Ontario Waterpower Association

Best Management Practices Guide for the Mitigation of Impacts of Waterpower Facility Construction

GENIVAR

NATURAL RESOURCE SOLUTIONS INC.
Aquatic, Terrestrial and Wetland Biologists

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DISCLAIMER

This guide has been commissioned by the Ontario Waterpower Association (OWA) as a working resource for practitioners for the mitigation of waterpower facility construction related impacts and furthers the OWA's commitment to foster and maintain positive and productive relationships with those having an interest in waterpower. The use of this Best Management Practices (BMP) Guide in no way absolves proponents from legal requirements under municipal, federal or provincial legislation as it is intended as a guide only. Appropriate regulatory agencies should be contacted early in the construction planning process to ensure that waterpower facility construction activities and their associated mitigation measures are consistent with current legislation and policies.

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PREAMBLE

In 2003, Ontario Power Generation (OPG) published a report entitled "Environmental Construction Guidelines Manual – A Guide to Best Environmental Management Practices at Hydroelectric Facilities" (OPG, 2003).[1] This manual was intended for internal OPG use only and it should be noted that OPG has not been actively maintaining and updating this manual for a number of years, and therefore it was used as a starting point for the OWA guide. The OWA guide has been developed under the guidance of a Steering Committee with representation from the Ontario Waterpower Association (OWA), OPG, Fisheries and Oceans Canada (DFO) and the Ontario Ministry of Natural Resources (MNR).

At any given time, there can be waterpower facility development projects proceeding through the provincial OWA Class Environmental Assessment (EA) and/or the federal EA process in Ontario. Facility owners are also reviewing existing operations to determine if additional capacity can be achieved through repair and/or rehabilitation. Many of these projects will soon move into the regulatory approval, final design and construction phases with more projects to follow as the need and desire for renewable energy continues to grow. The waterpower projects working their way through the waterpower development timeline are expected to result in the construction of a significant number of new waterpower facilities within the next decade.

As the provincial organization representing the collective interests of the waterpower industry, the Ontario Waterpower Association (OWA) is committed to providing the best available information for the mitigation of waterpower facility construction impacts in support of environmentally responsible, publicly accountable waterpower project development. As part of its ongoing commitment to sustainable and responsible waterpower development, the OWA recognizes that practical guidance is required to support developers, agencies, consultants and contractors in meeting permitting requirements, completing contract documents and ultimately in the implementation of waterpower facility construction projects. Several documents have already been developed for the OWA that can be used as a reference when constructing waterpower facilities. These documents have been generated as Best Management Practices (BMP) guides and focus on species at risk including Lake Sturgeon (*Acipenser fulvescens*), American Eel (*Anguilla rostrata*) and Channel Darter (*Percina copelandi*). These guides provide a current understanding of the habitat and life history requirements of these species that can inform the assessment of and selection of potential mitigation methods or approaches during the construction of waterpower facilities.

[1] The OPG 2003 report has been referenced in this document and, where applicable, sections of text from that document have been used in this BMP guide with permission from OPG.

1. INTRODUCTION

There are many stages in the lifecycle of a waterpower project including initial concept development, design, environmental assessment, permitting and approvals, final design and tendering, construction, operation and ultimately decommissioning. While this Guide focuses on the Construction Phase of the project, it is important to understand that reviewing agencies, the public and Aboriginal Communities require details on all phases of the project (Design, Construction and Operation) early on in the planning process for a waterpower project. It is understood that the manner in which a waterpower facility is designed and ultimately operated has potential to impact natural ecosystems if proper consideration is not given to mitigating potential impacts.

In Ontario, the OWA Class EA for Waterpower Projects provides a process whereby proponents take into account the potential impacts and benefits of proposed waterpower projects as well as the interests of individuals, communities, agencies and organizations. The opportunity for consideration of impacts during the design and, by association the operation of a facility, is therefore captured within the existing EA and permitting process and is not the subject of this document.

This guide was developed to provide practical and current best management practices that will assist proponents in determining how best to construct, rehabilitate or repair a waterpower facility in an environmentally responsible manner. As the design progresses towards the final design, the utilization of best management practices should reduce the risk of unacceptable impacts thereby reducing the risk of costly mitigation at later stages of development.

This guide will be useful to environmental planners and engineers during their day to day decision making, planning and design activities associated with waterpower construction. The guide will also prove useful during the preparation of specifications and tender documents for waterpower construction. The BMPs have been designed in a manner such that entire BMPs or portions thereof can be easily incorporated into project tender documents. Professionals working on waterpower construction sites, including contractors, inspectors and contract administrators will also find this guide useful as a reference document. In addition, it is anticipated that agency personnel involved in waterpower design review and permitting will find opportunity to use this guide to help in the execution of their mandates. The activity specific BMPs were developed closely with agencies to ensure that the content best reflects current agency practice, policy, and legislation. Given this, use of this guide should greatly assist proponents in meeting agency specified requirements during the construction phase of a project.

1.1 ONTARIO'S WATERPOWER POTENTIAL

Ontario's water resources are an integral part of the province's environmental, social, cultural and economic fabric, and are vital to meeting the renewable energy requirements of the province. There are hundreds of waterpower development opportunities contained within the Great Lakes, Hudson Bay and the St. Lawrence watersheds within the province. The drainage patterns, topography and geology of

these major watersheds and subwatersheds have been proven to be a large opportunity base for the development of waterpower, a renewable and secure energy source.

The province's existing waterpower facilities are an important part of the backbone of the provincial bulk power system, with many stations providing electricity for more than a century. They have been, and continue to be, affordable reliable sources of electricity that produce power consistently while providing social, economic and environmental benefits to communities and industries across the province and to Ontario as a whole.

Ontario's existing and potential waterpower can:

- Moderate electricity prices;
- Contribute to the provincial economy[2];
- Ensure grid reliability;
- Integrate other renewables;
- Advance aboriginal and northern prosperity; and
- Achieve environmental sustainability.

The OWA has confirmed that there is more than 5,000 MW of additional practical potential that could be developed. [3]

1.1.1 FACILITY DEVELOPMENT AND REHABILITATION

Currently, there are numerous waterpower facility developments and rehabilitation projects proceeding through the provincial OWA Class EA and/or the federal EA process in Ontario. Many of these projects will soon move into the regulatory approval, final design and construction phases with more projects to follow as the need and desire for renewable energy continues to grow. The provincial government aims to double the amount of electricity generated by renewable sources by 2025 while reducing its dependence on coal generation (OPA, 2012). Currently, there are almost 200 operating waterpower facilities in Ontario that, collectively, account for approximately one-quarter of the Province's installed capacity (8,000 Megawatts [MW]) and electricity generation (35-38 Terawatt hours (TWh) annually) (OWA, 2011). Facilities in the province range in size from less than 100 kilowatts (kW) to more than 1,000 Megawatts (MW). The waterpower projects working their way through the waterpower development timeline will ultimately result in the construction of a significant number of new waterpower facilities. Facility owners are also reviewing existing operations to determine if additional capacity can be achieved through repair and/or rehabilitation.

[2] In addition to employment and investment, waterpower production contributes directly to the Consolidated Revenue Fund in excess of $150 Million annually (unique to waterpower)
[3] Evaluation of Ontario's Waterpower Potential (Hatch,2005)

2. SCOPE AND OBJECTIVES

2.1 SCOPE OF THE GUIDE

There are many stages in the lifecycle of a waterpower project including initial concept development, design, environmental assessment, permitting and approvals, final design and tendering, construction, operation and ultimately decommissioning. Ultimately, this guide was developed to provide practical and current management practices that will assist proponents in determining how best to construct, rehabilitate or repair a waterpower facility in an environmentally responsible manner.

The OWA Class Environmental Assessment (EA) for Waterpower (OWA 2011) promotes an environmental planning approach whereby mitigation methods are developed and applied to the identified potential impacts of waterpower development. The net effect of the particular impact, following mitigation, is then evaluated to determine the acceptability of that net effect within the broader context of the need for sustainable renewable energy production in the Province of Ontario. Although the mitigation methods contained herein may provide useful insight for waterpower environmental assessment this guide is primarily focused on the use of Best Management Practices (BMPs) for the planning and execution of waterpower construction.

The purpose of this guide is not to provide advice or guidance to a proponent on how to proceed through a permitting and approvals process.

2.2 OBJECTIVES OF THE GUIDE

The OWA and its partners have undertaken to produce this **Best Management Practices Guide for the Mitigation of Impacts of Waterpower Facility Construction** to aid practitioners and developers in carrying out construction activities, while minimizing risk to the environment. The need is evident for a practical guide that can be used for contract administration, preparation of tender documents and also for contract execution at the site level. Accordingly, the objectives of this guide are as follows:

1. To detail current industry practices relevant to construction mitigation
2. To link construction mitigation methods to specific potential impacts to the natural environment
3. To provide state of the knowledge information based on demonstrated and proven construction mitigation methods
4. To provide flexibility with respect to the selection and application of approaches and techniques, and
5. To provide an overview of the legislative, regulatory and policy context that guides construction mitigation.

3. FRAMEWORK OF THE GUIDE

The framework of this BMP Guide, as presented in Figure 1, is structured to provide the user with an easy reference to key information.

Section 1 - Presents an introduction to the guide and sets the context of the guide in relation to waterpower development in Ontario.

Section 2–Defines the scope of the guide and addresses limitations in terms of the aspects of waterpower development not covered by this guide. It also summarizes other overall objectives of the guide.

Section 3–Provides an overall layout for the guide and summarizes the subject matter considered in each section of the guide

Section 4 - Outlines an overview of the federal and provincial legislation and policies applicable to waterpower development and documents the approvals required before construction can begin.

Section 5 - Details general advice on the management structure that should be in place to achieve the best possible results, in terms of mitigation and environmental protection, during construction.

Section 6–Provides a quick reference to BMPs related to specific construction activities. A general example of how the BMPs were developed is shown in Figure 2. Firstly, the construction activity of concern is identified. Then the elements of that activity which have the potential to create negative impacts are identified. Following this, the components of the environment (i.e. surface water quality) that each element has a potential to effect are determined. These components are discussed herein as "environmental receptors". Details of the potential effects on the identified receptors are then provided. To offset the potential effects on environmental receptors recommended BMPs are then provided. Permitting and approval requirements have been identified within these BMPs. The BMPs are found in Appendix A.

Section 7– Details specific contingency plans that should be in place on a waterpower construction site to ensure that valuable response time is preserved in the event of an occurrence such as a hazardous material spill, an extreme weather event or a discovery of archaeological significance.

Section 8– Explains the concept of an Environmental Management Plan and summarizes the benefits of having an Environmental Management Plan in place on a waterpower construction site.

Section 9 and 10- A glossary of terms used in this report and a list of cited references is provided.

Figure 1: Framework of the Best Management Practices Guide

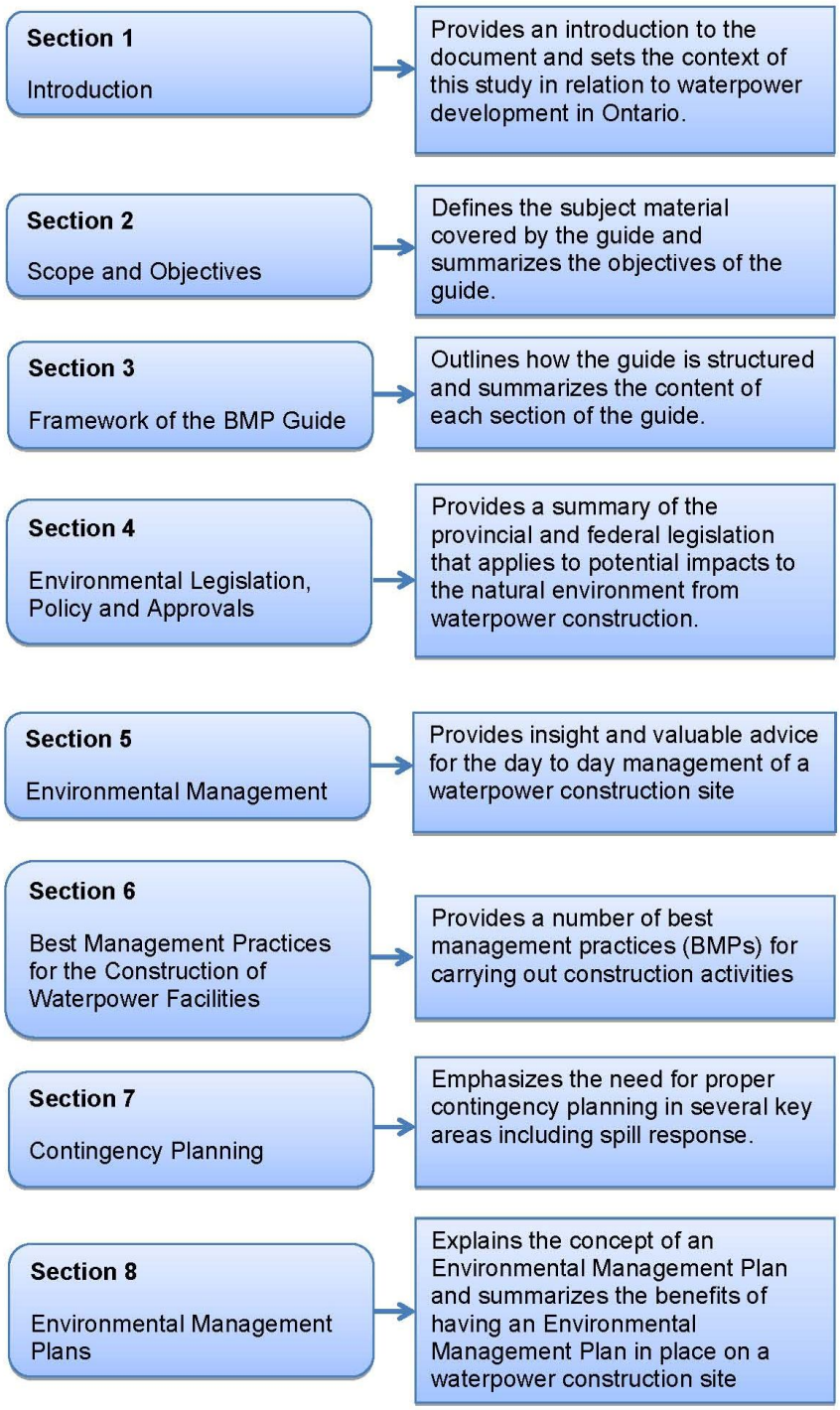
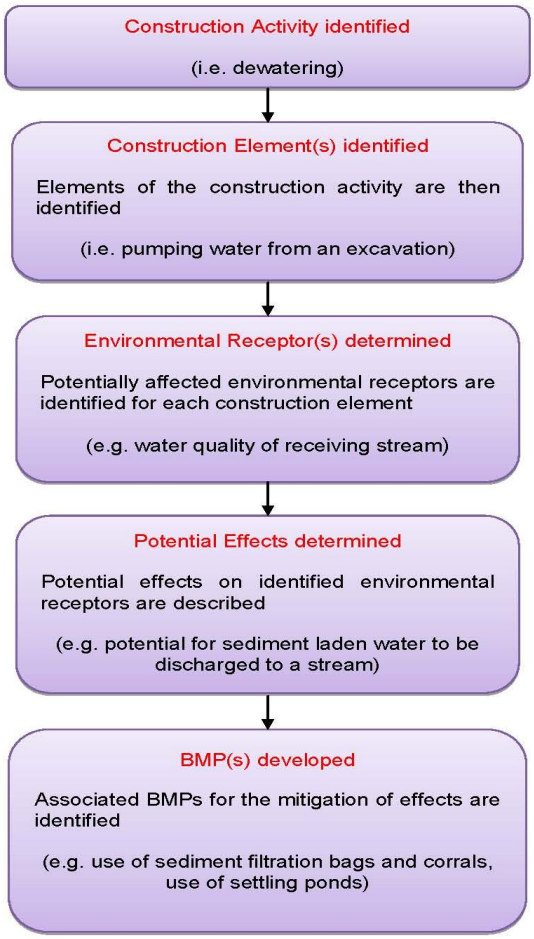


Figure 2: Process for the Development of Best Management Practices



4. CONSTRUCTION RELATED ENVIRONMENTAL LEGISLATION

All waterpower development projects are subject to approval by multiple government agencies in both levels of government, federal and provincial. As well, projects may be subject to municipal approvals through the application of local bylaws. The legislation relevant to these approvals is extensive and is not the focus of this section of the guide.

This section assumes that permits are in place and is not intended to provide advice on obtaining permits. For further information on permitting requirements for waterpower construction the reader is encouraged to contact the OWA.

A summary is provided of **federal and provincial legislation and regulations that are specifically associated with the construction phase** of a waterpower project. The purpose of this section is to familiarize users of this guide with the environmental legislation that applies during construction of their waterpower projects and to indicate what implications the legislation may have during the construction phase of the project.

4.1 FEDERAL LEGISLATION AND REGULATIONS

Federal legislation associated with waterpower construction projects is detailed below.

4.1.1 FISHERIES ACT

The *Fisheries Act* is administered by Fisheries and Oceans Canada (DFO). The Act protects fish and their habitats. The sections of the *Act* that have implications for waterpower construction are summarized in Table 1.

Table 1:Federal Fisheries Act – Applicability to Waterpower Construction

Section	Paraphrased Wording of the Act	Implications for Construction
20	Ensures safe passage for fish around obstructions to fish migration. "Obstruction" is defined in the Fisheries Act as any "slide, dam or other obstruction impeding the free passage of fish". An obstruction does not have to amount to a complete barrier. The Minister may require fishways to be constructed and maintained, and that adequate flows are provided to ensure fish passage.	While this provision is primarily applied to the Design and Operation of a facility, it is important to note that during construction fish passage needs to be maintained, particularly during critical migration periods. A coffer dam would be considered a temporary obstruction to fish passage. Following BMPs and working within appropriate timing windows can often mitigate these impacts during construction.
22	This section is for the provision of minimum flow below obstructions. Subsection22(1) requires sufficient flow over the spill way or crest of an	While these provisions (sections 22 (1) to (3)) are primarily applied to the Design and Operation of a facility, it is important to note that during construction coffer dams and de-

	obstruction for the safe decent of fish. Subsection 22(2) requires the owner of an obstruction to providesufficient flow for free upstream and downstream passage of fish during theconstruction of an obstruction. Subsection 22(3) requires sufficient flow downstreamof an obstruction to provide enough water for fish spawning and egg incubation. The requirement for sufficient flow over an obstruction (Subsection 22(1)) is at theMinister's discretion. The Minister also establishes measures to accommodate fishmovement during construction of an obstruction and the quantity of water to bemaintained downstream of an obstruction for fish spawning and egg incubation.	watering can impact fish passage and water flows. Following BMPs and working within appropriate timing windows can often mitigate these impacts during construction.
30	Water diversions or intakes may require a fish guard or screen to prevent the entrapment of fish.	In most instances this requirement is associated with preventing fish from sustaining injury leading to death. This is particularly relevant to juvenile fish migrating downstream through the turbines of a hydroelectric facility as well as to juvenile fish entering irrigation ditches, pumps, and water extraction facilities used during construction. In some cases preventing fish from becoming entrained is sufficient to ensure safe passage around a potential obstruction. In other cases additional measures, (e.g. bypass channel) may also be required.
32	Prohibits the destruction of fish by any means other than fishing without prior approval.	Authorization from DFO to destroy fish required prior to blasting. DFO's Guidelines for the Use of ExplosivesIn or Near Canadian Fisheries Waters: http://www.dfo-mpo.gc.ca/Library/232046.pdf
35	Prohibits works or undertakings that	Authorization from DFO required prior

	may result in harmful alteration, disruption or destruction of fish habitat, unless authorized by the Minister.	to impacting aquatic habitat through construction activities**.**
36	Prohibits the deposit of deleterious substances (as defined in Section 34) into waters frequented by fish unless authorized under regulations made by the Governor in Council. A deleterious substance is defined by the Fisheries Act as any substance that, if added to water, (such as sediment) makes the water deleterious to fish or fish habitat or any water containing a substance in such quantity or concentration or has been changed by heat or other means, that if added to water makes that water deleterious to fish or fish habitat.	Sediment deposits or fuel/chemical spills during construction into Canadian fishery waters would be considered a violation of the Fisheries Act. Following BMPs will often mitigate these impacts during construction.

Additional Sources of Fisheries and Oceans Canada Guidance:

Legislation and Policy

http://oceans.ncr.dfo-mpo.gc.ca/habitat/hmp/guides/documents/Introduction_e.pdf

Fish Mortality Position Statement

http://oceans.ncr.dfo-mpo.gc.ca/habitat/hmp/guides/documents/DFO_fish_mortality_EN_2009_10_22.pdf

Existing Facilitates Position Statement

http://oceans.ncr.dfo-mpo.gc.ca/habitat/hmp/guides/documents/Existing-Facilities-Position-Statement_e.pdf

Guide to Fish Passage

http://www.dfo-mpo.gc.ca/habitat/role/141/1415/14155/passage/index-eng.asp

4.1.2 SPECIES-AT-RISK ACT

The federal *Species at Risk Act (SARA)* protects species listed under Schedule A of the*Act*. DFO administers the provisions of the *Act* as it relates to aquatic species (fish and mussels). Parks Canada administers the provisions of the *Act* when the species in question is located within a national park, national historic site or protected heritage area. Environment Canada takes responsibility for all other species at risk. Table 2 summarizes the sections of the Act applicable to Waterpower Construction.

Under this legislation, in-water work activities cannot impact any aquatic species at risk (fishes and mussels) listed under the federal Species at Risk Act and/or critical habitat listed in Recovery Strategies (www.sararegistry.gc.ca).

The reader is referred to DFO distribution maps at www.conservation-ontario.on.ca/projects/DFO.html to screen project sites for aquatic species at risk and/or critical habitat.

Table 2: Federal Species at Risk Act - Applicability to Waterpower Construction

Section	Wording of the Act	Implications for Construction
32(1)	*"No person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species…."*	Discovery of such a species could result in temporary shutdown of construction until a process for dealing with the species is agreed to with the appropriate federal agency.
33	*"No person shall damage or destroy the residence of one or more individuals of a wildlife species that is listed as an endangered species or a threatened species or that is listed as an extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada- if* *(a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continentalshelf of Canada;* *(b) the listed species is an aquatic species; or* *(c) the listed species is a species of migratory birds protected by the Migratory Birds Convention Act."*	Discovery of the residence of such a species could result in temporary shutdown of construction until a process for dealing with the residence of the species is agreed to with the appropriate federal agency. Species at Risk Maps and Recovery Strategies should be consulted early in the design phase of the project to avoid costly relocation of facility components or redesign should the residence of a species be discovered.

Section	Wording of the Act	Implications for Construction
58(1)	*"Subject to this section, no person shall destroy any part of the critical habitat of any listed endangered species or of any listed threatened species—or of any listed extirpated species if a recovery strategy has recommended the reintroduction of the species into the wild in Canada —if* *(a) the critical habitat is on federal land, in the exclusive economic zone of Canada or on the continental shelf of Canada;* *(b) the listed species is an aquatic species; or* *(c) the listed species is a species of migratory birds protected by the Migratory Birds Convention Act."*	Discovery of the critical habitat of such a species could result in temporary shutdown of construction until a process for dealing with the habitat of this species is agreed to with the appropriate federal agency. Species at Risk Maps and Recovery Strategies should be consulted early in the design phase of the project to avoid costly relocation of facility components or redesign should the residence of a species be discovered.

4.1.3 NAVIGABLE WATERS PROTECTION ACT

The Navigable Waters Protection Act (NWPA) assists in the protection of the public's right to navigation in Canada. With the exception of those works described under the NWPA Minor Works and Waters Order, no work shall be built or placed in, on, over, under, through or across any navigable water without prior NWPA approval.

"Works" are defined under the NWPA as:

a) any man-made structure, device or thing, whether temporary or permanent, that may interfere with navigation; and

b) any dumping of fill in any navigable water, or excavation of materials from the bed of any navigable water, that may interfere with navigation.

Navigable waters may include any body of water capable of being navigated by floating vessels of any description for the purpose of transportation, recreation or commerce, and includes a canal or any other body of water created or altered for public use as a result of the construction of any work.

Certain projects, called "minor works", that Transport Canada has deemed will not limit or prevent navigation, do not require individual approval pursuant to the NWPA under the condition that they will be placed, built and maintained according to the NWPA Minor Works and Waters Order.

The Minor Works and Waters Order is primarily a self-assessment tool, meaning that it is the responsibility of the proponent to determine if their proposed works are considered minor in accordance with one or more of the classes of the Minor Works and Waters Order. In the event that works are proposed to be placed in, on, over, under, through or across navigable waters that are not listed as minor and/or cannot be completed in accordance with the specific standards and criteria listed under the Minor Works and Waters Order, an NWPA application must be made. Failure to construct works in accordance with the standards and criteria identified in the Minor Works and Waters Order could result in enforcement action.

The NWPA application process and type of approval required varies depending on the complexity and the nature of proposed works. Once an NWPA application has been made, officials from the Navigable Waters Protection Program determine the extent of interference to navigation associated with the works (i.e. substantial or other than substantial) and determine the applicable NWPA approval required.

Table 3 summarizes the sections of the NWPA that are applicable to waterpower construction.

For the most up-to-date information on the Navigable Waters Protection Program and to access the Minor Works & Waters Order visit:

http://www.tc.gc.ca/eng/marinesafety/oep-nwpp-menu-1978.htm

Table 3: Navigable Waters Protection Act Applicability to Waterpower Construction

Section	Wording of the Act	Implications for Construction
10(1)	*"10(1)Any lawful work may be rebuilt or repaired if, in the opinion of the Minister, interference with navigation is not increased by the rebuilding or repairing."*	Applicable generally to rebuilding or repairing of any lawful work if rebuilding or repairing does not increase interference with navigation.
10(2)	*"10(2) Any lawful work may be altered if* *(a) plans of the proposed alteration are deposited with and approved by the Minister; and* *(b) in the opinion of the Minister, interference with navigation is not increased by the alteration."*	Applicable generally to the alteration of any lawful work if the alteration does not increase interference with navigation.
15	*"(1) If the navigation of any navigable water over which Parliament has jurisdiction is obstructed, impeded or*	Should an unanticipated obstruction to navigation occur as a result of construction, Transport

	rendered more difficult or dangerous by the wrecking, sinking, partial sinking, lying ashore or grounding of any vessel or part of one or by any other thing, the owner, master or person in charge of the vessel or thing by which any obstruction or obstacle is caused shall *(a) forthwith give notice of the existence thereof to the Minister or to the chief officer of customs and excise at the nearest or most convenient port"*	Canada must be notified immediately.

4.1.4 MIGRATORY BIRDS CONVENTION ACT

The *Migratory Birds Convention Act* is administered by the Canadian Wildlife Service and protects migratory birds and their habitats. Table 4 summarizes the sections of this act that are applicable to waterpower construction.

Table 4: Migratory Birds Convention Act Applicability to Waterpower Construction

Section	Wording of the Act	Implications for Construction
6	"*Subject to subsection 5(9), no person shall* *(a) disturb, destroy or take a nest, egg, nest shelter, eider duck shelter or duck box of a migratory bird, or"*	Discovery of a migratory bird's nest could result in the temporary shutdown of construction until a process for dealing with such a discovery is agreed to with the Canadian Wildlife service. It is recommended that work occurs outside bird nesting windows. Consult the following website for a listing of protected bird species: http://www.ec.gc.ca/nature/default.asp?lang=En&n=496E2702-1

4.2 PROVINCIAL LEGISLATION AND REGULATIONS

4.2.1 ENDANGERED SPECIES ACT

The *Ontario Endangered Species Act(ESA)* contains provisions to protect provincially listed endangered, threatened or extirpated species and their habitats. MNR administers this Act. Table 5 summarizes the sections of the Act relevant to waterpower construction.

Table 5: Ontario Endangered Species Act - Applicability to Waterpower Construction

Section	Wording of the Act	Implications for Construction

Section	Wording of the Act	Implications for Construction
9(1)(a)	*"No person shall,* *(a) kill, harm, harass, capture or take a living member of a species that is listed on the Species at Risk in Ontario List as an extirpated, endangered or threatened species;*	Discovery of a listed species that has not been previously identified through the EA process and for which a permit to construct does not exist, could result in a temporary shutdown of construction while a process for dealing with such a species is agreed to with the MNR.
10(1)(a)	*"No person shall damage or destroy the habitat of a species that is listed on the Species at Risk in Ontario list as an endangered or threatened species*"	Discovery of the habitat of a listed species that has not been previously identified through the EA process could result in a temporary shutdown of construction while a process for dealing with such a species is agreed to with the MNR.

4.2.2 LAKES AND RIVERS IMPROVEMENT ACT

The Lakes and Rivers Improvement Act contains provisions that require anyone who presently owns a dam or is planning on building a dam to submit their project for approval. The intent of the act is to provide for (as set out in the Act):

> (a) The management, protection, preservation and use of the waters of the lakes and rivers of Ontario and the land under them;
>
> (b) The protection and equitable exercise of public rights in or over the waters of the lakes and rivers of Ontario;
>
> (c) The protection of the interests of riparian owners;
>
> (d) The management, perpetuation and use of the fish, wildlife and other natural resources dependent on the lakes and rivers;
>
> (e) The protection of the natural amenities of the lakes and rivers and their shores and banks; and
>
> (f) The protection of persons and of 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). 1998, c. 18, Sched. I, s. 23.

In particular Section 14(1) and Section 16(1) are of key importance with respect to the development or redevelopment of a hydropower site in Ontario. Table 6 summarizes the pertinent parts of these sections.

Table 6: Lakes and Rivers Improvement Act - Applicability to Waterpower Construction

Section	Wording of the Act	Implications for Construction
14(1)	*"No person shall construct a dam in any lake or river in circumstances set out in the regulations without the written approval of the Minister for the location of the dam and its plans and specifications. 1998, c. 18, Sched. I, s. 29."*	A dam may not be constructed without it first having been reviewed in accordance with the requirements of section 14(1) through 14(12), and not before receiving written approval to construct. The approval consists to two parts: approval of the proposed location followed by approval of the proposed dam.
16 (1)	*"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 by the Minister. 1998, c. 18, Sched. I, s. 31."*	An existing dam cannot be altered by the owner without the approval of the MNR as issued under sections 16(1) and 16(2). All projects are reviewed by the MNR in accordance with the most recent issue of the Lakes & Rivers Improvement Act and associated Technical Guidelines and Best Management Practices issued by MNR.

4.2.3 ONTARIO WATER RESOURCES ACT

The Ontario Ministry of the Environment regulates the use and alteration of water resources in Ontario including all lakes and watercourses through the*Ontario Water Resources Act (OWRA)*. Table 7 summarizes the sections of this act that are applicable to waterpower construction.

Table 7: Ontario Water Resources Act - Applicability to Waterpower Construction

Section	Wording of the Act	Implications for Construction
34(1)	*"Despite any other Act, a person shall not take more than 50,000 litres of water on any day by any means except in accordance with a permit issued under section 34.1. 2007, c. 12, s. 1 (8)."*	If unanticipated water taking over 50,000 litres/day is required (as an example for dewatering and excavation) that is not covered under an existing permit to take water then that water taking cannot occur until a new permit or an amendment of an existing permit is secured.

4.2.4 ENVIRONMENTALPROTECTION ACT

The Ministry of the Environment in Ontario administers the *Environmental Protection Act* (EPA) which relates to atmospheric emissions including gases, particulate matter, odour, heat, sound, vibration etc. that results from power generating or auxiliary operations. It also applies to temporary structures, such as portable concrete batch plants that release emissions into the air, including dust from stockpiles and cement silos. Environmental Compliance Approval (Air and Noise) are required for construction, alteration, extension or replacement of any plant, structure, equipment and so on that might result in atmospheric contaminants and/or a permanent altered rate of emissions.

The *Act* also covers required approvals for sewage and solid waste disposal sites as well as liquid wastes such as sludge and slurries from tank cleanouts and waste treatment operations.Proponents must register liquid waste disposal schemes with Ministry and supply information regarding off-site hauling and disposing of liquid and hazardous waste. Approvals may also be required for dewatering activities prior to discharging water back into a natural watercourse.

5. ENVIRONMENTAL MANAGEMENT CONSIDERATIONS DURING CONSTRUCTION

5.1 ROLES AND RESPONSIBILITIES

The successful construction of a waterpower facility requires the coordinated efforts of many individuals who provide expertise and unique skill sets in various disciplines working together to meet the challenges of the project.

Owner or Proponent- generally the company or group that has funded the project from the Class EA, through detail design/approvals and ultimately through construction. Depending on the type of contract executed for the project, it is common for the owner to retain a company to oversee the construction on their behalf as a Contract Administration Team.

Contract Administration Team- manages all aspects of the project from the maintenance of construction sequencing and schedules to financial matters, documentation and quality control/quality assurance among many other duties. The Contract Administration Team, on the owner's behalf, typically assigns a Contract Administrator (CA).

Contract Administrator - leads the team and is responsible for liaising with all members of the project including the contractor and the regulatory authorities. This individual and their employer are ultimately responsible for ensuring project success on behalf of the owner. Project success is often measured in financial terms but environmental liability protection through the strict adherence to the project controls founded in provincial and federal legislation is also of extreme importance. Traditionally the Contract Administration Team has consisted of professional engineers with diverse specialties and focus areas who are supported on a day to day basis by technicians, inspectors and clerical staff. Complex projects, such as is the case with a waterpower development, often require other professionals to assist the Contract Administration team in their respected disciplines. The roles and responsibilities of the supporting professionals should be well defined at the outset of the project and supported by an established communication structure with the team. These professionals can include design engineers, biologists and other specialists as determined by project scope.

Environmental Monitors - A successful construction project typically has an individual or individuals assigned whose role it is to confirm that environmental protection is maintained through compliance with permits, approvals, authorizations and best practice commitments made by the owner. These individuals are often referred to as project Environmental Monitors (EM). Typically these individuals are focused on quality control and assurance as it relates to environmental compliance. These professionals are required to have extensive and demonstrated understanding of potential environmental impacts related to the construction activities and full comprehension of the regulatory framework (permits, approvals and authorizations) of the project. With a full understanding of the project developed prior to construction by means of a thorough review of the construction activities, environmental constraints, project schedules, tender documents, permit conditions and local site conditions, these team members are in a position to provide timely advice. In addition, they can also serve a critical role in liaising

with the Contract Administration Team, contractor, regulatory agency representatives (including enforcement) and the owner as required. This intermediary role between all parties allows for quick and efficient communication of environmental issues and ultimately satisfactory resolutions. The responsibilities of these individuals can be quite diverse and include training, promotion of environmental awareness, inspection of erosion and sediment control measures, coordination of incident reporting, documentation of compliance and due diligence, development of containment measures, restoration plans and work site isolation plans (see BMP 020). They can also assist in the review and approval of third party/contractor plans and designs.

To ensure compliance with all the regulated environmental facets of the project, the contractor or proponent should employ individuals tasked with overseeing all aspects of the construction related to the environment. Primary duties may include the installation and monitoring of the erosion and sediment controls, ensuring environmental provisions specified in the contract are adhered to, identifying deficiencies in the environmental protections plans, liaising and coordinating with the various supervisors responsible for the day to day construction activities along with reporting and communication duties. Retaining this skill set is extremely valuable in bringing environmental issues to the forefront at critical times during the construction project to ensure that tight schedules and timelines for the project are met.

Agencies -Various provincial and federal agencies that participated in the EA process and permitting and approvals may also provide a screening role during construction. These agencies may oversee/monitor aspects of the construction based on their applicable legislative mandates. In addition, some agencies routinely issue permits/approvals in support of the construction stage and receive progress documentation for the duration of the construction and beyond. The roles of each agency will vary with the type of project as well as the geographic location of the proposed facilities. These agencies can include the Ministry of the Environment (MOE), Ministry of Natural Resources (MNR), , Environment Canada, Transport Canada (TC) and Fisheries and Oceans Canada (DFO), along with others at various times throughout construction.

5.2 PROVIDING ONSITE ENVIRONMENTAL AWARENESS

A significant amount of effort and expertise go into planning the development of a waterpower facility well before the clearing and grubbing of a site begins. Beginning with a concept and progressing through a Class Environmental Assessment towards the final design review and approvals/permitting, potential environmental impacts and benefits arising from the waterpower development will have been identified, studied and considered. Acknowledging the potential for various environmental effects including those from construction, the design team and regulatory agencies should have collaborated to bring the best possible mitigation, compensation and restoration strategies to the project. It is the responsibility of all those associated with construction to execute those strategies. The best possible starting point for the successful completion of a waterpower construction project is to have all construction participants associated with the construction review together all the documentation including the Environmental Study Report (ESR), design documents (tender drawings and specifications), permits and approvals with regard to the environmental sensitivities of the project site. This should occur after award of the contract and well in advance of the

construction start date so that potential conflicts arising from complicated staging operations and schedules can be scrutinized against the identified environmental constraints and obligations. This allows for advance identification of potential schedule conflicts with environmental constraints, or environmental risks that may be associated with certain construction phases. This is just one benefit to enhanced environmental awareness on the site. Others include: the significant reduction in risk and legal liability resulting from environmental mishaps through the provision of 'due diligence' and compliance; protection from the high costs of fines or charges which could be applied; significant reduction in costs and responsibility of site remediation and restoration; and the maintenance of an untarnished corporate reputation.

The awareness of environmental sensitivities should be sustained by all construction participants for the duration of the construction phase. It is important to note that due to the lengthy construction periods associated with waterpower developments and the complexity of the undertaking, some environmental issues may arise as a result of construction delays, weather conditions and other unforeseen factors. As a result, regular reviews of upcoming construction activities, the construction schedules and sequencing will maintain a proactive focus on environmental issues.

5.3 ENVIRONMENTAL AWARENESS AND SPECIALIZED TRAINING

In order to ensure that everyone involved in the construction phase of the project has an expectation of an appropriate respect and regard for the environment, certain environmental education should be considered to support the construction of waterpower projects. In this regard, all major environmental sensitivities of the site should be identified along with the potential risks to these features that may be relevant during construction. This should target everyone that works on the construction project to raise general awareness of not only the surrounding environment but also the individual's personal potential liability as well as responsibility to protect. These educational efforts could include presentations during site indoctrination, signage posted around the construction camp, work areas, access roads and administration offices along with regular/seasonal information packages. This information could be focused on potential wildlife encounters/interactions, species at risk and sensitive species concerns, sensitive environmental features (fish and wildlife habitat)hazardous material management, general housekeeping requirements around the construction camp site and possible Aboriginal Communities concerns or interests (e.g. access restriction to traditional fishing grounds).

While it is expected that skilled and experienced environmental professionals will at least occasionally and sometimes frequently be working on the waterpower construction project, it is also important to raise awareness and provide specialized environmental training opportunities for other staff. Environmental monitors and engineering inspectors routinely scrutinize the environmental protection put in place to prevent the movement of potentially deleterious substances into watercourses or other sensitive environmental features, but it this should also be a focus for everyone working on the project. In particular, workers should be instructed that if they observe an environmental issue during their work, they report such to their supervisors.

Another specialized training program that is recommended is emergency spill response. Training provided in this regard would allow swift reactions to contain spills, documentation of the event as well as execution of proper clean up and site remediation measures.

5.4 DOCUMENTATION

Proper and timely documentation is a critical facet of any successful construction project.The various forms of documentation compiled during the construction of a waterpower project provides a lasting record of all activities and inspections. Documentation maintained on site should also include copies of all environmental permits and conditions, approvals and correspondence with the various regulatory agencies and environmental sub consultants. In some cases, unforeseen site conditions may necessitate the amendment to existing permits or acquisition of new ones. These particular documents inform all parties of the environmental requirements for the project, provide standards and objectives which are to be met, and allows for the planning for and advancement of critical work that is needed to ensure that the construction schedules can be maintained with a high regard for environmental protection.

In addition, the provision of environmental reports and inspection records can also inform all parties involved in the construction as to the current conditions of the site, identify areas of concern (present and future), document receipt of environmental clearance(s) to proceed with site activities, and keep the regulatory agencies up to date with the progress of the construction and overall success of the protective measures employed. These reports document undertakings in environmental protection and through the established communication protocols ensure that appropriate reactions are undertaken quickly and efficiently.

While every attempt is made to ensure adequate environmental protection, some unforeseen incidents may occur during the life of the construction project. The proper documentation of these events provides a record of the incident and the action taken to resolve the issue. In some cases, it is a simple correction and clean up while in other cases longer term monitoring may be required to ensure that remediation/restoration has been effective. These reports can then be used to adjust future activities to prevent similar incidents as well as demonstrate that “due diligence” was being maintained. Frequently an owner or their agents have template forms or report frameworks which apply to a project or which can be modified for contractor use.

Examples of site documentation that are maintained on a waterpower construction project can include:

- Various Provincial Permits
- Conservation Authority Permits
- Federal Authorizations
- Permit/Approval Amendments And Extensions
- Construction Schedules
- Site Inspection Records
- Spill And Accident Reports, Forms and Follow up Action lists
- Environmental contingency plans

- Waste manifests
- Nest Searches and other pre-clearing assessments
- Environmental Clearance Letters
- Correspondence (letters and emails)
- Site Drawings and Tender Documents
- Change Orders
- Record of Site Conditions

5.5 SITE DEVELOPMENT AND ENVIRONMENTAL MONITORING

The construction of a waterpower facility is often a multi-year project that results in dramatic alterations to the selected construction site over time; beginning with basic clearing activities and the development of the access road network, to the definition of the construction footprint and ultimately the completion of the facility. While the design details, approvals and environmental protection measures for the undertaking developed before construction attempt to address these changing site conditions, it is often the case that unforeseen circumstance may necessitate the need for an amendment to an existing permit. One example is the risk of sediment movement into sensitive environmental features like wetlands and watercourses due to grading changes and ever increasing exposed soils associated with phased construction activities. Approved erosion and sediment control plans developed during the design phase of a project are intended to address the majority of these potential risk areas, but in some cases earthworks and other activities can create potential pathways for sediment movement that were not previously envisioned. It is for this reason that environmental construction monitoring and ongoing improvements and maintenance of erosion and sediment controls are critical throughout the construction period.

In the case of multi-year projects, seasonal or winter shutdowns are often a reality due to inclement weather and poor working conditions. Site stabilization measures are even more critical in preparation for these times to ensure that the site is effectively contained and can withstand the upcoming thaw and wet conditions that the site will experience in the spring. Additionally, routine site inspections should continue through this period to ensure that erosion and sediment control measures are functioning in response to mid-winter thaws and other unusual weather conditions that can occur during this period.

Phased construction activities (both for the facility as a whole and in isolated construction activities), require that certain environmental tasks are completed before the work can advance. It is critical to understand if there are any environmental constraints that may halt or interfere with the scheduled work. Examples of this could include nest searches if vegetation clearing is scheduled during the breeding bird season or an approval requirement for the identification and relocation of significant vegetation species within a proposed clearing area. These activities can take considerable time and may severely restrict progress of the work. Restrictions on in-water construction related to fish spawning periods have the potential to impact on the schedule of activities like coffer dam construction and dewatering activities.If the proposed construction schedule is delayed or advanced for any reason, the environmental implications of those changes should be reviewed in detail to effectively minimize delays and prevent environmental non-compliance.

The proper phasing of construction should move beyond effective site containment and recognize opportunities to restore areas as soon as possible depending on the stage of project completion and appropriate seasonal timing. This early approach to restoration (in advance of full project completion) provides for the early establishment of vegetation communities and ground cover which affords a much more durable and effective measure of erosion control than other more temporary measures (like straw matting or erosion blankets). At a minimum, the construction of a waterpower project should have a restoration element which takes place as laydown areas, construction camps, temporary access roads and other site elements are no longer required. These restoration requirements can then be executed at the appropriate time in the construction project lifespan coupled with the best seasonal opportunities for effective restoration.

5.6 COMMUNICATION

Communication with agencies, the public and Aboriginal Communities is important through all phases of waterpower development, from concept to design, to construction and through to operation.

It is important that those who expressed an interest in being appraised of the construction activities, during project planning, and parties who are directly affected by those activities should be regularly communicated with during construction. Any commitments made through permitting and approvals that require ongoing public notification and involvement should also be respected.

5.7 INTEREST GROUPS

Proponents should consider sending regular updates or developing and maintaining a project website so that other interest groups such as cottagers associations, tourist camp operators, and trappers etc. who have expressed an interest in the projects progress can be kept informed.

5.7.1 ABORIGINAL COMMUNITIES

Aboriginal Communities who have expressed an interest during the EA process or permit applications, as applicable in being regularly updated should be informed of the progress of construction. The most effective means of doing so is for a proponent to arrange regularly scheduled meetings at the Aboriginal Community with those designated, by Chief and Council, to act on the Community's behalf. If a Community indicates that it would like to have a representative from the proponents organization attend a more formal forum such as a Band Council Meeting, it is advisable for a proponent to commit to doing so.

5.7.2 MUNICIPALITIES

If a project is within the bounds of one or more Municipalities and representatives from these communities have requested regular updates, a proponent should contact the community(s) and determine the most appropriate vehicle for the

provision of the updates. Often municipalities will assign someone from their Planning Department or the Clerk's office to liaise with the project.

5.7.3 APPROVAL AGENCIES

Approval agencies will often require regular updates on project progress, such as information on deviations from project schedule, notification of changes that may require agency review and input prior to implementation, etc. As part of the project manager's task list, it is good practice to identify the agency contact that will retain the project file once it is approved for construction. This is critical given the number of approval agencies that are involved and the number of approvals completed with permit conditions related to construction.

5.7.4 TOOLS FOR COMMUNICATION

Proponents can use any or all of the following suite of communication tools to keep interested and affected parties informed of the projects progress, impacts of weather, delays in equipment delivery, etc.

- Create a project webpage and regularly update it
- Publish a short regular newsletter that can be mailed to a predetermined mailing list and/or downloaded from the project webpage
- Conduct face to face meetings with key agency staff through offering of or accommodating requests for site tours
- Develop an email distribution list for those individuals and agencies who wish to receive regular updates directly. This list can be based on information gathered through the Class EA Open houses and by direct solicitation at meetings with communities, agencies, and Aboriginal Communities, etc.
- Hold Public Information Centres soon after commencing construction and at regular intervals thereafter until project is complete and commissioned.
- Consider hiring a member of the local community to act as a liaison between the project and the interested parties
- Considering identifying one or more contact people that interested parties can contact for information on the construction project

The First Nations Environmental Assessment Toolkit for Ontario is another important source of information for ideas on project communication. It is available at http://www.cooeatoolkit.org/.

6. BEST MANAGEMENT PRACTICES FOR THE CONSTRUCTION OF WATERPOWER FACILITIES

6.1 INTRODUCTION TO BEST MANAGEMENT PRACTICES

BMPs are guidelines that apply the best available methods or technologies based on known science that, if followed, should allow a proponent to meet the required standard(s) or achieve the desired objective(s) of not only complying with mandatory regulations (environmental and construction), but also maintaining a superior level of environmental performance.

BMPs support 'sustainable practices/principles' and are generally accepted techniques that, when used alone or in combination, prevent or reduce adverse effects a project can create for the natural environment. Examples of BMPs include Sediment and Erosion Control Plans and Access Management Plans to minimize traffic disruption during construction.

By understanding the standards a project must meet, a proponent can choose an appropriate set of best management practices to help carry out the construction of a waterpower project while achieving the required standards and objectives.

6.2 SPECIFIC CONSTRUCTION ACTIVITIES

6.2.1 PROJECT EXECUTION PLANNING & SAFETY TALKS

Safety is paramount when undertaking the construction of a waterpower project, and the requirement to work safely applies to everyone involved in the project. On a daily, weekly and monthly basis, the work schedule will be reviewed, hazard(s) identified, andenvironmental mitigation measures discussedwith those supervising the work. As such, it is critical that, at the start of each day and at the start of any new activity during the day, a safety session is held to review the elements of the activity at hand, to make sure that the elements of the task are understood along with necessary controls to mitigate the risks to the environment. These meetings provide a forum for discussion and an opportunity to raise concerns or questions that should be addressed before the work commences. Concerns left unaddressed have the potential to create an increased level of risk for an incident. It is important that all parties involved in a project are committed to the project safety program and follow through with that commitment including periodic safety audits in conjunction with the environmental audits to reinforce the need for compliance.

6.2.2 DEWATERING OF WORK AREA

Many aspects of waterpower construction require that a work area be dewatered to facilitate construction "in the dry". Work areas do not always need to be

completely dewatered, whichever the case the impacts outlined below should be reviewed. Excavation may need to occur below the existing groundwater table and excavation areas may collect surface water runoff, especially during storm events. In both instances, it is often necessary for the contractor to remove water, sometimes on a continuous basis, to facilitate construction in the dry. Most often the means of removing water are specified in the Lakes and Rivers Improvement Act approval for the project.

Dewatering of a work area can also occur with the use of localized pumping to lower the groundwater table in vicinity of the excavation. In these cases, a series of well points are usually installed adjacent to the excavation area. The well points are then connected to a pumping system which extracts groundwater, thereby lowering the groundwater table.

In-stream coffer dams are constructed to separate the watercourse from the work area. Although cofferdams are typically built to limit leakage into the work area, it is often not possible to completely eliminate leakage, and removal of accumulated water from the work area is necessary. When cofferdams are first completed, there is often a considerable amount of water retained insideof the cofferdam wherethe work is to occur. In these cases, removal of the standing water is usually necessary before construction can proceed.

For smaller watercourses a work site can be isolated with coffer dams and a bypass pump located to direct the full volume of flow around the work area and discharge it at some point downstream of the work area. This allows the contractor to work within the dewatered channel, restore the channel to required specifications and then remove the dam and re-water the channel once construction is complete.

For any of the above noted activities there are potential impacts that must be considered and appropriate mitigation for these impacts must be developed and then implemented by the contractor. Table 8 summarizes the potential impacts that may occur and refers the reader to the appropriate BMPs (Appendix A) that may be used to mitigate these impacts.

Additional guidance for “Measures to Protect Fish and Fish Habitat when Carrying Out an Isolated Crossing” is provided in DFO’s Operational Statementfor Isolated or Dry Open Cut Stream Crossings: http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/os-eo22-eng.htm

Table 8:Dewatering of Work Area - Summary of Potential Impacts and Recommended BMPs for Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP and OPSS Specification(s)
Pumping water from excavation	Water quality of receiving stream	Suspended sediment in the pumped water impacts water	001, 002, 003, 004, 005

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP and OPSS Specification(s)
		quality of the receiving watercourse by increasing the suspended solids loading above background levels. Sediment is the fine-grained particles that are sometimes transported in water. Turbidity refers to the cloudiness of the water. Sediment and turbidity can result in a variety of harmful impacts to fish and fish habitat. Suspended sediment can: • irritate fish gills and lead to death, • destroy protective mucous covering the eyes and scales of fish, making infection and disease more likely, • reduce light penetration in water, affecting fish feeding and reducing survival. • Sediment particles absorb warmth from the sun and increase water temperature which can stress some species of fish. • The small spaces between gravel particles become clogged, preventing the free flow of oxygenated water and the removal of waste products from developing eggs deposited in the gravels. This often suffocates the eggs and results in their death. In fact, it may even make gravel beds unsuitable for the future incubation of eggs. • The habitat of bottom-dwelling organisms, such as crayfish and insects, is destroyed. Fish rely on these organisms for food. • The sheltered areas between boulders and	OPSS 518

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP and OPSS Specification(s)
		gravel particles are eliminated. Young fish need these areas to survive. For more information refer to the Working Around Water Fact Sheet: http://www.dfo-mpo.gc.ca/regions/central/pub/fact-fait-mb/mb6-eng.htm	
Use of well point pumping to depress groundwater table in a work area	Aquatic habitat in adjacent watercourses	Pumping can impact stream flow and groundwater discharge thereby impacting aquatic habitat. Impacts can range from reductions in water depth, velocity and wetted perimeter to complete dewatering of substrate. Impacts have the potential to impact fish.	007
	Stream temperature in adjacent watercourse	Depending on the degree of pumping the reduction in groundwater discharge to a watercourse can result in elevated stream temperatures beyond the naturally occurring temperatures. In the case of a watercourse supporting cold water fish, this can negatively impact on the physiology of the fish and can also lead to death if stream temperatures exceed the thermal tolerance limits of these fish.	008
	Water levels in adjacent wells	As pumping occurs, a temporary impact to water levels in wells within the zone of influence of the pumping can occur. This may negatively affects human consumption patterns and/or businesses.	009

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP and OPSS Specification(s)
Bypass pumping of a watercourse around a work area	Fish community within bypassed area	If a section of channel is dewatered without consideration of the resident fish community, mortality of fish can occur. The greatest potential for impacts occur when fish are not removed from the isolation area and relocated downstream of the work area prior to bypass pumping occurring or when timing windows for in-water work are not adhered to.	006
	Water quality in watercourse	A significant risk during bypass pumping is that the capacity of the pumps is exceeded or that the upstream dam is somehow compromised. In both of these instances, water will re-enter the isolated work area. In the work area there is usually a large amount of unconsolidated construction materials (sand, gravel, disturbed streambed). If water re-enters the work area this material can become suspended leading to excess suspended sediment (potential impacts from suspended sediment are summarized previously in Table 8) load to the watercourse.	020
	Channel stability at discharge point for pumping operation	If proper energy dissipation is not employed at the point in the watercourse where the bypassed flow is discharged, significant scour and erosion of the channel and banks can occur.	005

6.2.3 INWATER WORK

In water work will always be a part of the development of a waterpower facility and can range from cofferdam placement, relocation and removal of cofferdams, intake and tailrace plug excavations, improving streambed hydraulics, culvert installation, to sediment removal, etc. These in-water works can negatively impact fish and fish habitat (eg aquatic plants) when best management practices are not followed. In water work should be kept to a minimum by working within the 'timing windows' where the work will have the least chance of having impact on aquatic and terrestrial habitats. The work should be carefully staged or planned, should include sediment and erosion control plans, and be executed as

quickly as possible. The use of silt curtains, selective dewatering of the area, collection and treatment of sediment laden water prior to it returning to the water body are all measures that can be used to minimize potential impacts.

Table 9 summarizes the potential impacts that may occur during in water work and refers the reader to the associated BMPs (Appendix A) that may be used to mitigate these impacts.

Table 9: In Water Work - Summary of Potential Impacts and Recommended BMPs for Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Cofferdam construction	Water quality in stream or lake	A portion of the material being excavated is added to the water column which impairs water quality	023
	Aquatic Habitat	Physical disturbance of habitat by coveringnative substrate or habitat features such as pools with cofferdam material	023
	Fish	Fish passage can be impacted if coffer dams are left in place during migration periods. If water intakes are not property screened, fish can become entrained	023
Removal of blasted rock	Water quality in stream or lake, habitats for fish and aquatic residents	Sediment entering water column from excavation settles on habitat, impairs gill function of fish.	022, 023

6.2.4 DRILLING AND BLASTING

Potential Impacts to Fish and Wildlife

Drilling and blasting activities in construction of a waterpower facility can include both civil (surface) and mining (tunnelling) projects that are designed to cut rock along the excavation perimeter and fragment the mass of rock to permit it to be easily removed. These two aspects of cutting and fragmenting rock need to be considered independently since drillhole patterns and explosive products differ depending on the required end-result.

Modern advances in explosives design, engineering rock mechanics and the development of standard specifications means that heavy overblasting resulting in unstable final rock walls, excessive rock movement and uncontrolled blast vibrations should be a thing of the past. The Drilling and Blasting Best Management Practice (see BMP 021) attempts to explain the differences between the different roles that drill and blast procedures are intended to achieve, investigate some of the pitfalls that engineers find themselves in when reviewing drill and blast activities, and provide comments for this type of project based on the principal Ontario Provincial Standards used to manage specific drilling and blasting on many projects.

Table 10 summaries the potential impacts to the natural environment from blasting and refers the reader to the appropriate BMPs (Appendix B), which provide mitigation advice for the impacts of blasting.

Table 10: Drilling and Blasting - Summary of Potential Impacts and Recommended BMPs for Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Drilling	Water quality in stream or lake	A portion of the material being excavated is added to the water column which impairs water quality and increases suspended sediment (refer to suspended sediment impacts in Table 8)	021, 023
	Fish and breeding birds	Disturbance of birds engaged in breeding activity as well as injury or mortality of the birds and their young can occur if blasting occurs during the breeding season. Drilling and blasting may also impact bird feeding activity e.g. bald eagle and osprey feeding areas are deemed significant wildlife habitat under the Significant Wildlife Habitat Technical Guide (SWHTG) and associated Decision Support System (DSS). http://www.mnr.gov.on.ca/en/Business/FW/Publication/MNR_E001285P.html	021, 023

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Blasting	Water quality in stream or lake, habitats for fish and aquatic residents	Blast may release materials into the water column and it may release shock wave energy that directly impacts fish and invertebrates in the area. The use of explosives in or near water produces shock waves characterized by a rapid rise to high peak pressure followed by a rapid decay to below ambient hydrostatic pressure (Wright and Hopky, 1998). The primary cause of damage in fish exposed to a blast pressure shock wave appears to be the outward rupture of the swim bladder as a result of the expansive effect of this negative hydrostatic pressure (USACE, 2004). The primary site of damage in finfish is the swim bladder, although post mortems on fish exposed to underwater explosions has also revealed damage to kidneys, livers and spleens (Keevin et al., 1997). Vibrations from the detonation of explosives may also cause damage to incubating fish eggs (Wright, 1982). There may be a requirement to remove and relocate fish from an isolated area prior to blasting occurring.	006, 021, 023
Removal of blasted rock	Water quality in stream or lake, habitats for fish and aquatic residents	Increase in suspended sediment (See Impacts Listed in Table 8). Sediment entering water column from excavation settles on habitat, impairs gill function of fish	021,022, 023

6.2.5 CLEARING AND GRUBBING

Many aspects of waterpower construction require that vegetation be cleared within a work area. The removal of vegetation is one of the most significant alterations encountered during construction. When vegetation is removed, the underlying soils are fully or partially exposed to various natural forces such as rain, flowing water, wind, and gravity.Erosion is defined as the physical removal

or detachment of soil materials. The subsequent transport and deposition of these detached particles (sediment) from the source location by the action of a mobile agent is referred to as sedimentation.

Vegetation clearing involves the cutting and removal of trees, shrubs, or other woody vegetation in order to facilitate waterpower development (i.e. storage areas, facilities, roads, construction camps, laydown areas, transmission lines, access roads and head-pond preparation). See DFO's Operational Statement on Riparian Vegetation Removal for further information for vegetation removal near water/fish habitat.

Grubbing involves removing stumps, roots, embedded logs, rock and debris from the upper levels of the soil. Grubbing is completed in order to prepare for grading activities, removal of unstable organic soil in load carrying zones, and to minimize visual obstacles at the roadside (OPG, 2003).

Table 11 summarizes the potential impacts that may occur as a result of vegetation clearing and references the reader to the appropriate BMPs that may be used to mitigate these impacts.

Table 11: Vegetation Clearing - Summary of Potential Impacts and Guidelines for Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	Associated BMP for Mitigation of Impact
Vegetation clearing	Vegetation/Vegetation Communities	Direct impacts from clearing include the decrease in overall abundance of vegetation in the work area. Depending on the location of the work area in relation to the surrounding natural area, there are potential impacts to vegetation outside of the work area, due to damage from construction activities.	013, 014, 015, 016, 017, 018 OPSS 201,801 NMS 31 11 00
		The establishment of invasive and/or exotic species in the work area, surrounding natural areas, or in areas where invasive plant material is transported, may be facilitated by vegetation clearing, and may out-compete native species.	018
		Rare species may be encountered in the work area, and have the potential to be damaged or destroyed.	019
	Terrestrial wildlife habitat	The diversity of species utilizing wildlife habitats may decrease due	013

Activity	Receptor Potentially Impacted	Details of Potential Impact	Associated BMP for Mitigation of Impact
		to habitat fragmentation for a variety of bird, mammal and insect species. Vegetation clearing within the key breeding bird period (May 1 – July 31) may significantly impact nesting species in the work area. Decreasing available wildlife habitat can decrease the wildlife population, as well as indirectly affecting key ecological processes such as pollination and decomposition. .	
		Rare species may be encountered in the work area, and have the potential to be injured or killed. Wildlife habitats may also be damaged or destroyed.	019
	Soil	Soil disturbance may occur due to vegetation clearing, including soil compaction and erosion. Areas where soil is disturbed are also more prone to the establishment of invasive and/or exotic species.	018
	Fish Habitat	Erosion and Sediment release from clearing may negatively impact on fish habitat. Loss of riparian or aquatic vegetation can destroy fish habitat. Many species of fish use vegetation for cover and spawning and these are often good feeding areas.	001,002,003,004
	Water Quality	Vegetation Clearing can lead to increases in erosion and sedimentation to watercourses. If sediment becomes mobile and enters a waterbody – suspended sediment can impact fish and fish habitat (refer to suspended sediment	001,002,003,004

Activity	Receptor Potentially Impacted	Details of Potential Impact	Associated BMP for Mitigation of Impact
		impacts in Table 8).	

The Canadian Food Inspection Agency (CFIA) has several Ontario regions regulated under Ministerial Order due to the presence of Emerald Ash Borer (EAB), a highly destructive beetle that has killed millions of trees in North America and poses a major economic threat to urban and forested areas. As EAB spreads rapidly by movement of infested ash species (*Fraxinus* spp.), the CFIA has placed movement restrictions on all ash material, including logs, branches and woodchips, within these regulated areas (CMAF, 2011). Since movement of brush or wood product from vegetation clearing could transfer this pest, to previously non-infested areas, a CFIA inspector should be contacted in order to obtain a *Movement Certificate* if any ash species are proposed to be removed out of work areas under Ministerial Order.

For an additional source of guidance regarding clearing and grubbing, the reader is referred to the following link to DFOs Operational Statement for Maintenance of Riparian Vegetation in Existing Right-of-Way:

http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/os-eo12-eng.htm

6.2.6 NEW WATER CROSSINGS

The construction and operation of access roads and watercourse crossings, if not properly constructed, may negatively impact on aquatic habitats at the site and in areas up or downstream from the construction site. Some potential impacts include sedimentation generated during watercrossing construction, fish passage impacts due to improperly installed or designed water crossings, chronic erosion due to unstable road slopes and/or undersized water crossings, destruction of fish habitat due to the location of the crossing. Maintenance phase impacts may be associated with the use of herbicides for vegetation control in close proximity to water, or hazardous substance inputs from repairs/replacement of bridges, abutments or culverts. Impacts may also occur as a result of exceeding the flood discharge capacity of the structures (MMM, 2007).

Planning for water crossings on access roads should be completed well in advance of construction and should utilize any and all of the following: an actual site survey, detailed-scale recent mapping, or aerial photography. Route selection should be directed toward minimizing the number of stream crossings and avoiding unsuitable or unstable crossing sites. Unsuitable crossing sites may be characterized by steep topography, areas with insufficient gravel, deep

swamps, bedrock, and erodible or shallow rocks. Sites having significant instream habitat for aquatic biota should also be avoided. Road crossings should traverse the stream beds as close to a 90^{o} angle as possible and should be located, where possible, along straight sections of a stream. Water crossings can impact fish movement and migration, and fragment fish habitat. If culverts are being used, sizing of culverts must be appropriate so that water velocities don't present a barrier to fish passage or cause downstream erosion.

New watercourse crossing structures should retain the pre-installation stream conditions to the extent possible and the design of the structure is determined by a number of factors including presence/absence of fish habitat, sensitivity of fish habitat, engineering requirements, cost and availability of materials, and cost of inspection and maintenance. The presence of fish habitat can, dictate the method of construction, often requires a high level of mitigation, and can require a Fisheries Act Authorization to complete the construction. Typically new watercourse crossings can be broken down into two categories; culvert structures (closed and open bottom), and span structures (bridge).

6.2.7 CULVERT CROSSINGS

Culvert construction is generally governed by technical specifications (e.g. within tender documents). Appropriate culvert sizing is needed to address fish passage requirements, flood risk, duration and watershed size. Placement of new culverts usually requires submission of a Public Lands Act Work Permit application and often a Fisheries Act review (basic requirements are listed below). Dewatering and watercourse diversions may be needed during the installation of the culvert and this can be accomplished through the use of plug structures, flumes, pumping or cofferdams (see BMP-020). Impacts to aquatic habitat and biota associated with coffer dams include the potential for excess sediment to be suspended and carried downstream by river flow during the installation and removal of the dam. Depending on the size and type of coffer dam utilized the structure will have direct impacts on the substrates and habitat for which it has been placed, and has the potential to strand fish within the enclosure (see BMP 006). The most significant potential impact during construction and removal of the coffer dam is the potential for excess sediment to be suspended and carried downstream by river flow (refer to Section 5.3.1 for related information on dewatering of work area and associated BMPs). An appropriate reference to aid planning when considering placement of culverts considering is Wilson (1996).

If water crossings fail or are poorly installed some of the potential negative impacts to the aquatic environment would include: flooding, increased erosion, increased turbidity (damage or mortality of biota – refer to the table above that lists the effects of sediment),fish passage impacts, downstream erosion, scour of the streambed and head cutting. Sediment and erosion control measures should be installed prior to construction and maintained diligently throughout the construction. Maintenance should continue until such time as the disturbed areas are sufficiently stabilized through vegetative growth. Potential overland flow paths should be identified in advance of construction and receive added protection and scrutiny during inspections, particularly during the periods before and after rain events.

Potential impacts from culvert construction include vehicle spills, sedimentation impact to water flows and levels ,water quality impairment and biota damage and mortality (sensitive area and buffer zone infringement, fish habitat and populations, vegetation removal). These potential impacts must be considered and appropriate mitigation for these impacts must be developed and then implemented by the contractor. The following DFO operational statements provide additional guidance for mitigating the impacts of bridge maintenance activities.

Culvert Maintenance

http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/os-eo07-eng.htm

6.2.8 BRIDGE CROSSINGS

Bridge construction is very similar to culvert construction and is usually governed by technical specifications (e.g. within tender documents) and is subject to regulatory approvals. Appropriate sizing is needed to address fish passage requirements, flood risk, watershed size, and whether the structure is permanent or temporary. Placement of new bridges usually requires submission of design information as part of an MNR Lakes and River Improvement Act Authorization and Public Lands Act Work Permit application and often a Fisheries Act review (basic requirements are listed below) and Navigable Waters Protection Act Permit. Dewatering and watercourse diversions may be needed during the installation of the bridge and this can be accomplished through the use of flumes, by-pass channels and/or cofferdams (see BMP-020).

Road approaches to streams may be built up by infilling part of the floodplain with gravel, rock, and sandy materials. Abutments are placed at each end of the stream crossing to support the bridge. Larger spans may require piers anchored in the streambed for additional support. Some excavation in the streambed or floodplain may be necessary to install the abutments and piers on a stable foundation. The most frequently used bridges used during construction of waterpower projects are removable Bailey Bridges. Sometimes ATV/ snowmobile trail bridges are required for accessing control structures (OPG, 2003).

Impacts to aquatic habitat and biota associated with use of coffer dams when installing a bridge include the potential for excess sediment to be suspended and carried downstream by river flow during the installation and removal of the dam. Depending on the size and type of coffer dam utilized the structure will have direct impacts on the substrates and habitat for which it has been placed, and has the potential to strand fish within the enclosure (see BMP 006). The most significant potential impact during construction and removal of the coffer dam is the potential for excess sediment to be suspended and carried downstream by river flow (refer to Section 5.3.1 for related information on dewatering of work area and associated BMPs).

Other potential impacts from bridge construction include vehicle spills, sedimentation impact to water flows and levels,water quality impairment and biota damage and mortality (sensitive area and buffer zone infringement, fish habitat and populations, vegetation removal). These potential impacts must be considered and appropriate mitigation for these impacts must be developed and then implemented by the contractor. The following DFO's operational statements provide additional guidance for mitigating the impacts of bridge maintenance activities.

Bridge Maintenance

http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/os-eo04-eng.htm

Clear Span Bridges

http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/os-eo05-eng.htm

Temporary Stream Crossing

http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/os-eo23-eng.htm

Potential impacts associated with culvert and bridge crossings along with a reference to the associated BMPs are found in Table 12

Table 12: Bridge and Culvert Crossings - Summary of Potential Impacts and Recommended BMPs for Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Clearing and grubbing for site access and shoreline at crossing location	Water quality in watercourse	The removal of riparian vegetation along the shoreline leads to erosion and the potential for sediment to enter the watercourse which may: • irritate fish gills and lead to death, • destroy protective mucous covering the eyes and scales of fish, making infection and disease more likely, • reduce light penetration in water, affecting fish feeding and reducing survival. • Sediment particles absorb warmth from the sun and increase water temperature which can stress some	010, 011, 013

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
		species of fish. • The small spaces between gravel particles become clogged, preventing the free flow of oxygenated water and the removal of waste products from developing eggs deposited in the gravels. This often suffocates the eggs and results in their death. In fact, it may even make gravel beds unsuitable for the future incubation of eggs. • The habitat of bottom-dwelling organisms, such as crayfish and insects, is destroyed. Fish rely on these organisms for food. • The sheltered areas between boulders and gravel particles are eliminated. Young fish need these areas to survive. For more information refer to the Working Around Water Fact Sheet: http://www.dfo-mpo.gc.ca/regions/central/pub/fact-fait-mb/mb6-eng.htm	
	Breeding birds	The removal of vegetation can result in the loss of breeding bird habitat, and the potential for injury or mortality of breeding birds within the area being cleared.	013

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
	Buffer zone infringement	The removal of riparian vegetation along the shoreline leads to reduced bank stability, potential erosion and sedimentation, and disturbance to fish habitat.	010, 011, 013
Machinery and heavy equipment in vicinity of a watercourse	Water quality in watercourse	With all construction in or near water there is a potential for hazardous material such as hydraulic fluid, or gasoline to enter the water course which changes the quality of water within the watercourse and may result in mortality to fish or aquatic biota.	010, 011, 034 OPSS 182
	Aquatic habitat	Heavy machinery in water can also destroy fish habitat (rutting of the watercourse) and can result in downstream erosion.	010, 011, OPSS 182
In water construction	Aquatic habitat and aquatic biota, water quality	In water construction has the potential to disturb aquatic habitat and biota which may result in injury or mortality of fish and aquatic biota, and may also result in sedimentation of critical aquatic habitat such as spawning areas (see impacts listed in Table 8)..	010, 011
Installation and removal of coffer dams for worksite isolation	Culverts, bridge dewatering and induced flow changes	As worksite isolation takes place with the use of coffer dams, negative impacts from coffer dam construction may occur including: • Fish passage can be blocked; • Water flows altered (upstream flooding, downstream, low water levels impacting aquatic biota due to water temperature increases or habitat loss); • Downstream erosion and sedimentation	010, 011, 020

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Water diversion	Fish community within bypassed area	If a section of channel is dewatered without consideration of the resident fish community, mortality of fish can occur. If screens are not placed on the equipment – fish can become entrained. (Refer to DFO's fish screen guide).	006
	Water quality in watercourse	A significant risk during bypass pumping is that the capacity of the pumps is exceeded or that the upstream dam is somehow compromised. In both of these instances, water will re-enter the isolated work area. In the work area there is usually a large amount of unconsolidated construction materials (sand, gravel, disturbed streambed). If water re-enters the work area this material can become suspended leading to excess suspended sediment load to the watercourse.	020
	Channel stability at discharge of pumping operation	If proper energy dissipation is not employed at the point in the watercourse where the bypassed flow is discharged, significant scour and erosion of the channel and banks can occur	004
Dewatering activities	Water quality of receiving stream	Depending on the amount of suspended sediment in the pumped water there is the potential to impact water quality of the receiving watercourse by increasing the suspended solids loading in the watercourse above background levels. This has the potential to result in sedimentation of critical aquatic habitat such as spawning areas. It also has the potential to interfere with native fish by causing gill abrasion or interfering with foraging activities of site feeding fish.	001, 002, 003, 004, 005

6.2.9 EXCAVATIONS

Excavation of soil and rock is integral to the construction of a waterpower facility. It is a principal component of the, preparation of access roads, laydown areas, and facility locations for items such as concrete batch plant locations, site buildings, extraction of borrow materials, etc. Often excavations must occur on sloped areas as well as areas adjacent to watercourses, wetlands, swamps and lakes which are part of the landscape associated with the waterpower site that is being developed. Steps should be taken to ensure erosion and sedimentation into sensitive habitats is avoided. For a summary of mitigaitve measures that can be implemented to alleviate imapcts associated with excavation, the reader is referred to BMP 022.

6.2.10 DREDGING

Dredging is defined as the underwater excavation (deepening and widening) of a waterbody or watercourse but does not include dredge spoil disposal (covered in Section 5.3.8 - Dredging). Dredging is usually undertaken in wetlands, rivers, lakes, streambeds, and shoreline areas to facilitate the construction of foundations, control structures, station intake and discharges power canals (channel leading to the intake) beyond the end of the draft tube discharge, etc.

Areas that are dredged at least once every few years over an extended period is referred to as maintenance dredging. The following DFO Operational Statements provide additional guidance for mitigating the impacts of maintenance dredging activities.

Maintenance dredging:

http://www.pac.dfo-mpo.gc.ca/habitat/os-eo/pdfs/dredging_e.pdf)

For further information with respect to storage of dredged materials the reader is referred to:

http://www.iadc-dredging.com/index.php?option=com_content&task=view&id=140&Itemid=330

The reader is referred to Table 13 for a summary of potential impacts associated with dredging and the associated BMPs that may be consulted to determine possible mitigation for these impacts.

Table 13: Dredging – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Excavation of Underwater Materials	Water quality of receiving waterbody	Dredged materials are not contained at the cutting head or bucket of backhoe or dragline – refer to Table 8 for a summary of impacts.	001, 004, 005, 026
	Aquatic habitat	The potential effects of underwater excavation are destruction of habitat and benthic communities.	001, 004, 005, 026
Deposition of Dredged Materials	Water quality of receiving waterbody	Dredged materials are not retained with in silt curtained area or materials escape from the basin intended to retain sediment – refer to Table 8 for a list of impacts.	001, 004, 005,026
	Aquatic habitat	Dredged materials are not contained and settle on habitat areas or benthic communities, impacting fish.	001, 004, 005, 026
	Terrestrial Habitat	Dredged material are often contained on-land. Containment areas could impact aquatic habitats and sensitive terrestrial habitats if not located with proper consideration of the environment.	026

6.2.11 ROAD AND TRAIL CONSTRUCTION

The construction and operation of access roads and trails may impact on terrestrial and aquatic ecosystems in areas distant from the waterpower project or dam site. Access roads represent linear corridors. For new projects, roads would, in most instances, be associated with traversing forested non-urban lands, but must meet the demands of construction traffic and provide long term service for the operating life of the facility (MMM, 2007). Access roads (and trails) may be constructed for permanent or temporary use and are built to provide access for the construction of various facilities and/or to facilitate follow-up maintenance and long-term accessibility. Skid trails are temporary trails used by skidders in removing trees. Many access roads are constructed of gravel surfaces 3.6 to 9.7 m in width. Roads receiving greater use or required for longer periods of time may be constructed with an asphalt surface

Potential environmental impacts of road construction are vehicle spills, sedimentation and erosion of adjacent habitats, changes in watercourse flows and levels and air emission impacts from vehicle emissions, noise and dust). Additional impacts may include water quality impairment, and biota damage and mortality Identification of environmentally sensitive or special areas should be completed in the Environmental Assessment (EA) process and should be avoided entirely or receive high priority in making trade-offs about road locations, and staging areas. These special areas include fish habitat, wetlands, areas of rare, threatened and endangered plants and wildlife, special wildlife habitat (including snags used by cavity nesting birds, stick nests colonial bird roosts, dens, calving grounds, deer yards, etc.), hazard lands, steep hilly terrain, areas with erodible soils, recreational areas, sensitive areas of human habitation or land use, resource user facilities, habitations, heritage resource sites, etc.

Road construction on Crown land will also require development of appropriate road use management strategy including decommissioning and custodianship. Signage or other structures may be required for public safety to address road use/access.

Additional guidance is found in MNR's Forest Access Road Document:

http://www.web2.mnr.gov.on.ca/mnr/forests/public/guide/roads%20&%20water%20crossings/Section5to5.5.pdf

Table 14 summarizes the potential impacts that may occur with new road construction and refers the reader to the appropriate BMPs that may be used to mitigate these impacts.

Table 14: Road Construction Summary of Potential Impacts and Recommended BMPs for Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Clearing and grubbing	Terrestrial vegetation, woodlots, potentially sensitive areas	Road construction can result in the removal of trees, shrubs, and terrestrial vegetation.	012, 013, 014 OPSS 201 NMS 31 11 00
	Breeding birds	The removal of vegetation can result in the loss of breeding bird habitat, and the potential for injury or mortality of breeding birds within the area being cleared. Breeding birds are sensitive to noise and disturbance and may abandon nesting territories and nests.	013, 019

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
	Water quality in watercourse	The removal of riparian vegetation along the shoreline leads to erosion and the potential for sediment to enter the watercourse which may result in sedimentation of critical aquatic habitat such as spawning areas. It also has the potential to interfere with native fish by causing gill abrasion or interfering with foraging activities of site feeding fish.	001, 002, 003, 004, 005
	Terrestrial and aquatic biota and water quality in watercourse	With all construction there is a potential for hazardous material such as hydraulic fluid, or gasoline to spill. These hazardous materials have the potential to damage terrestrial biota and may extend into a water course changing the quality of water within the watercourse and may result in mortality to fish or aquatic biota.	032,033,034
Installation and removal of coffer dams for worksite isolation	Culverts, bridge dewatering and induced flow changes	As worksite isolation takes place with the use of coffer dams, water levels both upstream and downstream of the worksite can be altered. Water levels upstream can increase which may result in flooding or sedimentation,while downstream water levels may decrease resulting in impacts to aquatic biota and downstream resources. Temporary sedimentation may also occur downstream as a result of coffer dam installation and removal which may result in sedimentation of critical aquatic habitat such as spawning areas. It also has the potential to interfere with native fish by causing gill abrasion or interfering with foraging activities of site feeding fish.	001, 002, 003, 004, 005, 020

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Stockpile material	Environment surrounding stockpile area	Stockpile material has the potential to run off site during rain events resulting in sedimentation of the surrounding lands which may choke out vegetation resulting in mortality. Sediment if not contained within designated stockpile areas may end up in watercourses resulting in sedimentation of critical aquatic habitat such as spawning areas.	001, 002, 003, 004, 005
Water diversion	Fish community within bypassed area	If a section of channel is dewatered without consideration of the resident fish community, mortality of fish can occur. Therefore, fish must be removed from the isolation area and relocated downstream of the work area prior to bypass pumping occurring.	006
	Water quality in watercourse	A significant risk during bypass pumping is that the capacity of the pumps is exceeded or that the upstream dam is somehow compromised. In both of these instances, water will re-enter the isolated work area. In the work area there is usually a large amount of unconsolidated construction materials (sand, gravel, disturbed streambed). If water re-enters the work area this material can become suspended leading to excess suspended sediment load to the watercourse.	020
	Channel stability at discharge of pumping operation	If proper energy dissipation is not employed at the point in the watercourse where the bypassed flow is discharged, significant scour and erosion of the channel and banks can occur.	004
Dewatering activities	Water quality of receiving stream;	Depending on the amount of suspended sediment in the	001, 002, 003, 004, 005

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
	fish and fish habitat	pumped water there is the potential to impact water quality of the receiving watercourse by increasing the suspended solids loading in the watercourse above background levels. This has the potential to result in sedimentation of critical aquatic habitat such as spawning areas. It also has the potential to interfere with native fish by causing gill abrasion or interfering with foraging activities of site feeding fish.	
	Channel stability at discharge of pumping operation	If proper energy dissipation is not employed at the point in the watercourse where the bypassed flow is discharged, significant scour and erosion of the channel and banks can occur.	004

6.2.12 DEMOLITION

In redeveloping or developing sites, it is often necessary to demolish existing structural elements. If not already done as part of the EA process and detailed design, it is advisable for a Level 1 Environmental Site Assessment to be performed to identify potential pollution sources and remediating options. Demolition projects generate waste materials that can include concrete, steel, wood, soil and other items. These materials need to be collected and safely disposed of offsite. Uncontaminated materials can be removed from the site using normal construction vehicles. Reuse and recycling of uncontaminated materials may reduce costs and avoid the need for removal, where appropriate. Contaminated materials, must be handled and transported to an approved waste disposal site(s) in accordance with federal and provincial regulations by licensed waste haulage firms.

Table 15 summarizes the potential impacts associated with demolition and refers the reader to the appropriate BMPs that may be used to mitigate these impacts.

Additional guidance is provided in NMS 02 41 16 – Structural Demolition.

Table 15: Demolition – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Demolition	Sensitive aquatic habitat features (wetlands, pools, etc)	Residue from demolition and potentially product from the demolition entering the water resulting in a physical disturbance of habitat by covering native substrate or habitat features such as pools with demolition material,	024, 032, 033
	Air	Dust from demolition activities are carried offsite by air movements. Impacts can range from impairing visibility to damaging equipment in areas in close proximity to the site.	024, 037
	Human	Dust from demolition can result in inhalation related impacts on human as well as flora and fauna.	024, 037
Removal of waste	Sensitive aquatic habitat features (wetlands, pools, etc)	Materials being removed from area being demolished can fall into water body resulting in a physical disturbance of habitat by covering native substrate or habitat features such as pools with demolition material. In addition, surface dust or residual chemicals can become dissolved affecting water quality and impacting fish and aquatic habitats.	024, , 033, 037
	Air	Dust exits the site and impacts local area vegetation and animals.	024, 037
	Human	Dust can result in inhalation related impacts on human as well as flora and fauna.	024, 037
	Offsite	If waste storage area fails to contain runoff or if materials are not covered to prevent dusting unwanted materials could enter the air or drainage system.	024,036,

6.2.13 GROUTING

Grouting is generally governed by technical specifications (e.g. within tender documents). Grouting involves pouring or injecting a compound (i.e., cement

slurry, polyurethane or other chemical compounds) under pressure to fill cracks and voids in concrete, stabilize rock anchors, and to provide new exterior to structures. Grout compound should be confined to the structure requiring the grout and excess quantities should be collected into an external collection area. Grout compound should not be deposited into a water body.

Care needs to be taken to minimize the potential for a release of these materials beginning with proper storage of raw materials and proper handling (BMP-033) or review of various different methods of grouting. Similarly, chemical grouts are often used in smaller quantities for more specialized purposes and the need for proper storage, mixing and injection of this type of grout is of even greater importance as the components themselves are toxic and can have a wider effect if a release takes place than cementitious grouts. Extensive use of chemical grouts in areas adjacent to water bodies may require toxicity testing and regulatory approval. Specific spill prevention, preparedness and response measures will need to be addressed in the Environmental Protection Plan and the Spills Response Plan. In addition to discharges at the point of grout delivery, spills can also occur at grout pump locations. Table 16 summarizes the potential impacts associated with grouting and refers the reader to the appropriate BMPs that may be used to mitigate these impacts.

Table 16: Grouting – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Storage of grout materials	Soil, groundwater contamination and humans	A release of materials directly onto the ground or resulting from a containment failure can introduce grout components directly to the workers, soil and possibly the water table.	025, 032, 033, 034, 036
	Water quality of receiving stream; aquatic habitats and biota	Grout materials that travel to a water course can impact water quality by changing the pH, rendering the water toxic to the organisms in the watercourse and humans who may consume the water. Epoxy groutscan affect not only surface water but ground water should they be accidentally released.	025, 032,033, 034, 037

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
	Human	A release of cementitious materials can result in impacts on skin, eyes and breathing if dust cloud is significant. A release of the components of two part epoxy can result in toxic effects on humans from skin contact and inhalation.	025, 032, 033, 034, 036,
Grout Preparation	Soil	Discharges to soil (equipment spills, liquid or powdered grout spills).	025, 032, 033, 034, 036,
	Waterbody	Water quality impairment (pH, suspended solids).	025, 032, 033, 034,
	Human	Toxic effects to the human body.	025, 032, 033, 034, 036,
	Fish	Damage or mortality of biota (e.g. sediment dwelling organisms, spawning bed damage, fish toxicity.	025, 032, 033, 034, 036,
	Air	Dust or fumes can impact on individuals.	025, 037

6.2.14 STRUCTURE REPAIRS AND REHABILITATION

This grouping of activities applies to those sites where existing dams and/or previous generation facilities are being developed or redeveloped. This activity is generally governed by technical specifications within tender documents in a similar manner as new construction. A key element to repair and rehabilitation of an existing structure to enable development of the energy production potential is to conduct a Phase 1 Environmental Site Assessment if not already done during the planning and design stages. Phase 1 consists of a survey of the site to determine the presence of Designated Substances. A specific designated substance survey with sampling and volume estimates would provide a more detailed assessment of the type and extent of materials to be removed. In Ontario, the Occupational Health and Safety Act designates substances such as asbestos, lead, and mercury all of which may be in existence at an older facility. Typically materials may include asbestos in floor tiles, ceiling tiles or insulation of finished power control rooms and equipment, switchgear with mercury, lead used

as paint on steel or as a lubricant for bolts on equipment, and PCBs in control cables and paint. Areas that are to be dewatered as part of the work can also present a risk as the water may have acted as a cover preventing the escape of fumes resulting from materials reacting with oxygen or re-suspension of sediments that may contain toxic elements. At the same, concern should also be focused on assessing the impacts of temporary construction related loads on existing structures such as snow loading or ice pressures. These should be considered in relation to how dams, water control gates and spillways will be operated during the project lifespan. All of these concerns should be considered to ensure that the rehabilitation plan minimizes the requirements for demolition or alteration of existing structures while providing sufficient space to accommodate the proposed development.

Construction activities should be scheduled to accommodate restrictions for the protection of the natural environment including wildlife habitat, and to accommodate manmade constraints such as half-load season, tourist season, high traffic periods, and other water users.

Table 17 summarizes the potential impacts of structure repair and rehabilitation and refers the reader to the appropriate BMPs that may be used to mitigate these impacts.

Table 17: Structure Repairs and Rehabilitation – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Demolition	Air	Demolition can create dust or possibly release toxic materials into the air.	024, 033,
	Water	Demolition can create sediment that possibly contains toxic materials which could enter the water column.	024, 033, 034,
Waste Removal	Air	Loading and hauling to disposal can result in dust being released into the air.	024, 033, 035
	Water	If waste is wet runoff could be contaminated which could impact environment along haulage route.	033, 034, 036, 035
	Offsite	If waste storage area fails to contain runoff or if materials are not covered to prevent dusting unwanted	033, 034, 036,

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
		materials could enter the air or drainage system.	

6.2.15 CONCRETE BATCH PLANT AND ONSITE CRUSHING OPERATIONS

Concrete batch plants are required for waterpower development where it is impractical to bring concrete from a ready mix plant. If a portable plant is not on site, batching will be done on site using pre-packaged dry mix materials that are loaded into a ready mix truck along with water and admixtures. Portableconcreteplantscanemitsignificantamountsoffineandcoarse particulatesandgaseousemissions.

Concretemanufacturingreleasesthefollowingsubstances which have been declared toxicundertheCanadianEnvironmentalProtectionAct,1999(CEPA):PM_{10}, sulphuroxides,nitrogenoxides,volatileorganiccompounds,andgroundlevel ozone. Similarly, particulatematterlessthan2.5micronsin size ($PM_{2.5}$) has beendeclaredtoxicunderCEPAbecauseof humanhealth and environmentalconcerns. Particulatematter (PM)isthemainsubstanceofconcernreleasedfrom thisactivity and it is mainly releasedthroughfugitiveemissionsduringmaterialshandling, mixingandstorage activities and road dust. Batchplantscan emitsignificantamountsofPMandgasesifnotequippedwithproperair pollutioncontroldevicesoriftheseconstroldevicesarenotoperatedormaintained properly. The useofabaghousedustcollectoris an example of amitigationmeasure that can be used to reducetheemissionofPM. Approvals from the Ministry of the Environment are required for a batch plant and crushing facilities.

In Ontario there are specific regulations that affect portable concrete batch plants:

- Air Pollution Regulation (Environmental Protection Act R.R.O 1990, Reg. 346), and
- Point of Impingement Standards, Point of Impingement Guidelines and Ambient Air Quality Criteria (AAQCs)

Reference should be madeto theCanada-WideStandardsforPMandOzone(developedbytheCanadian Council of the Ministries of the Environment)to addresstheindustrialsectorswhereemissionreduction strategiesforPMweredeveloped. Operators of temporary(mobileorportable)concrete batchplantsarerequiredto reportunderNationalPollutantReleaseInventory on an annual basis.

If onsite crushing will be undertaken, it will need to be operated in a manner similar to a concrete batch plant in order to control dust and noise associated with crushing.

Additional source of best management practices:

Ready Mixed Concrete Association of Ontario - Recommended Guideline for Environmental Practices for Canadian Ready Mixed Concrete Industry

http://www.rmcao.org/sites/default/files/CRMCA%20EMP%20MAY%2004.pdf

Table 18 provides a summary of the potential impacts that may occur during concrete batching and crushing refers the reader to the appropriate BMPs that may be used to mitigate these impacts.

Table 18: Concrete Batching and Crushing – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Crushing and screening materials	Air	Dust released into air can negatively impact respiration leading to lung disease and impaired lung function.	027, 037
	Water quality of receiving water body	Dust and fines from site mix with runoff and enter water body. High levels of dust fall into aquatic systems may adversely affect aquatic biota not adapted to high levels of sedimentation. Refer to Table 8 – Impacts of Suspended Sediment	027, 037
Batching concrete	Air	Dust released into air can negatively impact respiration leading to lung disease and impaired lung function; an also cause skin and eye irritation	027, 037
	Water quality of receiving water body	High levels of dust fall into aquatic systems may adversely affect aquatic biota not adapted to high levels of sedimentation, negative impacts on water quality. Refer to Table 8 – Impacts of Suspended Sediment	027, 037
Filling cement silo	Air	Dust released into air can negatively impact respiration leading to lung disease and impaired lung function; an also cause skin and eye irritation.	027, 037
Washing out	Water and Land	Cement and fines from washing out	004, 034,027

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
trucks and pumps		of ready mix truck and pump with runoff and enter waterbody refer to Table 8 – Impacts of Suspended Sediment). Specific washout areas should be implemented to avoid impacts to natural vegetative areas. These can also result in skin and eye irritation if splashing occurs.	

6.2.16 EARTH DAM AND DIKE CONSTRUCTION

Many waterpower projects involve the use of earthen materials to construct main dams, saddle dams, or dikes as part of development of a project. Earth dams and dikes that form part of a project will have been designed on the basis of a comprehensive geotechnical investigation. Monitoring during construction is important to ensure that compliance with the construction specifications is achieved to further ensure that the final arrangement of the dam will meet the design intent. It is common best practice that the consultant responsible for the detailed design and who prepared the construction drawings and specifications provide field monitoring during the construction activities.

Construction of earthfill structures is done in stages beginning with a start up meeting on site which should involve all parties (owner(s), owner's representatives, contractor and subcontractor(s) (if one or more is involved), dam designer and site engineer to ensure that all parties are aware of the expectations associated with proper construction of the particular earthfill structure. The site meeting is then followed by the steps in the construction sequence starting with survey layout of the dam followed by site clearing, foundation preparation, material preparation and placement, testing to verify proper placement following the directions of the quality control/quality assurance program that was developed during the design stage of the project.Table 19 summarizes the potential impacts associated with earth dam and dike construction and refers the reader to the appropriate BMPs that may be used to mitigate these impacts.

Table 19: Earth Dam and Dike Construction – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Site clearing / vegetation clearing	Water	Materials disturbed during clearing are washed into a water body. Refer to Table 11 for impacts associated with vegetation clearing and grubbing.	013, , 028, OPSS 201 NMS 31 11
In-water work and site isolation	Water quality in stream or lake; aquatic habitat; fish	Refer to Table 8 – Dewatering of Work Area – Summary of Potential Impacts and Recommended BMPs for Mitigation	001, 002, 003, 004, 005,028 OPSS 518
In-water work / foundation cleaning	Water	During the construction stage of the dam there will be times when construction can result in the production of sediment laden water when foundation rock is being cleaned to receive the earthfill materials. Refer to Table 8: Dewatering of Work Area - Summary of Potential Impacts and Recommended BMPs for Mitigation	001, 002, 003, 004,028
	Sensitive aquatic habitats	Timing windows will be set by MNR to determine in-water work windows to protect local fish populations.	
Material haulage	Air and Water	Waste materials are often contained on-land. Containment areas should be set back from aquatic habitats and not situated on sensitive terrestrial habitats.	032,033,036
Placement and compaction	Social and sensitive species	Noise from compaction of material as well as production of materials being used to construct the dam or dike.	See Section 6.2.20
Material placement / grading	Air; water; sensitive habitat features (eg. Wetlands, moose,	Loading, hauling, dumping, spreading, shaping and compacting can all release dust into the air that can impact humans as well as plants and animals.	037

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
	feeding areas, etc)		
	Water	If sediment becomes mobile and enters a waterbody – suspended sediment can impact water quality, fisheries, plants and invertebrates.	001, 002, 003, 004,

6.2.17 CONCRETE AND ROLLER COMPACTED CONCRETE

During construction or rehabilitation of a waterpower facility, proper placement of concrete for dams, spillways and powerhouses would have been considered as part of the overall design work during the EA phase. Decisions about concrete use and placement need to balance project costs and environmental considerations. Since almost all dams are constructed in existing riverbeds, a comprehensive field investigation would likely have been done as part of the EA phase and would have identified environmentally sensitive areas and to allow for project planning to protect the environment and help to avoid costly modifications during construction.

Reinforced concrete dams are the most common form of dam used in the waterpower industry. The environmental success of the construction of a concrete dam involves consideration of many items including;

•Development of an environmental management plan to identify and address potential environmental concerns and develop mitigation strategies;

•Implementation of measures to ensure that all activities on the site are carried out to avoid spillage into local water bodies;

•Use of aggregates which are clean, strong, chemically stable and easily accessible;

•Techniques to handle concrete on site to minimize segregation, and implementation of placement techniques to ensure that it will be in place within the time window;

• Cooling mechanisms if excessive temperature are predicted, For example with a large concrete pour;

•Ensure that the formwork is sufficient to safely contain the concrete.

Roller-Compacted Concrete (RCC) can be a cost and time saving technique and. is typically used for high head dams . RCC dams provide a number of advantages over conventional mass concrete gravity dams; Successful construction with limited environmental impacts hinges on properly identifying and incorporating mitigation measures during the design phase to be implemented as part of the construction stages. The best management practices involve design measures to address thermal cracking, optimum concrete mix requirements to facilitate placing and compaction, setting out the maximum time interval management for supply and spreading of the RCC material, determination of the optimum thickness for the RCC lift, selection of the proper compacting equipment and design of a seepage collection system to collect high pH runoff during placement. The best management practices, numbers 029 and 030 in Appendix A, address these issues and provide references for further consideration as part of concrete or RCC placement.

In either case, the design of the concrete or RCC dam should identify areas of concern with respect to the overall environmental, safety, economic and timely construction of the dam. The following resources may provide some additional insight with respect to construction concerns related to concrete dams and how to manage them.

http://www.madehow.com/Volume-5/Concrete-Dam.html

http://www.barrages-cfbr.eu/Info/documentation/texte/pb2002/anglais/pb2002-c5-p113.pdf

http://courses.washington.edu/cm510/Lecture3.pdf

6.2.18 OVERHEAD TRANSMISSION LINES

Substations and overhead transmission lines connect waterpower projects to the grid and enable energy delivery. Construction has the potential to impact terrestrial and aquatic habitat. Short-term disturbances to the environment can occur, but provided mitigation measures are implemented, impacts should be low in magnitude and short term in duration.

Impacts can occur when clearing the right of way (ROW) for the transmission line resulting in the loss of overhead cover, shading, riparian buffers, increased sediment inputs, and direct damage to the streambed and riparian zones if fording of heavy equipment is required. New transmission lines often cross watercourses; to assist proponents and contractors, DFO has prepared an Ontario Operational Statement for "Overhead Line Construction" which identifies mitigation measures for during line construction to ensure fish habitat is protected.

http://www.dfo-mpo.gc.ca/regions/central/habitat/os-eo/provinces-territories-territoires/on/os-eo14-eng.htm

Construction of overhead transmission lines should be scheduled over the winter to minimize the impacts on riparian vegetation and watercourses as well as terrestrial bird species. Trees within the ROW should be removed along with brush; stumps can be left in place. At water crossings, shrubs and ground cover should be left undisturbed to the greatest extent possible to maintain a buffer to protect the watercourse and reduce sediment input. Vegetation removal in the buffer should be limited to only the large trees that will impact on the performance of the line. If necessary, planting should be done following construction to minimize erosion. Plantings near watercourses will also support fish habitat functions by providing overhead cover, shade, and riparian buffering to minimize impacts on aquatic habitat.

Table 20 provides a summary of potential impacts associated with transmission line construction and refers the readers to BMPs which provide advice on mitigating these impacts.

Table 20: Transmission Lines – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Clearing	Vegetation identified for protection	Removal of vegetation to permit construction as well as access for construction impacts vegetation. Refer to Table 11 for Impacts associated with clearing and grubbing.	013, 014, 016, 019, 031 OPSS 201
Water crossing construction	Streams and rivers	Bridges and culverts installed incorrectly can cause the direct release of sediments to the stream, impede fish movement and provide unwanted access. Refer to Table 11 for Impacts associated with clearing and grubbing.	010, 011, 016, 023, 031

6.2.19 SNOW MANAGEMENT

Snow management involves the relocation of snow to locations where impacts are less likely to occur due to freezing, compaction or during the spring melt. Snow removal can be undertaken to enable construction activities to continue throughout the winter season. These activities include access road construction and maintenance, transmission line construction, maintenance of site laydown areas, parking lots, material storage for batch plants and equipment storage. In the course of carrying out these activities, watercourses can be blocked and

potentially freeze to the bottom, culverts can be plugged, stored equipment damaged and materials contaminated. As well, during melt the potential for erosion and damage to watercourses is increased along with the risk of possible loss of site access due to road washout.

Table 21 summarizes the potential impacts associated with snow management and refers the reader to the appropriate BMPs that may be used to mitigate these impacts.

Table 21: Snow Management – Summary of Potential Impacts and Recommended BMPs or Mitigation

Activity	Receptor Potentially Impacted	Details of Potential Impact	BMP(s) and OPSS Specification(s)
Snow plowing	Streams	Streams become blocked and frozen which can result in flooding during melt periods.	004, 035, 037, 043
	Fish	Fish movement can be prevented if snow causesthe stream to be blocked or redirected.	038
	Construction Site	Hazardous items need to be properly marked and identified such as oil containing equipment, storage containers, etc to avoid accidental release.	n/a
Snow storage	Streams	Potential water quality impacts - Runoff from snow storage areas impacted by salt or other materials collected.	038
Winter road construction	Streams	Construction of a road can block streams and drainage paths. Flooding and erosion can result due to the water flowing in areas not accustomed to flow of these magnitudes. Refer to Table 14 - Road Construction.	038
	Fish	Rivers and streams can freeze to the bottom and prevent fish movement or reduce the available habitat until spring freshet opens the watercourse. Refer to Table 13 - Road Construction.	038

6.2.20 EROSION AND SEDIMENT CONTROL

The construction of a waterpower facility, like all other types of construction projects,results in disturbance to vegetation, soil and natural drainage patterns. Vegetation removal exposessoil and creates areas where the erosive forces of water and wind can scour and disperse soil particles (refer to definition of Erosion and Sedimentation). Erosion prevention is the preferred mitigation measure for reducing or eliminating the potential for sedimentation. Once soild particle are mobilized they can be deposited into sensitive areas like wetlands or lakes and rivers which negatively impact on aquatic habitats. The risk of sedimentation to these features is increased when you have large un-vegetated surfaces, steep topography, and highly mobile soils. In addition, waterpower construction projects often take a number of years to complete which also present increased seasonal risk of sedimentation. For these reasons, proper and dynamic erosion and sediment control strategies and site drainage planning would have been a primary consideration during the detail design stage of the project and should continue to be revisited/modified throughout the life of the construction stage.

Sediment originating from construction sites and entering a watercourse is considered a deleterious substance and is prohibitedunder subsection 36(3) of the Fisheries Act. The deleterious effects of sediment on aquatic organisms such as fish is well understood in the scientific community and can include impairment to respiratory function, decreased reproductive success, lowered tolerance to toxicants or disease and increased physiological stress on aquatic life. Sediment entering a watercourse has a lasting negative impact on water quality, sensitive fish habitat features such as spawning and juvenile development areas, and increases the likelihood of flooding potential, and negatively influences the natural geomorphic processes within the natural channel system (Greater Golden Horseshoe Conservation Authorities 2006). Sediment impacts to aquatic habitat are highly variable due to factors including water velocities, sediment particle size, and the magnitude/frequency of the sediment release, impacts can be observed many kilometres away from the actual release site.

The development of a responsive and adaptive erosion and sediment control plan coupled with the diligent execution and inspection of the plan significantly reduces the risk of severe environmental mishaps, associated fines/legal costs, restoration and monitoring costs, and the likely delay to the project schedule. There are numerous documents that can be used when developing and modifying sediment and erosion control plans. In addition, there are specialized design courses for erosion and sediment control planning which include field training for the application of the various techniques.

Most documents are arranged in sections that address two primary issues; erosion prevention and sediment containment. Some examples of comprehensive erosion and sediment control documents have been referenced at the bottom of this section.

Specific to the development of the erosion and sediment control plan, the **first** priority should be the *prevention of localized erosion* wherever possible. There

are many techniques available to prevent and control erosion, some of which include:

- Limit and phase the extent of vegetation clearing required for project.
- Stabilize the disturbed areas as soon as possible with plantings, erosion control mats/blankets, terra-seeding, mulch application etc.
- Maintain vegetated buffer strips around sensitive natural features
- Sediment fencing should be placed around the perimeter of the work zone
- Control size and height of stockpiles and locate them away from slope areas, waterbodies/wetlands and other environmentally sensitive areas.
- Reduce velocities of runoff using slope texturing techniques, berms or other energy dissipaters
- Use properly installed rock or straw bale check dams in drainage pathways

Once soil erosion has been addressed in the development of the plan, sedimentation risk should be minimized through *proper containment measures*. The selection and application of the various measures available should be considered in relation to site conditions. Some of these control measures include:

- Properly installed and maintained heavy duty sediment fencing (perimeter controls)
- Maintained sediment retention berms and ponds
- Inceptor swale/dike
- Strategically installed sediment retention tubes, channel soxx and siltsoxx
- Control and treatment of dewatering effluent using filter bags and ponds

It should be noted that in water construction activities associated with waterpower construction projects require specialized planning and activity-specific plans to address sediment containment and environmental controls.

It is not the intention of this document to provide detailed and specific measures for the prevention of erosion and containment of sediment. Numerous sources already exist to which the reader is referred for these specifics. Table 22 provides a summary of sources that can be consulted in the development of a comprehensive erosion and sediment control plan. Future editions of the BMP Guide may seek to include further Best Management Practices for sediment control.

For further advice on erosion and sediment control and mitigation measures the reader is referred to OPSS 805 – Temporary Erosion and Sediment Control Measures and the associated OPSD drawings (see Appendix C).

Table 22: Sources of Detailed Information on Erosion and Sediment Control

Source	Reference (see Section 8 for reference citations)
Erosion and Sediment Control Guidelines for Urban Construction	GGHCA, 2006 http://www.sustainabletechnologies.ca/Portals/_Rainbow/Documents/ESC%20Guideline%20-%20December%202006.pdf
Instream Sediment Control Techniques Field Implementation Manual	TROW, 1996
City of Edmonton Erosion and Sediment Control Guidelines	Stantec, 2005.
City of Edmonton Erosion and Sediment Control Field Manual	Stantec, 2005
Erosion and Sediment control at Construction Sites Guidelines	City of Moncton, 2009
Construction Site Erosion and Sediment Control. Planning Design and Performance.	Pitt et al., 2007
Access Guidelines for Access Road and Water Crossing Instream Sediment Control Techniques Field Implementation OMNR Technical Guides Erosion and Sediment Control	OMNR, 1995 Trow, 1996 Wilson, 1996

6.2.21 AIR QUALITY AND FUGITIVE DUST

The construction of a waterpower facility will inevitably result in the production of dust from construction activities. Dust can be considered a nuisance problem as local residents and their properties are subjected to dust emissions from the construction site. Depending on the amount of dust and its chemical constituents, dust can also impact human health. Construction activities use a variety of raw materials including, abrasives, concrete, cement, mortar, rock, sand and top soil, all of which contain silica. The prolonged inhalation of dust containing silica can lead to lung disease characterized by shortness of breath and impaired lung function which may give rise to complications that can result in death (OMOL, 2011).

The generation of dust during construction can also cause impacts to the natural environment. Large amounts of dust may induce changes in vegetation due to increased heat absorption and decreased transpiration. High levels of dustfall

into aquatic systems may adversely affect aquatic plants and fish that are not adapted to high levels of sedimentation (NDSD, 2002).

There are a number of dust suppressants available (beyond watering) which can be applied to control dust. These range from water to lime based products such as calcium sulphate to petroleum based emulsions to chloride salts including calcium and magnesium chloride. When choosing a dust suppressant a number of factors should be considered in order to protect the integrity of the surrounding environment;

- How soluble is the product in water and what is the proximity of the nearest sensitive water or groundwater feature to the application site?
- How biodegradable is the product?
- Are their restrictions of the use of the chemical through legislation?
- Have the potential impacts to local sensitive natural features such as aquatic habitat or wetlands been taken into account?

Water is the most commonly used suppressant and also is considered to have the least potential impact to the surrounding environment. Guidance surrounding the use of water as a dust suppressant is found in BMP 037. As there are varying guidelines for the use of the various chemical suppressants, consultation with the manufacture of the suppressant should occur to ensure that all applicable guidelines are followed during application. The proponent is also encouraged to consult the local office of the Ministry of the Environment when considering the use of chemical suppressants.

In addition to the use of dust suppressants, there are a number of practices that can be implemented on a waterpower construction site, in order to control dust and the impact of dust to human health and the natural environment. The reader is referred to BMP 037 for a summary of these practices. OPSS 506 also provies applicable advice in this regard.

Cheminfo Services has prepared a document for Environment Canada that provides a comprehensive range of practices that can be used to control emissions of fugitive dust from a construction site. (Cheminfo, 2005)

An additional reference is the Guide to the Preparation of a Best Management Practices Plan for the Control of Fugitive Dust for the Ontario Mining Sector (CEMI, 2010).

6.2.22 NOISE

In Ontario, in 1971, sound and vibration were defined as contaminants under the *Environmental Protection Act* (EPA). In 1974, the EPA was revised to empower local municipalities, subject to approval of the Ministry of Environment (MOE), to pass bylaws regulating the emission of sound and vibration. The Model Noise Control Bylaw was developed by MOE to help municipalities pass noise bylaws

and it is used as a guideline for MOE staff when conducting an assessment or investigation. Noise management is not a simple undertaking and in addressing noise associated with site construction close attention should be paid to MOE Regulatory requirements.

Noise can be defined as sound that is occurring at the wrong time or place. Most people think of construction sites as noisy places, which they typically are. But some construction sites in urban or rural areas producesound that can interfere with the activities of birds, animals and people nearby. This sound may become especially disturbing at times of day such as in the evening if the work extends beyond normal work hours and during normal sleep periods.

If noise problems develop and are not addressed satisfactorily, they can result in poor relations between contractors, owners and neighbours, as well as potential charges under municipal bylaws. The best solution is to avoid problems before they develop or to take steps to minimize them and their impacts. It is not possible or necessary to eliminate all of the noise produced by construction operations. However, good planning and design of operations and activities, and a common sense consideration of others should avoid most noise problems. Assess the level of the noise the construction operation is generating and implement measures to reduce the potential impacts.

Planning of noise-reduction measures should be aimed at fulfilling one or more of the following three requirements:

1. Reduction of the possibility of hearing damage,
2. Creation of a quieter working environment, and
3. Avoidance of annoyance to third parties.

Although the first measure is paramount from a health and safety perspective, all three requirements should be met with noise-control best management practices. The following references, all of which are downloadable PDFs, provide some guidance with regard to developing a noise management strategy for a construction site.

http://www.nyc.gov/html/dep/html/noise/index.shtml

http://www.corp.delta.bc.ca/assets/Engineering/PDF/SFPR_environmental_management_plan_phase1.pdf

http://iaerc.pmh1.ca/01_Management%20Plans/01_PMH1/01_CEMP/PMH1%20CEMP%20Rev%2006/S0_ENV_CEMP-PMH1_15.0%20Noise%20Management%20Plan_Rev06%20_2011-07-19_.pdf

MOE has Noise Pollution Control documents that can also be referred to when developing the strategy. Future editions of the BMP guide will seek to include further guidance on Best Management Practices for noise management.

7. CONTINGENCY PLANNING

Many of the impacts associated with construction of a waterpower facility can be anticipated and addressed by implementing mitigation measures and BMPs to prevent or control such impacts (i.e. erosion and sedimentation). Sometimes, events can occur that are uncommon. Without proper planning, these events can cause significant damage to the natural or cultural heritage environment. Responsible waterpower development involves anticipating all potential events that may occur and having BMPs in place which can be used to deal with these events. These procedures are often dealt with under the general category of contingency planning.

The following events require that rapid response be taken to ensure that impacts to the natural and cultural heritage environment are minimized to the extent possible.

1. Encounters with unexpected terrestrial flora and fauna,

2. Extreme weather events,

3. Spills to air, water, soil involving hazardous materials,

4. Spills to air, water, soil involving sediment in waterways

5. Discoveries of archaeological significance, and

6. Forest, equipmentor facility fire.

7.1 ENCOUNTERS WITH UNEXPECTED FLORA AND FAUNA

During the construction process, encounters with local wildlife, and impacts to wildlife habitats, vegetation species and communities are unavoidable. In all cases, however occurrences of significant species or natural features (e.g., Species at Risk, Significant Wildlife Habitat) within or around the work area should be reported to the local OMNR District office and, where applicable, to the Canadian Wildlife Service (e.g., involving federal lands or in relation to migratory birds). Typically, proponents will have dealt with the potential for significant flora and fauna that may occur within the vicinity of work areas as part of their EA process and this information should be relayed to the appropriate audience during the construction phase of development. This section deals with situations where unexpected flora or fauna are discovered.

In order to limit the impacts on these terrestrial features, appropriate guidance is required that clearly details important preliminary measures and necessary responses when significant species or features are encountered. Completion of preliminary measures, such as pre-construction natural features inventories and wildlife surveys, provide important base information describing existing conditions within and surrounding the work area. These should also identify the occurrence of any Species at Risk or significant wildlife habitats. This background information will help inform subsequent

steps that need to be followed to mitigate construction-related impacts on the natural environment. It will also provide the necessary information that relevant government agencies require to evaluate the need for special permits or authorizations that regulate impacts to significant species and natural features. Clear guidance on how to respond to unexpected encounters with flora and fauna during the construction stage will limit confusion and standardize the appropriate reactionary measures such that impacts on those species and natural features are minimized to the extent possible. BMP 019 should be used for the preparation of such guidance.

7.2 EXTREME WEATHER EVENTS

Seasonal changes to weather patterns and conditions coupled with the ever-present potential for severe storm events during the construction of a waterpower facility can create significant environmental risks and negatively influence many aspects of the project. It is expected that over time, and in the face conditions brought on by climate change, these weather events and conditions will become more extreme and unpredictable. In order to provide the best level of protection possible from these weather related risks, proper planning and preparedness should be engrained in the planning and execution of all construction activities.

At a basic level, routine environmental construction monitoring will allow for the identification and correction of all site containment issues throughout the project, including in advance of forecasted weather events. It is recommended that the Environmental Monitor (EM) or designate will monitor weather conditions for the duration of the construction project and use extreme weather or storm predictions to inform construction activities. In addition to extreme weather events, special regard for seasonal changes to site conditions should also be planned for and the project should have effective mitigation strategies in place. As waterpower projects depend in most cases (with the exception of pump storage) on the water flow in river systems, it is well understood that during a multi-year construction project, there are periods of high river levels associated with spring freshet and increased levels of precipitation in the fall and early winter. In response to these seasonal changes in river levels and flows, the planning of in water construction activities and design details surrounding project elements such as coffer dams, dewatering strategies etc. should account for these conditions. In some cases special provisions will be required to adjust original plans and specifications if the construction schedule is significantly delayed or advanced, moving some sensitive construction elements into a higher risk time of year (spring and fall).

Some considerations that should be examined related to extreme weather events and seasonal conditions include:

- Effective site containment at all times through proper erosion and sediment controls and routine monitoring
- Routine monitoring of weather for the duration of construction and tracking of severe weather events as they occur relative to the project site.
- Long term construction schedules that account for constructability of project elements during the spring and fall.

- Rapid response teams that can mobilize quickly to inspect and ensure site containment and environmental compliance
- Scheduling of in-water construction activities to coincide with lower risk seasons (late spring to early fall).
- Development of provisions to provide added environmental protection during extreme weather events.

7.3 SPILLS TO AIR, WATER, AND SOIL

Hazardous materials are found on almost all construction sites and as such measures need to be put in place to both prevent spills from occurring and to respond rapidly if one does occur. BMPs 032 Waste Management, 033 Hazardous Materials Management, and 034 Spill Response have been prepared to assist in the dealing with the potential for a spill involving hazardous materials.

Additional spills response procedures may be required and a complete spills risk assessment should be completed to ensure compliance.

7.4 DISCOVERIES OF ARCHAEOLOGICAL SIGNIFICANCE

Although it is an infrequent occurrence, excavations associated with construction can unearth archaeological artifacts and in rare instances, human remains.

The first point of contact when human remains are discovered should be the local police force. For a compete summary of the appropriate actions to be taken in the event of the discovery of human remains during waterpower construction the reader is referred to the Ministry of Tourism and Culture Website at

http://www.mtc.gov.on.ca/en/publications/SG_2010.pdf

This website also provides information on the appropriate course of action should other archaeological discoveries (not human remains) be discovered during construction.

7.5 FOREST FIRES

Many existing stations and new waterpower sites that are and will be developed in Ontario will be located on rivers that are surrounded by forest. Forest fires can originate from natural causes such as lightning. They are more likely from the activities that are associated with the harvesting of the forest, development of new mines, campers, hunters, aggregate extraction and development of waterpower sites, to name a few of the possible causes.

As part of the approval process, the only time the proponent will be required to do this is if they are clearing land on a Sustainable Forestry License (SFL), then they will need to be compliant with the Modifying Industrial Operations Protocol (MIOP). This protocol can be found by going to the following webpage and searching using the full name for MIOP.

http://www.mnr.gov.on.ca/en/Business/AFFM/index.html

If work is not occurring on a SFL, a contractor/operator does not have to do follow the MIOP requirements but they have to be familiar with the requirements of the Forest Fire Prevention Act (administered by MNR), which requires that the developer/contractor(s) have sufficient equipment on site to deal with a fire until it can be reported and a response is initiated by MNR's Aviation and Fire Management Branch. However, the basic training with regard to forest fire response training is available to anyone and the MIOP outlines training and capable requirements. Training is available through Ministry of Natural Resources approved training providers. Companies can purchase the training materials along with student notes and deliver the training in house. However, this would require an individual from the company to first take the training and to maintain their ongoing competency to provide the training. The training materials are available from St. Josephs Communications at 1-613-740-3353.

In order to be able to respond in case of a fire, there will need to be training provided on how to properly utilize the firefighting equipment and a plan for exiting the site should it not be possible to immediately suppress the fire. As well, the plan should identify those working conditions, should they develop, that will require work restrictions to be enacted such as clearing and grubbing in only the early morning hours should the fire hazard rating become high or stopping work if it is extreme. If the company is working on an overlapping licence on the managed forest they will need to be compliant with the MIOP. If they are not working under an SLF, following the MIOP should be followed to mitigate any fire starts particularly during periods of high fire hazards.

MNR's Aviation, Forest Fire and Emergency Services branch (AFFES) can assist the developer/contractor with identifying appropriate equipment needs if the MIOP or a site Fire Response Plan is brought to the local Fire Management Headquarters (FMH) ahead of time for review. At a minimum, a fire response plan will be required to follow requirements as set out under the Forest Fires Prevention Act (FFPA). The following list is not all-inclusive but captures the key points:

- All equipment or machinery requires a serviceable fire extinguisher that is rated at a minimum of 6A80BC and is located on or within 5 metres of the equipment or machinery
- Equipment or machinery not in use must be parked on a non-combustible service (mineral soil, rock, etc)
- Equipment or machinery is checked daily for accumulation of flammable debris and debris removed
- Fire extinguishers for chainsaws must be serviceable, ABC rated and contain a minimum of 225 grams of dry chemical
- Fire extinguishers must be started no less than 3 metres from where they were fuelled

- Any chimney, burner, engine (or any other spark emitting outlet) operating within 300 metres of a forested area must have a spark arrestor
- Mufflers or spark-arresting devices cannot be modified or altered in any way
- No person may smoke while walking in a forest area
- Debris from land clearing shall be burned as per Outdoor Regulation 207/96 – Outdoor Fires

The amount and type of fire suppression equipment required for a given project will be identified by MNR but it is wise for a developer/contractor to request that MNR visit the site(s) and verify that sufficient equipment is present and in good working order. Similarly, the site Environmental Monitor should inspect and verify the status and the location of the suppression equipment as an ongoing preventative measure during fire season which can last from early spring to late fall. By doing so a developer/contractor will minimize the risks of a fire getting out of control and of being charged for the costs of suppression should the MNR need to respond to the fire.

8. ENVIRONMENTAL MANAGEMENT PLANS

8.1 INTRODUCTION

The World Bank defines an 'Environmental Management Plan'(EMP) as the synthesis of all proposed mitigative and monitoring actions, set to a timeline with specific responsibility assigned and follow-up actions defined. The EMP is one of the most important outputs of the environmental assessment process. The EA will identify the key areas and concerns related to the project in order that the contractor can prepare an Environmental Management Plan (EMP). The EMP will cover key components of the project and associated activities that must be managed and monitored to ensure minimal impact on the environment during the execution of the project.

The following is an example of the table of contents for an EMP that was prepared for a waterpower redevelopment project.

ListofTables

ListofAppendices

The EMP would initially be prepared based on the information flowing from the Class EA process and the conditions of approval from the various regulatory agencies. The EMP will be modified/amended based on the actual work schedule and construction techniques that the successful contractor proposes to employ to construct the waterpower facility. It is expected/required that the contractor provide the details with regard to how his organization, both on- and off-site, will plan for and address the items noted in the TOC of the EMP prepared for the project, including the provision of information with respect to:

- Roles and responsibilities of site and higher level staff
- Contact information for all key staff and emergency responders
- Operational Plans including Emergency Response Plans (if required)for:
    - Site Orientation and Safety Training
    - Erosion and Sediment Control Plan

- Access Plan for all Roads, Trails and Transmission Lines
- Key Material Supply Plan:
    - Borrow Area
    - Aggregate Storage
    - Equipment and Materials (e.g. Transformers)
    - Cement, Chemicals, Fuels
- Environmental Monitoring Plan
- Fire Protection:
    - Site Fire
    - Forest Fire
- Flooding and Extreme Weather:
    - Storm or Snowmelt
    - Cofferdam Failure
- Spills:
    - Chemicals and Fuel
    - Cement and Concrete
- Waste Management:
    - Hazardous Material Management
    - Domestic

9. GLOSSARY OF TERMS

Blowdown –a tree or group of trees that have been blown down from the wind

Buffer –this “no touch” zone, is where construction activities should not occur.

Clearing –the cutting and removal of vegetation

Desiccation –severe dehydration

Dripline –theoretical vertical line from the tips of the outermost tree branches to the ground surface.

Edge Effects– the difference in the physical environment along the edge of a natural area/habitat and its interior. Vegetation along the edge of habitats experience higher exposures to wind speeds and solar radiation.

Exotic species –plants or animals that have been deliberately or accidentally introduced into areas beyond their natural range; Synonyms may include introduced, invasive or non native species.

Flora– The plants of a particular region, listed by species and considered as a whole

Fauna –mammals, birds, amphibians or reptiles

Felling –the act of removing a tree.

Fragmentation –form of habitat fragmentation that results when large natural areas are cleared, creating gaps and isolated habitats; Fragmentation has many impacts on biodiversity and ecological function.

Fugitive Dust - any particulate matter becoming airborne, other than being emitted from an exhaust stack, directly or indirectly as a result of human activity

Grubbing –the removal of embedded vegetation in the ground, such as stumps, roots or logs.

Herbaceous –herbaceous plants are those that lack a permanent woody stem.

Invasive species –plants or animals that have been deliberately or accidentally introduced into areas beyond their natural range;Synonyms may include introduced, invasive or non native species.

Muskeg –a swamp or bog formed by an accumulation of sphagnum moss, leaves, and decayed matter. This acidic soil type is common in the Arctic and Boreal regions.

Native Species - Species which belong to a taxon that is a naturally occurring endemic of a region or has migrated into the region and established and without having been

transported by human actions into the region, and without having been able to establish principally as a result of human alterations of the region's environment.

Naturalized Species- Alien species which have established stable self sustaining populations such that control/ eradication efforts are not feasible

OPSS – Ontario Provincial Standards and Specifications which are produced and maintained by the Ontario Ministry of Transportation

Restoration –the attempt to return a site to its original state, Restoration includes soil handling, site preparation and planting of vegetation.

Root Zone –The roots of a mature tree can typically be found growing at a distance of one to three times the span of the branches. This area is referred to as the root zone.

Rutting –a sunken track or groove in the soil made by construction machinery or other vehicles. Rutting is most damaging under wet conditions.

Slash –wood waste, including branches, tree tops, woody debris generated during logging operations or debris generated through natural forest disturbances such as wind and snow.

Vegetation –trees, shrubs, other woody vegetation and herbaceous species

Work Area –the area in which construction activities are to occur. The boundaries of this area should be flagged or delineated with site fencing.

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Appendix A – Best Management Practices Listing

BMP-001 – Treatment of Pumped Discharge Water
BMP-002 – Suspended Solids Removal – Use of Filter Bags and Sediment Corals
BMP-003 – Suspended Solids Removal – Use of Fractionation Tanks
BMP-004 – Suspended Solids Removal – Use of Settling Ponds
BMP-005 – Energy Dissipation for Discharge Water
BMP-006 – Removal and Relocation of Fish
BMP-007 – Monitoring Watercourse Flow, Water Level and Aquatic Habitat During Dewatering
BMP-008 – Monitoring Watercourse Temperature During Dewatering
BMP-009 – Monitoring Adjacent Wells During Dewatering
BMP-010 – Culvert Construction
BMP-011 – Bridge Construction
BMP-012 – Road Construction
BMP-013 – Vegetation Clearing – General
BMP-014 – Vegetation Clearing - Grubbing
BMP-015 – Vegetation Clearing – Handling, Storage and Disposal of Grubbed Material
BMP-016 – Vegetation Clearing – Vegetation Protection
BMP-017 – Vegetation Clearing – Site Restoration
BMP-018 – Vegetation Clearing – Preventing the Establishment of Invasive Species
BMP-019 – Encountering Unexpected Flora and Fauna
BMP-020 – Worksite Isolation
BMP-021 – Drilling & Blasting
BMP-022 – Excavation
BMP-023 – In water work
BMP-024 – Demolition
BMP-025 – Grouting
BMP-026 – Dredging
BMP-027 – Concrete Batch & Crushing Plant Operation
BMP-028 – Earth Dam & Dike Construction
BMP-029 – Roller-Compacted Concrete Dams
BMP-030 – Concrete Gravity Dams
BMP-031 – Transmission Line Construction
BMP-032 – Regulated Waste Storage and Handling
BMP-033 – Hazardous Materials Management
BMP-034 – Spill Response
BMP-035 – Regulated Waste Transportation
BMP-036 – Material Storage Handling
BMP-037 – Control of Fugitive Dust
BMP-038 – Snow Management
BMP-039 – Wetlands
BMP-040 – Migratory Birds
BMP-041 – Surface Water Quality and Fish Sampling Programs
BMP-042 – Small Hydropower and Methyl Mercury

Appendix B –BMPs

BMPs to be inserted here as completed

Appendix C –Specifications Referred to in BMPs and Additional Appropriate Items

National Master Specifications

NMS 02 41 16 –Structural Demolition

NMS 31 11 00 - Clearing and Grubbing

Ontario Provincial Standard Specifications and Drawings

OPSD 220.010 - Barrier for Tree Protection

OPSS 201 – Clearing and Grubbing

OPSS 206 – Grading

OPSS 491 – Preservation, Protection and Reconstruction of Existing Facilities

OPSS 501 – Compacting

OPSS 506 – Dust Suppressants

OPSS 511 – Rip-Rap, Rock Protection, and Granular Sheeting

OPSS 801 - Construction Specification for the Protection of Trees

OPSS 802 - Topsoil

OPSS 803 - Sodding

OPSS 804 - Construction Specification for Seed and Cover

OPSS 805 - Temporary Erosion and Sediment Control Measures

Drawings Associated with OPSS 805

OPSD 219.100 Light-Duty Straw Bale Barrier
OPSD 219.110 Light-Duty Silt Fence Barrier
OPSD 219.130 Heavy-Duty Silt Fence Barrier
OPSD 219.150 Sandbag Barrier
OPSD 219.180 Straw Bale Flow Check Dam
OPSD 219.190 Silt Fence Flow Check Dam
OPSD 219.200 Sandbag Flow Check Dam
OPSD 219.210 Temporary Rock Flow Check Dam V-Ditch
OPSD 219.211 Temporary Rock Flow Check Dam Flat Bottom Ditch
OPSD 219.220 Excavated Sediment Trap In Ditch
OPSD 219.230 Chute For Excavated Sediment Trap
OPSD 219.231 Berm Barrier
OPSD 219.240 Dewatering Trap

OPSD 219.260 Turbidity Curtain
OPSD 219.261 Turbidity Curtain Seam Detail

Appendix D –Suppliers

Fractionation Tank Systems (BMP 003)

AQUATECH 905 907-2700

http://www.aquatechdewatering.com/rentals_sales_discharge.php

Fish Isolation Nets (BMP 006)

http://www.fishfarmsupply.ca/

http://lakefish.net