the fund.

BC Hydro also contributes to Fisheries Renewal BC that delivers community fisheries related projects and programs. The company wide program budgeted between three and seven million dollars per year for this program. The Strategic Environmental Initiatives Program was designed for programs that advance BC Hydro’s interests in environmental issues and that can enhance its overall performance.

The financial fund available for dam modifications is unique to BC Hydro. The monies available through BC Hydro funding for dam decommissioning initiatives apply only to the watersheds directly affected by BC Hydro dam structures. Given that over 95% of the dams in the province do not fall within these watersheds; there is an urgent need to secure government funding and commitment in the form of immediate financial resources and annual budget allocations. Other options may be to gain corporate support or perhaps even international funding to meet the costs of dam decommissioning in BC.
A combination of funding sources will probably be needed to accomplish any one dam decommissioning project or study. One thing that will be crucial to the entire process are the partnerships between the dam owner (or government agency if the dam is abandoned), downstream landowners, relevant government agencies, local first nation groups, and any other stakeholders. Partnerships offer a wide range of views and perspectives, a creative wealth of solutions, create community ownership of the process, and, perhaps most importantly, provide a diverse range of access to funds and monies available for such endeavors.

This report includes a fairly comprehensive list of government, corporate, and private funding sources that proponents can use for various dam management related strategies. The funding opportunities list is attached in Appendix A of this report. The list includes a brief summary on the requirements and available funds from each of the sources.

5.3. Recommendations and future goals

The end of the 20th century has seen the emergence of an important new trend relating to dams. This entails the decommissioning of impoundments that no longer serve a useful purpose or provide only marginal benefit. Many of these same dams are expensive to maintain, have unacceptable levels of impacts and in some cases pose a public safety threat. ‘Momentum for river restoration is accelerating in many countries and many of these efforts revolve around relatively old, small dams that have been, or are likely to be decommissioned’ (WCD Report, November 2000).

Experience in North America and in Europe shows that decommissioning dams has enabled the restoration of fisheries and riverine ecological processes. While decommissioning efforts have generally received public support to date, there have also been some valuable lessons learned from these initiatives. Most importantly, there is a need for a cautious and risk adverse approach to the decommissioning of dams or ‘other dam management strategies’. If these efforts are well conceived and executed, there is every reason to believe that we can restore the overall health of our rivers.

Whether or not a dam continues to provide benefits, and to what degree, can change over time. These changes need to be monitored and evaluated to determine when the costs begin to outweigh the benefits. When the costs of doing business exceed the benefits, if it were like any other business, the project would be declared bankrupt.

Due to the significant costs and risks that are associated with upgrading or replacing many of these structures, communities are now learning that removal or decommissioning is a viable solution. For dams that still serve an important function, most of these can also be modified or operated more effectively than they are at present in order to reduce negative impacts and improve public benefits to our river systems. The ORC hopes that others will be able to add to and revise the list of existing issues and future candidates, and we encourage interested parties to help expand and move the discussion forward.
Specific recommendations based on the discussions reviewed under issues and experience that are unique to British Columbia include the following:

1. Designing and implementing better decision making processes

More studies and resources are currently required to address the specific needs of individual river systems as well as more effective management strategies for existing dam structures. A decision making process for dealing with the multitude of issues, options, and opportunities is required that incorporates the following:

   a. Clear structured decision making framework
   b. Wider focus using more diverse stakeholder value based thinking to create more attractive alternatives that stand a better chance of wide support,
   c. Adaptive management as a means of coping with uncertainties in managing complex natural resource systems which includes dealing with tradeoffs and insights along the way, and
   d. Meaningful technical information on the issues, impacts, and options that are available for rehabilitating each particular river system

2. Ensure adequate baseline information requirements

Without adequate baseline information on the integrity of our river system, fish stocks, wildlife, and impacts of dam structures on the ecosystems, it is not possible to manage water use or dams in an optimal manner, or make informed decisions about what is best for the river system. Similarly, documentation of our dam removal projects, especially with smaller projects is important to future decommissioning projects. Despite the widespread assumption that dam removal will improve the overall health of a river, there is very little information to support or refute this premise, as is the case.

3. Promote integrated multi-criteria evaluations for future prioritization

There are limited means or mechanisms of incorporating or evaluating multi-criteria economic, social, and environmental information requirements into the planning process. The current regulatory and dam safety evaluation mechanisms of the provincial agencies responsible for managing our dams, do not adequately address historical fish or wildlife values, ongoing negative ecological impacts of dams, nor do they encourage or support evaluation of future social or environmental benefits that are often associated with removal or decommissioning of dams. A standardized checklist is required by the province to facilitate the following:

   ♦ Identification and analyses of the historical as well as the existing social and ecological values associated with a river system
   ♦ Evaluation of the potential social and environmental impacts from the existing dam as well as from potential retirement options
♦ Selection of appropriate mitigation/enhancement measures required to address the impacts, and
♦ Identification of requirements for monitoring and determining the effectiveness of the measures.

3. Mandatory water license review period for dams

The life cycle of a dam should not only focus on structural integrity, but should also include economic, social, and environmental values that are likely to change over time. By issuing a finite time frame on a license, the government can re-evaluate whether a dam provides only a marginal benefit, if it has become obsolete, or if it would provide greater opportunities to the community and to the health of the river system if it was removed or decommissioned. It has been proven in many instances, that restoring free flowing rivers in developed areas can act as a catalyst for further economic benefits derived from activities such as land reclamation, aesthetic improvements to the river system, and recreational opportunities that arose from dam removal. Under a limited license period, the re-licensing of dams provides a much-needed opportunity to re-evaluate the appropriate use of a river’s resources and the future operations of a dam.

5. Ensure sufficient resources

Without the adequate human, technical, and financial resources available to carry out their numerous responsibilities related to dam management and safety, the provincial agencies will continue to carry out the logistically impossible task of trying to manage all of the water license issues, dams, and river systems using an evaluation and planning process that is based on limited and sometimes questionable data. Regulatory mechanisms, public pressure, and financial incentives have proven to be the most effective tools in motivating dam owners to improve operations, to increase societal or environmental benefits, and to reduce the negative impacts associated with existing dams.

Furthermore, additional funding will be required in the very near future to deal with the growing number of potential problems that are likely to arise from dam structures that will have reached the end of their life cycle or that are likely to be abandoned due to the costs associated with upgrading.

We are reaching a point where the risks associated with the multitude of safety, economic, social, and environmental concerns is becoming dangerously high. The Outdoor Recreation Council hopes the province will take appropriate action to allocate greater resources to appropriate provincial agencies to deal with these concerns before it is too late. By continuing to selectively remove or decommission those dams that do not make sense, (‘including those that have been abandoned, have excessive costs related to benefits, or pose a safety hazard’), we can begin to restore the numerous benefits associated with healthy free-flowing rivers.

6. Incorporate short and long-term costs into water license agreements

Greater financial assistance should be provided by the province for dam owner that take the initiative to help remove, decommission, modify, or upgrade their structures.
Since dams or their life cycle are potentially finite, removal or decommissioning is more likely to become more of an issue in the future. However, the costs for decommissioning to date have not been considered as part of the life cycle costs of dams. Decommissioning has not entered into benefit and cost calculations that establish the feasibility of new projects. Some of these costs should be automatically incorporated into the existing water use license fees. The fees could also be scaled based on the revenue expected to be generated from dam operations as well as the negative impacts the dams are likely to have on the health of the river. This would provide financial incentives to dam owners to try and reduce the negative impacts of their dam structures and operations.

To conclude, various provincial agencies, BC Hydro, and stewardship groups are to be commended for their hard work and efforts to date on addressing some of these issues. However, it is obvious that the provincial agencies responsible for dealing with dam management, have limited resources to deal with all of these issues effectively. There is a legitimate concern about the limited human, technical, and financial resources that are currently being allocated to the existing management of our dams and the health of our rivers. Additional funding will be required in the very near future to deal with the growing number of potential problems that are likely to arise from dam structures that will have reached the end of their economic and structural life cycles or that is likely to be abandoned due to the costs associated with upgrading.

The BC Outdoor Recreation Council hopes to bolster and promote greater public support for the allocation of greater resources towards these issues so that we can move forward towards the more effective and comprehensive management of our rivers and streams. Safety, economic, social and environmental issues associated with dams are reaching the point where they can no longer be ignored. The Outdoor Recreation Council hopes the province will take the necessary action to allocate greater resources to appropriate provincial agencies to deal with these concerns before it is too late. By continuing to selectively remove or decommission those dams that do not make sense, and by improving the management of and reducing the impacts from dams that still provide value, we can begin to restore the numerous benefits associated with healthy rivers.
BIBLIOGRAPHY


British Columbia Ministry Of Environment, Lands, and Parks, 2001, Personal communication with the Water Management, Public Safety, and Fisheries Branches, February and March 2001, Victoria


Williams, P.B., 2000, Reviving Living Rivers, A presentation prepared by International Rivers Network at the European NGO hearing on WCD related issues, Slovakia.

Appendix A

Funding Opportunities for
Dam Decommissioning or Modification Initiatives
Funding Opportunities
There are three main sources of funding for dam decommissioning projects: (i) public funding; (ii) private funding; (iii) corporate funding. Public funding includes all government agency budgetary allowances and grants. Private funding includes anything from donations made by individuals to foundation grants and sponsorship. Corporate funding is any funding, donation or sponsorship by a corporate group.

Funding sources are categorized by the above three categories and each source is briefly outlined by mission statement or focus of group or agency, eligibility, budget and application deadline.

Public Funding Sources:
Public funding sources are sub-categorized into two groups: (i) provincial; and (ii) federal. Note that all content is taken directly from literature or website provided by the funding agency.

PROVINCIAL SOURCES:

Public: Provincial Funding Source 1

Source Name: Fisheries Renewal BC
Fund/Grant: Applied Research and Development Program
Focus/Mission: Support research based projects that promote: (i) community participation and increased capacity; (ii) sustainability and renewal of fisheries resources; (iii) increased knowledge of resources; and (iv) economic development.
Eligibility and Selection Criteria: Projects should demonstrate strong partnerships among researchers, end-users in industry, community, and First Nations groups. Projects must have a science and technology related component and should address one of the following project areas:
Project areas (statements have been edited to retain only sections relevant to dam decommissioning and habitat studies):
(1) Research into…enhancement, experimental design and monitoring of habitat restoration
(2) Research into traditional ecological knowledge (traditional First Nations management techniques), and multi-species management

Note: Other topics that fit the within the program objectives will also be considered.

Funding Information: Total funding for the program is $300,000 for the 2000/2001 fiscal years. The maximum award per project is $50,000. Program provides funding for up to 100% of research-related costs. Projects are awarded funding through open competitions, with proposals evaluated by a Peer Review Committee

Website: www.scbc.org/programs/fisheries
Public: Provincial Funding Source 2

Source Name: Fisheries Renewal BC
Fund/Grant: Salmon Renewal Program
Focus/Mission: To draw communities together, promote local decision-making and use local resources in renewing provincial fisheries.

Eligibility and Selection Criteria: Designated program delivery partners will fund local groups in conservation, restoration and enhancement projects involving all species of salmon and trout in fresh water and saltwater estuaries. Funding is available for works on public, private and First Nations lands.

Project areas include (statements have been edited to retain only sections relevant to dam decommissioning and habitat studies):

1. Inventory, assessment and mapping of salmonid habitats and stocks.
2. Watershed monitoring and evaluation.
3. Salmonid habitat restoration
4. Local salmonid enhancement projects
5. Community based watershed planning and stewardship
6. Public awareness projects
7. Education projects

Funding Information: The Program has initial funding of 3.5 million per year, which will be distributed by program delivery partners through grants to local project teams. Co-funding arrangements may be considered. Program provides funding for up to 100% of research-related costs. Projects are awarded funding through open competitions, with proposals evaluated by a Peer Review Committee

Website: www.fishrenewal.gov.bc.ca/fsrbcprograms

Public: Provincial Funding Source 3

Source Name: Fisheries Renewal BC
Fund/Grant: Planning and Partnership Program
Focus/Mission: To help communities develop a partnership approach to resolving the problems facing BC fisheries by developing long term vision plans and effective relationships and inclusive planning processes.

Eligibility and Selection Criteria: The program will fund individuals, groups and organizations. Project must develop partnerships or plans related to BC fisheries by one or more of the following (statements have been edited to retain only sections relevant to dam decommissioning and habitat studies):

1. Sector wide or regional based strategic planning and partnership initiatives
2. Research and information gathering.
3. Workshops or meetings to facilitate groups coming together for a common purpose.
4. Feasibility studies/risk assessments with broad benefits to the seafood sector as a whole.
Funding Information: Grants are available up to $10,000. Staff are available to help groups acquire the tools needed to explore new ideas and develop sustainable fisheries opportunities.

Website: [www.fishrenewal.gov.bc.ca/fsrbcprograms](http://www.fishrenewal.gov.bc.ca/fsrbcprograms)

Public: Provincial Funding Source 4

**Source Name:** Fisheries Renewal BC  
**Fund/Grant:** Original Ideas Program  
**Focus/Mission:** Support original ideas that advance the aim of Fisheries Renewal BC as it works to renew and revitalize BC fisheries.

**Eligibility and Selection Criteria:** Applicants may include any registered society, agency, organization or entity including First Nations, educational institution, science and research institutions, community groups and organizations as well as local governments. Note: Federal and provincial agencies cannot be a lead applicant but may be a co-applicant.

Projects will be considered if they do not fit within existing Fisheries Renewal BC programs and if they (statements have been edited to retain only sections relevant to dam decommissioning and habitat studies):

1. Address an issue facing the fisheries sectors.
2. Address challenges or opportunities that have broadly shared benefits
3. Bring proven expertise to the project or show potential to develop the needed expertise.
4. Develop practical partnerships within and between fisheries sectors and interests
5. Present an effective plan that reflects local, regional or provincial priorities

The second stage of screening requires that the project encourage cooperative relationships, enhance the fishery in a new or innovative way, that activities are transferable, and that the proposal is creative and cost efficient. The project must also help to develop or provide a model for a sustainable fishery.

**Funding Information:** Proponents must contribute 25% of total project costs, in cash or in kind. No upper limit has been set on funding requests; each proposal will be considered on its merits. Funds from federal or provincial funding sources are eligible as co-funding contributions.

**Website:** [www.fishrenewal.gov.bc.ca/fsrbcprograms](http://www.fishrenewal.gov.bc.ca/fsrbcprograms)

Public: Provincial Funding Source 5

**Source Name:** Ministry of Environment, Lands and Parks  
**Fund/Grant:** Urban Salmon Habitat Program (USHP)  
**Focus/Mission:** To protect and restore salmonid habitats in urban areas in the BC portion of the Georgia Basin.
Eligibility and Selection Criteria:

Any non-profit group may apply including First Nations, schools, science and research institutions, community groups and others. Professionals or consultants assisting the stewardship group must not sign or co-sign the application.

Applications will be evaluated against the following criteria:
1. Ability of the project to meet stewardship objectives
2. Location of the project (salmonid values; degree of or potential for urban, agricultural or industrial developmental impacts on these values)
3. Quality of the proposal (research, presentation, technical merit, skills/experience, coordination with partners, etc.)
4. Amount of joint funding and/or contributions in kind
5. Liaison relationship with local governments

Funding Information:

During any one year the funding that will be allotted to each applicant will be a maximum of 80% of the project’s annual costs to a maximum of $30,000. A community group must provide a minimum of 20% of each year’s total cost of its project. Ultimately, funding is dependant upon the ability of the project to meet USHP goals, past performance (for continuing projects) and the total amount of USHP funds available. There are limitations on how monies are allocated and application deadlines are set annually. Please refer to the website for more information.

Website: [http://www.landcentre.ca/urban/ushp.html](http://www.landcentre.ca/urban/ushp.html)

Public: Provincial Funding Source 6

Source Name: Ministry of Advanced Education, Training and Technology (AETT); Administered by the Science Council of BC

Focus/Mission: GREAT scholarships provide support to full-time graduate students in BC universities undertaking studies in the natural or applied sciences. In the Aquatic Resources sector, students are involved in many diverse and interesting areas, including: disease resistance and therapeutics in salmon; and genetic studies of important commercial species.

Eligibility and Selection Criteria: Applicants must be Canadian citizens and Permanent Residents intending to pursue graduate studies in natural or applied sciences. Applications may be made prior to or after a student enters graduate studies. During the tenure of the award, students must be registered in full-time graduate studies in a BC university.

The selection criteria for a project are:
1. Industrial significance – relevance to industry, level of collaboration, training opportunity
2. Rating of student – recent academic performance, work experience
3. Quality of proposed research – concept validity, scientific method, clarity of submission
Funding Information: Applications are submitted by the student in collaboration with a company in the BC private sector. The collaborating company must be prepared to contribute a minimum of $2,500 cash or in-kind contribution toward the project costs incurred by each scholarship student. GREAT scholarships are worth up to $20,000 per year. They can be used to top up other major scholarships to a maximum total of $25,000. There is one competition each year and the application deadline is January 31. Application forms are available in hard copy, or downloadable in RTF format.

Website: [http://www.scbc.org/programs/great/default.asp](http://www.scbc.org/programs/great/default.asp)

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Public: Provincial Funding Source 7

Source Name: Ministry of Environment, Lands and Parks

Fund/Grant: Habitat Conservation Trust Fund (HCTF)

Focus/Mission: The focus is on freshwater wild fish, native wildlife species and their habitats.

Eligibility and Selection Criteria: Provincial government agencies, First Nations groups, local governments, community and conservation groups, universities and colleges, and individuals may apply for HCTF funding.

The selection criteria for a project are that it:

1. Improve management
2. Provide benefits to fish and wildlife and their habitats and which address impacts to adjacent ecosystems and non-target species.
3. May provide needed conservation & management information in the face of development or resource extraction.
4. Is a cost-shared (partnership) proposal.
5. Support changes in practices of resource users
6. Support large scale planning processes that may give a better return for species and habitats through partnerships
7. Is coordinated, i.e., activities will bring benefits to ecosystems, groups of species or, for single species, activities are coordinated throughout the range of the species, e.g., a provincial bull trout plan with regional activities; a provincial dragonfly plan with regional activities.

Funding Information: In April 2000, the HCTF provided $5.4 million for 151 fish and wildlife conservation projects around the province. Each year, the Trust Fund supports over 150 projects ranging in budget from $2,000 to $300,000. The HCTF encourages partnerships but will fund up to 100% of project costs.

Website: [www.elp.gov.bc.ca/hctf/](http://www.elp.gov.bc.ca/hctf/)
**Public: Provincial Funding Source 8**

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<tr>
<th>Source Name</th>
<th>Ministry of Environment, Lands and Parks and BC Hydro</th>
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<tr>
<td>Fund/Grant</td>
<td>Columbia Basin Fish and Wildlife Compensation Program</td>
</tr>
<tr>
<td>Focus/Mission</td>
<td>To coordinate and fund a variety of activities that help sustain and enhance fish and wildlife populations in the Canadian portion of the Columbia River system.</td>
</tr>
<tr>
<td>Eligibility and Selection Criteria:</td>
<td>Project applications are reviewed by various individuals and committees to ensure that they are cost effective, achievable, biologically appropriate and socially desirable. Specific objectives are to enhance existing fish and wildlife habitat in areas affected by BC Hydro’s hydroelectric developments in the Columbia River Basin and to enhance habitat in other areas where the opportunity for on-site enhancement has been significantly reduced or eliminated by reservoir development.</td>
</tr>
<tr>
<td>Funding Information:</td>
<td>Application date is August 1st. All ongoing and new projects are funded from the annual budget of $3.2 million dollars.</td>
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<tr>
<td>Website:</td>
<td><a href="http://www.cbfishwildlife.org/">www.cbfishwildlife.org/</a></td>
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**FEDERAL SOURCES:**

**Public: Federal Funding Source 1**

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<th>Source Name</th>
<th>Funded by Fisheries and Oceans Canada; Administered by Pacific Salmon Endowment Fund Society</th>
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<tr>
<td>Fund/Grant</td>
<td>Pacific Salmon Endowment Fund</td>
</tr>
<tr>
<td>Focus/Mission</td>
<td>To promote the conservation, restoration and enhancement of Pacific salmonids for the benefit of present and future generations and to provide a funding mechanism for projects promoting the conservation, restoration and enhancement of Pacific salmonids.</td>
</tr>
<tr>
<td>Eligibility and Selection Criteria:</td>
<td>Applicant must be a charitable organization with a non-taxable status. Projects must be carried out in the province of BC and have a strong volunteer component to their organization and their project. The project must have support from other groups and agencies involved in similar activities in the area. Funding is limited to capital and sunset project expenditures. On-going labour costs or operational expenses are not considered for funding. The types of projects supported are (types have been edited to retain only sections relevant to dam decommissioning and habitat studies): (1) Spawning channels (2) Outplanting (3) Fishways and fish ladders (4) Water supply augmentation (5) Habitat restorations (6) Bioreconnaissance (7) Marking, tagging (8) Watershed inventory Other projects or activities not directly related to enhancement may include: (1) Workshops and seminars (2) Research (3) Special events, brochures, advertising or other means of promotion The three main target areas for funding are the Thompson-Shuswap river system; the Georgia Basin; and the Central Coast.</td>
</tr>
</tbody>
</table>
**Funding Information:**
The initiation of the PSEF was announced in February 2001 and the Department of Fisheries and Oceans contributed $30 million dollars for the fund. The initial 6-month interest available for 2001 projects is $750,000 with an estimated 1.5 million available annually for project expenditures.

**Website:**  
[www.psf.ca](http://www.psf.ca)

### Public: Federal Funding Source 2

<table>
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<tr>
<th>Source Name</th>
<th>Fisheries and Oceans Canada; Administered by Natural Sciences and Engineering Research Council of Canada (NSERC)</th>
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<td>Fund/Grant</td>
<td>Marine and Aquatic Research Science Grant Program</td>
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<tr>
<td>Focus/Mission</td>
<td>To stimulate further research and training in fisheries, marine and aquatic sciences and encourage discussions and innovation through post-graduate and post-doctoral grants.</td>
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<tr>
<td>Eligibility and Selection Criteria</td>
<td>Applicants must be Canadian citizens and Permanent Residents intending to pursue post-graduate or post-doctoral studies in natural or applied sciences. Applications may be made prior to or after a student enters graduate studies. The types of research being funded are (types have been edited to retain only sections relevant to dam decommissioning and habitat studies):</td>
</tr>
<tr>
<td></td>
<td>(1) Aquaculture</td>
</tr>
<tr>
<td></td>
<td>(2) Behaviour and toxicity of contaminants in marine and fresh waters</td>
</tr>
<tr>
<td></td>
<td>(3) New indicators of fish health and ecosystem health</td>
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<tr>
<td></td>
<td>(4) Fish habitat</td>
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<tr>
<td></td>
<td>(5) Factors affecting the growth and survival of fish such as reproductive capacity, spawning success, and larval survival</td>
</tr>
<tr>
<td>Funding Information</td>
<td>A total of $395,000 will be awarded by DFO to 75 post-graduate students. The grants are supplements to existing scholarships and fellowships given by NSERC. The grants were announced on March 13, 2001</td>
</tr>
</tbody>
</table>
Public: Federal Funding Source 3

Source Name: Environment Canada
Fund/Grant: Eco-Action Community Funding Program
Focus/Mission: To help groups carry out action oriented projects that protect or improve the environment in their community.
Eligibility and Selection Criteria:
Funding may be provided to non-profit groups and organizations, which are not part of the federal, provincial, territorial or municipal governments. Examples of eligible groups are community groups, environment groups and representative Aboriginal organizations or associations.
Projects must benefit the physical environment and the benefits must be measurable. The types of projects that are funded are (types have been edited to retain only sections relevant to dam decommissioning and habitat studies):
(1) Address Environment Canada’s priority issues of clean air and climate change, clean water and/or nature (nature includes: (i) restoring a wetland; (ii) restoring and conserving habitat through a variety of enhancement techniques; (iii) persuading community members to protect environmentally sensitive areas)
(2) Provide opportunity for Canadians to take positive action at the community level.
(3) Encourage people to be more environmentally responsible.

Funding Information:
Funding available is up to a maximum of $100,000. The average amount given to any one group is $25,000. The maximum length of a project is 2 years. Application deadlines are February 1st and October 1st.

Website: [www.ec.gc.ca/ecoaction](http://www.ec.gc.ca/ecoaction)

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Public: Federal Funding Source 4

Source Name: Revenue Canada
Fund/Grant: Canada’s Ecological Gifts Program
Focus/Mission: To protect ecologically sensitive areas of land through tax assistance.

EcoGifts are defined as gifts of full title to a property, or of the value of a conservation ‘easement,’ ‘covenant’ or ‘servitude’ attached to that title as defined under provincial or territorial legislation. Land can be donated outright or kept with restricted long-term use or restricted access.

Eligibility and Selection Criteria:
Ecogifts can include land that are:
(1) identified, designated or protected for environmental conservation;
(2) a locally important area;
(3) close to environmentally significant properties;
(4) buffer environmentally sensitive areas such as water bodies, streams or wetlands; or
(5) support the conservation of biodiversity or Canada’s environmental heritage.
Funding Information: Individuals or corporations who donate private land to the federal, provincial, or territorial governments, Canadian municipalities, or one of about 125 approved charities receive a federal tax deduction against up to 100% of their annual income. Unused portions of the tax deduction can be carried forward for up to five years. The February 2000 Federal Budget introduced further changes to the Income Tax Act that reduced by 50%, the tax payable on the deemed capital gains associated with EcoGifts.

Website: [www.cws-scf.ec.gc.ca/ecogifts](http://www.cws-scf.ec.gc.ca/ecogifts)

Private Funding Sources:

Private funding sources are defined as any source of funding from private foundations or from non-government organizations.

Private Funding Source 1

<table>
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<tr>
<th>Source Name</th>
<th>Earthwatch</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund/Grant</td>
<td>Centre for Field Research: Field Research Projects</td>
</tr>
<tr>
<td>Focus/Mission</td>
<td>The role of the Centre is to create a public offering of significant research that addresses scientific, environmental, and public policy problems.</td>
</tr>
<tr>
<td>Eligibility and Selection Criteria:</td>
<td>Post-doctoral or equivalent scholarship. A limited number of projects headed by doctoral students working with an advisor with sufficient educational and field training. Research teams must include qualified volunteers, who are members of Earthwatch, to join scientists in the field and assist them with their data collection and other research tasks.</td>
</tr>
<tr>
<td>Funding Information:</td>
<td>Grants ranging from $10,000 to $15,000 US are available for field research projects. Most funds come from the donations of Earthwatch members who enlist for the opportunity to join scientists in the field and assist them with their data collection and other research tasks. Earthwatch grants per volunteers are typically in the range of $250 to $1,000 US.</td>
</tr>
<tr>
<td>Website:</td>
<td><a href="http://www.earthwatch.org">www.earthwatch.org</a></td>
</tr>
</tbody>
</table>

Private Funding Source 2

<table>
<thead>
<tr>
<th>Source Name</th>
<th>Canadian Foundation for Innovation (CFI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund/Grant</td>
<td>Innovation Fund</td>
</tr>
<tr>
<td>Focus/Mission</td>
<td>To strengthen the capability of Canadian universities, colleges, research hospitals, and other not-for-profit institutions to carry out world-class research and technology development.</td>
</tr>
</tbody>
</table>
Eligibility and Selection Criteria: Eligible Canadian universities, colleges, hospitals and not-for-profit research organizations can apply for CFI support. Only projects with total costs of $100,000 or more are eligible. Projects must meet the three following CFI criteria:

1. Enable researchers to work on groundbreaking topics that are currently beyond their means and that will support innovative research that is linked to new ideas and concepts or different ways of performing research.
2. Reinforce and support excellent research; or help create excellence where there is already evidence of real potential and need to do so.
3. Help attract and retain the best researchers and create a stimulating and innovative training environment that will prepare individuals for research and other careers that will benefit Canada.
4. Make a difference and contribute to the Canadian economy and/or to the improvement of society, the quality of life, health, or the environment.

Innovative research may require not only multidisciplinary approaches but also contributions from individuals from a variety of institutions and/or sectors.

Funding Information: CFI intends to invest up to $350 million in the 2001 competition. Two further competitions are planned after the 2001 competition. CFI will contribute up to two-thirds or more of project total costs.

Website: www.innovation.ca

Private Funding Source 3
Source Name: Donner Canadian Foundation (DCF)
Fund/Grant: Donner Canadian Foundation Fund
Focus/Mission: The DCF seeks to encourage individual responsibility and private initiative to help Canadians solve their social and economic problems.
Eligibility and Selection Criteria: The Foundations grant-making continues under the guidance of a Board of Governors composed of the Donner family and eminent Canadians from a variety of fields. The foundation focuses on specific program interests, among these interests are research initiatives on public policy.
Funding Information: Since 1967, the DCF has contributed over $75 million dollars to more than 600 projects across Canada.
Website: http://donnerfoundation.org/
Private Funding Source 4
Source Name: The McLean Foundation
Fund/Grant: The McLean Foundation Fund
Focus/Mission: Emphasis on projects showing promise of general social benefit but which may initially lack broad public appeal
Eligibility and Selection Criteria:
Grants made by the Foundation are restricted to organizations which are recognized by Revenue Canada as “charitable organizations” and which are able to provide a registration number. Grants are not made to individuals. Grants are made to 6 general categories including arts, education, general, conservation, health and welfare.
Funding Information: In 1999, the Foundation paid out a total of $1,328,515 of which, approximately 20% was dedicated to conservation projects. There is no information provided for limitations for grant requests or average project funding.
Website: www.mcleanfoundation.on.ca

Private Funding Source 5
Source Name: The J.W. McConnell Family Foundation
Fund/Grant: The J.W. McConnell Family Foundation Fund
Focus/Mission: To enhance the ability of Canadians to understand, adapt, and respond creatively and effectively to the underlying forces that are transforming Canadian society and the world.
Eligibility and Selection Criteria:
Applicants must be a registered charitable organization and the project must serve the general public without regard to race, religion, gender or nationality. The Foundation generally does not consider requests where primary activity of the project is strictly local or regional where there is neither a high potential or clear strategy for the applied dissemination of learning across Canada.
Conferences, workshops, training scholarships and bursaries, buildings and facilities, equipment or endowments, advocacy, production of film, video or publication, academic or basic research are not supported by the Foundation.
The primary activity of a project must take place within Canada.
Projects must embody the Foundations preferred program characteristics:
(1) Effective strategies – clear statement of challenge to be addressed and its context
(2) Long term horizon – promote long-term change and effect preventative measures for issues and national challenges
(3) Breadth and depth – initiatives are rooted in local communities and integral to a country wide strategy
(4) Innovation and risk – promote new models of collaboration, release latent resources, involve people in new ways, and employ integrative ways of working together.
(5) Organization strength – applicant organization should have a clear mission and goals, supportive and involved constituency, capable management and committed volunteers.
**Funding Information:** No limits or budget is provided. Applicants are asked to submit a letter outlining the project, the amount and duration of grant request and background information on organization. Contact information is available on website for more details about foundation and grant requests.

**Website:** [www.mcconnellfoundation.ca/grants/](http://www.mcconnellfoundation.ca/grants/)

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**Private Funding Source 6**

<table>
<thead>
<tr>
<th>Source Name</th>
<th>Vancouver Foundation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund/Grant</td>
<td>Environment</td>
</tr>
<tr>
<td>Focus/Mission</td>
<td>To encourage and assist in the resolution of broad environmental issues arising in British Columbia</td>
</tr>
<tr>
<td>Eligibility and Selection Criteria:</td>
<td>Eligible applicants include registered charities and qualified donees under the Income Tax Act. Grants are not made to individuals or to businesses.</td>
</tr>
<tr>
<td>Goals for projects in the environmental field:</td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td>To support processes that involves the affected constituencies in the planning, management and implementation of strategies achieved preferably through consensual processes.</td>
</tr>
<tr>
<td>(2)</td>
<td>To support research projects that increase scientific understanding, the need and methodology of which are seen by the affected constituents to be well founded.</td>
</tr>
<tr>
<td>(3)</td>
<td>To support representative, non-government organizations to develop, facilitate and help implement the resource management elements of sustainable development plans.</td>
</tr>
<tr>
<td>(4)</td>
<td>The development and delivery of training programs for First Nations and other communities who are or will become involved in the management of natural resources</td>
</tr>
<tr>
<td>(5)</td>
<td>To support activities and projects that address broad watershed and marine issues in a cross-sectoral manner.</td>
</tr>
</tbody>
</table>

**Funding Information:** Organizations should have at least 50% of their funding in place before they apply. No information is provided for budget or grant request limitations. Contact information is available on website.

**Website:** [www.vancouverfoundation.bc](http://www.vancouverfoundation.bc)
Corporate Funding Sources:

Corporate funding sources are defined as any source of funding from a corporate entity.

Corporate Funding Source 1

<table>
<thead>
<tr>
<th>Source Name</th>
<th>BC Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund/Grant</td>
<td>Bridge Coastal Restoration Program (BCRP)</td>
</tr>
<tr>
<td>Focus/Mission</td>
<td>To restore fish and wildlife populations and habitat in watersheds impacted by the construction of hydroelectric generation facilities in BC Hydro’s Bridge River Coastal Generation area. These 15 watersheds are located through the Fraser Valley, Vancouver Island, Coastal, Bridge River, and Shuswap areas.</td>
</tr>
<tr>
<td>Eligibility and Selection Criteria:</td>
<td>The application process is open to any individual or group. Potential applicants include: (i) individuals, (ii) community groups; (iii) municipal, provincial, or federal governments; (iv) corporations; (v) First Nations; (vi) educational institutions; (vii) consulting companies. Eligible projects must: (i) be located in one of the 15 watersheds covered by the program; (ii) address footprint impacts and limiting factors; (iii) be scientifically supportable; (iv) meet information requirements and formats specified in application package.</td>
</tr>
<tr>
<td>Funding Information:</td>
<td>The BCRP will provide $1.5 million in annual funding for fish and wildlife projects. There is no funding limit to projects on an annual or multiyear basis. However, projects requesting BCRP funding in excess of $100,000 as a one-time cost, or in excess of $200,000 on a multi-year basis will be viewed as special circumstances.</td>
</tr>
<tr>
<td>Website:</td>
<td><a href="http://www.bchydro.bc.ca/bcrp/">www.bchydro.bc.ca/bcrp/</a></td>
</tr>
</tbody>
</table>

Corporate Funding Source 2

<table>
<thead>
<tr>
<th>Source Name</th>
<th>BC Hydro</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fund/Grant</td>
<td>The Peace/Williston Fish and Wildlife Compensation Program</td>
</tr>
<tr>
<td>Focus/Mission</td>
<td>To enhance and protect fish and wildlife within the watersheds of the Williston and Dinosaur reservoirs.</td>
</tr>
<tr>
<td>Eligibility and Selection Criteria:</td>
<td>The application process is open to any individual or group. Potential applicants include: (i) individuals, (ii) community groups; (iii) municipal, provincial, or federal governments; (iv) corporations; (v) First Nations; (vi) educational institutions; (vii) consulting companies. Eligible projects must: (i) be located in the Peace/Williston areas; (ii) sustain and enhance fish and wildlife populations; (iii) be consistent with the mandates and policies of both BC Hydro and the Ministry of Environment, Lands and Parks; (iv) use compensation funds effectively for the benefit of fish and wildlife in the program area; (v) provide the people who use and enjoy the fish and wildlife resources of the region an opportunity for input into the program; (vi) take a long-term view of providing benefits to the fish and wildlife resources of the area.</td>
</tr>
</tbody>
</table>
BC Hydro established a fund that has a current value of $23 million dollars to support the program. In fiscal 2000/2001 the fund provides $1.09 million for the fish and wildlife program in the watershed.

**Corporate Funding Source 3**

**Source Name:** Shell Canada  
**Fund/Grant:** Shell Environment Fund (SEF)  
**Focus/Mission:** To provide financial support for grass roots, action-oriented projects that improve and protect the Canadian environment.  
**Eligibility and Selection Criteria:** Any Canadian resident can apply on their own or on behalf of a service club, charitable or volunteer organization, environmental group, youth group or others. Eligible projects are those that propose innovative, action-oriented ways of improving and protecting the Canadian environment. SEF will not support lobbying and advocacy activities, operating or general expenses for an organization, large projects requiring significant funding where SEF funding is a small part of overall project costs, conferences and workshops, or individual research projects.  
**Funding Information:** Any individual or group can only receive a grant once for any single project. SEF provides grants up to $5000 per project.  
**Website:** [www.shell.ca](http://www.shell.ca)

**Corporate Funding Source 4**

**Source Name:** Mountain Equipment Coop (MEC)  
**Fund/Grant:** Environment Fund  
**Focus/Mission:** The objectives are: (i) to protect the outdoor environment in areas having significant recreational or wilderness value to MEC members; (ii) to educate MEC members in environmental issues and to enhance their awareness, concern, and support for the environment; and (iii) to promote the safe and environmentally conscious use of MEC products in outdoor recreation activities.  
**Eligibility and Selection Criteria:** All projects must: (i) support environmental and/or conservation goals; (ii) not be designed for profit purposes; (iii) have goals that are attainable within the fiscal year; and (iv) involve volunteers. The categories for projects supported by MEC are (categories have been edited to retain only sections relevant to dam decommissioning and habitat studies):  
(1) Land acquisitions for conservation  
(2) Projects that educate the public on environmental issues  
(3) Advocacy and education projects which advance conservation or environmental causes  
(4) Environmental research projects
Funding Information: MEC will dedicate up to 0.4% of each previous year’s gross sales towards financial support of the Environmental fund. For land acquisition, the grants will be up to an aggregate of $100,000 annually. For other areas, the range for grants is generally from $2000 to $10,000. Grant applications are reviewed three times per year on January 31st, May 31st and September 30th.

Website: www.mec.ca

Corporate Funding Source 5
Source Name: Toronto Dominion Bank
Fund/Grant: Friends of the Environment Fund (FEF)
Focus/Mission: To provide support for worthwhile community-based initiatives that make a positive difference to the Canadian environment. The FEF vision that when people join together, every positive action, no matter how large or small, contributes to the overall health of our environment

Eligibility and Selection
Criteria:
(1) Protects and preserves the environment
(2) Assists young Canadians in understanding and participating in environmental activities in local communities
(3) Enhances partnerships among environmental organizations
(4) Takes place within the geographic scope of the Community Fund chapter.

Funding Information: Applications for the Fund are reviewed throughout the year. No information is provided for annual budget or grant request limitations.

Website: www.fef.ca