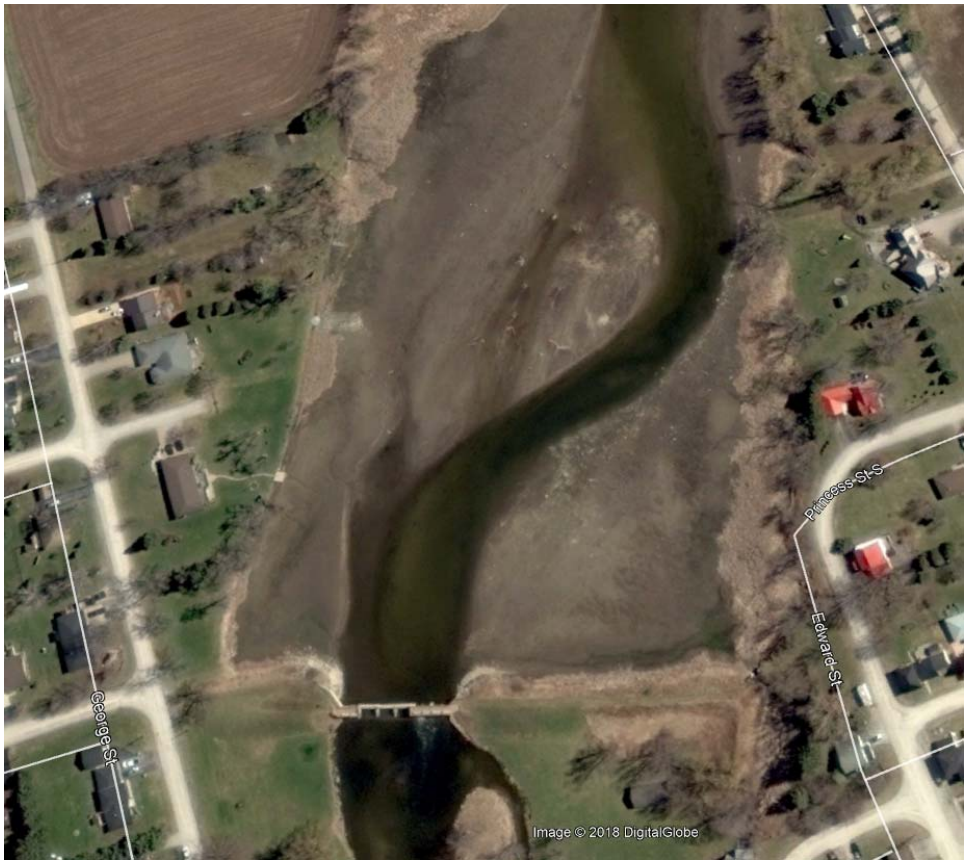
MVCA GORRIE DAM FUTURE PLANS STUDY

November 2018
Project #18-494



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In June 2017 the emergency spillway at the Gorrie Dam was exceeded by floodwaters which washed out parts of the earthen berm and damaged parts of the concrete infrastructure. The Maitland Valley Conservation Authority (MVCA) is now considering three alternatives for the site:

- Decommissioning of the current structure
- Repair the current structure
- Replacement/redesign of a new structure

Generally, dams in Ontario are regulated by the province under the Lakes and Rivers Improvement Act (LRIA). LRIA provides the Minister of Natural Resources and Forestry (MNRF) with the legislative authority to govern the design, construction, operation, maintenance and safety of dams in Ontario.

The Ontario Environmental Assessment Act sets out a planning and decision-making process so that potential environmental effects are considered before a project begins. Class Environmental Assessments (Class EAs) apply to routine projects that have predictable and manageable environmental effects. Works at the Gorrie Dam may follow a Class EA process.

To assist with the decision-making process, comply with regulatory requirements for dam safety and address possible environmental effects of the works, several studies must be completed. The key studies focus on assessing the risks associated with the existing dam and its ability to hold back water and safely convey large flow events. These studies are typically completed as part of a Dam Safety Review which is reviewed by the MNRF under the regulatory requirements of the LRIA. They are typically completed by water resources, structural and geotechnical engineers. These studies would not only support the decision-making process, but may also be used to secure approvals and work permits for any proposed works.

Review of the available information and an engineer's report in 1974, when the dam previously failed, strongly suggests that the dam likely does not meet today's dam safety standards. This would likely still be the case even if the failed section was repaired. This conclusion would have to be confirmed and defined for MNRF review in terms of the Hazard Potential Classification (HPC) and the Inflow Design Flood (IDF). Should the dam be confirmed not to meet current standards, the repair to the dam will likely be significant and approach the cost for constructing an entirely new dam.

Since the level of study to assess the condition of the existing dam may not be too significant, other studies will be required to assist in the decision making process. These

studies are typically completed as part of the Class EA process. These studies will examine the net negative impacts associated with the following:

- Natural Environmental Considerations
- Land Use, Resource Management Considerations
- Social, Cultural and Economic Considerations
- Aboriginal Communities Considerations

Should the preference or decision be made to rebuild or construct a new dam, then a detailed level of study would be required to ensure the works meet current regulations and environmental standards. Currently, the most contentious issues at the Gorrie dam appear to be associated with the social, cultural and economic considerations associated with the dam.

If the removal of the dam is the preferred course of action, then less study would be required. This in part is due to the most significant concerns associated with possible dam failure have already occurred. Even with the dam in its current breached state, some study is required, as the remaining dam, as defined by the LRIA, still presents a risk to public safety and a hazard to private and public property.

Table A summarizes the cost for studies to be completed for each of the three options under consideration. A preliminary cost estimate is also provided for the implementation of each option.

Table A: Cost Estimate of Dam Alternatives

OPTIONS	COSTS ($1000)		
	Studies	Implementation (Engineering & Construction)	Total
Decommissioning of the current structure	32 -115	380 – 750	435 – 910
Repair the current structure	132 - 250	1,100 - 1,720	1,300 -2,074
Replacement/redesign of a new structure	142 - 275	2,000 - 3,000	2,260 – 3,455

This Study has not examined the “Do nothing” option. This option would have to be examined as part of the Class EA process. The cost presented also do not represent the full life-cycle costs associated with the dam (i.e. long-term operations and maintenance). Other cost not included are those associated with potential accidents (insurances) or a future dam failure or changes in property values (increase and / or decreases).

MVCA GORRIE DAM FUTURE PLANS STUDY

1.0 INTRODUCTION

In June 2017 the emergency spillway at the Gorrie Dam was exceeded by floodwaters which washed out parts of the earthen berm and damaged parts of the concrete infrastructure. The Maitland Valley Conservation Authority (MVCA) is now considering three alternatives for the site:

- Decommissioning of the current structure
- Repair the current structure
- Replacement/redesign of a new structure

The decision to remove or replace a dam is a site-specific issue. The issue is complex because of competing values and competing regulatory issues, and therefore the decisions require careful planning and review. To be effective and credible to managers, decision makers, and the public, a removal project needs to be informed by science, including social, economic, and environmental data. Sometimes the best available science is not enough, and additional investigations are needed. Decisions about dam removal or reconstruction take place in specific economic and social contexts that also need to be considered. The decision-making process for dam removal is most effective when they are well organized, open, and inclusive of all the people in the affected communities (Heinz, 2002)

Greck and Associates Limited (Greck) were retained to assist the MVCA with their decision-making process by providing:

1. A report which defines the scope of work and fees for the following studies:

    - Requirement to satisfy the Lakes and River Improvement Act. (LRIA);
    - Engineering studies;
    - Environmental studies;
    - Geotechnical studies;
    - Public and agency consultation requirements;
    - Current standards requirements; and

2. Providing a ballpark cost estimate for each of the primary alternatives.

This study has not examined the “Do Nothing” option which will have to be examined as part of a Class Environmental Assessment, should future works and the Gorrie dam proceed under this process.

2.0 SCOPE OF WORK

The following report was prepared by completing the following tasks.

1. Collect and review of background information on the dam and head pond.

2. Meet with the MVCA and conduct a site visit.

3. Contact the local MNRF district and regional offices to obtain any additional background information and to confirm LRIA requirements.

4. Review MVCA/Conservation Authority Class EA requirements.

5. Identify goals, objectives, general scope of work, and key deliverables for key studies including but not limited to:
    a. Engineering studies (water resources, structural, geotechnical and civil)
    b. Environmental (natural heritage, ecological, terrestrial, fishers, fluvial geomorphic)
    c. Surveys (topographic, bathymetric, sediment sampling)
    d. Cultural / Aboriginal communities assessments

6. Prepare concept plan and range of cost for each alternative under consideration

7. Prepare a draft and final report

This report summarizes the work completed by this study. For each of the three alternatives the following items were considered:

- The scope of work required for each technical study,
- The estimated fee to undertake these studies,
- The timeline for completing these studies, and
- The cost estimate to implement the alternative.

3.0 BACKGROUND

3.1 DAMS REVIEWS IN ONTARIO

Dams have been an important component of the development of Ontario. Large dams and their reservoirs continue to play an important role in supplying a safe and cost-effective source of hydroelectric energy, protecting our communities from flood hazards, and regulating water levels and stream flows in our lakes and rivers. There are more than five thousand dams and weirs in Ontario. The average life expectancy for most dams is about 50 years, while concrete elements of the dam may have longer lifespans. Most dams are privately-owned structures, typically under 3m in height. The remainder is owned by the federal and provincial government, Ontario Power Generation, and conservation authorities.

Many dams are approaching or have exceeded their normal life expectancy. They are in poor condition and no longer provide their originally intended function. They present risks to public safety, owner liability issues, and impacts to the natural environment. Most of Ontario dams in existence today were constructed for industrial (e.g. forestry, grist mill), flood control, hydroelectric power production and other uses such as water supply prior to the 1970's. Some have evolved to serve new functions. There are attempts to find alternatives uses for these structures including the development of small hydro sites.

While risks are greatest to the landowners, the impacts of dam failure can extend well beyond the legal property boundaries of the dam owner. Furthermore, the cost associated with maintaining operating and addressing the hazards associated with publicly owned dams supported through general tax levies can extend beyond those who may be directly impacted by or benefiting from the operation of the dam.

There a few different types of dams, however the most common in Ontario are gravity earth dams. Gravity dams are structures which rely primarily on their sheer weight to hold back water and their low centre of gravity to resist over turning. They are typically constructed from concrete and require sound foundations. Earth dams use natural materials such as earth or rock fill and are readily adapted to earth foundations. They are massive structures that require special attention to overtopping, seepage control (e.g. clay core), embankment slope stability and breaching around the sides.

Most small low head dams in Ontario operate as "run of the river "structures. Run of the river dam operations typically have minimal active storage capacity, and as such, the rate of flow out of a dam is equal to the rate of flow into the dam. With normal flow over or just below the spillway elevation, there is little active storage capacity to hold back water should upstream flows increase. These types of operations typically have normal water levels in the head pond flowing over the dam spillway or flowing through a sluiceway or

turbine with water levels just below the spillway. Run of the river operations can have different quantities of passive storage. Passive storage is the quantity of water which is permanently retained or held back by the dam. Passive storage is reduced with the age of a dam as it accumulates with sediments.

Without proper maintenance and operation, the potential for failure increases as dams continue to age. As the potential for failure increases so does the potential risks or threats to the loss of life, property damage and impacts to the natural environment.

The owners of these aging structures should consider one of the following courses of action:

- Rehabilitation and maintenance,
- Divest the dam to someone who can operate and maintain the dam,
- Decommission the dam, or
- Rebuild the dam.

Dam rehabilitation and maintenance requires a financial outlay for capital works and maintenance operations. These costs are considered normal and should be expected as an owner of the dam. If these required commitments cannot be achieved, then one of the other options should be considered.

While divesting the liability of a dam to a new owner may be considered as an option, the new prospective buyer would likely be concerned with the dam's condition and inherent liabilities and as such would likely influence the negotiations.

Economic issues are an important factor in deciding whether to decommission a dam or rehabilitate the dam. Once the associated costs have been identified through the decommissioning planning process, the decision to follow through will often depend on whether it is identified as the lowest cost alternative.

Rebuilding a dam may involve decommissioning of the old dam and the new dam would be subject to a rigorous review, approval and permitting process. The cost of this option would be significant.

As each dam site is unique, the specific economic factors influencing the decision to decommission a dam will vary from site to site. Common economic factors that should be considered include:

- Costs associated with rehabilitation or upgrades required to meet present-day dam safety standards.
- Threat of liability associated with an injury to a member of the public either boating, swimming, or fishing in proximity to the dam.

- Threat of liability associated with injury or property damage resulting from the failure of an unsafe dam contributing to high insurance premiums.
- Annual and periodic maintenance costs (life-cycle costs).
- Dam operating costs, and in some cases fishway operating costs.
- Social implications

3.2 DAM FAILURE, PUBLIC SAFETY AND REGULATORY REQUIREMENTS

The Ontario Ministry of Natural Resources and Forestry (MNRF) has the responsibility for overseeing the safe design, construction, operation and maintenance of all dams in Ontario. They provide standards and guidelines on how this is done and apply these standards in the management of their dams. Dam owners must seek Lakes and Rivers Improvement Act (LRIA) approval from the MNRF for any new dam construction, or for repairs, alterations, improvements or decommissioning of a dam. All dam owners whether public agencies, private corporations or individuals, have a responsibility to ensure their dams are safe.

Dam failures are often associated with failure of earth embankment dams, due to overtopping, foundation collapse, piping and seepage, see Figure 1. In Ontario, floods are perhaps the most significant events which threaten the safety of the dams. History of past dam failures shows that most dams have failed due to flood flows having exceeded their design capacity, and thereby exceeding the capacity of the spillways. Consequently, it is important to ensure that the service and emergency spillways have an adequate capacity to handle the flows arising from extraordinary rainfall. Damages to a dam and the increased risk of its failure often heighten the consideration to decommissioning the structure.

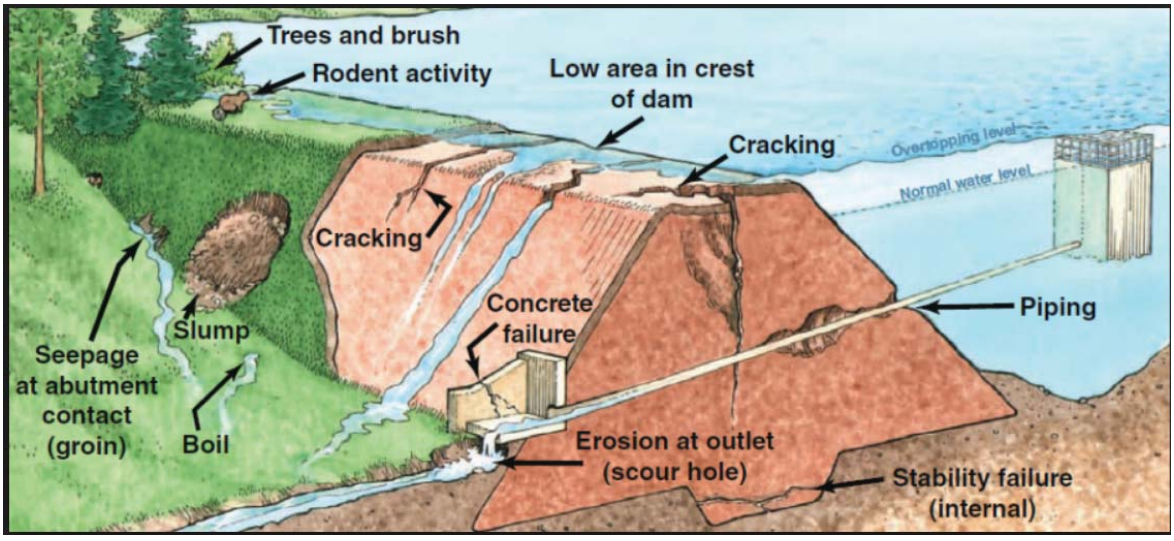

Figure 1:Modes of earth dam failure (USDA 2012)

Dam failures can present threats of loss of life and property damage. Recorded losses in the past have been very high, and as such, it is important to fully justify the need for dam owners to better understand the risks to the public posed by dams, the kinds of hazards that promote these risks and the reasons why dams fail.

Dam owners are responsible for any damages caused by the failure of the structure or because of poor operating or management practices. The best means for minimizing risk is to act with due diligence. Owners should be familiar with the operation, maintenance and inspection requirements of their structures and recognize that appropriate and timely operating and maintenance practices are essential to the safety and integrity of the structure.

Minimum dam safety standards in Ontario are outlined in the 2011 Dam Safety Review – Best Management Practices document (MNRF 2011). Insofar as MNRF guidelines and standards may not represent current engineering practice or address all design requirements, the MNRF provides flexibility for the design engineer to follow the most applicable standards.

3.2.1 Regulatory Requirements

The decision to modify, alter, construct or decommission a private dam by its owner is typically not a public matter. For these undertakings, there are several federal and provincial regulations that typically look after the public interests. For public agencies, the Environmental Assessment Act may be used to protect public interests. Figure 2 illustrates the wide number of acts involved with the implementation of works in natural channel systems.

Common Law / Riparian Rights

Owners of lands adjoining a river, stream or lake have certain rights related to the use of water. These rights arise from the ownership of the bank, that portion which adjoins the upland with the water itself. Riparian rights have been established from traditional Common Law. It may be said that the Common Law or the riparian rights are geared to simpler times where perhaps only an adjoining owner was affected by waters.

Today, water affects more than the rights of adjoining owners of land; therefore, it has been the practice to examine other statutory powers whenever there may be impacts or benefits for the public and often all downstream users. For this reason, Common Law or riparian rights are limited to some extent by federal and provincial legislation.

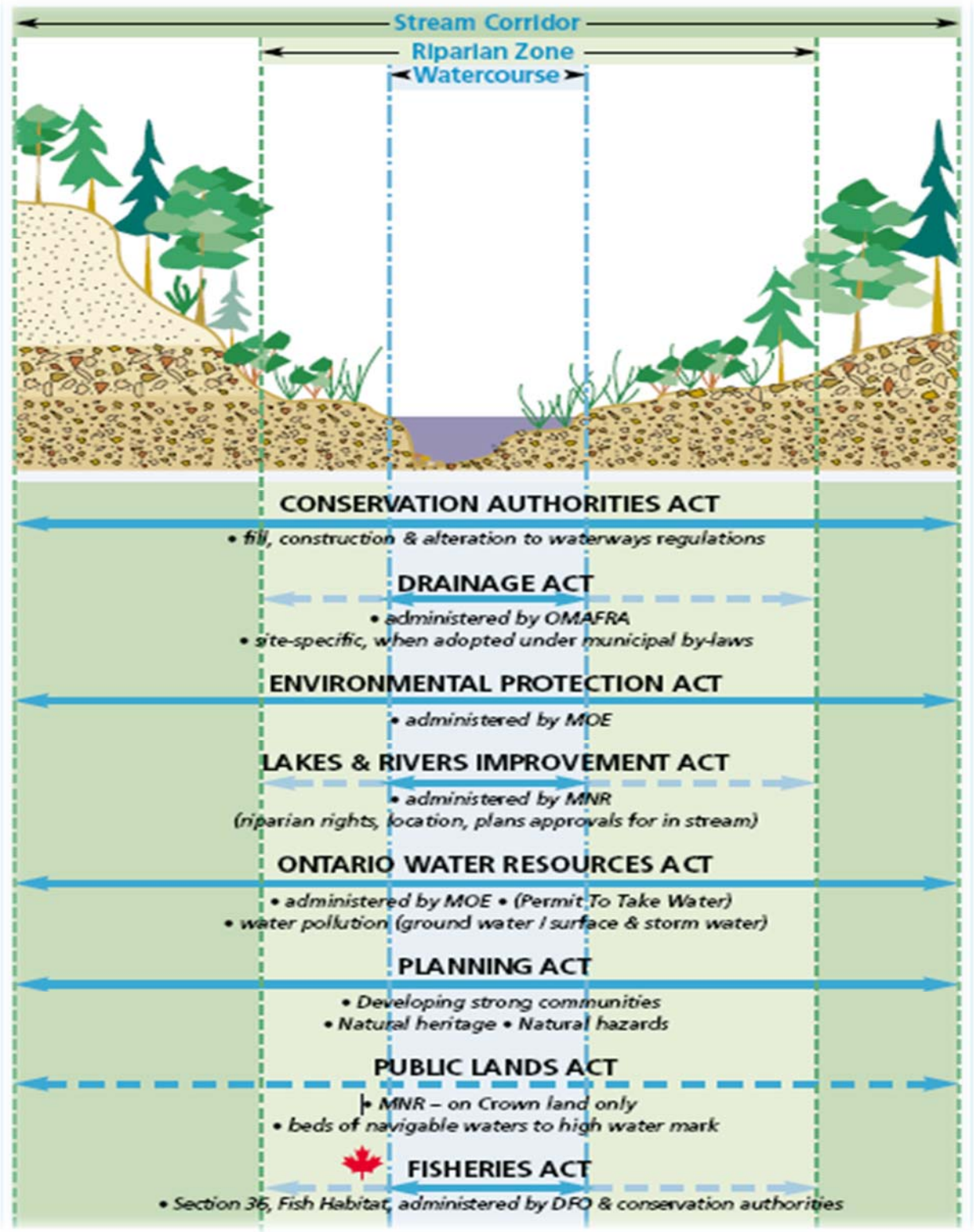

Figure 2: Acts Which Apply to the Protection and Management of Stream Corridors (MNR Natural Hazards Technical Guides)

Federal and Provincial Regulations

There are several federal and provincial regulations which must be considered when working around lakes and rivers. These regulations are required for public safety, mitigating damages to public and private property, and to address a number of environmental concerns including the protection of fish habitat, species at risk, water quantity and quality. As an owner of a dam, these regulations are a normal component in the operation of the dam including its decommissioning. The following list some of the federal and provincial acts and regulations and how they may apply to dam decommissioning, restoration and new construction.

LAKES AND RIVERS IMPROVEMENT ACT (LRIA) - ONTARIO MINISTRY OF NATURAL RESOURCES

Generally, dams in Ontario are regulated by the province under the Lakes and Rivers Improvement Act (LRIA). LRIA provides the Minister of Natural Resources and Forestry with the legislative authority to govern the design, construction, operation, maintenance and safety of dams in Ontario. The MNRF "Technical Guidelines and Requirements for Approval Under the Lakes and Rivers Improvement Act" includes a specific section related to the decommissioning of dams.

The Ontario Lakes and Rivers Improvement Act (LRIA) defines a dam as;

"a structure or works holding back or diverting water and includes a dam, tailings dam, dike, diversion, channel alteration, artificial channel, culvert or causeway.

LRIA Section 16 states that no person shall alter, improve or repair any part of a dam in the circumstances prescribed by the regulations, unless the plans and specifications for whatever is to be done have been approved.

The purposes of the LRIA are to provide for the:

a) management, protection, preservation and use of the waters of the lakes and rivers of Ontario and the land under them;
b) protection and equitable exercise of public rights in or over the waters of the lakes and rivers of Ontario;
c) protection of the interests of riparian owners;
d) management, perpetuation and use of the fish, wildlife, and other natural resources dependent on the lakes and rivers;
e) protection of the natural amenities of the lakes and rivers and their shores and banks; and
f) protection of persons and or property by ensuring that dams are suitably located, constructed, operated and maintained and are of an appropriate nature with regard to the purposes of clauses (a) to (e).

FISHERIES ACT - ENVIRONMENT CANADA

The goal of the Fisheries Act is to protect fisheries and fish habitat in both marine and inland waters. The Act prohibits activities that result in the harmful alteration, disruption, or destruction of fish habitat. The Fisheries Act is administered by the Department of Fisheries and Oceans Canada.

CONSERVATION AUTHORITIES ACT - DEVELOPMENT, INTERFERENCE WITH WETLANDS AND ALTERATIONS TO SHORELINES AND WATERCOURSES REGULATION

A principal mandate of Conservation Authorities in Ontario is to prevent the loss of life and property due to flooding and erosion, and to conserve and enhance natural resources. The Development, Interference with Wetlands & Alterations to Shorelines & Watercourses Regulation is a key tool in fulfilling this mandate because it prevents or restricts development in areas where the control of flooding, erosion, dynamic beaches, pollution or the conservation of land may be affected by development.

PUBLIC LANDS ACT - ONTARIO MINISTRY OF NATURAL RESOURCES

There may be matters under the Public Lands Act of Ontario which need to be considered such as ownership of the land in which the dam and/or head pond is located.

ONTARIO WATER RESOURCES ACT – MINISTRY OF THE ENVIRONMENT

This provincial legislation regulates the taking of water from an impoundment and the protection of water quality.

NAVIGABLE WATER PROTECTION ACT – TRANSPORT CANADA

The Navigable Waters Protection Act (NWPA) was originally intended to protect marine navigation routes by controlling the logging industry and the construction of bridges and dams. The primary purpose of the Act is to protect the public right of navigation. The construction or decommissioning of a dam is typically reviewed from the perspective of altering the existing known navigable conditions and the potential to create new navigable hazards.

ENDANGERED SPECIES ACT – MINISTRY OF NATURAL RESOURCES

This provincial act is administered by the Ministry of Natural Resources and Forestry. The purposes of this Act are to identify species at risk, protect species that are at risk and their habitats, promote the recovery of species that are at risk and promote stewardship activities to assist in the protection and recovery of species that are at risk. The construction or decommissioning of a dam could affect local Species at Risk (SAR).

ENVIRONMENTAL ASSESSMENT ACT - MINISTRY OF THE ENVIRONMENT

Some proponents, such as Municipalities and Conservation Authorities, may be subject to the Environmental Assessment Act through their responsibilities to their own Class EA process. Projects involving a 'Disposition of Rights to Crown Resources' require that the Ministry of Natural Resources ensure that there is EA coverage. Where the proponent is not subject to its own Class EA, the Ministry of Natural Resources will apply its Class EA for Resource Stewardship and Facility Development Projects. In situations where the project involves only private lands (i.e. both banks and the bed of the water body are private land) then there is no legal requirement to apply the MNR Class EA.

3.3 THE GORRIE DAM

3.3.1 Dam History

The Gorrie dam is located on the North Maitland River in the Village of Gorrie and Municipality of Howick, see Figure 3. It was originally operated constructed for the operation of a mill. The original mill building, and remnants of the former mill race still exists on the property. The dam is owned and located on lands owned by the Maitland Valley Conservation Authority (MVCA). The property is open to the public for passive recreational uses.

The following is a chronological summary of the dam's history prepared by the MVCA.

1. The original dam and sawmill were constructed in 1856 by the Leech Brothers.
2. The mill and dam were reconstructed in 1867 so that the mill could be used for grinding flour.
3. The dam was rebuilt in 1929 by Ben Maquire -6 concrete bays were added, one operational with flashboards, earthen works and millrace.
4. MVCA purchased the mill and dam in 1963.
5. The existing dam was repaired in 1970 by MVCA. Two more bays were made operational, stop logs were installed, the north wingwall was repaired, sediments were removed from the pond, and leaks in north earth bank were repaired.
6. In May 1974 the dam and earth berm were damaged by flood waters.The dam was overtopped, and portions of the earth berm/dam were washed out on the north and south side of concrete structure. The concrete structure was also partially undermined, See Figure 4 .
7. The Township of Howick and the MVCA received a petition from residents of Gorrie to repair the dam.
8. In 1976 B.M. Ross and Associates were retained by MVCA to provide a preliminary assessment of the structure and identify if it could be repaired.

9. In 1977 Dominion Soils were retained by MVCA on the recommendation of MNR to investigate the soil conditions under the dam site and within the existing earth dam.
10. B.M. Ross and Associates summarized the findings as follows:
    a. Soil investigations revealed that the dam site is located on pervious materials (silty sand and gravel deposits) which will ultimately lead to piping and loss of the foundation support. This could result in the failure of the structure.
    b. Similarly, the earth embankment fills have not been chosen for their impervious nature, contain pockets of topsoil, and are not compacted uniformly in place.
    c. The existing earth fill dikes and concrete spillway structures have not been constructed with acceptable engineering properties of soil strength, impermeability and resistance to piping. (Letter to MVCA from Ken Dunn, P.Eng. B.M. Ross: June 9/77).
11. B.M. Ross and Associates recommended that to prevent the potential for piping under the dam that a continuous sheet steel piling cut off wall be installed across the dam site. He advised that it would be very difficult to install such a wall at this site. Mr. Dunn concluded his letter by stating that in his opinion he didn't think that it would be economically feasible to make repairs to the existing earth dike and concrete spillway as recommended in the soils report. (Letter to MVCA, Ken Dunn, P.Eng. B.M. Ross and Assoc. June 9/77)
12. MNR's engineer concurred with Mr. Dunn's assessment of the findings of the soils investigation and stated in their report dated: June 7, 77 that: failure of the existing dam was bound to eventually occur due to the pervious soils underlying the structure.
13. They stated that a new dam would require sheet steel piling to be installed to a depth of 20ft on the upstream side of the dam/dikes across the full length of the structure (750ft) along with the construction of a new dike and/or concrete dam. They estimated the cost at $150,000 to undertake this work.
14. In 1978 MVCA's Board requested MNR's approval to undertake the bare minimum repairs to restore the dam.
15. In 1978 B.M. Ross and Associates were authorized by MVCA with the approval of MNR to develop engineering plans for a bare minimum approach to repairs. These repairs were to include only the following: reconstruct the abutment wall; pointing of the spillway; repair the breach in the dike with clay material, grouting of the scour holes and the inclusion of an emergency spillway design.

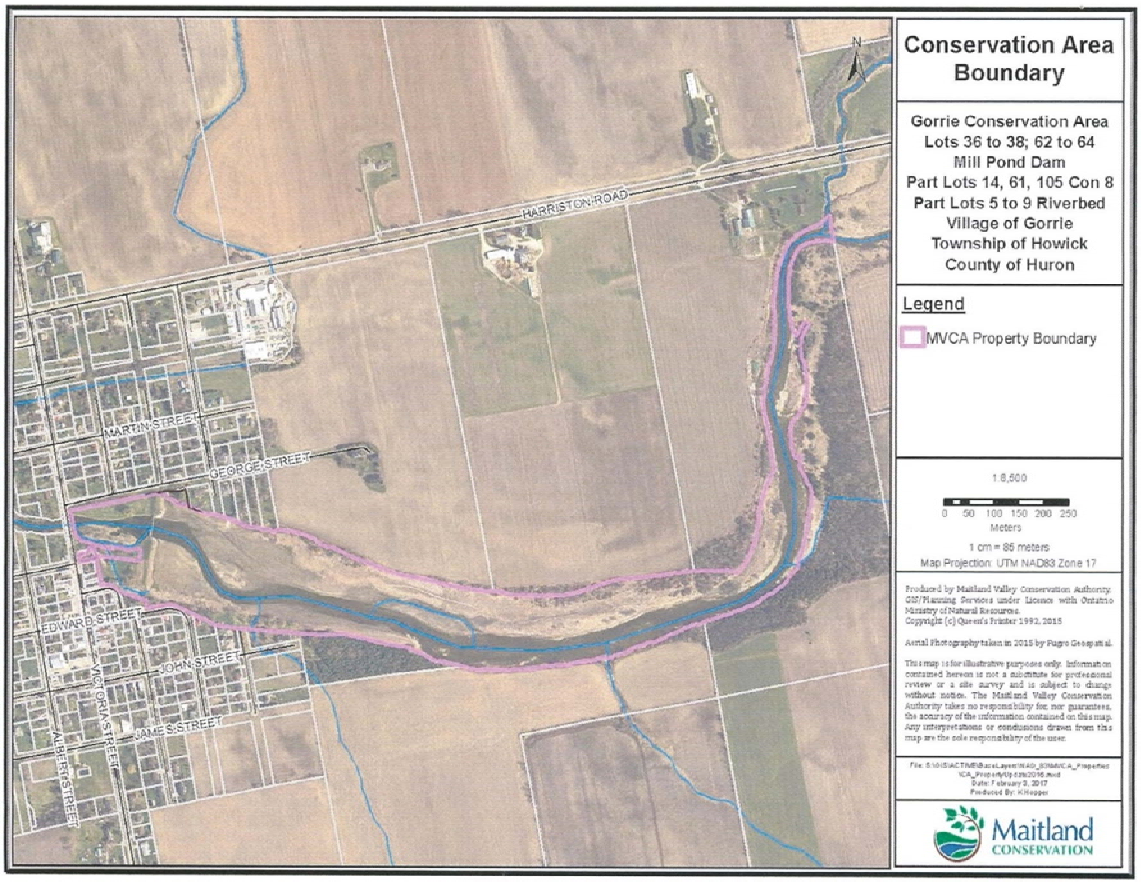

Figure 3:Gorrie Dam Location

Figure 4: 1974 Dam Failure

16. B.M. Ross and Associates advised MVCA and MNR that they would not be responsible for any future problems associated with insufficient capacity of the existing waterway opening of the existing dam and undermining and failure of the existing structure, if MVCA proceeded with the proposed repairs. (Letter to MVCA: Dec. 8/1978).
17. MVCA decided to undertake bare minimum approach to the repairs with the support of MNR in 1979. The estimated cost was $75,000.
18. Repairs halted in July 1979 due to the engineer identifying serious engineering deficiencies with respect to the southeast wingwall once the site had been dewatered. Forty feet of the concrete spillway was undermined, and water was discovered flowing underneath the dam from one side to the other. This discovery meant that the dam would be unstable under flooding conditions. The engineer provided several alternatives to try and rectify this situation.
19. Revised estimate of costs to repair the dam and dike system was approved by MVCA and MNR: $220,000. The additional repairs did not include the installation of sheet steel piling to prevent piping of water under the dam site.
20. Final cost of the repairs was $204,690, equivalent to $672,847 in 2017 dollars.
21. In 1980-1988 water seepage problems were encountered on the south side of the earthen berm. This area was a problem for seepage prior to 1974 and is suspected to be part of the original earthen berm construction in 1929. Engineers recommended the installation of 4" drainage tiles along the toe of the berm to take water seepage away and to monitor the situation. New clay material was placed at the south side of mill race entrance and partial replacement on the north side of mill race entrance to eliminate piping in 1981 and 1984. Water seepage remains a problem to this current day at the south berm. In 2016 and 2017 an increase in seepage was noted in two locations and monitored.
22. In June 2017 the dam was once again overtopped by flood water, see Figure 5. This time the flood water washed out the earth berm at the emergency spillway constructed after the dam breach in 1974. While the dam was breached, it did occur at the more controlled location of the emergency spillway. Parts of the concrete infrastructure also sustained some damages.

The dam currently operates as a run of the river system. The dam is not designed to function as a flood control facility. The dam water level is actively managed during high flow periods to prevent overtopping of the structure. This operation is coordinated with the adjustment of the Wroxeter Mill Pond dam (located 5.5 km downstream of the Gorrie), and at the Howson Dam in Wingham (located 16 km downstream of the Gorrie).

Figure 5: 2017 Dam Failure

The Howick Official Plan has identified the following:

- No significant wetlands are on the subject lands
- Proposes a Natural Heritage feature be identified for wildlife habitat
- Classifies the system as supporting warm water aquatic habitats however also includes migratory salmonids
- Defined the area as Valley lands and
- Part of Natural Heritage system

The MVCA currently has several operational concerns including:

1. There has been no Environmental Assessments or Dam Safety Reviews completed on the structure.
2. Operations to control flows at the dam must be done in sequence with the dams in Wroxeter and Wingham. Releasing water from the Gorrie dam can influence the dam operations at Wroxeter and Wingham. Wroxeter must be operated first in a high water event as it has greater effect from the Gorrie dam due to its proximity.
3. Operation of the stop logs is limited during high flows. Cables can break when trying to lift stop logs (3 at a time) in high flows. Access to remove stop logs in the two south bays may not be possible in high water events due to safety and lack of access. It may not be possible to remove all boards in a high water event.

4. Operations are adjusted annually to consider fish passage of salmonids. Typically stop logs are installed just prior to May long weekend. Trout may still require flow to go back downstream, and one section would remain out.
5. There are capacity issues with the current design as the dam almost overtopped in the winter of 2008 when no boards were in place.

The MVCA has several current repairs and concerns regarding the dam structure including:

1. The instability of the earthen berm.
2. Ongoing seepage and piping of water through the dam
3. Infiltration of water through cracks in sections of the north wall
4. The need for parging and repairs to concrete at several areas of the dam.
5. the need for replacing an existing gabion wall
6. the loss of anchor to support the steel beam channel used for stop logs
7. The discharge of stream flows through the park (picnic shelter location) since the erosion of the emergency spillway erosion. This has also led to ice damage occurring during winter months.

3.3.2 Dam Structures and Operation

The Gorrie dam is a gravity dam. It consists of both an earthen dam, berm or embankment and a concrete dam. On the concrete structure wooden stop logs are used to control flow past the two sluiceways. It has a concrete spillway and had an emergency spillway on a portion of the earthen dam. The sluiceway is opened annually to facilitate passage of migratory trout and salmon and to facilitate ice flows and passage of the spring freshet. The Maitland River is noted for it high-quality coldwater migratory steelhead fishery. This annual operation tends to flush out a portion of the accumulated sediments.

During times of reported high flows, the MVCA implements coordinated measures to regulate the operation of three dams. These operations primarily consist of manual removal or placement of wooden stop logs.

3.3.3 Dam Head Pond

The head pond (pond of water created by the dam) is relatively narrow, and the backwater extends for a considerable distance upstream. The pond primarily lies in rural farmland with the exception of residential lots in the Village of Gorrie.

4.0 STUDY REQUIREMENTS

Making decisions related to the future of existing dams has increased in recent years. This has come about due to;

- The state of their conditions;
- An increase awareness of responsibilities as a dam owner;
- Increased understanding of the environmental impacts associated with dam;
- Increased enforcement of legislation associated with dams;
- Use of dams as a renewal energy source and
- The failure of structures.

Making the best decision has not been easy for many communities, public agencies, regulators and stakeholders. The decision-making process requires science-based information and public consultation to develop consensus amongst all parties involved.

To help make the best decision several studies must be completed. These studies are required to assess the various issues of concern related to:

- Engineering (e.g. water resources, structural, and geotechnical)
- Environmental (e.g. terrestrial and aquatic ecology, fluvial geomorphic);
- Social (e.g. Public and private interests and public agency mandates);
- Economic

These studies can be used to support the decision-making and design process, facilitate the public consultation process, obtain a variety of regulatory approvals and to secure work permits.

The following sections present a general discussion of the most common studies. Included is a brief description of the study and the scope of work as it pertains specifically to the Gorrie Dam. An estimated range in the costs is provided for the completion of the studies. The scope of works is described for each of the three alternatives and is based on the current condition of the dam and its head pond.

This report assumes that any proposed plans to undertake works for either of the three alternatives at the Gorrie dam will require at the minimum approval under the LRIA, EPA, Fisheries Act, and Ontario Regulation 164/06 (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation) and Environmental Assessment Act (Class EA process).

The information presented is not intended to be complete or a thorough description of the entire scope of work or list of studies which may be required. For example, the following

factors will influence the need for additional studies and the scope of work which may be completed within any study:

- Specific issues of concern may be of less or more importance than is currently known or fully understood at this time by the public, agencies and other stakeholders or interest groups, (e.g. recreational uses of the head pond, boating, angling, skating, bird watching etc.),
- Unique features and characteristics of the dam and its head pond may be unknown and require study (e.g. potential for increased salmonid spawning habitat).
- The scope of work may not be as significant as with other dam projects due to the current breached state and potential support that can be provided other regulatory agencies.
- Studies may reveal limitations or gaps with existing information or raise issues with currently not fully understood (e.g. cascade dam failure impacts).

The information provided is intended to support the timing and financial planning process for the MVCA to decide on the future of the dam. These studies will also facilitate consultation with the public and other stakeholders. A summary of these studies is illustrated in Table 1.

The studies presented below have been generally organized into two basic categories, those which are essential under the LRIA, and those which may be used to support a Class Environmental Assessment process. The LRIA studies have been initially listed, as this tends to be the lead act from which the need to considered other legations may be triggered.

Many of the studies complement each other and are required as part of or to support other studies. As such, some studies may be required prior to the completion of others and some are not complete until other studies have been prepared. To understand each study, they are presented independently.

Cost estimates have been prepared to carry out each study. The cost for any given study will vary with the availability of information, the scope of work required, and the methodologies used. The cost for these studies will also depend on whether they are completed separately or in combination with other studies. For these reasons, a low and high cost estimate has been provided.

The studies may be completed at various levels of detail, starting with very basic assessments and then expanded, as necessary, based on the findings and outcomes. For example, detailed hydraulic analyses may not be necessary unless there is decision to rebuild the dam. As such, a very basic hydraulic analysis may be all that is necessary to support the option for dam decommissioning and to discuss the feasibility for rebuilding

and new dam construction options. By taking this approach, the costs for completion of the studies may be better managed and controlled. This approach, however, may result in a greater time to complete all studies and extend the period as to when a final decision can be made.

4.1 DAM SAFETY REVIEW

A Dam Safety Review (DSR) is a systematic review and evaluation of all aspects of design, construction, maintenance, operation, and surveillance, and other factors, processes and systems affecting a dam's safety. A DSR is not mandated in Ontario, and there is no regulation requiring that such a study be completed. The MNRF has identified the use of a DSR as a best management practice for owners of dams. The review defines and encompasses all components of the "dam system" under evaluation (including the dam, spillway, foundation, abutments, reservoir, tailraces, etc.). The evaluation should be based on current knowledge and standards, which may be different from the acceptable standards at the time of original construction or a prior DSR. (MNRF2011).

A DSR is used to demonstrate that the dam is safe, operated safely and is being maintained in a safe condition, and that surveillance is adequate to detect any developing safety problem (MNRF 2011). It may also be used to identify safety decencies and areas where improvements are required to improve the dam's safety

The Gorrie Dam has experienced two significant failures one in 1974 and more recently in 2017. After the first documented failure, an engineer's report in 1978 warned of the potential for a repeated failure. For these reasons, the safety of the Gorrie dam should be a serious consideration.

A detailed DSR of the Gorrie Dam to current MNRF Best Management Practices recommendations has not been completed. The MNRF recommends that every ten (10) years the dam should be reviewed to determine its Hazard Potential Classification (HPC) and if Classified as having a high to very high classification then a detail DSR should be completed.

The scope of work within a DSR encompasses several different investigations and studies. The information in these studies is used to draw conclusions on the safety of the dam. These studies can be completed independently and subsequently used as part of DSR.

Table 1: Gorrie Dam Cost Estimate for Studies and Implementation of Options

STUDIES	Relative Priority	REMOVAL			REPAIR			REPLACE		
		Complete Removal of existing earthen dam and concrete structure. Restoration of site to natural riverine conditions including minor works to restore flood plan and channel system.			Assumed the reconstruction of the failed section of earth dam and utilizing the existing structure(s) would not be adequate to satisfy LRIA. At a minimum an additional new flow control structure would be required to better handle high flood flows.			Assumed none of the existing dam would be salvageable and that a completely new earth and concrete dam would be required either at the exact location or within proximity to the existing dam.		
		Scope of Work	Cost Low	Cost High	Scope of Work	Cost Low	Cost High	Scope of Work	Cost Low	Cost High
LRIA - Dam Safety - Plans and Specifications Approval										
Geotechnical Investigations	Must do as part of a Dam Safety Review	Limited Work Required. May need to know the soil characteristics for offsite disposal	$ -	$ 10,000	Earthen dam soil properties, dam seepage, slope stability etc.. Existing data suggests poor soils for earth dam and foundation soils.	$ 15,000	$ 25,000	Soil in earthen dam, foundation soils for structures several locations, dam seepage, slope stability	$ 15,000	$ 30,000
Dam Structural Assessments	Must do as part of a Dam Safety Review	Limited Work Required. May need to know dam structural design and materials for demolition purposes and offsite disposal.	$ -	$ 5,000	Integrality of existing structure, expected remaining life span, sluiceway, spillway, operational controls, Need to assess alternatives for an additional structure etc. Excludes detail design	$ 15,000	$ 30,000	Limited Work Required for demolition of the existing structure. Need to asses alternatives for a new dam, sluiceway, spillway, operational controls etc. Excludes detail design.	$ 5,000	$ 15,000
Dam Operations, Review Records, Historical and Future Requirements	Must do as part of a Dam Safety Review	Limited or Not Required	$ -	$ 5,000	Historical use(s), past failures, accidents need to be assessed	$ 5,000	$ 10,000	Historical use(s), past failures, accidents need to be assessed for design of new dam	$ 5,000	$ 15,000
Watershed Hydrology	Must do as part of a Dam Safety Review	Limited assessment may be required. Primarily required to determine the HPC for the dam and for water and flood risk management during period of dam removal.	$ 10,000	$ 15,000	Detailed assessment required. Flood hazard flows including return period events, regulatory flood, historical flood, maximum probable flood, inflow design flood. For environmental considerations base flows, minimum environmental flow, bankfull flow	$ 20,000	$ 30,000	Detailed assessment required. Flood hazard flows including return period events, regulatory flood, historical flood, maximum probable flood, inflow design flood. For environmental considerations base flows, minimum environmental flow, bankfull flow	$ 20,000	$ 30,000
River and Dam Hydraulics	Must do as part of a Dam Safety Review	Limited assessment may be required. Primarily required to determine IDF and HPC for the dam and for water and flood risk management during period of dam removal.	$ 10,000	$ 15,000	Water levels and flood risks required for return period events, regulatory flood, historical flood, maximum probable flood, inflow design flood. Dam break analysis shown separately. Operational review of existing flow control structures including sluiceways, spillways, water taking. Determine the IDF and HPC. Requires prior completion of Watershed Hydrology Study.	$ 20,000	$ 30,000	Water levels and flood risks required for return period events, regulatory flood, historical flood, maximum probable flood, inflow design flood. Dam break analysis shown separately. Operational review of proposed flow control structures including sluiceways, spillways, water taking. Determine the IDF and HPC. Requires prior completion of Watershed Hydrology Study.	$ 20,000	$ 30,000
Dam Break Analysis and Hazard Potential Classification	Must do as part of a Dam Safety Review	Dam break analysis likely not required or at most a qualitative assessment. HPC required.	$ -	$ 5,000	Detailed hydraulic analysis for various flood events. Must include cascade dam failure analyses due to dam in Wroxeter. Requires prior completion of River and Dam Hydraulics Study.	$ 10,000	$ 15,000	Detailed hydraulic analysis for various flood events. Must include cascade dam failure analyses due to dam in Wroxeter. Requires prior completion of River and Dam Hydraulics Study.	$ 10,000	$ 15,000
LRIA - Location Approval										
New Dam Location Study	Only Required if a new dam location is under consideration	Not Required	$ -	$ -	Not Required	$ -	$ -	LRIA requires a separate study to obtain approvals for the location of a new dam. Follows MNRF RSFD Class EA	$ 47,000	$ 110,000
Class EA/Environmental Studies										
Fluvial Geomorphology Study	Good to complete the Class EA process	Limited Work Required. May need to know impacts to downstream and upstream channel stability due to changes in hydrology and sediment transport.	$ -	$ 5,000	Limited Work Required. Need to assess impacts existing and additional flow control structure will have to channel stability. Need to know impacts to downstream and upstream channel stability due to changes in hydrology and sediment transport.	$ 5,000	$ 10,000	Completed as part of New Dam Location Study		
Aquatic Resources and Fish Habitat Study	Good to complete the Class EA process	Conservation of fish habitat and fish migration and passage. Federal Fisheries Act	$ -	$ 5,000	Conservation of fish habitat and fish migration and passage. Federal Fisheries Act. Update migratory fish passage procedures for additional flow control structure.	$ 5,000	$ 10,000	Completed as part of New Dam Location Study		
Water Quality Study	Good to complete the Class EA process	All water quality criteria, as established by the Ministry of the Environment for the protection of fish and other aquatic life should be met in a lake or river at the location of a dam both during and after construction. Limited or Not Required	$ -	$ -	All water quality criteria, as established by the Ministry of the Environment for the protection of fish and other aquatic life should be met in a lake or river at the location of a dam both during and after construction.	$ -	$ 5,000	Completed as part of New Dam Location Study		
Head Pond Bathymetry, Sediment Quantity and Quality Study	Good to complete the Class EA process	Limited Work Required. May need to know sediment load, quantity and quality that remains to be flushed over time.	$ 5,000	$ 10,000	May need to know what potential sediment load will be captured by the head pond long term operational purposes.	$ 10,000	$ 15,000	Completed as part of New Dam Location Study		
Wildlife Habitat	Good to complete the Class EA process	Howick Official Plan identifies valley lands and Part of Natural Heritage system for its wildlife habitat. Considerations required for the protection of wildlife that depends on lakes, rivers, and adjoining wetlands. Special consideration required for valuable, threatened or endangered species.	$ -	$ 5,000	Howick Official Plan identifies valley lands and Part of Natural Heritage system for its wildlife habitat. Considerations required for the protection of wildlife that depends on lakes, rivers, and adjoining wetlands. Special consideration required for valuable, threatened or endangered species.	$ -	$ 5,000	Completed as part of New Dam Location Study		
Natural Heritage Wetlands Study	Good to complete the Class EA process	The Howick Official Plan has identified no provincially significant wetlands or wetlands of local significance at the Gorrie dam pond. It does recognize that there are natural features including wetlands that boarder the head pond. Assess imparts to boarder wetlands.	$ -	$ 5,000	The Howick Official Plan has identified no provincially significant wetlands or wetlands of local significance at the Gorrie dam pond. It does recognize that there are natural features including wetlands that boarder the head pond. Assess imparts to boarder wetlands.	$ 5,000	$ 10,000	Completed as part of New Dam Location Study		
Historical and Archeological Study	Good to complete the Class EA process	Should consider due to the historical uses of the area.	$ -	$ 5,000	Should consider due to the historical uses of the area	$ -	$ 5,000	Completed as part of New Dam Location Study		
Fill, Construction and Alteration of Waterways	Good to complete the Class EA process	Ontario Regulation 164/06 (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation, Update regulatory flood plain with dam removal.	$ -	$ 5,000	Ontario Regulation 164/06 (Development, Interference with Wetlands and Alterations to Shorelines and Watercourses Regulation, Update regulatory flood plain with restored modified dam.	$ -	$ 5,000	Completed as part of New Dam Location Study		
Water Taking and Water Power Study	Good to complete the Class EA process	Full assessment of the impacts for temporary and or permanent water taking including power generation must be studied . Water taking subject to authorization by permit from the Ministry of the Environment (MOECC).	$ -	$ -	Full assessment of the impacts for temporary and or permanent water taking including power generation must be studied . Water taking subject to authorization by permit from the Ministry of the Environment (MOECC).	$ 5,000	$ 10,000	Completed as part of New Dam Location Study		
Navigable Waters Study	Good to complete the Class EA process	The Navigable Waters Protection Program (NWP) approval requirements of DFO/CCG.	$ -	$ 5,000	The Navigable Waters Protection Program (NWP) approval requirements of DFO/CCG.	$ 5,000	$ 10,000	Completed as part of New Dam Location Study		
Aboriginal Communities Consultation	Must do	Consult with Aboriginal Communities	$ 2,000	$ 5,000	Consult with Aboriginal Communities	$ 2,000	$ 5,000	Completed as part of New Dam Location Study		
Public Consultation	Must do	Managed by MVCA	$ 5,000	$ 10,000	Managed by MVCA + third party consultant (optional)	$ 10,000	$ 20,000	Managed by MVCA + third party consultant (optional)	$ 20,000	$ 30,000
SUBTOTALS										
Technical Studies	Essential to obtain LRIA Approvals		$ 20,000	$ 55,000		$ 85,000	$ 140,000		$ 122,000	$ 245,000
Environmental / Class EA Studies	Good to complete the Class EA process some manditory tasks		$ 12,000	$ 60,000		$ 47,000	$ 110,000		$ 20,000	$ 30,000
All Studies			$ 32,000	$ 115,000		$ 132,000	$ 250,000		$ 142,000	$ 275,000
Engineering Design		Detail design, permitting and inspection. Will include design drawings, design brief, water and sediment management plan. Excludes construction inspection and contract administration	$ 23,000	$ 45,000		$ 66,000	$ 104,000		$ 120,000	$ 180,000
Capital Costs		Mob and Demob, Water Management, ESC, earthworks, concrete removal and disposal, channel and floodplain restoration	$ 380,000	$ 750,000	Mob and Demob, Water Management, ESC, existing earth dam reconstruction, additional concrete dam, site restoration, optional new fish passage facilities and footbridge	$ 1,100,000	$ 1,720,000		$ 2,000,000	$ 3,000,000
TOTAL COST			**$ 435,000**	**$ 910,000**		**$ 1,298,000**	**$ 2,074,000**		**$ 2,262,000**	**$ 3,455,000**

In the interim of deciding what to do with the dam, even in its current breached state, it is still is functioning as a dam to some degree. Therefore, the MVCA may wish to examine some of the key studies which will identify the major risks the current dam presents to public safety, property damages, and environmental and economic impacts.

If the existing dam is to be reused in any way as part of a dam restoration option, then a detailed DSR should be completed for the Gorrie Dam. This would be necessary to adequately understand its deficiencies and the costs associated with its restoration to current standards. Completion of a DSR for the Gorrie dam would have to be completed based on it is current design, condition and operation. The general scope of work may include but not limited to:

1 Reviewing construction records;

2 Adequacy of the dam design to extreme events, floods and earthquakes for which the dam may or may not have been for;

3 Structural stability, seepage and erosion resistance of all portions of the constructed water barriers including their foundation, as well as any natural water barriers under normal and extreme loading conditions;

4 Spillways must be capable of discharging the design flows safely, be able to adequately pass the inflow design flood and to draw down the reservoir if required in an emergency;

5 Design and limitations of all gates, valves, intake flow control equipment and hoists, including controls, power supply and winter heating criteria, to ensure timely, safe and reliable operation.

6 Operating rules under various conditions, and their conformance with the design intent and criteria;

7 Adequacy of the as-constructed facilities to deal with special phenomena affecting safety (for example, debris, ice conditions and erosion) that may have been insufficiently considered at the time of design and construction as well as verification that they will function as and when required; and

8 Potential failure modes and criticality, and adequacy of design, construction and operation features addressing these failure modes.

If the existing dam was to be decommissioned or completely reconstructed it may not be necessary to complete all the various investigations and analyses necessary to draw the conclusions on the dam's safety. For example, at the Gorrie dam the two well-recorded

breaches along with a determination of the Hazard Potential Classification (HPC) and the Inflow Design Flood (IDF) will likely reveal the dam is not safe to current standards. This would have to be further reviewed with the MNRF, as risks will remain in the interim to the physical decommissioning of the structure or in the interim of constructing a new dam.

A significant component of a DSR is examining the potential for dam failure which could result in the sudden discharge of water causing risks to public safety and property damage. The assessment typically requires an examination of the dam by a geotechnical, structural and water resources engineers. Technical studies which may be used to support a Dam Restoration alternative may be used to support Dam Decommissioning or Dam Replacement alternatives. The scope of work for the DSR is covered by compiling the works and conclusions drawn from the studies discussed in the following sections

4.2 GEOTECHNICAL STUDY

Geotechnical investigations are primarily required to examine the stability of the earth dam or earth embankments, and the soils the earth and concrete structure are founded on. The examination is required to determine if the dam meets current dam safety guidelines and provides the required factors of safety. The analyses typically examine the soil bearing capacity, settlement, liquefaction, seepage and uplift.

These studies typically require field programs to obtain soil samples to asses soil properties and to assess groundwater conditions through the earthen portion of the dam. The field studies require supporting information on pond water levels, site topography and operational procedures. Operational procedures need to be reviewed as they can affect the stability of the earth structure. For example, rapid drawdown of water within the dam could result in high porewater pressure causing localized failures of the earth embankment within the head pond area.

A geotechnical report for the Gorrie dam was completed in 1977. This investigation revealed a number of limitations associated with the native soils and materials used to construct the dam. While the recent dam failure has not been directly associated with any soil investigations, the type and location of the dam failure appear to be strongly associated with soils associated with the earth dam.

If the dam is to be decommissioned a rigorous geotechnical assessment of the dam is likely not required. A general examination of the soil material types and quality may be required to select a suitable fill disposal location. While likely not a problem at the Gorrie dam, if the soils were for some reason contaminated special consideration would be required for a suitable disposal site. For this reason, soil quality samples should be examined.

If the existing dam is to be repaired, an updated geotechnical study would likely be required. The scope of work would consist primarily of a series of boreholes along and on either side of the dam to define soil properties and groundwater levels. This data would be essential to define soils present, seepage characteristics and slope stability of the earthen dam.

There is a strong chance that this geotechnical study would yield similar findings to earlier studies and indicate the existing earthen dam structure does not meet current standards. Should this be the case, then the repair of the existing dam would require reconstruction or replacement of the entire earth structure. Mitigative works may also be required to protect the soils on which the concrete structure is founded upon. Should this be the case then the study should provide recommendations for geotechnical improvements to the structure to meet current dam safety requirements.

If a completely new dam is to be constructed, two soil investigations would be required. The first investigation would be like that for decommissioning the existing dam with the exception that the soils may be examined for reuse in the construction of a new dam. The second investigation would be to examine soils and provide design recommendations for an entirely new dam. This second study could be quite extensive depending on the number of options available for relocation of the dam. A separate New Dam Location Study is required for approval under the LRIA, and soil samples will have to be collected at a number of potential dam relocation sites. The study would provide geotechnical recommendations for a new earthen dam structures at the preferred new location for a dam.

4.3 STRUCTURAL STUDIES

Structural studies are completed by qualified structural engineers and are primarily required to investigate, assess, and design the concrete portions of the dam. These structures are required to resist the hydraulic forces of water and sediments behind the dam and to provide the flow control functions for the dam including the sluiceway and spillway. They may include mechanical or operational elements such as low flow bottom draw pipes, public access, safety facilities, and fishways.

The existing structure is currently 89 years old and had repair works implemented in 1979. Concrete structures of this type typically have a lifespan of 75 years. While concrete elements may last longer, deterioration of concrete exposed to natural elements (water wind, freezing, ice jams etc.) should be expected. As such, while portions of the dam are relatively new, a significant portion has likely reached it safe life expectancy.

Typically, the structural investigations consist of a review of original design plans, visual inspections and in some case sampling of the concrete and operational steel

components. Structural assessment will examine the ability of the structure to withstand its own load and those imposed by hydrostatic forces.

If the dam is to be decommissioned, a rigorous structural assessment of the concrete dam structure is likely not required. A simple assessment may be required to determine the most appropriate method for its demolition, removal and disposal.

If the existing dam is to be repaired, then a more detailed assessment of the structure and recommendations for its repair will be required. This assessment would examine the remaining lifespan of the structure, condition of the concrete, and determine what, if any, concrete works would be required to extend the dams lifespan. There may also be a need to consider requirements for increasing the dam's hydraulic capacity from an operational perspective and for improving public access and safety.

Since the existing earth structure has already failed on two occasions, the concrete structure likely does not meet current hydraulic operational requirements. As such, the existing concrete dam will likely not meet the LRIA approvals. To address this operational limitation, the existing structure would have to be modified, but more likely a second concrete dam element will be required at the Gorrie dam. For this reason, a more detail structural design component would be required for this alternative. For the purposes of this study, the need to design a second concrete structure was considered in the Engineering Design costing section for alternative in Table 1.

If a completely new dam were to be constructed, a minor structural study would be required for the removal of the existing dam and more work would be required to determine the most suitable structural design for a new dam. The scope of study for a new dam will primarily consist of examining alternative structure types and the components which form the basic flow control and operational requirements. The cost for this scope of work is considered in Table 1. The costs for structural services to design the new structural elements are shown separately in the engineering design section.

4.4 HYDROTECHNICAL STUDIES

Qualified water resources engineers typically complete Hydrotechnical studies. These investigations include a variety of technical analyses including:

- Watershed hydrology
- River hydraulics
- Dam hydraulics
- Dam break analyses
- Inflow Design Flood (IDF) and
- Hazard Potential Classification (HPC)

These studies are an essential component to obtaining LRIA approvals for works at dams. They are not limited to supporting the assessment of flood hazards but are required to support geotechnical and structural studies for the design of any new earthen and concrete dams. These studies can be used to support environmental studies which may be required as part of the Class EA process. The hydrotechnical studies may be completed as separate studies, i.e. hydrology, hydraulics, or dam break or completed a single study due to the linkages between the analytical evaluations.

For an earth-fill dam, as in Gorrie, it is assumed that the dam will fail if the water level exceeds the impermeable crest of the dam for any length of time (MNR 2004). Therefore, hydrotechnical studies must be conducted to assess the impacts associated with an incremental increase in water surface elevation downstream due to the failure or mis-operation of the dam. The impacts are examined in terms of the potential for the loss of life, property damages, or adverse environmental impacts. This is conducted for a number of hydrological events and is used to define the Inflow Design Flood (IDF). The IDF is, therefore, the most severe flood for which the dam and its associated structures should be designed for.

4.4.1 Hydrology

Selection of an appropriate IDF for a dam is related to the HPC. The LRIA has minimum IDF criteria for dams based on the Hazard Potential Classification (HPC). The HPC assigned to a dam is a measure of the greatest incremental losses that could result from the uncontrolled release of water or stored contents behind a dam due to the failure of the dam or its appurtenances based on the worst-case but realistic failure condition (MNR, 2011). For example, if the dam is defined as having a “Low” HPC the minimum acceptable IDF is a flow event that somewhere between Regional Flood and half of the Probable Maximum Flood (PMF).

To identify the HPC and determine an appropriate IDF hydrotechnical studies must examine watershed hydrology for a wide variety of conditions. Typical flood flow conditions include events such as the 1:100 year, 1:1000 year, the Probable Maximum Flood (PMF), and regulatory flood (e.g. Regional Storm event).

Hydrotechnical studies may also include the assessment of flow conditions which support protection and restoration of local natural resources of importance. Typically, these flow regimes include those associated with more frequent flow conditions, for example baseflow and channel bankfull flow. Under more specialized conditions flows may be required for extended dry periods for flow augmentation and prolonged wet events for fish passage (e.g. 1:10 year 3-day delay).

While some basic flow information is currently available at the Gorrie dam, much of this data is from past studies and is incomplete and outdated. As such, a new set of watershed hydrology data would be required. The level of detail required varies with the alternatives under consideration at the Gorrie dam.

If the dam is to be decommissioned, a limited level of analysis would be required. Even with the dam in its current breached state, a basic level of assessment must be completed. The remaining dam is still considered functional under the LRIA. Therefore, there is still some level of risk to public safety, property damage and environmental impacts. At a minimum, approvals under the LRIA will require some basic quantitative assessment of the flood risks. Simple flow estimates can be used to determine how much water could be retained by a major storm event by the remaining structure and what the incremental increase in flood risks would be, should this remaining portion fail. This assessment would need to consider the current level of risks in the interim of its physical decommissioning.

Should the LRIA be interpreted to require a more detailed understanding of the conveyance and storage of various flood flow past the currently breached dam, then a new hydrologic model and flood frequency analyses will be required.

Issues related to low flows or bankfull flow are likely of limited concern over the short term, provided normal baseflows and bank full flows are not significantly altered. For example, this could occur if the existing outlet at the concrete dam become obstructed and a new channel forms at the breached location of the earth dam.

If the dam is to be repaired, then a number of very specific hydrologic events must be examined. These hydrologic events are critical to examining the risks associated with the dam failure. These risks must include a consideration for the expected remaining service life of the Gorrie dam and for any new additions to the existing dam. The assessment of risks to public safety, property damages and environmental impacts associated with the failure of the dam are used to define the dams HPC. These flow events are also used as part of the geotechnical, structural studies for the existing dam and for any new concrete flow control structure(s).

A wide range of hydrologic events must be examined in the assessment of dam failure this includes:

- 2 to 100 year return period design storms (50% to 1% probability of occurring annually)
- 1000 year return period storm (0.1% probability of occurring annually)
- Probable Maximum Flood (PMF) (0.0001% probability of occurring annually)
- Regulatory storm flood (Hurricane Hazel Regional Storm).

The scope of work typically requires the development of a deterministic hydrologic model for assessing design storm and historical floods, and statistical (regional flood frequency) analysis of existing river flow data. The LRIA has a number of guidelines and standards for the development of these flow events. The IDF will be defined to one of the hydrologic events. The IDF will need to be determined for the restored Gorrie dam as per the procedures outlined in MNR, 2011. The IDF should be used to make recommendations for the improvements to the dam such that it would meet approvals required under the LRIA.

If a new dam is to be constructed, the same hydrologic analyses used to asses the reconstruction of the dam would be required. The information would be used to design a new dam and the interim risks associated with the remaining structure.

4.4.2 River and Dam Hydraulics

The potential impacts or the flood hazard associated with the operation, and or failure of a dam are determined by examining the river response to the design and operation of a dam under various hydrologic event and during a dam break situation. Flood hazard elevations and flood areas are examined downstream, upstream and within the area ponding. Dam break analyses are also conducted during wet weather events and sunny day events.

Computer-based simulation hydraulic models are typically used to examine river hydraulics. There are a number of software programs available from which a hydraulic simulation model can be developed. Selecting the most appropriate software largely depends on the level of detail required, the complexity of flood hazards present, the availability of suitable data for modelling purposes and costs for model setup analysis and data interpretation. While most the most commonly used USACE HEC RAS operation is typically used under steady state flow condition, this methodology may not be adequate for assessing dam break scenarios and overland floodplain storage. In these types of analyses unsteady flow analytical methods will be required.

Next to having suitable hydrologic data, river hydraulic analyses rely strongly on the quality and accuracy of topographic data. This data is required to define the lands which may be impacted by the storage, backwater and control and release of flood water. It is also required in the development of the stage storage-discharge relationship for the dam's head pond. This relationship is important in assessing the operation of the dam and assessing the impacts associated with a dam break.

Therefore, the availability of suitable topographic data is very important requirement when examining flood hazards. Typically, in highly developed urban areas there is good information available for regulated floodplain areas managed by local conservation

authorities. This information, however, may not be adequate when examining the incremental increase in flood hazards associated with more extreme events such as 1:1000 year and the PMF. Typically, there is less detailed mapping in more rural areas as in Gorrie.

Obtaining suitable topographic data from sources such as LiDAR can be costly and take time to obtain. Careful consideration must be made to determine if this level of detail is required. For this reason, the hydraulic analysis may be completed in phases. The initial phase would assess the risks based on available information. If specific risks identified are critical to the decision making process, or for design proposes, then more detail LiDAR based information should be considered.

If the dam is to be decommissioned, then the level of hydraulic study required will be limited largely due to its current breached state. The analyses required would focus on developing an understanding of existing flood elevations upstream and downstream of the dam and demonstrating the changes which occur as a result of dam removal. These analyses would be used to interpret the risks associated with any work around or under the existing breach dam conditions. The analyses will also be used to assess changes anticipated in regulatory flood elevations as a result of complete dam removal. Since the dam is not used for flood control purposes changes to downstream flood hazards would not be expected but may need to be demonstrated.

Should the dam be reconstructed, a more detailed assessment of the dam operation and river hydraulics will be required. No suitable models currently exist for the Maitland River through Gorrie (Personnel commination's MVCA staff 2018). As such, a hydraulic model would be required. Since the Gorrie dam is located a few kilometres upstream of the Wroxeter Mill Pond dam, a cascading dam failure analysis may be required. In this type of analysis, the failure of the Wroxeter dam would have to be considered coincidently with and due to the failure of the Gorrie dam.

The model would have to include the hydraulic components of the existing dam to assess their performance and determine the HPC and IDF. Should the existing structure be determined to be inadequate, then the model could be used to determine and assess the performance of any dam improvements (i.e. modifications to the existing structure and or the addition of a second structure).

If an entirely new dam is to be constructed, then very similar analyses would be required as for the reconstruction of the existing dam. The primary difference is the analyses would be used to assess new dam alternatives. These analyses may be more extensive, as they would be based on different site conditions and would have to examine a wider variety of alternatives.

4.5 NEW DAM LOCATION STUDY

Under Section 14 of the LRIA for new works, two distinct approvals are required if a new dam is to be constructed:

1 Location Approval and

2 Plans and Specifications Approval.

The previous sections have discussed various elements related to plans and specification approval. A separate letter of approval is required for the location of any new dam. While applications may be submitted for simultaneous approval of each, it may be best to obtained location approval prior to completing a task for plans and specifications approval. As such, the implementation of a new dam requires considerably more time and costs.

The New Dam Location study requires considerably more work and touches on many of the environmental and social considerations that would be part of a Class Environmental Assessment process. Therefore, this study would be quite comprehensive and require contribution by a diverse team of professional engineers and scientists.

It is not likely that an entirely new dam within the vicinity of the existing dam would require the completion of a New Dam Location study, particularly if it were to be constructed with essentially the general purposes and same area of ponding (personal communications with MNRF staff, October 2018). If there was a need to relocate the dam more significantly, then a New Dam Location may be required. Should this be the case, there would be a considerable amount of information readily available to support this study. The need for this study would have to be discussed with the MNRF.

The greatest challenge with having to complete a New Dam study would be obtaining the necessary approval. Since the existing dam is somewhat grandfathered in its current location, has certain advantages over applying for an entirely new dam. For example, any impacts or alterations associated with the head pond will have already been accepted by the people and accommodated by the natural environment. Considerations for building an entirely new dam may result in impacts which are unacceptable to today's standards. Alternatively, since the existing dam is in such a poor state and the local soils have known to be not suitable for a dam or inherently costlier to support a dam, finding a new dam location may be a better longterm solution.

Further details regarding the completion of a New Dam Location Study are provided in Section 4 – Location Approval Requirements of in the LRIA Technical Guidelines – Criteria for Approval (MNR 2004).

The location approval study was established to provide for the adequate protection of natural resources, interests of riparian landowners, other uses, and natural amenities where a location for a dam, water crossing, or channelization is proposed on a lake or river.

The key elements of the new dam study include the following:

- Basic description of the proposed new dam
- The proposed water management plan
- Assessment of upstream impacts within the zone of influence
- Assessment of downstream impacts within the zone of influence
- Assessment of aquatic resources
- Waterpower (if a proposed function for the dam)

The upstream impacts assessment requires the following considerations:

- Work site and area to be flooded
- Natural amenities
- Water taking
- Navigable waters
- Historical and archeological sites
- Fill, Construction and alternative waterways

The downstream impacts assessment requires the following considerations:

- Flooding and erosion
- Total flow diversion
- Low flows
- Turbidity and sediments
- Consent or release from riparian owners

The assessment of aquatic resources requires the following considerations:

- Fisheries policy
- Features of lakes and streams
- Water quality
- Wildlife habitat

5.0 ENVIRONMENTAL ASSESSMENT PROCESS

5.1 BACKGROUND

The Ontario Environmental Assessment Act sets out a defined planning and decision-making process so that potential environmental effects are considered before a project begins.

The act applies to:

- Provincial ministries and agencies
- Municipalities such as towns, cities, and counties
- Public bodies such as conservation authorities and Metrolinx

Individual environmental assessments are prepared for large-scale, complex projects with the potential for significant environmental effects. They require Ministry of the Environment, Conservation and Parks (MOECP) approval. Works which might be implemented at the Gorrie Dam would not typically be considered significant enough for an individual environmental assessment.

However, works at the Gorrie Dam may require a class environmental assessment process (Class EA). The Class EA is a more streamlined self-assessment process. The Class EA's apply to routine projects that have predictable and manageable environmental effects. The proponent in a Class EA must:

- Prepare the class environmental assessment after having an approved Terms of Reference (TOR) and,
- Submit documentation to the MOECP for review and approval.

Ontario currently has Terms of Reference for eleven (11) class environmental assessments that cover routine activities. For the dam-related works that may be undertaken at the Gorrie dam there are two possible TOR which may be used for a Class EA processes including:

1 Conservation Authorities Class EA, and

2 MNRF -Resource Stewardship and Facility Development (RSFD) Class EA.

The Class EA document outlines the planning processes for each class of project, including:

- Public, government agency and indigenous community consultation,
- Assessing potential environmental effects,
- Assessing alternatives and,

- Required documentation.

The MVCA will be the proponent to undertake the works at the dam, so it would be logical to use the Class Environmental Assessment for Remedial Flood and Erosion Control Projects (Class EA). This Class EA sets out procedures and environmental planning principles for Conservation Authorities to follow to plan, design, evaluate, implement and monitor a remedial flood and erosion control project so that environmental effects are considered as required under the Environmental Assessment Act. This Class EA however, tends to focus on matters related to remediating flooding and erosion problems and therefore may not be considered one which is entirely suitable for works associated with the decommissioning, restoration and or replacement of a dam and its head pond.

Often the MNRF RSFD Class EA is considered a more suitable process to follow when working around dams. While it is similar in concept to the Conservation Authority Class EA, it tends to better fit the greater concerns and interests of proponents, stakeholders and public. While the MNRF may issue a LRIA approval this does not dispose the Crown to trigger its RSFD Class EA.

For the reasons described above, identifying the specific Class EA process may be difficult. What is more important, however, is to select a process which at a minimum follows the spirit of the Class EA process, as it is the process which helps resolve the issues associated with the intentions of a proponent and developing consensus amongst the various agencies, stakeholders and public.

For the purposes of this report, discussion is provided around studies which could be used to support the MNRF RSFD Class EA process. These studies could be equally applied for the completion of other Class EA processes or a planning process which simply follows the spirit of a class EA process.

Figure 6 illustrates the structure of the MNRF RSFD Class EA process. A key feature of this structure is a review task which categorizes the nature of the project and proposed undertaking. The categories determine the level of review and level of consultation required to evaluate projects.

Determining the most appropriate process to take is one the MVCA can undertake on its own or with help from others. This task does not need to be completed through public consultation. The MVCA may use the screening process to classify each of the three alternatives under consideration.

For example, if the MVCA believes the removal of the dam and restoration to a natural channel system would have low net negative effect and/or public concern, then it could proceed as a Category A Class EA and implementation of the dam removal could begin.

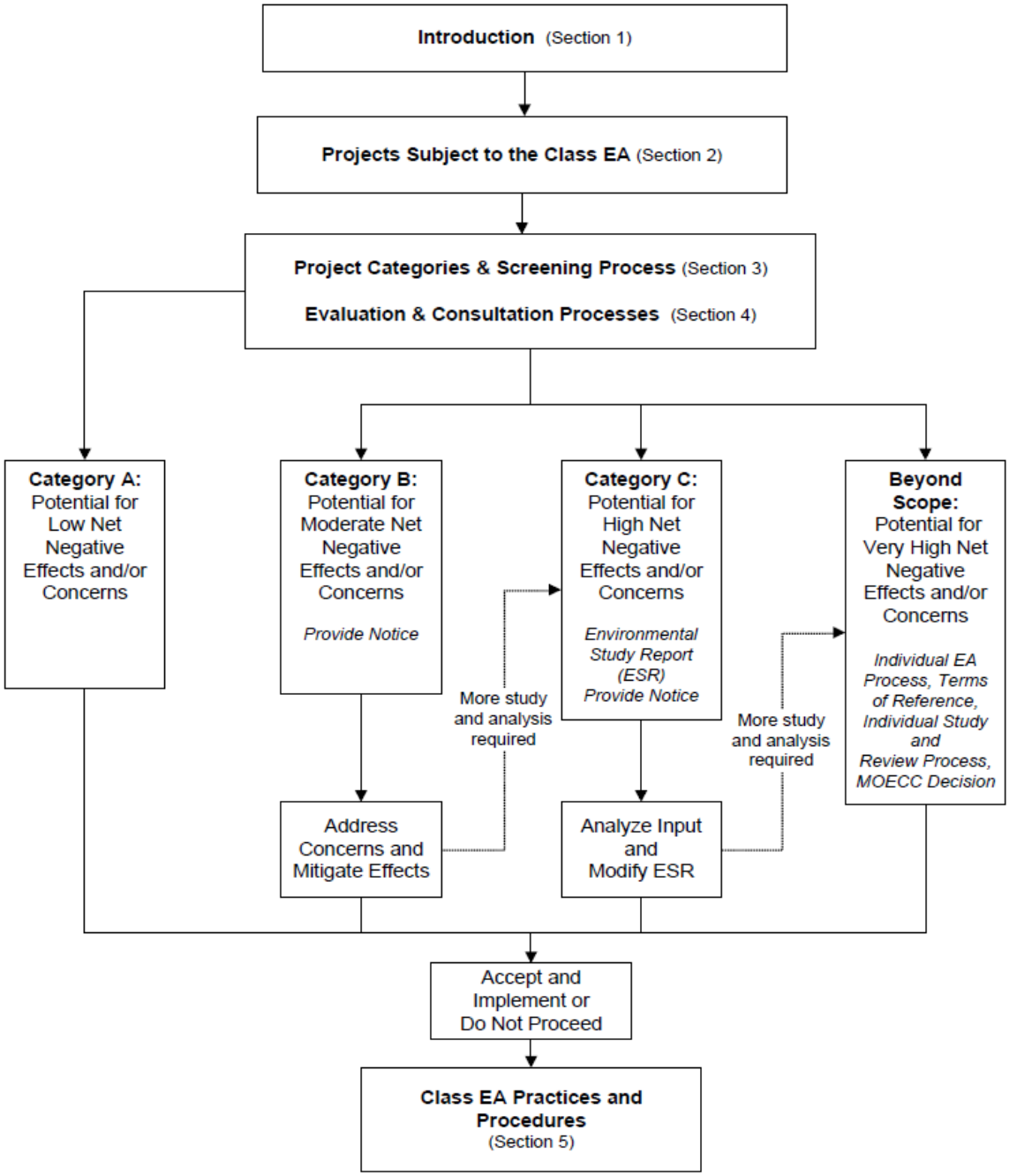

Figure 6: Structure of the Class EA for Resource Stewardship and Facility Development

The existing breached state of the dam and its historical operations would suggest that the environmental effect of a dam removal could be relatively minor. Recent online public comments regarding the desire to save the dam in order to save the pond ("Save the Dam – Save the Pond", http://ourgorrie.com/savepond.html) suggests there are potential net negative effects and or concerns with this course of action. As such, a Category "B" Class EA would may be more appropriate. Under this category public consultation would be mandatory.

If there is potential for a high net negative impact, as there could be with the construction of a completely new dam, then the project would likely have to begin as a Category "C" EA. This is a reasonably strong possibility due to the poor state of the existing dam, changes in environmental regulations (since the original dam was built), and the social economic implications (high costs) of constructing a completely new dam.

The cost for completing Class EA's increases with the complexity of the study and consultation process required. In other words, a Category "C" Class EA will cost more to complete than a Category "A" Class EA. It is highly unlikely that if the project would proceed to an individual environmental assessment as the cost to do so would be very high. In this case, it is likely that the "Do nothing" option will likely be the course of action for the Gorrie Dam. In this case the site would reman as is.

5.2 STUDIES

To facilitate the screening process and/or to complete an ESR, several studies will be required to address the potential regulatory, environmental and social issues which may arise from the project. These studies will make use of the information which will be developed to obtain approvals for plans and specifications or vise versa. Most of these studies will also need to be completed as part of a New Dam Location Study, should this become a requirement. This may also be required as part of the regulatory process for construction permitting. Table 2 lists typical MNRF Class EA Screening Criteria.

All items listed should be considered, including those which may be unique to the Gorrie Dam and/or not listed. Based on the availability of existing information, history of the existing dam and recent interest by the public, most of the key issues will focus around the land use, social, cultural and economic considerations for the dam.

If the dam was to be removed there would likely be a net increase in environmental benefits, as the river would be allowed to return to its more natural state. The removal would also be of economic benefit to the MVCA as long-term risks (e.g. public safety and damages to property) associated with dam failure and routine maintenance would no longer exist. Conversely, there could be public concern related to the cultural values

associated with the exiting dam and head pond. This is common for dams under consideration for removal.

At this time, based on preliminary consultation with Aboriginal communities by the MVCA, there are no known issues of concern. None the less, this must be further examined as part of the Class EA process.

Generally, the environmental impacts of dams are well understood, therefore early in the decision-making process, detailed environmental studies are typically unnecessary. Environmental studies should therefore be completed at a relatively higher scoping level. Scoping level studies are used to determine if there are any potential issues of concern that could be deemed “significant” based on available background information. Extensive data collection and processing is typically not part of these studies. These studies document their data sources, assumptions and recommendations for further investigation should they be deemed necessary and important to the overall decision-making process.

Should the reconstruction of the existing dam be a preferred approach, the scope of work for environmental studies would likely expand. While some items may be grandfathered due to the presence of the historical dam, other items will require review under current legislation. Current legislation may influence the attributes, operational requirements and methodology used for the reconstruction of the dam.

Dams alter the natural environment of flowing river systems. Table 3 lists several impacts associated with dams in the natural environment. Understanding the potential for these impacts at the Gorrie dam are important to the decision-making process. If the dam is removed these impacts can be avoided and the natural system can be restored. Alternatively, if the existing dam is repaired or a new dam is constructed, then measures to mitigate and or compensates for the impacts may be required.

Table 2:Screening Criteria

NATURAL ENVIRONMENTAL CONSIDERATIONS
Air quality
Water quality (ground or surface)
Species at risk and/or their habitat
Management of invasive or alien species (e.g., fish, wildlife, insects, plants, disease)
Fish or other aquatic species, communities, populations or their habitat (including movement of resident and migratory species)
Terrestrial wildlife (including numbers, populations, diversity and movement of resident or migratory species)
Natural vegetation and terrestrial habitat linkages or corridors through fragmentation, alteration and/or critical loss
Soils and sediments (e.g., release of contaminants, sedimentation)
Natural heritage features and areas (e.g., significant earth or life science features, areas of natural and scientific interest, provincially significant wetlands)
LAND USE, RESOURCE MANAGEMENT CONSIDERATIONS
Transportation and access (land or water) (e.g., new, restricted, in remote area, or traffic patterns)
Water quantity (flows and levels, drought response)
Land use (local authorized resource users, adjacent land uses)
Waste management objectives
Current or future use of Crown resources (e.g., Crown forest resources, mineral aggregate)
SOCIAL, CULTURAL AND ECONOMIC CONSIDERATIONS
Cultural heritage resources - including archaeological sites, built heritage, and cultural heritage landscapes
Local, regional or provincial economics (impact to businesses or residents, direct and indirect effects, employment effects, increased demand on government services)
Land subject to natural or human-made hazards (e.g., flooding, erosion, contamination)
Public health and/or safety
Noise levels
Recreational use of Crown land (e.g., views and aesthetics, tourism)
ABORIGINAL COMMUNITIES CONSIDERATIONS
First Nation reserves or Aboriginal communities
Existing or asserted Aboriginal or treaty rights to and/or use of lands, waters or resources
Sacred, spiritual, or ceremonial sites
Traditional or resource uses, or economic activities
Lands and/or waters subject to land claims

Table 3: Summary of Typical Dam Impacts on the Natural Environment

Natural Channel System	Elements	Impacts from Dams on the Natural Environment
Flow Regime	• Natural Variability- influences availability and suitability of habitats • Baseflow • Bankfull Flow • Flood Flow	• Lessens the variability in flow by: • Prolonging the duration of flow rates which form the channel system • Reducing the occurrences of high flow events • Creation of impoundments
Channel Form and Functions	• Channel type and stability - influenced by local climate and geology. The following functions are dynamic yet stable • Bankfull flow • Sediment transport (suspended and bedload) • Bed and bank erosion	• Alters channel functions which require the channel to attain a new form and function for stability including: • Altering sediment transport function as a result of collection sediments in the head pond • Increased channel bed and bank erosion downstream of the dam as a result of prolonged high flows and altered sediment transport • Loss of channel complexity downstream due to a loss of smaller particle sizes and armouring by larger bed materials
Aquatic Environment	• Aquatic Habitats – influenced by the type and health/stability of the natural channel system. This is dependent on the natural variability in flow to provide the conditions critical to aquatic organisms. • Bank/Habitat Stability • Channel Form (pools-riffles-runs) • Channel Diversity • Instream Structures • Bed Substrate quantity and quality • Connectivity	• Habitats are created for species not native to the channel system • Loss of habitat diversity for native species • Loss of critical habitats • Barriers to fish movement and natural ranges • Can disrupt life history requirements • Can displace natural fish species and favour invasive or tolerant fish • Change the aquatic vegetation communities • Similar effects on other aquatic organisms including aquatic invertebrates, mollusk and crustaceans
Riparian Environment	• Riparian Habitat – influenced by interaction and linkage through flood flows • Attenuation of flood flows • Nutrient exchange • Inputs of organic material • Sediment exchange	• Decrease the frequency and magnitude flow events in the channel spill into the riparian zone and floodplain • Reduction in critical habitats for reptiles and amphibians • Nutrient and sediment exchange does not take place as frequently • Widening of the channel through bank erosion
Biochemical	• Water Quality - influenced by flow regimes, channel form and functions, and riparian zone interaction including • Dissolved Oxygen • Temperature • Nutrients • Total Suspended Solids • Organic Carbon	• Ponding of water changes the biochemical processes of a river • Increased temperatures from warming of the sun • Decrease in dissolved oxygen • Algal blooms • Changes nutrient levels, total suspended solids • Historical use of dam may also result in sediment contamination

5.2.1 NATURAL ENVIRONMENTAL CONSIDERATIONS

Environmental Studies that are to be considered but not limited to, include:

- Fluvial Geomorphology
- Aquatic Resources and Fish Habitat
- Water Quality
- Sediment Quantity and Quality
- Wildlife Habitat
- Natural Heritage Wetlands
- Water Taking
- Each of these studies is explained briefly below

Fluvial Geomorphology

A fluvial geomorphologic study examines the interactions between the physical river form and function, and the water and sediment it transports. Dams control both the movement of water and sediment, therefore, channel features such as riffles, pool, and meandering are altered. These alterations in the channels form and function can result in accelerated rates of channel erosion downstream of a dam and sediment accumulation upstream of a dam. These changes could affect natural aquatic habitats and result in violations under the Federal Fisheries Act and Species at Risk Act (SARA).

Understanding the impacts on channel morphology will help to understand the implications attributed with either removing the dam or reinstating the former dam or constructing a new dam.

Aquatic Resources and Fish Habitat

The Howick Official Plan classifies the Maitland River and Gorrie dam area system as a warm water aquatic habitat with the presence of a migratory salmonid fishery.

The presence of dams and their head ponds have two significant and common impacts on the aquatic ecosystem including, the physical barrier to fish passage and changes in aquatic habitat. This second impact is brought about by changes in natural flow variability, water storage, water temperature and sediment transport.

An aquatic study may include, but may not be limited to, the assessment of the following:

- Are there species at risk impacted by the presence of the dam?
- Can fish and other organisms (e.g. mussels) obtain safe passage upstream or downstream of the dam?
- Are there quality spawning habitats upstream of the dam?
- Can resident fish find refuge during extreme low and high flow conditions?

- Does the dam act as to separate populations of organisms once connected to each other which could have long-term effects on genetic health and sustainability of species?
- Does the head pond support recreation sport fishing opportunities?
- Does the head pond create a thermal barrier to the upstream movement of coldwater species, and will this become increasingly more important in coldwater streams that are susceptible to climate change?
- What is the nature of the interaction between the aquatic community in the head pond and those of the river system (e.g. do the warm water pond species compete with the coldwater species)?
- Does the dam provide a means for managing invasive species?
- Does the dam and head pond support or protect a Species at Risk?
- Does sediment management for the pond protect downstream habitats?
- Does the warming of the water from the sun impact the coldwater fish community?

Water Quality

Since online ponds capture flows from upstream land uses and stream processes, the impoundments of water created by a dam can result in considerable changes to the water quality of rivers. The significance of these changes or impacts to water quality may need to be examined. The degradation in water quality is largely attributed to the sediment trapping, nutrient accumulation functions, and large surface area of the head pond. This degradation may not only be seen in the watercourse downstream but also within the pond itself.

A suite of other water quality parameters are also modified by dams including dissolved oxygen, nitrogen and phosphorous. For example, as sediments accumulate the nutrients which are associated with these sediments also accumulate. Ponds and wetlands are often referred to as a “nutrient sink.” Higher concentrations of phosphorus can support excessive growths of suspended, floating and filamentous algae which may contribute to reduced water clarity and oxygen concentrations in the pond environment. Other cycles are also interrupted including the flow of organic carbon and changing the nutrient balance. As a result, downstream reaches are subjected to changes in water quality that can alter the suitability of certain habitats for aquatic organisms.

High bacterial concentrations have also been reported in online ponds which have been intended for body contact recreational uses such as swimming. Bacterial concentrations can also be worsened in rural areas where upstream cattle access to streams is permitted. In more urbanized settings large flocks of geese are attracted to ponds and can also contribute to increasing bacterial contamination.

Sediment Quantity and Quality

Understanding sediment quantity and quality is important to both the dam removal process and the long-term operation of a dam. Due to the inherent function of dam, sediments are trapped and accumulated within the head pond. Understanding both the quantity and quality of the sediment is important not only from an environmental perspective but also from an economic one. Dredging of ponds can be very costly.

Sediment quantity is typically identified through a bathymetric survey of the sediment surface and obtaining a depth of sediment depths. Accurate estimates of sediment quantity can be difficult to obtain. At the Gorrie dam the annual pond drawdown period may provide an excellent opportunity to get a more accurate estimate of the sediment quantity.

Two basic components of the sediment quality include chemistry, and particle size. Chemical analyses are used to assess the potential for contaminated soils. If contaminated soils exist in a head pond, they can be very costly to remove and dispose of, if the dam is removed.

Understanding sediment particle size can aid in sediment management for a dam removal. Coarse sediments are typically easier to remove and dispose of offsite. A study of pond sediment can also aid in understanding and the development of a long-term sediment management plan, should the dam be restored.

Vegetation and Wildlife Habitat

The creation of reservoirs has both positive and negative effects for terrestrial vegetation and wildlife habitat. The inundation of the land by water inevitably leads to the loss of local native terrestrial vegetation and wildlife habitat. In return, however, the ponded water may attract other vegetation communities and wildlife species.

From a casual public perspective, ponds are often seen as a feature which attracts wildlife; this is attributed to the fact that there is a greater ability to see wildlife in an open setting. The wildlife attracted may not be native to the riverine environment and that which can readily obtain access to the area such as waterfowl and other birds. Other species observed in ponds may have always been a part of the local riverine ecosystem, however, have adapted themselves to the pond environment. As such, the pond has not necessarily attracted the wildlife, it has only made it easier to observe.

Public opinions regarding wildlife can often be very different and challenging to address. Ponds have been known to attract wildlife which for some people become unwanted, particularly in more urbanized environments. For example, large populations of Canadian

Geese and beavers have on occasion become unwanted due to the impacts they have on public and private lands. Others may find the presence of this wildlife a positive experience as it is not something that occurs regularly. They tend not to be as aware of the impacts experienced by others exposed to this wildlife on a regular basis.

The quality and value of the wildlife habitat needs to be examined from a professional perspective to understand the impact or the role of dam removal or dam reconstruction may have in sustaining healthy natural wildlife populations.

The study of vegetation communities and wildlife habitat typically occurs over several seasons. The study would be used to determine the sensitivity, and potential impacts dam removal or dam reconstruction may have on vegetation communities, birds and wildlife.

Natural Heritage Wetlands

The Howick Official Plan has identified no provincially significant wetlands or wetlands of local significance at the Gorrie dam pond. However, it does recognize that there are natural features including wetlands that border the head pond. It includes changing" Open Space" land to "Natural Environment". It defines the area as Valley lands and Part of a Natural Heritage system for wildlife habitat.

The designations of the lands in the official plan are likely based on the presence of the dam and head pond. The implications of these designations on the possible removal, repair or construction of a new dam will need to be examined.

Water Taking

By law, in Ontario, you must have a permit if you plan to take 50,000+ litres of water in a day from the environment. Currently, there are no specific requirements for the taking of water at a dam. Should reconstruction of the dam or of a new dam require alterations to the uses of the water then water taking permits must be obtained. The requirements for these permits are often not clearly understood and as such should have a preliminary review of the possible desire to use the water and the possible permitting requirements should be examined as part of the decision making process.

5.2.2 LAND USE, RESOURCE MANAGEMENT CONSIDERATIONS

The Gorrie dam and head pond currently occupy 11 ha (27 acres) of land. If the dam is removed much of this land will be available for alternative uses. The uses of this land however would be limited, as much of it will likely remain as regulatory floodplain by the MVCA. There is the possibility that removal of the land will also lower the regulatory flood elevation, thereby increasing the opportunity for land use change in a currently restricted area adjacent to the boundary regulatory floodplain and/or within the flood fringe area.

Considering possible options to remove and or rebuild the dam the implications to the official plan and possible alter uses of the land should be examined.

5.2.3 SOCIAL, CULTURAL AND ECONOMIC CONSIDERATIONS

The potential for impacting or improving the social and cultural heritage values are currently unknown. The economic implications for any decision made are also unknown. Understanding these aspects of the project will have a significant affect on deciding how to proceed with either dam removal, reconstruction or a new dam.

Furthermore, a technical heritage study may be warranted with public input to better understand and define the social and cultural values. Heritage is defined as everything that we value that we want to preserve and pass on to future generations. Cultural heritage is the portion of our culture that retains the evidence of human activity (MNRF 2006).

Information on how cultural heritage resources should be identified, and how to assess their significance and develop mitigation techniques is found in, “A Technical Guideline for Cultural Heritage Resources for Projects Planned Under the Class Environmental Assessment for MNRF Resource Stewardship and Facility Development Projects and the Class Environmental Assessment for Provincial Parks and Conservation Reserves” (2006).

If a significant heritage resource and/or cultural heritage landscape is being affected, technical studies may be required that include items such as archaeological assessments by licensed archaeologists and built heritage and/or cultural heritage landscape studies by qualified heritage consultants may be required.

Economic consideration will have a significant influence on the future of the dam. This is not only important for the decision-making process but also for determining the ability to implement the preferred option. Table 4 summarizes the range in costs for studies and implementation of each of the three options considered in this study. A range in costs has been provided at this early stage of the planning process.

Table 4: Summary of Studies and Implementation Costs

OPTIONS	COSTS ($1000)		
	Studies *	Implementation (Engineering & Construction) **	Total
Decommissioning of the current structure	32 -115	380 – 750	435 – 910
Repair the current structure	132 - 250	1,100 - 1,720	1,300 -2,074
Replacement/redesign of a new structure	142 - 275	2,000 - 3,000	2,260 – 3,455

* Cost by study provided in Table 1

Clearly there is a large difference in cost between options. The benefits associated with these costs need to be established. Who pays and who benefits also needs to be considered. The costs for repair and or replacement are 2.5 to 4 times higher than removal. This is consistent with the findings of other studies which reported a difference of three times greater (Born et al.,1998).

The Class EA process will need to explore associated costs in greater detail with considerations for "cost-benefit", including who pays and who benefits.

The costs presented do not represent the full life-cycle costs associated with the dam. Dam and reservoir maintenance, reconstruction and rehabilitation can be very high. It is quite likely that the cost of maintaining the Gorrie dam has well exceeded its current value.

The potential for an accident or dam failure can also be viewed as an economic issue for dam owners. Dam owners can be held financially responsible for losses suffered because of a dam (Smith D. C.,1980). Dams can also affect the value of the property. Many landowners are of the opinion that lakefront property is worth more than riverfront property; however, a study was undertaken by the Michigan Department of Natural Resources which shows that the value of riverfront property was at least equal to or greater than the value of properties fronting onto lakes and reservoirs. The values of some properties have been shown to decrease when they contain a dam that requires extensive repair or removal (Born et al., 1998).

5.2.4 ABORIGINAL COMMUNITIES CONSIDERATIONS

The Crown has a duty to consult Aboriginal communities when it has knowledge of an established or asserted Aboriginal or treaty right and contemplates conduct that may adversely affect that right (MNRF 2015). While Conservation Authorities are either charitable or non-profit organizations legislated under the Conservation Authorities Act,

1946 and not a Crown agency, it highly recommend that aboriginal communities be directly consulted on this project.

The decision and planning process must include but may not be limited to the following Aboriginal communities considerations:

- Recognition of any First Nation reserves or Aboriginal communities with the project site,
- Existing or asserted Aboriginal or treaty rights to and/or use of lands, waters or resources,
- Sacred, spiritual, or ceremonial sites,
- Traditional or resource uses, or economic activities, and
- Lands and/or waters subject to land claims

A consultation record is also important to ensuring that all consultation activities undertaken with Aboriginal communities are fully documented. This includes all attempts made to notify or consult the community, all interactions with and feedback from the community, and all efforts to respond to community concerns.

5.3 PUBLIC CONSULTATION

Consultation with interested persons (local landowners, general public, stakeholder, special interest groups etc..) is a cornerstone of the Class EA process and is a legal requirement of the *Environmental Assessment Act*. (MOECC 2014). The MVCA should seek to involve all interested persons as early as possible in the planning process so that their concerns can be identified and considered before irreversible decisions and commitments are made for the chosen approach or specific proposals. The MVCA should present sufficient and varied opportunities for consultation and interested persons should take advantage of the opportunities and become involved in the planning process. The results of the consultation must be documented at the end of the planning process. Consultation, when done well, can improve the outcome of the planning process.

The MVCA may want to consider having the public consultation process facilitated by a third party. There a few reasons for this consideration including:

- MVCA will be the proponent for this project, and there could be a perceived conflict of interest,
- Consultation around the future of an existing dam and its head pond is typically the most challenging in the planning process, primarily due to a variety of possible contentious issues,
- Public consultation requires notifications, documentation and the sharing of information, knowledge, opinions, and ideas by all parties so that a consensus can be developed and,

- Experienced professionals in this field may be able to streamline the public consultation process.

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APPENDIX

Figure 7:Upstream side of concrete dam, both sluiceways fully open

Figure 8: View across concrete spillway, damages and repairs to concrete buttresses

Figure 9: Upstream view of concrete dam

Figure 10: Upstream view of drained head pond and vegetated floodplain

Figure 11: View of breached earth dam

Figure 12: View of gravel and cobble deposits in floodplain from breached earth dam