AN ANALYSIS OF THE LEGAL IMPLICATIONS OF ENGINEERING RESPONSES TO SELECTED DAM OWNER ISSUES

by

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Date **October 08, 1999**
ABSTRACT

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by Jay B. Joyner

Some key aspects of the legal regime within which dam owners operate are examined, particularly as the law impacts on five specific technical dam-related issues: dam safety, water quality, emergency planning, debris management, and fish habitat creation. The thesis reviews the general legal environment including important statutory requirements and common law obligations arising from riparian rights, nuisance, negligence, and strict liability. Approaches to dam safety decision making, including prescriptive standards and risk analysis, lead to the conclusion that prescriptive standards offer greater legal certainty than risk analysis as a basis for dam safety planning. An examination of the effect of dams on water quality and riparian rights indicates that changes in sediment and nutrient loads, temperature, and dissolved oxygen might form a basis for legal action by riparian owners. Possible changes to current emergency planning practice suggest that a proposed regulatory change in British Columbia will impose significant new obligations on dam owners. An examination of debris management practices concludes that dam owners have a duty of care with respect to some debris in the reservoir and with respect to collected but escaped debris that passes the dam. Finally, newly created fish habitat is subject to the same legal obligations as existing habitat. Deliberately created habitat may also create liability exposure if it becomes debris during a flood.
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Chapter 1

INTRODUCTION

1.1 SCOPE AND INTENT

This thesis is a primer on elements of the basic law applying to the ownership and operation of a dam in British Columbia (BC) and to five specific technical engineering issues confronting BC dam owners. For the purpose of this thesis, the term "dam owner" includes individuals, corporations or other business entities, governments, agencies, and all of the employees of such entities, including engineers. This thesis provides such people with general knowledge about the basic legal regime within which dam owners operate and with an introduction to legal considerations with respect to specific dam-related engineering problems.

The intent of this thesis is to provide dam owners and their employees, particularly engineers, with the necessary background to effectively understand the legal regime and to communicate with legal and other personnel about dam-related legal issues. It is also intended to stimulate an awareness of legal issues and responsibilities associated with specific engineering problems faced by dam owners. Such knowledge and awareness will, hopefully, be reflected in more informed, more efficient, and more economically efficacious engineering decisions.

Although the basic legal principles discussed in this thesis are applicable to all aspects of dam operations, the examples used and issues examined are generally limited to hydrotechnical and flood-related problems.
1.2 STRUCTURE

This thesis is divided into two major topics, with a number of sub-topics within each major division. The structure may be summarized as follows:

1. Major Topic One: Basic "Dam Law" in BC.
   a) This topic begins with a review of the sources of law affecting dam owners and explains the complex web of federal, provincial, and common law obligations of dam owners.
   b) The thesis then considers specifics of basic law applicable to dams, including common law riparian rights, four statutes fundamental to dams in BC, and the law relating to nuisance, negligence, and strict liability – the three complaints most likely to lead to a lawsuit against a dam owner. In each case the relevant details of the law are examined and examples, often from past court decisions, are used to illustrate the impact on the dam owner. This portion of the thesis provides the reader with background knowledge of important elements of BC law affecting dam owners. The chapters comprising the second major topic expand on this background knowledge with respect to specific technical issues.

   a) This topic takes a detailed look at five quite different engineering issues facing dam owners for which there is no ready regulatory answer. In short, either the legal effect of the engineering response to the issue is unclear or different engineering responses have
significantly different legal effects. The five issues and the related fundamental “grey areas” examined are:

i) Dam safety and foreseeable extreme events. How big a spillway does the law, rather than economic analysis, mandate? Is the PMF (the probable maximum flood) ever the legally required design inflow flood?

ii) Dams, water quality, and riparian rights. Does the effect a dam and reservoir have on water quality adversely affect riparian rights?

iii) Emergency preparedness and dam owner responsibility. Is the dam owner responsible for warning and evacuating floodplain residents?

iv) Debris management. Is the dam owner liable for damage caused by reservoir debris or debris which is washed through the spillway during a flood?

v) Fish habitat creation. What are the dam owner’s responsibilities towards fish habitat created by construction and operation of the dam?

b) In each case, the standard industry approach is examined, the law specific to the issue is reviewed, and conclusions are drawn regarding possible legal ramifications of engineering decisions.
1.3 DISCLAIMER

The legal regime within which a dam must be conceived, approved, designed, constructed, operated, maintained, and decommissioned is extremely complex. This thesis is not intended to be legal advice regarding that regime but merely to indicate some of the bases for potential legal liability to a dam owner. This thesis does not purport to be an exhaustive analysis of either the law or the engineering issues discussed herein. It is intended that this research constitute a primer for those interested in dam owner liability. Both the appropriate legal and engineering response to any given situation may vary from the examples, referenced legal cases, or hypothetical situations raised in this thesis. In some cases, particularly in division or chapter summaries, very broad generalizations are made which may not apply to a given specific situation. Dam owners should seek professional engineering and legal advice with respect to the specifics of their own situations. It is the hope of the author that this thesis will provide dam owners with sufficient background to knowledgeably seek such advice. Finally, note that this thesis considers only hydrotechnical issues facing dam owners. Structural issues, including earthquake effects, are not specifically examined.

1.4 READING THE THESIS

The following four brief divisions provide some guidelines to understanding terms and references in this thesis.

1.4.1 GLOSSARY

Following the body of the thesis is a glossary which defines a number of terms, including some “shorthand” references, used throughout the main text.
1.4.2 CROSST-END-REFERENCES

References to other parts of the thesis are to a specified "division" of the thesis. For example, "See division 1.4.2" refers to the thesis section bearing that number. The word "division" is used to refer to sections of the thesis to avoid confusion with references to sections of statutes.

1.4.3 LEGAL TERMINOLOGY AND REFERENCES

This thesis contains a considerable amount of legal research, particularly in the second chapter. For those unfamiliar with legal terminology and methods of reference, the following comments may be useful.

1.4.3.1 Statutes and Regulations

The provisions of statutes and regulations are often referenced to the section, subsection, clause or other numbered division of the statute or regulation. All such references are to a "section" followed by the number of the section, subsection, clause or other division. For example, the reference "(section 42(1)(a))" refers to clause (a) of subsection (1) of section 42 of the relevant statute or regulation.

References to the statute or regulation as a whole are given in standard legal reference format by identifying the title of the legislation, the government publication in which the official version can be found and the year of proclamation or coming into force, followed by the chapter or regulation number. For example, the Water Act is referenced as:

The name of the statute is the *Water Act* (the names of legislation and court cases are italicized) and the official version can be found at chapter 483 of the Revised Statutes of British Columbia (published by the Queen's Printer in BC).

### 1.4.3.2 Judicial Decisions

Court cases are also referenced in standard legal format. Judicial decisions are printed or “reported” in various “report series” which have numbered volumes, sometimes numbered sequentially and sometimes by year. The legal reference format includes the case name (known in legal terminology as the “style of cause”) which identifies the parties to the lawsuit, the year of the case law report series in which it can be found, the volume number for sequentially numbered report series, and the page number at which the decision can be found. The court which rendered the decision is sometimes included for information purposes. The first person or organization in the case name (to the left of the “v.” or “versus”) is the plaintiff and the second person or organization (following the “v.”) is the defendant although these can be reversed for appeal decisions (in which case the first name is the appellant and the second the respondent). For example, the famous case *Donoghue v. Stevenson* is cited as:


This citation indicates that the case may be found at page 562 in the 1932 volume of the “Appeal Cases” report series (a British series). It is a decision of the British House of Lords. The Appeal Cases volumes are numbered by year which is indicated by the use of square brackets around the year. The Canadian case *R. v. Cote* is cited as:

This citation indicates that the case may be found at page 244 of volume 51 of the 3rd series of the “Dominion Law Reports”. It is a decision of the Supreme Court of Canada. The Dominion Law Reports are numbered sequentially which is indicated by the use of round brackets around the year (which, for sequentially numbered series is for information only). Note that the “R.” indicates that this is a criminal case; R. is short for “Regina”, the Latin form of the “Queen” or Crown. Some cases are reported in more than one report series.

1.4.4 BIBLIOGRAPHY AND FOOTNOTES

References to sources other than legal case reports are found in the Bibliography. References to legal cases and statutes are made via footnotes.
Chapter 2

ASPECTS OF BC LAW RELATING TO DAM OWNERS

2.1 INTRODUCTION

This chapter provides a foundation upon which the engineering portion of this thesis is constructed. In order to understand the potential liabilities which may arise from the engineering issues raised in subsequent chapters, it is necessary to review the legal origin of those liabilities and the nature and possible defences to particular areas of concern. This chapter will be at least partly familiar to anyone who has taken an introductory business or engineering law class but it does go into some detail about aspects of the law of special concern to dam owners probably not covered in such courses.

Dam owners may run afoul of the law in a number of ways:

1. Failure to comply with regulatory requirements can lead to penalties and enforcement orders in accordance with a particular statute. For example, BC Hydro was charged under the Fisheries Act (and subsequently acquitted at trial) with, among other things, killing fish as a result of operational decisions in response to extreme inflows on the Bridge River. That case is described in detail in division 2.4.3.4.3 and in Appendix B.
2. Regulated river flows can lead to lawsuits by downstream property owners or other floodplain users. In the early 1970's, the town of Peace River, Alberta, sued BC Hydro claiming that the operation of the WAC Bennett Dam on the Peace River resulted in higher-than-natural low flows\(^1\). Because the regulated river level did not drop as much during low flow periods, the town claimed it was unable to properly maintain a drinking water intake. They also claimed that the less variable regulated flow regime eroded riverbed support of a water pipeline. The town's claim was based on three causes of action: riparian rights, negligence, and nuisance. In a more current example, the Mikisew Cree First Nation is presently suing BC Hydro with respect to alleged changes in the ecosystem and socio-economics of the Peace-Athabasca delta in northern Alberta. According to the claim, those changes are caused by the regulation of summer flood flows on the Peace River. The Mikisew are also alleging infringement of riparian rights, negligence, and nuisance. Each of these causes of action is discussed in this chapter.

3. A flood is the most obvious legal risk facing dam owners, particularly the extreme flood which would result from a dam failure. For example, in the early 1980's an Ontario floodplain resident sued a small dam owner for damages caused to his property by a flood following an extreme rainfall event\(^2\). The resident alleged negligence and argued strict liability (also discussed in this chapter). The dam was not a flood control structure; it was constructed to stabilize lake

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\(^2\) _Pattison et al v. Prince Edward Region Conservation Authority_ (1984), 53 OR (2d) 23 (OHC); aff'd (1988), 45 CCLT 166 (OCA).
levels for recreation. The plaintiff contributed to his own losses by blocking a natural drainage channel and misjudging previous extreme flood levels. Nevertheless, the primary reason for absolving the dam owner of liability was the consent of the plaintiff to the dam’s construction and operation.

This chapter provides the legal background behind each of the above types of problem. It first reviews the origins of BC’s “dam law” and then examines in some detail historical and current common law riparian rights and significant federal and provincial legislation regulating dams. The chapter concludes with an in-depth look at the three most likely claims against a dam owner in a law suit: negligence, nuisance, and strict liability.

As an aid to understanding the linkages between these issues, Figure 1.1, on the following page, presents a graphical representation of the topics in this chapter.

For the “legally challenged”, the chapter begins with an executive summary to highlight key components of the detailed divisions in this chapter. In addition, each major division ends with a boxed, highlighted summary of that division. However, an appreciation of the technical engineering discussions in the final five chapters requires that this chapter be read in its entirety.
Figure 1.1: A Portion of the Legal Regime for Dam Owners

Legal analysis in this thesis
2.2 EXECUTIVE SUMMARY

Dam owners have legal rights and obligations arising from both statutory and common law. Statutory law includes federal and provincial statutes and regulations as well as licences, permits, approvals, orders, policies issued or made by regulatory agencies. The common law consists of all the recorded judgments of courts in lawsuits across Canada and, to a lesser extent, in other countries with laws founded on British common law.

The basic types of law affecting dam owners include primarily criminal, international, and civil laws. Civil laws include contractual rights, property rights, and torts. This thesis focuses on riparian property rights and the torts of nuisance (unreasonable interference with land), negligence (failure to exercise a reasonable standard of care), and strict liability (for inherently dangerous acts).

The constitution of Canada gives the provincial and federal legislative bodies jurisdiction over different aspects of the legal regime in which dam owners operate. For example, BC may legislate with respect to water rights but the federal Parliament may affect the exercise of those rights by legislating with respect to fisheries and navigation. The general wording of the constitution often results in both levels of government regulating similar aspects of dam operations, such as pollution.

Riparian rights attach to land bordering or containing a portion of a watercourse. Traditional riparian rights include, among others, the right to receive water from upstream in its natural quality and quantity subject to reasonable use by upper riparian owners, and the right to make use of received water for reasonable purposes. A legislated water licencing system has replaced the riparian right to use
water except in limited cases. Licencing has also removed the right to receive the natural flow but, arguably, a riparian owner is still entitled to water in its natural quality.

The Water Act, the modern form of a 140-year-old water use regulatory system, requires a licence for the use of water in BC. The Act imposes obligations on dam owners to compensate others for damages resulting from the construction, maintenance, use, operation, or failure of a dam. One current impact of the Act is the requirement, appended to licences, for dam owners to negotiate Water Use Plans with other stakeholders in the watershed. A potential impact arises if the proposed Dam Safety Regulation significantly increases a dam owner’s public responsibilities in the event of a dam safety emergency.

The Waste Management Act is a provincial pollution regulation statute. In general, it prohibits the discharge of pollutants into the environment without regulatory approval. Arguably, it may regulate the discharge of water through or over a dam if that water is capable of injuring fish or other wildlife.

The Fisheries Act is federal legislation regulating, among other things, conservation aspects of fisheries. Dam owners are prohibited from killing fish, affecting habitat, or introducing pollution into fisheries waters. However, due diligence is a defence to charges with respect to those prohibitions.

The Navigable Waters Protection Act is federal legislation regulating and protecting navigable waters. Dams, debris booms, and other works interfering with navigation require regulatory approval. What constitutes navigable water is not entirely clear but probably includes any watercourse “frequently” navigated by a kayak or larger vessel. Regulators are currently requiring that the owners of existing but previously not-approved dams seek retroactive approvals.
Many of the offences in the above statutes are "strict liability" offences. Usually, the only defence available to such charges is that the dam owner exercised due diligence to avoid committing the offence. The components of due diligence should be a part of virtually all dam owner decisions. Components include training, planning, qualified personnel, regulatory approval, and supervision and monitoring.

Nuisance is an unreasonable interference with the use and enjoyment of land and entitles a successful plaintiff to an injunction or damages in compensation for losses. Nuisance requires a significant harm continuing over time or posing a real threat of serious harm. The defendant need not be negligent or act intentionally for a nuisance claim to succeed but the defendant's act must be unreasonable. A defendant will avoid some or all liability if he or she has statutory authority to create a nuisance, has acquired a prescriptive right to do so, has the consent of the plaintiff, is the victim of unforeseeable acts by third parties, or if the plaintiff negligently contributed to the problem.

The tort of negligence compensates a plaintiff for the dam owner's faulty conduct. For the conduct to be negligent the following criteria must be met:

1. The plaintiff must suffer damage caused by the dam owner's conduct.

2. The dam owner's conduct must be in breach of the standard of care that a reasonable or prudent person would exercise in the same circumstances given the foreseeability of the risk. In short, the dam owner must not create an unreasonable risk of harm. An unreasonable risk is one in which the probability of harm multiplied by the consequences of the conduct exceeds the social purpose or benefit of the dam and the cost to the dam owner to avoid the risk. Courts often look to industry or legislated standards to determine the
minimum standard of care.

3. The dam owner must owe a duty of care towards the plaintiff. A duty is owed when harm to the plaintiff as a result of the dam owner's conduct is reasonably foreseeable or if the dam owner has created an expectation of duty in the mind of the plaintiff.

4. The damage suffered by the plaintiff must not be too remote a consequence of the dam owner's conduct. Damage is not too remote if a reasonable person would realize there is a real risk of damage from his or her conduct.

5. The dam owner has no defence to the claim, including contributory negligence by the plaintiff, an assumption of risk by the plaintiff, or illegal activity on the part of the plaintiff.

The Rule in Rylands v. Fletcher, also known as strict liability, holds a dam owner liable for ultrahazardous activities where the risk of harm and possible consequences are high. Impounding water is such an ultrahazardous activity. If impounded water causes harm, even if the dam owner was not negligent and did not intend to cause harm, he or she may be liable. Defences to claims under the Rule in Ryland v. Fletcher include the consent of the plaintiff to the dam, contributory negligence by the plaintiff, act of God, deliberate act of a third party, and legislative authorization of the dam.
2.3 BACKGROUND TO BRITISH COLUMBIA "DAM LAW"

2.3.1 SOURCES OF LAW IN BRITISH COLUMBIA

2.3.1.1 Discussion

The plethora of laws that apply to dams can be bewildering. Federal, provincial, and municipal statutes, as well as regulations, policies, and bylaws all have an impact on dam owners. Appendix A lists some of the many statutes that apply to just the environmental issues facing a dam owner. Furthermore, decisions by judges in court cases relating directly or indirectly to the problems of dam owners also affect prudent floodplain management. To fully understand the legal framework within which a dam owner must operate, it is necessary to understand where the laws originate.

The law affecting the rights, responsibilities, and liabilities of dam owners in British Columbia is derived from two sources: common law and statutory law. "Common law" refers to rules established by courts in Canada, particularly in the Province of British Columbia, and in other English-speaking countries, particularly the United Kingdom. These rules are based upon centuries of decisions by judges in court cases. Most of these rules are recorded, or "reported", in written decisions of the courts of the English-speaking world.

Modern common law is founded upon the principles of "stare decisis", a Latin phrase meaning "already decided", and equity. Through precedent, the common law seeks to establish a body of law upon which persons can base business and other decisions with confidence that, should a dispute arise which is similar in all significant ways with an earlier dispute, the current dispute will be resolved in the same manner as the earlier event. This provides a sense of certainty in
interpersonal dealings. Equity evolved after the concept of stare decisis and attempted to temper “unfair” decisions forced by rigid precedent. The common law might be considered “basic law” in the sense that it always applies unless varied by statutory law (Irwin, 1988).

“Statutory law” includes all of the legislation (statutes or Acts), regulations, and other rules promulgated by the Parliament of Canada, the legislature of the province in question, and those bodies to which have been delegated portions of federal or provincial legislative power (such as municipalities in the case of the provincial legislatures). Licences, permits, approvals, orders, Orders-in-Council (directives from the Governor General or Lieutenant Governor on behalf of the federal and provincial cabinets, respectively), and ministerial decisions may, for the purpose of this thesis, also be considered “statutory law”.

At the apex of statutory laws are the statutes, or “acts”, passed by the federal Parliament and the provincial Legislatures. Regulations are established pursuant to a particular statute but are passed by Cabinet (federal or provincial as appropriate), the responsible Minister, or a board or tribunal (BC Hydro (3), 1999). Regulations typically provide details about the operation of the statute. Licences, permits, and approvals are usually issued by the responsible Minister or the government department responsible for administration of the statute in accordance with the act and any applicable regulations. These documents often contain specific rights and obligations of the dam owner (for example, the right to use a certain quantity of water or to construct a dam in accordance with approved plans). Orders are typically enforcement tools issued by the responsible government department or Minister requiring the dam owner to take appropriate action to bring his or her activities into compliance with the act or regulations (BC Hydro (3), 1999).
Courts are often involved in interpreting the meaning and limits of statutory law. Statutory law often modifies or replaces common law.

The common and statutory law of different provinces vary as the courts and legislature of each Province make decisions or create statutory law based on the needs of that particular Province. The statutory law of one province does not (generally) have effect outside of that Province's borders. However, several factors tend to bring both common law and statutory law into line across the country:

1. The common law and statutory interpretations of a Province's courts may be given consideration by the courts of other Provinces in deciding similar cases or considering similar statutes. Judges often consider the case law of other jurisdictions in reaching their own decisions, particularly if a similar dispute has not given rise to a judicial decision in their own Province. This is especially relevant with respect to dam owners as relatively few dam-related disputes have led to reported judgments.

2. The Supreme Court of Canada is the highest court of appeal for most Canadian judicial decisions. Its decisions create uniformity of law with respect to those issues before it.

3. In the interest of promoting interprovincial trade and commerce and, to some extent, resource management, many provincial statutes strive for uniformity with similar statutes in other Provinces.

Statutory laws created by Parliament are generally applicable (or influential) across the country. The decisions of Canadian courts with respect to those statutes are also generally applicable (or at least influential) across the country. Provincial
Statutory laws are only applicable within the enacting Province. Federal laws take precedence over provincial legislation (Laskin, 1995).

2.3.1.2 Summary

| Dam owners have legal rights and obligations arising from both statutory and common law. Statutory law includes federal and provincial statutes and regulations as well as licences, permits, approvals, orders, policies issued or made by regulatory agencies. The common law consists of all the recorded judgments of courts in law suits across Canada and, to a lesser extent, in other countries with laws founded on British common law. |

2.3.2 BC LAW CLASSIFIED BY NATURE AND PURPOSE

Law may be classified by its origin, as described above, or by its nature and purpose (Irwin, 1988). From this point of view, the law of British Columbia might be broken down into five major categories: (1) criminal law, (2) civil law, (3) military law, (4) martial law, and (5) international law (Irwin, 1988). Of the five, only criminal, civil, and international law effectively impact water resources in BC.

2.3.2.1 Criminal Law

Criminal law regulates actions or crimes against persons and property deemed severe or significant enough to be punished by the state (Irwin, 1988). Criminal law is governed by the Criminal Code, a federal statute. However, many other statutes (both federal and provincial) prescribe offences punishable by fines and imprisonment in the same manner as those offences set forth in the Criminal Code.
2.3.2.2 International Law

International law includes both a "common law" element and rights and obligations conferred by treaties. Many treaties are sponsored by the United Nations, such as the International Law of the Sea treaty. Others may be between two or more nations, such as the Boundary Waters treaty which governs use and management of trans-border watercourses between Canada and the US. International law is not considered in this thesis.

2.3.2.3 Civil Law

Civil law deals with private rights and obligations (Irwin, 1988), or those issues between private parties not punishable by the state. There are three main classes of private rights and obligations: (1) contractual rights, (2) property rights, and (3) torts (Irwin, 1988). All three of these classes may impact on water resources and dam owner responsibility and liability.

2.3.2.3.1 Contractual Rights

Contractual rights arise from interpersonal agreements (contracts) between parties. Contracts are usually written but, except for a few exceptions, need not be. Dam owners will be parties to many contracts covering a wide range of activities. As contracts give rise to negotiated rights and obligations and as the effect of those agreements varies from contract to contract, such rights and obligations will not be considered in this thesis.

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3 See the "Treaty Relating to Boundary Waters and Questions Along the Boundary Between Canada and the United States", an appendix to the International Boundary Waters Treaty Act, R.S.C. 1985, chapter I-17.
2.3.2.3.2 Property Rights

Property rights are comprised of the statutory and common law provisions regarding land (called “real” property) and “personal” property (essentially anything that can be moved and is not affixed to real property). Dam owners must deal with both kinds of property; the dam sits on land (and is probably itself real property) and its construction and operation entail the use of many items of personal property. Property issues include, among others, ownership disputes (especially with respect to property pledged as security for loans), access (such as easements and rights of way), and preservation (such as theft and trespass). This thesis discusses riparian rights – property rights attaching to land adjacent to, or across which flows, a watercourse. Other property rights will not be examined.

2.3.2.3.3 Torts

This thesis is concerned primarily with wrongs potentially done by a dam owner to others and the liabilities flowing from such wrongs. Therefore, with some exceptions, the thesis focuses on torts, which are wrongs against individuals and which include acts or omissions which either cause loss or injury or infringement of legal rights without loss or injury (Irwin, 1988). There are many kinds of torts, most of which will not be considered in this thesis. Torts not considered include defamation, assault, breach of contract, trespass, and others. Of primary concern to dam owners are the torts of nuisance, negligence, and those actions leading to claims of strict liability. Each of those torts is summarized below.

2.3.2.3.3.1 Nuisance

A nuisance is “an unreasonable interference with the use and enjoyment of land by its occupier or with the use and enjoyment of a public right to use and enjoy public rights of way” (Linden, 1993). Nuisance may be private or public. Public
nuisance in Canada is usually criminal (Linden, 1993). Private nuisance pertains to “unreasonable interference with the use and enjoyment of land” and today has its greatest impact in private environmental actions, which might include flooding (Linden, 1993). An aggrieved person may sue a dam owner seeking an injunction to prevent the continuance of the nuisance or seeking financial recompense (damages) for loss or injury caused by the nuisance.

Note that nuisance is similar in concept to trespass. The primary difference is that trespass requires an intentional invasion of another person’s property (BC Hydro (4), 1999) and nuisance need not be intentional. As the intentional infliction of harm is not within the scope of this thesis, trespass will not be considered.

2.3.2.3.2 Negligence

Negligence is “the failure to exercise the standard of care of a reasonable person under similar circumstances” and is based upon the reasonable foreseeability of the harm (Binder, 1992). For example, liability for negligence arising from failure to properly operate or maintain a dam is a risk to which dam owners must respond. Obviously the most extreme example of a potential negligence claim would result under a dam failure. Suits in negligence seek compensatory damages.

2.3.2.3.3 Strict Liability

Some acts are deemed so risky that, if things go wrong, the actor should be held liable even in the absence of negligence or the intent to do wrong. Such actions give rise to strict liability – the finding of liability simply because harm resulted. Collecting water behind a dam is one such action. If the impounded water escapes and does damage, the dam owner may be strictly liable for the losses caused.
2.3.2.4 Summary

The basic types of law affecting dam owners include primarily criminal, international, and civil laws. Civil laws include contractual rights, property rights, and torts. This thesis focuses on riparian property rights and the torts of nuisance (unreasonable interference with land), negligence (failure to exercise a reasonable standard of care), and strict liability (for inherently dangerous acts).

2.3.3 Statutory Jurisdiction of Federal and Provincial Legislators

2.3.3.1 Discussion

Canada's constitution provides for a federal system of government under which the power to make statutory law is divided between the federal (national) Parliament and the provincial Legislatures. The Provinces may delegate some of their legislative power to municipalities and regional governments (Rueggeberg and Thompson, 1984). The federal Parliament has delegated some of its legislative power to the territorial governments of the Yukon, North West Territories, and Nunavut.

Although similar in concept to the constitutions of other federal states such as Australia and the US, Canada's constitutional distribution of power has at least two significant differences. The first is that the residual power to legislate with respect to issues not specifically assigned to a particular level of government resides with the federal Parliament, not the provincial Legislatures. The second significant difference is that in Canada the federal government has exclusive, rather than concurrent, jurisdiction over particular issues (such as navigation and
fisheries). These differences have created uniquely Canadian constitutional difficulties (Harrison, 1971).

The Constitution Act specifies those subjects (called "heads of power") with respect to which either the federal Parliament or the provincial Legislatures may exclusively make laws. All Provinces are subject to the same rules. Section 91 of the Constitution Act is the primary list of heads of power for which the federal Parliament has exclusive jurisdiction. Section 92 of the Constitution Act provides the provincial heads of power. These two lists of heads of power are intended to be exhaustive and to cover all possible subjects but they are, of course, worded generally (Thompson, 1995).

If a particular area is not specifically assigned to either the federal or provincial heads of power (such as the environment), both levels of government are entitled to legislate in that area if they can rely on other areas within their exclusive jurisdiction. If the Provinces cannot find jurisdiction, the federal government has the residual power to legislate in that area. It is often easy, given the broad wording of the heads of power (see below) to find a basis for both levels of government to create valid legislation over the same general area. For example, because the Provinces have exclusive jurisdiction over property and civil rights, they are entitled to regulate the quality of water within their own boundaries. However, the federal government may legislate with respect to fisheries and so may regulate the quality of water for that purpose (BC Hydro (2)). Thus, a dam owner is subject to water quality regulations from both provincial and federal governments.

Statutory law promulgated by a legislative body which is outside the heads of power permitted that body is of no force or effect and is said to be "ultra vires"
(outside the jurisdiction of) that body. Determining whether a particular piece of legislation is *ultra vires* is often difficult because of the general wording of the heads of power (Thompson, 1995).

Several sections of the Constitution Act are particularly relevant to water resources. The provincial heads of power in section 92 having the most impact on water resources include:

- section 92(5): Provinces may make laws governing the management and sale of aquatic resources.
- section 92(10): Provinces may make laws regarding most local works and undertakings.
- section 92(13): Provinces may legislate with respect to property and civil rights within their borders.
- section 92(16): Provinces also have exclusive legislative power with respect to matters of purely local and provincial concern.

Section 92A(1)(c) specifically confirms that provinces have management powers with respect to hydroelectric developments.

The federal government may directly or indirectly affect water resources via the following provisions of section 91 of the Constitution Act:

- section 91 preamble: The preamble to section 91 provides the federal Parliament with a residual power to legislate for the "peace, order, and good government" of Canada. This residual power is often referred to as the POGG power. The POGG power allows the federal Parliament
to legislate on matters of national significance that are not expressly covered by sections 91 or 92 of the Constitution Act or when the national interest demands it (as was the case when national wage and price controls were implemented in the 1970's to combat inflation). There are two basic views regarding when the POGG power may be exercised. The first view holds that it may only be used when a national emergency affects the entire country (Thompson, 1995). The second view holds that it may be exercised when an issue of national concern demands attention, whether or not that issue affects the entire country or constitutes an emergency situation (Thompson, 1995). Thompson (1995) suggests that the courts are leaning towards the second interpretation.

- **section 91(1A):** Parliament has jurisdiction over the public debt and property. This gives the federal government jurisdiction over water owned by the federal Crown (for example, watercourses in national parks) (Harrison, 1971).

- **section 91(10):** Parliament may also affect water resources through its exclusive power to legislate with respect to navigation and shipping. This power is construed to include jurisdiction over the navigability of waters, allowing Parliament to legislate to protect and maintain navigability (Harrison, 1971).

- **section 91(12):** Parliament also has exclusive jurisdiction to make laws regarding fisheries.

The federal government also has the power to make treaties with foreign states, to regulate trade and commerce, provide for the defense of Canada, and via a
combination of section 91(29) and section 92(10)(a) the power to legislate with respect to canals and other works or undertakings connecting two or more provinces or extending beyond the boundaries of a single province (Laskin, 1995). In addition, if a work or undertaking is specified as being for the general advantage of Canada or of two or more provinces (via sections 91(29) and 92(10)(c)) it may be regulated by the federal Parliament notwithstanding its siting wholly within one province. Finally, the federal Parliament also has a spending power that allows it to make grants of money to the provinces under whatever conditions the federal government thinks appropriate (Laskin, 1995). Those conditions could, of course, impact water.

Laskin, in “Jurisdictional Framework for Water Management”, examined the extent of federal jurisdiction in a number of areas affecting water resources. A summary of his comments follows:

• Water supply for domestic and industrial purposes is, subject to interference with federal property or law, wholly within the jurisdiction of the Provinces.

• The federal power to regulate navigation is not affected by ownership of the bed of the watercourse and so federal legislation may regulate obstructions to navigation even if, as is the case with dams, those obstructions sit upon the streambed that is owned by the Province. In the US, the federal powers over navigation and commerce have been interpreted as allowing federal regulation of hydroelectric and flood control facilities, including their operation. In Canada, the operation of hydroelectric dams is wholly within provincial jurisdiction provided federal navigation and fisheries requirements are met.
The federal power to regulate fishing extends to licensing, seasons, conservation, and pollution affecting fisheries. It is the conservation aspect of this head of power that most directly impacts dam owners. Conservation concerns may require the dam owner to make provision for fish passage or may impose flow regulations or other operational restrictions. Note, however, that the Provinces have jurisdiction over the proprietary and marketing aspects of fishing such as the granting of private rights to fish, determining the law of private fishing rights, and the possession and sale of fish once caught (Harrison, 1971).

Pollution of waters may be regulated by both the Provinces and the federal Parliament under appropriate heads of power.

Power development, irrigation, reclamation, and recreation are, subject to compliance with federal laws regarding fisheries and navigation, within provincial jurisdiction. Section 92A(1)(c) of the Constitution Act specifically provides that the Provinces have exclusive jurisdiction over the management of hydroelectric developments (subject to federal regulations regarding navigation and fisheries).

In times of war, the federal power of defense would probably (it has not been tested) allow the federal Parliament almost unlimited control over water resources. In peacetime, this power is probably limited, in so far as water resources are concerned, to regulation of armed forces facilities.

The power to make treaties with foreign states lies with the federal Parliament (although provinces are able to make “agreements” with
foreign states). By treaty it is possible for Parliament to assume jurisdiction over heads of power granted to the Provinces although there is some question whether Parliament may unilaterally enter into treaties regarding such powers.

2.3.3.2 Summary

The constitution of Canada gives the provincial and federal legislative bodies jurisdiction over different aspects of the legal regime in which dam owners operate. For example, BC may legislate with respect to water rights but the federal Parliament may affect the exercise of those rights by legislating with respect to fisheries and navigation. The general wording of the constitution often results in both levels of government regulating similar aspects of dam operations, such as pollution.

2.3.4 CONCLUSIONS

As a result of the constitutional makeup of Canada, a dam owner will find it necessary to be cognizant of and to interact with both federal and provincial levels of government with respect to the approval, construction, and operation of the facility. There is also the need to interact with First Nations when treaty lands or lands subject to unsettled aboriginal claims are or may be affected by the dam and its operation. Finally, the municipality or Regional District within which the dam is situated may have bylaws or other statutory requirements to be met.
2.4 DAM OWNER LAW IN BC

The body of law relating to dam owners with which this thesis is concerned includes:

1. a collection of common law and legislation, often collectively referred to as "water law", which governs the allocation and use of water in BC;

2. tort law; and

3. other federal and provincial statutes impacting dams.

Each of these will be examined in some detail.

2.4.1 COMMON LAW RIPARIAN RIGHTS

2.4.1.1 Discussion

This division presents a summary of the traditional common law riparian rights. Readers should be aware that modern legislation has abrogated or modified many of these traditional rights and they are no longer enforceable in their common law form. However, a review of the law is important both from a historical perspective and because it forms the basis for current water law. It is also significant because at least one common law right, the right to water in its natural quality, may still be a potential source of liability for dam owners.

A riparian right is a right held by an owner of property which abuts a watercourse or across which a watercourse flows. A riparian owner is essentially an owner of creekside property. Riparian rights grew out of property law in the rural and agrarian English feudal tenure system as a means of allocating water resources
Clark, 1990). These rights entered the law of British Columbia as part of the general body of English law received in BC in 1858 (Chessman, 1984). They exist regardless of whether or not they are ever exercised by the owner (Clark, 1990).

Naturally flowing water is constantly changing and, therefore, at common law, there was no property in such water other than rights incidental to the ownership of land adjacent to that water (Thompson, 1995). Once water is captured in some manner (for example, in a swimming pool), it becomes, at common law, the personal property of the person who captured it (Thompson, 1984).

Thompson (1984) and others include as riparian rights the following:

1) The right of access to and from the watercourse.

2) The right to receive water onto the riparian land in its natural quality and quantity, subject only to the rights of upstream riparian owners to withdraw water from the watercourse for domestic and other reasonable uses and to public rights of navigation. Comments on this right follow:

- The domestic use right allows the withdrawal of water for "ordinary purposes connected with [the] riparian tenement, for example, the irrigation of a small holding" (Chessman, 1984). The right to withdraw additional water for other reasonable (primarily industrial) purposes was added as the industrial revolution began. Determining whether or not a use is reasonable requires a consideration of all circumstances, including the size of the stream, the season, the nature of the use, the operations involved, the current state of technology (Unknown, 1995), and the social and economic goals of society (Clark, 1990).
• Water withdrawn for reasonable use must be used for the benefit of the riparian tenement; it cannot be diverted to another property (Clark, 1990).

• Accompanying the right to receive water in its natural quality and quantity is a duty to allow water to flow naturally from the riparian land undiminished in quality or quantity except for the uses described above.

• For example, in New Brunswick, a hydroelectric dam owner was sued for blocking the entire flow during daylight hours in order to refill the reservoir emptied every night during power production periods. The operation of the dam in that manner resulted in the closure of a downstream mill. The dam owner was held liable at common law for unreasonably blocking the flow.

3) The right to have water leave the riparian land unobstructed (Unknown, 1995). In other words, a downstream owner (or dam) cannot block the natural exit of water from another riparian owner’s land.

4) The right to fish. At common law, fish in the watercourse are the property of the owner of the riverbed.

5) The right to sue in tort for nuisance or waste (degradation) with respect to infringement of riparian rights. Suits may seek injunctions to stop the offending action irrespective of the occurrence of damage (Unknown, 1995), and, if actual loss is suffered, may also seek damages (Chessman, 1984). Such actions are subject to the “de minimus non curat lex” principle

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4 Brown v. Bathurst Electric and Water Power Co. (1915), 43 NBR 527 (CA); 28 DLR 294
- the damage or the infringement of rights must be more than "minimal" (Unknown, 1995).

Riparian rights also applied to tidal waters but, in that case, were modified to reflect the Crown’s ownership of the bed of tidal waters, the public right to fish and navigate such waters, and to reflect the lack of upstream and downstream owners.

The common law also propounded rules relating to the ownership of the bed of the watercourse and natural accretion and erosion of that bed and the riverbank (Thompson, 1984). In general, a riparian owner owned the bed of a watercourse flowing across or wholly within the owner’s property and owned the bed to the midpoint of a watercourse forming a boundary between riparian properties.

Riparian rights, except for the right to fish, can only be transferred as part of a transfer of the banks or bed of the watercourse (Thompson, 1984).

Note that under common law, only riparian owners have a right to use water from the watercourse. Property owners with no riparian rights (that is, no property adjacent to the watercourse) have no right to water.

Chessman (1984) notes that the common law riparian rights offered significant protection of water quality. However, because of the right of upper riparian owners to make use of water, rights to flow were less well protected by the common law.

At common law therefore, it would be difficult to construct and operate a dam on any watercourse without the consent of downstream riparian owners and, if necessary, upstream owners. A dam obviously impedes the natural flow of water
to downstream properties (at least while the reservoir fills), may alter the velocity of the flow, may impede the drainage of water from upstream properties, and would not likely constitute domestic use. It may be that the dam and its operation and any related diversion of water constitute a reasonable use, in which case some downstream loss may be acceptable. Maintaining reservoir levels would impede the natural flow in dry years and may, at times, require spilling in quantities exceeding the natural flow. Also, the dam may change the quality of the water. For example, decreased sediment loads downstream of the dam and changes in water temperature and nutrient concentrations may occur. Chapter 4 considers this issue in detail.

2.4.1.2 Summary

Riparian rights attach to land bordering or containing a portion of a watercourse. Traditional riparian rights include, among others, the right to receive water from upstream in its natural quality and quantity subject to reasonable use by upper riparian owners, and the right to make use of received water for reasonable purposes.

2.4.2 RIPARIAN RIGHTS AS MODIFIED BY STATUTE

2.4.2.1 Discussion

In British Columbia, as in all of the common law Provinces of Canada, legislation has largely supplanted common law riparian rights. The provincial and federal governments have adopted a piecemeal approach to statutory water law, with a number of statutes in force, each generally applicable to one aspect of water rights:
use and allocation, quality and pollution, and indirect uses such as fishing and navigation (Rueggeberg and Thompson, 1984).

The statutory modification of common law rights in western North America was driven by a number of factors, summarized by Chessman (1984) as follows:

- The dry climate of much of the West imposed water shortages on non-riparian properties and impeded the development of those properties.
- The common law prevented large consumptive uses of water such as those required for mining and industry.
- The common law did not include a priority system to appropriately allocate scarce water.
- Riparian rights prevented the storage of water to secure a supply for dry years.
- Water could not be transferred to other, non-riparian locations without the consent of all riparian owners.
- Even if the consent of riparian owners was obtained, the contracts involved were with the owners but not tied to the land and so did not bind subsequent owners of the riparian lands.

The biggest concern with these limitations was the impediment to industrial development. This was particularly true of the growing BC mining industry in the late 1800's. In the US, an "appropriation doctrine" was adopted which abolished common law riparian rights and gave rights to water to whoever first appropriated it, subject to limits on quantity of withdrawals. In Australia, a
similar result was attained through legislation and a licensing scheme (Clark, 1990) and this statutory law approach was subsequently adopted in Canada.

The effects of that legislation may be summarized as follows (Thompson, 1984):

- Ownership rights in water in its natural state are vested in the Crown (usually the Province).
- Ownership of the beds of watercourses is vested in the Crown subject only to pre-existing rights.
- Ownership of game fish is vested in the Crown.
- The use of water, including both storage and withdrawal (Rueggeberg and Thompson, 1984), is regulated by a licensing system although riparian owners are still entitled to withdraw unallocated water for domestic use (Chessman, 1984). A riparian owner may no longer sue for authorized interference with flow by a licensed user (Thompson, 1984) but probably retains the right to bring an action against a person using water without a licence or in excess of the quantity permitted by the licence (Percy, 1988). Some commentators have gone so far as to suggest that there are no longer any riparian rights of use in BC as a result of Mr. Justice Munroe's declaration that "riparian rights to the use of water no longer exist in British Columbia"5 (Clark, 1990).
- A permit is required to discharge waste into a watercourse (see division 2.4.3.3). However, riparian rights with respect to water quality may remain undiminished (Chessman, 1984). It is unclear

whether a riparian owner retains the right to sue a polluter operating within the terms of a waste discharge permit but Harvey (1990) suggests that the following statement by the House of Lords is “is still good law in England and Canada today”: “Every riparian proprietor is entitled to the natural water of the stream, without sensible alteration in its character or quality. Any invasion of this right causing actual damage (or calculated to found an adverse right) entitles the injured party to the intervention of the court”6.

- Non-riparian owners may obtain licences to use water (Rueggeberg and Thompson, 1984).

These statutory changes greatly affect dam owners. Firstly, the changes provide a legislative regime in which water storage and use is regulated by licences which may be obtained by non-riparian owners. The issue of licences is not restricted to “non-consumptive” uses. Lower riparian owners’ rights to flow have been abrogated in favour of licenced uses, removing concerns about changes to the natural flow caused by the dam and its operation. However, concerns about riparian rights respecting water quality may still be an issue.

2.4.2.2 Summary

A legislated water licencing system has replaced the riparian right to use water except in limited cases. Licencing has also removed the right to receive the natural flow but, arguably, a riparian owner is still entitled to water in its natural quality.

6 Young v. Bankler Distillery Co. [1893] AC 691 (HL).
2.4.3 Current Legislation and Regulatory Requirements in BC

Note that the following summary and discussion of legislation affecting dam owners and their floodplain responsibilities is limited to the general effect of the legislation, with some specifics on provisions of particular interest to dam owners, and is not intended to be a thorough review of the applicability of the legislation to dam owners.

2.4.3.1 The Water Act

The Water Act is provincial legislation designed to conserve and regulate the use of BC’s water resources.

2.4.3.1.1 Introduction

For over a century, British Columbia has regulated its water resources, particularly the use of those resources. Statutory law regarding water has ostensibly extinguished common law riparian rights “in order to ensure an effective water allocation system” (Clark, 1990).

The need for statutory regulation arose in BC primarily out of the requirements of placer mining for large amounts of water. Common law riparian rights were not designed for and could not effectively or efficiently allocate water for such activities. The result, without regulation, was predicted to be considerable litigation with potential for armed conflict. To forestall such a drastic method of allocation, the colonial government passed the *Gold Fields Act* of 1859, allowing the government to grant exclusive rights to defined quantities of water in return for a fee. Those licences were subject to cancellation if the underlying rights were
not used. The most significant impact on water use was the issuance of licences to non-riparian owners (Clark, 1990).

In 1865, the Land Ordinances Act, another colonial statute, further eroded riparian rights by authorizing the diversion, transport, and use of water to and on non-riparian lands. A licence was required and compensation had to be paid to affected persons but there was no obligation to return the water to the watercourse. This legislation adopted elements of the appropriation doctrine by prescribing priority of record as the determining factor in dispute resolutions (Clark, 1990).

The modern Water Act has its most obvious origins in the Water Privileges Act of 1892, which was based upon Australian legislation. That statute confirmed that the right to the use of water was vested in the Crown in Right of British Columbia. The Act continued previous licencing schemes but did specifically allow riparian owners to use water for domestic and livestock watering purposes (Clark, 1990).

In 1897 the preceding acts were consolidated in the Water Clauses Consolidation Act (Clark, 1990). In the case of Esquimalt Waterworks Co. v. Corporation of the City of Victoria⁷, the Privy Council⁸ held that the consolidated legislation did not affect ordinary riparian rights but only affected riparian owners who wished to use water in excess of the ordinary right.

The first Water Act was passed in 1909 and introduced a more comprehensive scheme of water regulation. It expressly protected the riparian owner’s right of

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⁷ Esquimalt Waterworks Co. v. Corporation of the City of Victoria (PC)
⁸ Until 1949, the Judicial Committee of the Privy Council of the United Kingdom was Canada’s highest court of appeal. Since that date, the highest court of appeal in Canada has been the Supreme Court of Canada.

39
use for domestic purposes and provided that previously issued licences must take those riparian rights into account (Clark, 1990).

The *Water Act* of 1914 required riparian owners to file a statement of claim with the government to preserve their rights of use. The requirement that licences consider riparian rights was removed and, in fact, reversed – riparian owners now had a right to use water (for domestic purposes only) subject to the rights of licencees (Clark, 1990).

Water use legislation reached its “modern” form with the *Water Act Amendment* of 1925. That Act limited the use of water by riparian owners for domestic purposes to “unrecorded waters” only. The Amendment also clarified that the provincial Crown owned all water in the Province (Clark, 1990).

### 2.4.3.1.2 Details

The current Water Act includes the following provisions that directly affect dam owner responsibilities to riparian owners and other residents of the floodplain:

- By section 2(1), “the property in and the right to the use and flow of all the water at any time in a [BC watercourse] are for all purposes vested in the government” subject to rights granted by licence.

- The licencing scheme permits the use of water for up to three “purposes” as defined by the Act. Those three purposes may be chosen from the following list (as described in section 1):
  - Conservation: of fish and wildlife.
  - Conveying: the diversion, extraction, use or storage of water.
• Domestic: the use of water for "household requirements, sanitation and fire prevention, the watering of domestic animals and poultry and the irrigation of a garden" (the Water Act, section 1).
• Hydraulicking[sic]: the use of water under head to excavate.
• Industrial: the use of water for an industrial purpose prescribed by regulation.
• Irrigation: of cultivated land and hay meadows.
• Land improvement: protection of property, park development, and reclamation projects.
• Mineral trading: bottling water.
• Mining: for recovering minerals from the ground or ore.
• Power: electricity or otherwise.
• River improvement: "clearing and improving the bed, channel and banks ... to facilitate [logging]."
• Storage: collecting, impounding, and conserving.
• Waterworks: for a municipality, certain districts, or residential areas.

• Pursuant to section 11, if a riparian owner's rights would be prejudiced by the grant of a licence, that owner has a right (limited in time) to object to the license.

• Unrecorded water may still be used for domestic purposes but the onus is on the domestic user to prove that the water is unrecorded (section 42(2)).
• A licencee's rights are always subject to the rights of all licencees whose rights have precedence (section 6). In general, precedence is based upon the date of the licence (section 15(1)). In the event two or more licences are issued on the same date, precedence is determined by a priority of purpose. The order of priority in decreasing rank is: domestic, waterworks, mineral trading, irrigation, mining, industrial, power, hydraulicking [sic], storage, conservation, conveying, and land improvement (section 15(2)). In the event two licences are issued on the same date for the same purpose, the holders are entitled to equal precedence (section 15(3)).

• Licences that relate to a specific parcel of land, a mine, or an undertaking are transferred with that land, mine, or undertaking on its disposition.

• A licence may authorize the holder to make “changes in and about a stream”, a phrase defined by the Act to include modifications of the nature of the watercourse such as the land, vegetation, natural environment, or flow (section 1). Construction of a dam is “a change in and about a stream”. Such changes must be made in accordance with the regulations under the Water Act and require the licencee to use reasonable care not to damage other land, existing works, trees, and property. Furthermore, the licencee must “make full compensation to the owners for damage or loss resulting from construction, maintenance, use, operation, or failure of the works” (section 21(1)(b)). One BC Court of Appeal judge in Kelley v. Canadian Northern Railway Company⁹ held an almost identically

⁹ Kelley v. Canadian Northern Railway Company, [1950] 1 WWR 744 (BCCA).
worded section in an earlier version of the Water Act to be applicable to damage caused to land adjacent to a dam by flooding.

- Note also that by section 25, the abandonment, suspension, termination, or cancellation of rights under a licence does not relieve the owner of the dam to which the licence was appurtenant "of liability for damage resulting from the works constructed, operated or maintained by the owner, or from a defect, insufficiency or failure of the works". Thus, owners remain liable for damage stemming from abandoned or inoperable dams.

- Licences may be given to flood Crown land or to construct, maintain, or operate authorized works on that land (section 26(1)).

- A licencee has certain rights of expropriation granted by section 27 of the Water Act. Of particular relevance to dam owners is the right "to expropriate any land that would be flooded if the dam were constructed and utilized to the maximum height authorized". This probably refers only to lands within the area of a full pool reservoir, not to flood-prone lands downstream.

- Anyone proposing to interfere with works authorized by a licence must give the licencee a minimum of six month's notice in writing of their proposed action (section 29). This provides warning to dam owners of impending municipal or other actions that would affect the dam.
• The officers and employees of a licenced water supply or hydroelectric dam owner have a right, so far as is necessary to discharge their duties, to enter and cross any lands and premises (section 32).

• The Water Act includes a number of offences relating to unauthorized use of water and interference with authorized dams. Penalties include fines of up to $200,000 per day and prison terms of up to 12 months. Employees, officers, directors, and agents of convicted corporations who authorized, permitted, or acquiesced in an offence are guilty even if the corporation itself is also convicted. This is of concern to both the principals and the employees of a dam owner.

• The government may keep in reserve any portion of the unrecorded water in a watercourse to allow feasibility studies, conserve water for anticipated waterworks, irrigation, or power projects, or for use by the Crown for any purpose.

• The Water Regulation\textsuperscript{10}, promulgated pursuant to the Water Act, also contains a number of provisions of interest to dam owners, including regulations regarding "changes in and about a stream". Aside from matters of environmental concern, section 43(1) of the regulation requires that the dam owner "ensure that persons who are lawfully diverting or using water under the [Water Act] will not be adversely affected". This protects downstream licencees and the rights granted to them by their respective licences.

\textsuperscript{10} RBC 1988/204.
2.4.3.1.3 Examples of Impacts on Dam Owners

One currently topical example of the impact of the Water Act on dam owners is the potential requirement for a Water Use Plan. The BC Ministry of Employment and Investment and the Ministry of Environment, Lands, and Parks ("MELP") instituted the requirement of Water Use Plans as a condition of licences under the Water Act. Water Use Plans are "meant to clarify how rights to provincial water resources should be exercised and to recognize other social and environmental values associated with those resources" (MELP (1), 1998). Water Use Plans are particularly significant for dam owners because they specify operating conditions to address objectives beyond the owner's intended purpose for the dam (MELP (1), 1998). Those objectives include protection of fish and aquatic habitat, flood control, power generation, First Nations issues, industrial and municipal development, drinking water supply, recreation and tourism, forestry, irrigation, navigation, and "other cultural and heritage values" (MELP (1), 1998). The dam must be operated on a daily basis in accordance with the Water Use Plan.

The regulators may require that existing dams have a Water Use Plan created for them. This requirement is often added as a condition of new and amended water licences. The Water Use Plan Guidelines (MELP (1), 1998) indicate that Water Use Plans for existing facilities may require or recommend one or more of the following:

- a redefinition of the exercise of water rights;
- a modification to facilities;
- an amendment to the water licence;
- a voluntary diminishment of water rights (with compensation for losses); or
- a reduction in water rights.

The Water Use Plan Guidelines set out the process to be followed in creating a Water Use Plan (MELP (1), 1998):

1. The regulators under the Water Act initiate the process and inform all interested parties of that initiation.

2. The Water Use Plan is developed through multi-stakeholder consultation. The consultation process includes the following steps:
   a) The dam owner “scopes the water use issues and interests with regulatory agencies and key interested parties”.
   b) The dam owner determines the consultation process to be followed and initiates it. The owner has responsibility to manage the development process and to file the draft Water Use Plan with MELP.
   c) The stakeholders confirm the issues and interests in terms of specific water use objectives and measures to assess the meeting of the objectives.
   d) The dam owner gathers additional information on the impacts of water flows on each objective. This may involve technical (hydrological or other) studies as well as qualitative (for example, anecdotal) evidence.
   e) The stakeholders create operating alternatives for regulating water use to meet different interests of the stakeholders.
The stakeholders evaluate the alternatives in terms of the objectives.

The stakeholders determine and document the areas of consensus and disagreement and prepare a report on the completed consultation process.

The dam owner prepares a draft Water Use Plan and submits it to the regulators for review and approval.

3. The Province and DFO review the draft Water Use Plan. Those agencies may require changes.

4. Once authorized, the Water Use Plan must be implemented, monitored, and periodically reviewed, all as specified in the Water Use Plan.

The Water Use Planning process is ultimately the responsibility of the dam owner and so imposes significant financial obligations on the owner in addition to any resulting operational restrictions. Nevertheless, benefits for the dam owner may be realized in terms of improved community relations and, perhaps, operational flexibility in the sense that, with floodplain residents and other stakeholders aware of flood risk and having had input into flood control, the dam owner need not be reluctant to spill when required for dam safety for fear of flood related liability and bad press (Cattanach et al, 1998). Furthermore, the negotiation and the records associated with it may assist the dam owner in establishing due diligence if the dam operations are carried out in accordance with the Water Use Plan.
2.4.3.1.4 British Columbia Dam Safety Regulation

This not yet proclaimed regulation under the Water Act, referred to in this division as the Regulation will require the dam owner to operate and maintain the dam in accordance with:

- the Water Act and its regulations;
- the terms and conditions of all licences;
- the terms and conditions of any order made by the regulators under the Water Act;
- the directions of appropriate Ministry personnel; and
- any existing Operations, Maintenance and Surveillance Manual and Emergency Preparedness Plan, or EPP, for the dam (section 2(1)). The requirement for an Operations, Maintenance and Surveillance Manual and an EPP is not a required part of the licence for the dam but those documents may be requested by the regulators at a later time (section 2(2)).

The regulator must approve all alterations to a dam (except maintenance), as well as those procedures specified in the Operations, Maintenance and Surveillance Manual and certain emergency measures (section 2(3)).

Formal inspections of the dam must be carried out and reported upon although the Regulation does not specify frequency or extent of the inspections (section 3). The owner must repair any deficiency revealed by an inspection (section 3(1)(c)). Copies of the inspection report must be filed with the regulators (section 4), and
must be filed immediately if the inspection reveals "an unusual situation or potential safety hazard" (clause 4(1)(b)). The regulators may require the dam owner to have the dam inspected by a professional engineer (section 5).

Section 6 of the Regulation requires a dam owner to take action if "conditions are, or may likely be, hazardous to a dam", or if any part of the dam or any operation in connection with it will or may become a public safety hazard (including an environmental hazard). In such cases, a dam owner is required to operate in accordance with the EPP, or, if an EPP does not exist, in a "manner, and initiate any remedial actions, that will safeguard the public, minimize damage to public infrastructure, property, and works ... and the environment". Furthermore, an obligation exists to initiate emergency measures by contacting the Provincial Emergency Program, the dam safety regulators, and "all persons who may be endangered by the failure of the dam". In addition, the dam owner is required to advise people to evacuate and to remove property from endangered areas. The regulators may give instructions regarding the operation and hazard response activities in emergency situations.

These requirements are obviously onerous, particularly those requiring the dam owner to do more than initiate emergency response. The accepted industry practice is that the dam owner detects emergency situations, respond directly to the problem, and notify the appropriate emergency response agencies (including police, fire, rescue, and municipalities). It is then the responsibility of the downstream response agencies to warn the public and, if necessary, coordinate an evacuation. The Canadian Dam Association (the "CDA") Dam Safety Guidelines provide for that split of responsibilities although the Guidelines note that, if time is short, the dam owner should consider whether it would be better to notify downstream residents directly (CDA (1), 1999). The current version of the
proposed Regulation does not allow this division of tasks. Time will tell whether this heavy burden is placed on the dam owner when the Regulation becomes law. This issue is discussed in detail in chapter 5.

The Regulation would also require the dam owner to evaluate, if requested, the hazard potential of the dam (section 8) and, if required, install specified instrumentation.

As of mid-September, 1999, the Legislative Council has approved the Regulation in its proposed form. MELP staff is preparing a Regulatory Impact Statement for Cabinet consideration (Jolley, 1999). The date for the coming into force of the Regulation is not known as of the time of completion of this thesis.

2.4.3.1.5 Summary

The Water Act, the modern form of a 140-year-old water use regulatory system, requires a licence for the use of water in BC. The Act imposes obligations on dam owners to compensate others for damages resulting from the construction, maintenance, use, operation, or failure of a dam. One current impact of the Act is the requirement, appended to licences, for dam owners to negotiate Water Use Plans with other stakeholders in the watershed. A potential impact arises if the proposed Dam Safety Regulation significantly increases a dam owner’s public responsibilities in the event of a dam safety emergency.

2.4.3.2 The Waste Management Act

The Waste Management Act, referred to in this division 3.4.3.2 as the Act, is provincial legislation designed to control pollution and regulate municipal waste
management and contaminated site remediation. It is the primary provincial legislation respecting potential pollution at a dam.

2.4.3.2.1 Details

Section 3 of the Act prohibits a dam owner from introducing, causing, or allowing waste to be introduced into the environment without a permit to do so. Aside from the obvious contaminants of air pollution, litter, and refuse (and other, more esoteric sources of pollution), "waste" includes effluent (section 1(1)) which includes substances that might injure people or "any life form", interfere with visibility, or, among other things, damage the environment (section 1(1)). It is possible that sediment, debris, or abnormally warm or cold water, or water with elevated or depressed dissolved oxygen content might constitute effluent. If so, a permit is required and that permit may, among other things, require alterations to the dam and impose restrictions on discharge of effluent water (section 10). Permits may be altered any time the regulator deems it necessary (section 13). To date, the Act has not been used to regulate the discharge of water through turbines or by spilling from dams. However, a dam owner should be aware of the possibility that some discharges might be "effluent". See chapter 4 for a detailed discussion of dams and water quality.

2.4.3.2.2 Examples of Impacts on Dam Owners

Although the Act has not given rise to a reported case regarding a dam, the BC Court of Appeal has provided some guidance on the meanings of "effluent". In R. v. Seraphim, heavy rainfall caused a spill of toxic cyanide. The defendant was charged under the Act. The court held that to be effluent, the flowing material must be capable of causing injury or harm to man, property, or a life form.

(including plants and animals) capable of being present where the spill occurs. Thus, under the present wording of the Act, no actual damage need occur for water released from a dam to be "effluent" within the meaning of the Act as long as fish or some other organism or property might realistically be present downstream. This issue is discussed in detail in chapter 4.

2.4.3.2.3 Summary

The Waste Management Act is a provincial pollution regulation statute. In general, it prohibits the discharge of pollutants into the environment without regulatory approval. Arguably, it may regulate the discharge of water through or over a dam if that water is capable of injuring fish or other wildlife.

2.4.3.3 The Fisheries Act

The Fisheries Act, referred to in this division 2.4.3.3 as the Act, is federal legislation promulgated under the federal power to legislate with respect to coastal and inland fisheries.

2.4.3.3.1 Introduction

The federal Department of Fisheries and Oceans ("DFO") administers the Act. The legislation deals with many aspects of a fishery but the conservation provisions are of particular concern to dam owners. The Act prohibits the killing of fish, the destruction of fish habitat, and the pollution of fishery waters. DFO may require dams to be constructed and operated to reduce or eliminate harmful effects on fish.
2.4.3.3.2 Details

Provisions of the Fisheries Act particularly relevant to dam owners include:

- A dam owner may be required to design, construct, operate, and maintain an approved fish-way to permit fish passage around the dam (section 20). Similarly, a fish-stop or diverter may be required to prevent the death of fish or to assist the fish in negotiating the dam (section 21). All water intakes, ditches, channels, or canals conducting water from fisheries waters for the purpose of power generation must, if the regulators deem it necessary, have a fish guard preventing the passage of fish into the intake or other structure (section 30).

- Section 23 requires an owner to ensure free passage of migrating fish during the construction of a dam. The section also requires the dam owner to release sufficient water downstream of the dam to “be sufficient for the safety of fish and for the flooding of the spawning grounds”. What constitutes sufficiency of flow is at the government’s discretion.

- Section 32 prohibits the unauthorized destruction of fish “by any means other than fishing”. In short, killing fish is prohibited.

- Section 35 prohibits the carrying on of any unauthorized work or undertaking that results in the harmful alteration, disruption, or destruction of fish habitat. Authorization may be sought from the Minister.

- Section 36(3) prohibits the deposition of a “deleterious substance” in any water frequented by fish and the deposition of such substances in
such a manner that they may enter fisheries waters. A deleterious substance is defined in section 34(1) as, generally, any substance that would "degrade or alter or form part of a process of degradation or alteration of the quality of that water so that it is rendered or is likely to be rendered deleterious to fish or fish habitat". BC courts have held that sediment washed into the watercourse during a flood is a deleterious substance.\textsuperscript{12}

- By section 37, upon either the request of the responsible Minister or the initiative of the dam owner, plans, studies, and their related documents may be filed with the Minister for review. Should the Minister determine that a proposed dam or other work will affect habitat or introduce a deleterious substance into fisheries waters, the Minister may require changes to protect the habitat and waters or may restrict the operation of the undertaking (including directing its closing).

- Section 40 contains offence and punishment provisions, providing for both summary conviction and indictable offences for the contravention of sections 35 and 36 with fines and prison terms for multiple offences of up to $1,000,000 and three years in prison.

- By section 42, persons depositing a deleterious substance in fisheries waters may be jointly and severally liable to the Crown for clean-up measures undertaken by the Crown and steps taken by the Crown to prevent a similar occurrence. Furthermore, such persons are liable to licenced commercial fishermen for all income lost as a result of the

\textsuperscript{12} See \textit{R. v. British Columbia Hydro and Power Authority} (1997) 25 CELR (NS) 51 (BCSC).
deposition. These liabilities are absolute (do not require proof of fault or negligence) but the defences of act of war (and similar events), act of God, and sabotage are available.

- By section 78.2 the officers, directors, and agents of a corporation committing an offence under the Act are liable on conviction to the punishments described above.

- Section 78.6 provides that no person may be convicted of an offence under the Act if they used due diligence to prevent the commission of the offence or reasonably and honestly believed in the existence of facts which, if true, would render their conduct innocent. This provision is particularly important to dam owners who operate their dams with the appropriate due diligence.

2.4.3.3.3 Examples of Impacts on Dam Owners

Although the Act is concerned only with fisheries and so does not deal with direct impacts on the floodplain or its residents per se, it is a very significant influence on dam construction and operation. As an example, consider the charges brought against BC Hydro with respect to the operation of its Bridge River hydroelectric project in 1991. The charges resulted in a trial, R. vs. British Columbia Hydro and Power Authority\(^{13}\) (referred to as the “BC Hydro case”), which went to trial in 1997. It is worth reviewing the facts of the case in some detail, particularly as the case illustrates both the ease with which conflicts within the purview of the Act can arise and the defences available to dam owners in connection with Fisheries Act charges.

\(^{13}\)Ibid, n. 12.
BC Hydro’s Bridge River hydroelectric system (the “Bridge System”) has been in operation since 1960 and includes, on the Bridge River itself, Downton Reservoir, impounded by La Joie Dam, and Carpenter Reservoir impounded by Terzaghi Dam. La Joie Dam has a generating station but Terzaghi Dam does not. Tunnels divert water from Carpenter Reservoir through the mountains to the adjacent Seton River drainage basin. The Shalalth generating station is located at the outfall of the diversion tunnels. The Seton basin contains several other components of the Bridge System not relevant to this example.

Terzaghi Dam does not allow fish passage. Prior to its construction, DFO recognized that an existing run of 200 salmon in the Bridge River would be destroyed by completion of the dam. Nevertheless, construction was approved. There was no historical salmon spawning below the site of Terzaghi Dam because of frequent high flows. Following construction of the dam, flow in the Bridge River was reduced to nil immediately downstream of the dam. Groundwater and other sources restore sufficient flow to permit salmon spawning several kilometres downstream of the dam. As a result, a salmon run has developed below the dam since its construction.

Fish habitat is easily damaged by high flows which can increase sediment load, move gravel spawning beds, destroy food sources for fish, and damage riverbank vegetation which provides habitat for insects upon which fish feed and shades the stream. Juvenile fish may also be flushed out of the river (BC Hydro case).

In the spring of 1991 the snow pack in the Bridge River basin was considerably higher than normal. To minimize future storage problems, BC Hydro ran the Shalalth generators at maximum capacity (5400 cfs). By early May, inflows in the Bridge River basin exceeded outflows and Carpenter Reservoir started to fill.
Following its usual practice, BC Hydro sequentially shut its Shalalth and other Bridge System generators down in early June for maintenance. As a result, outflows were lower and Carpenter Lake's storage capacity was reduced as the reservoir filled.

In mid-July, a three-day temperature spike followed by heavy precipitation resulted in inflows exceeding projections. Additional water had to be released into Carpenter Reservoir through La Joie Dam. By late July BC Hydro concluded that a release from Terzaghi Dam would be necessary. After consultation with DFO, a spill of 2800 cfs commenced on July 24 and ended on July 31 when BC Hydro determined that a safe amount of available storage had been achieved in Carpenter Reservoir. Fish salvage operations were carried out following cessation of the spill.

Between August 7 and 12 a 1-in-100 year storm occurred in the basin. That storm was not predicted by Environment Canada upon whom BC Hydro relied, at least in part, for weather forecasting. BC Hydro determined that another spill was necessary from Terzaghi Dam and, after consultations with DFO, let the reservoir rise to free spill height. On August 9 BC Hydro determined that an additional spill through the spillway was necessary for protection of the dam. The controlled spill was gradually reduced when circumstances permitted and fish salvage operations were carried out. The spill peaked at 8500 cfs and by August 28 had been reduced to 50 cfs.

On August 29 a 1-in-1000 year storm event occurred. Environment Canada again failed to predict the storm. Another combined free and controlled spill was required from Terzaghi Dam. The spill peaked at 7500 cfs and, beginning September 7, was reduced in stages to facilitate fish salvage.
BC Hydro admitted that these spills killed fish and damaged fish habitat but argued that the spills did not appear to have a significant impact on the fishery based upon the numbers of salmon returning in subsequent years. BC Hydro also pointed out that before the dam existed there was no fishery downstream of the dam site because of high flows. In August 1991, inflows to the basin peaked at 29,000 cfs, all of which would, historically, have flowed down the Bridge River.

BC Hydro was charged with one count each of killing fish, damaging habitat, and introducing a deleterious substance (sediment) into water frequented by fish contrary to sections 32, 35, and 36 of the Act, described above. In response, BC Hydro raised a number of possible defences and a trial ensued. However, as the offences are “strict liability offences”\(^{14}\), the Crown prosecutors needed only prove that the violations occurred and the onus then shifted to BC Hydro to prove on the balance of probabilities that its defences applied (BC Hydro case).

Details of the various defences raised and the court’s decision with respect to each are provided in the author’s paper entitled “Successful Defences Against Charges Under the Fisheries Act”, appended to this thesis as Appendix B. In summary, BC Hydro was acquitted on all charges because, as provided by section 78 of the Act, the court found it to have acted with due diligence in conducting its operations (see division 2.4.3.5 for a discussion of due diligence). It is, however, important that dam owners realize that “normal” dam operations may give rise to Fisheries Act charges, even if DFO has been consulted regarding those decisions.

\(^{14}\) Note that a strict liability offence is not the same thing as a finding of liability in a court case founded on the Rule in Rylands v. Fletcher (also known as “strict liability”). The Rule of Rylands v. Fletcher is described in section 2.4.6. Upon bringing a charge of a strict liability offence, the burden of proof on the Crown is significantly less than the usual “beyond a reasonable doubt” for typical criminal offences. The purpose of strict liability offences is often to provide a standard of care which every person must meet (BC Hydro (6), 1999). See division 2.4.5.5 for a detailed discussion of standards of care in negligence.
2.4.3.3.4 Summary

The Fisheries Act is federal legislation regulating, among other things, conservation aspects of fisheries. Dam owners are prohibited from killing fish, affecting habitat, or introducing pollution into fisheries waters. However, due diligence is a defence to charges with respect to those prohibitions.

2.4.3.4 The Navigable Waters Protection Act

The Navigable Waters Protection Act, referred to in this division 2.4.3.4 as the Act, is one of the oldest pieces of legislation in Canada and predates most dams. The goal of the statute is to protect the public’s right to navigate waterways.

2.4.3.4.1 Introduction

The Act fulfills its mandate by requiring all “works” (including dams, booms, and related facilities) that affect navigable waters be approved by the Minister before construction. As part of the approval process, details of the proposed works must be filed in the Land Titles Office having jurisdiction over the land on which the works are to be built. Notices of the availability of the plans must be advertised and the public has one month to inspect the documents. The Minister may then approve the works on such terms and conditions as the Minister deems fit. With respect to dams, the *Navigable Waters Works Regulations*\(^\text{15}\) permit those terms and conditions to require, among other things, the construction and maintenance of log chutes, and the construction of roads and foot-ways over or around the works to link the upper and lower reaches of the river. The Minister’s terms and

\(^{15}\) *Navigable Waters Works Regulation*, C.R.C. 1978, chapter 1232, as amended.
conditions may also require the maintenance of flows and water elevations for navigation purposes. An approval for a dam will generally have a life of 50 years. Alterations to the works require ministerial approval and may be treated as new works, requiring a complete approval application process. The Coast Guard branch of DFO administers the Act.

2.4.3.4.2 Details

The Act requires dam owners to request approvals from the Minister for an obstruction of navigable water. Hydroelectric companies are often most familiar with this legislation in relation to transmission line river crossings but it applies to dams and related works as well. Particularly relevant provisions of the Act include the following:

- Section 2 somewhat vaguely defines “navigable water” as including “a canal and any other body of water created or altered as a result of the construction of any work”. Because approval is necessary only for “navigable waters”, this definition has been the cause of confusion regarding the statute’s applicability in specific situations.

- Section 3 includes dams, booms, piers, tunnels, pipes, power cables, wires, and approaches to other works in the definition of “work”. A “work” also includes anything not specifically mentioned that “may interfere” with navigation.

- Section 5(1) contains a general prohibition against building or placing a work “in, on, over, under, through or across any navigable water” unless the work, including its site and plans, have been approved, on such terms and conditions as the Minister deems necessary, prior to
commencement of construction. Note that the Minister may impose conditions on the dam owner to protect or enhance navigation. Locks are a typical requirement for dams built in frequently traversed navigable waters. Note that prior to 1956, approvals were given by federal Order-in-Council rather than “ministerial approval”.

- Section 5(2) contains an exemption for works that do not, in the Minister's opinion, “interfere substantially with navigation” but this exemption does not apply to dams or booms (including debris booms).

- By section 6, the Minister may order the removal or alteration of all unapproved works and any approved works that are not built to the approved plans, not built on the approved site, or not maintained according to the approved maintenance plan. However, the Minister may give retroactive approval to constructed works upon completion of an application process. This is a particularly significant provision as many dams in BC were not, for a variety of reasons, approved when constructed. At the time of writing, the Coast Guard is actively pursuing unapproved dam owners to make the appropriate applications for retroactive approval.

- Approvals are valid for a length of time specified by regulation (section 7). In the case of dams, this time period is 50 years (see the schedule to section 3(1) of the Navigable Waters Works Regulations). On expiration a new approval may be granted but the application’s review will consider changes in navigation over the years (Section 11). It is unclear whether section 11 allows the Minister to consider the navigability of a dam site today with respect to a dam for which
retroactive approval is sought (assuming no dam existed). This is potentially significant as modern recreational watercraft may render a previously non-navigable reach navigable, thus suggesting approval is necessary now even though it was not necessary when the dam was constructed.

- The approval process requires that the plans and a description of the proposed site be deposited in the relevant Land Titles Office. The availability of those documents for public inspection must be advertised in the Canada Gazette and two local newspapers at least one month prior to their filing (section 9). This, of course, ensures public input into the effect on navigation of the proposed (or existing) dam.

- Section 10 requires that rebuilding, repairing, or altering the dam be approved by the Minister. By the wording of the section, the Minister's refusal to approve such work might be limited to situations in which the upgrade would increase the interference with navigation. Note however that, by section 10(4), the "passage of time and changing conditions in navigation" may mean that an application for approval of an upgrade is treated as an application for a new work.

- Finally, note sections 21, 23, and 25 that prohibit depositing substances, including stone, gravel, and earth, into most navigable water outside of approved dumping locations. While other statutes deal more generally with pollutants and debris, it is worth remembering this further prohibition if the water is navigable.
2.4.3.4.3 Examples of Impacts on Dam Owners

The Act applies to "navigable waters" but does not define such waters in any useful way. Regulations under the Act do not provide any guidance. The Coast Guard’s Navigable Waters Protection Act Application Guide (referred to in this division as the “Application Guide”) defines navigable water as:

"... any body of water capable, in its natural state, of being navigated by floating vessels of any description for the purpose of transportation, recreation or commerce; it also includes a canal and any other body of water created or altered for public use, as a result of the construction of any work, as well as any waterway where the public right of navigation exists by dedication of the waterway for public purposes, or by the public having acquired the right to navigate through long use."

That publication also states that the authority to determine navigability of waterways rests solely with the Minister of Transport. This stance was rejected by the Federal Court of Canada in International Minerals & Chemicals Corp. (Canada) Ltd. v. Canada (Minister of Transport)\(^6\), referred to in this division as the “IMC case”, wherein Mr. Justice MacKay stated:

"In my view the issue [of the definition of ‘navigable waters’] before the Court is a mixed question of fact and law, not simply a question of fact to be determined within the exercise of discretion by the Minister. Rather, it is a preliminary question upon which the Minister’s jurisdiction under the Act depends. If there be dispute about that issue it is ultimately a

\(^6\) International Minerals & Chemicals Corp. (Canada) Ltd. v. Canada (Minister of Transport) [1993] 1 FC 559; 58 FTR 302; 10 CELR (NS) 85.
matter of statutory interpretation, subject to determination by the Court in an application or an action for a declaration.”

The IMC case dealt in part with the definition of “navigable waters”, relying, to some extent, on Mr. Justice Henry’s decision in Coleman et al. v. (Attorney General) Ontario et al“ (referred to in this division as “Coleman”) in which the Court held:

“In Canada the leading jurisprudence has evolved in decisions of the Supreme Court of Canada in the early part of the century with respect to waters in the Province of Quebec. The principles emerging from the cases may, for our purposes, be briefly stated without much elaboration.

1. A stream, to be navigable in law, must be navigable in fact. That is, it must be capable in its natural state of being traversed by large or small craft of some sort - as large as steam vessels and as small as canoes, skiffs and rafts drawing less than one foot of water.

2. In the context of the Canadian economy where the timber trade has developed, ‘navigable’ also means ‘floatable’ in the sense that the river or stream is used or is capable of use to float logs, log-rafts and booms.

3. A river or stream may be navigable over part of its course and not navigable over other parts; its capacity for navigation may therefore be determined by the courts independently at different locations.
4. To be navigable in law a river or stream need not in fact be used for navigation so long as realistically it is capable of being so used.

5. To be navigable in law, according to the Quebec decisions, the river or stream must be capable of navigation in furtherance of trade and commerce; the test according to the law of Quebec is thus navigability for commercial purposes. The underlying concept of navigability in law is that the river or stream is a public aqueous highway used or capable of use by the public. This concept does not embrace uses such as irrigation, power, fishing, or other commercial or noncommercial uses that do not depend upon its character as a public aqueous highway for passage. In law a river or stream is not navigable if it is used only for the private purposes, commercial or otherwise, of the owner.

7. Navigation need not be continuous but may fluctuate seasonally.

8. Interruptions to navigation such as rapids on an otherwise navigable stream which may, by improvements such as canals, be readily circumvented, do not render the river or stream nonnavigable in law at those points.

\( (1983) \) 143 DLR (3d) 608 (Ont. HC)

Henry, J., rejected this Quebec limitation with respect to the law of Ontario because he felt that modern recreational uses by the public ought to be taken into account.
9. It would seem that a stream not navigable in its natural state may become so as a result of artificial improvements.”

In IMC, MacKay, J., expanded and updated the decision of Henry, J., in Coleman. At pp. 314 - 315 he noted:

“Navigable waters within the Act implicitly include the concept of an aqueous highway, as Mr. Justice Henry described the underlying concept of navigability in law. That concept in turn implies, to me, that the waters be more than a small pond or lake isolated from other waters, and more than a prairie slough that fills with spring melt and virtually dries up in late summer. *It implies as well that the waters connect places which in the normal course would facilitate travel, even recreational travel, on a route that would have a likelihood of reasonable appeal to members of the public as a route to be traveled. The fact that a body of water will carry a canoe or other vessel is not in itself sufficient as a basis for considering the waters navigable and subject to regulation under the Act* [Emphasis added].

...a river, stream or creek that is, in its natural state, navigable in fact in the sense included within the Act, even for part of its length, would continue to be so after its course is obstructed by natural forces or by constructed works. On the other hand a river, stream or creek that in its natural state is not navigable in fact in the sense included within the Act does not become so by alteration of the natural state unless some portion of the waters then becomes capable of carrying vessels using the waters as an aqueous highway for travel or transport for trade, communication or recreation. Even where that may be the result of change the navigable
waters so created do not extend beyond the area where the waters are in fact navigable in that sense.

Even if, in periods of high water, Cutarm Creek in its natural state could provide the opportunity for travel by canoe or shallow draft vessel for a considerable portion of its length there is no evidence that in the normally short season of high runoff, the creek has served as an aqueous highway or that it is likely to have reasonable appeal to the public to be used as a highway for navigation. In my view, it would extend the concept of ‘navigation’ beyond that contemplated or warranted within Parliament’s powers under s. 91(10) to include as ‘navigable waters’ under the *Navigable Waters Protection Act* those creeks or streams that in their natural state throughout most of the year are not navigable in fact simply because for limited periods of high water during spring runoff or following extraordinary precipitation they are capable of carrying vessels of shallow draft. Rivers or streams that, in high water seasons, have a history of being used for flotation of logs, or that would be capable of carrying logs in areas where logging is a reasonable possibility may present a special case in this country...”

Some issues relevant to dam owners are not dealt with by the IMC case. For example, the case dealt with a proposed work. The granting of an approval for an existing dam raises the question of the appropriate test for such a structure – do the questions of navigability, ease of circumvention of natural navigation obstacles, and appeal to the public of a river route as an aqueous highway depend upon the technology available and the financial climate when the dam was
constructed or upon the situation today if a new dam was to be constructed on a "natural" river? Section 11 of the Act allows the Minister to consider changes in navigational use of a waterway for renewals of approvals but it is unclear whether similar considerations could or should apply to retroactive approvals.

It is interesting, and frustrating to the dam owner, to note that the Coast Guard does not immediately apply the relatively complex test set out in the IMC case. Rather, as indicated by the definition of navigable waters in the Application Guide, they take a simple view of the definition of "navigable waters": any river that is navigable by a kayak at any time of the year is navigable water.

Also, if a dam is constructed on a non-navigable reach of the river, its operation may severely impact the navigability of reaches downstream. As the point of the legislation is to preserve the navigability of rivers, there may be an argument that the stream as a whole should be classed as navigable or non-navigable, with any navigable portion making the whole "navigable water". If so, whether or not a dam was constructed on a non-navigable portion of a stream is irrelevant - the key would be whether any portion of the stream is navigable. In this situation, if no reaches downstream of the dam were navigable, approval would be straightforward with few if any operating constraints. If, however, any reach downstream was navigable, then there would likely be operating constraints to preserve that navigability.

This is likely not the current interpretation of the NWPA, however. Note that MacKay, J., in the IMC case makes clear that:

"... waters which in their natural state are navigable waters and thus subject to regulation under the Act, even for part of their length, would continue to be so after its course is obstructed by natural forces or by
constructed works...Even where [waters become navigable due to construction of a dam]...the navigable waters so created do not extend beyond the area where the waters are in fact navigable...” [Emphasis added].

Furthermore, his ruling in the case includes the following statement:

“In my view, neither crossing [the works in question were creek crossings in relation to the transport of ore at a minesite] is at a location where the waters of Cutarm Creek are navigable within the purposes of the Navigable Waters Protection Act. Thus they are not works requiring the approval of the ... Minister under that Act.”

While the IMC case did not deal with all the issues surrounding the definition of “navigable waters” the decision does provide much guidance. In particular, a watercourse must be navigable by some sort of craft (even a kayak) for some portion of the year. The Coast Guard takes this as the only significant portion of the definition and concludes that if a waterway is navigable one day a year by a kayak, that waterway is navigable water. However, the IMC case also requires that the watercourse be a “public aqueous highway”; the river must be used or capable of being used by the public to connect places on a route that does or would likely have reasonable appeal to the public as a route to be traveled. In short, navigability during high flows does not make a stream navigable water if it does not have reasonable appeal to the public as navigable water. This definition raises additional questions and certainly does not put an end to the uncertainty associated with the meaning of “navigable waters”.

It is also important to realize that the presence of rapids or falls does not make a river reach non-navigable if it could be “readily circumvented” by canals, locks, or other works. Also, an issue mentioned but not significant in the IMC case (which
involved a prairie river) but which would be important in BC is the use of a river to transport logs. Older court rulings from eastern Canada indicate that floating logs downstream may render the stream “navigable water” for purposes of the Act.

Another issue not dealt with in the IMC case was the proper approach to approving existing facilities – does the test depend on the navigability of the watercourse at the time the dam was constructed or on its navigability (assuming no dam) today? This may be significant if a river which would not have been considered navigable in the early years of the century because of a lack of commercial traffic is considered navigable today because of recreational use by modern kayaks or canoes.

To assist determination of the navigability of river reaches, a flowchart based upon the IMC case was created. That flowchart is set forth in Figure 2.1, on the following page.
Figure 2:1: Navigable Waters Protection Act Application Flowchart

1. **Yes**
   - Is the answer "required"?
     - No
       - NWP is approved
       - Yes
         - Was the answer "required"?
           - No
             - Consider the dam
             - Dam
           - Yes
             - Was the answer "required"?
               - No
                 - Apply for NWP approval
               - Yes
                 - No

does not exist in the record?
- Yes
  - Which work is covered? Is there a permit?
  - No
    - Could the original design be affected?
    - Yes
      - No
        - Yes
          - No
            - No
              - Consider the dam
              - Dam
2.4.3.4.4 Summary

The Navigable Waters Protection Act is federal legislation regulating and protecting navigable waters. Dams, debris booms, and other works interfering with navigation require regulatory approval. What constitutes navigable water is not entirely clear but probably includes any watercourse “frequently” navigated by a kayak or larger vessel. Regulators are currently requiring that the owners of existing but previously not-approved dams seek retroactive approvals.

2.4.3.5 Due Diligence

2.4.3.5.1 Discussion

Strict liability offences are found in many statutes, including the Fisheries Act as described in division 2.4.3.3. Such offences require that the Crown prove only that the defendant committed the prohibited act; no intent on the part of the defendant is required. Once commission is shown, the onus shifts to the defendant to show that he or she has a valid defence. In very rare circumstances a number of defences might be applicable. See Appendix B for a paper describing a variety of defences (almost all unsuccessful in that case) raised by BC Hydro in response to charges under the Fisheries Act. Normally, only one or two possible defences may be available. The two most commonly available defences are “act of God” and due diligence.

A natural event such as a severe rainstorm or earthquake is an act of God if it is unforeseeable. See division 2.4.5.5 and Chapter 3 for detailed discussions of foreseeability and extreme rainfall and flood events.
Because of the rarity of “acts of God”, it is likely that due diligence will be the
only possible defence to a strict liability offence. Due diligence requires that the
dam owner have acted in a non-negligent way or “took all reasonable care to
prevent the offence from occurring” (BC Hydro (7), 1999).

For the dam owner, the key concern is “what constitutes reasonable care?” To be
reasonable, actions must be proportionate to the risk – the higher the risk, the
greater the care that must be taken (BC Hydro (7), 1999). Because risk is the
product of probability and consequences, both the likelihood of harm and the
seriousness of harm must be considered by the dam owner in meeting due
diligence requirements.

Courts may take the following factors into consideration in determining whether
reasonable care was taken and so whether the dam owner was duly diligent (BC
Hydro (7), 1999):

- Was the dam owner’s conduct appropriate for the risk?
- Were there other, better, options for action available?
- Were there causes of the offence beyond the dam owner’s control?
- Did the dam owner meet or exceed industry standards?
- Did the dam owner have (or employ) an appropriate level of
  knowledge and skill?

Due diligence should be a dam owner’s approach to all aspects of his or her
operation for the following reasons:

- It provides the only defence to strict liability offences that is always
  available (assuming, of course, that the dam owner was duly diligent).
• A duly diligent owner probably meets the standard of care requirements in a defence to a claim of negligence (see division 2.3.5).

• Due diligence will likely reduce accidents and other problems which negatively impact the business side of dam operations.

• Due diligence enhances the safety of employees, equipment, facilities, the public, and the environment.

Some elements of due diligence include the following (BC Hydro (7), 1999):

• proper employee training;
• contingency plans, including EPPs;
• using (or hiring) properly qualified persons;
• properly planning work;
• consulting the appropriate regulatory authorities prior to acting; and
• supervising and monitoring work.

An example of a successful due diligence defence is described in Appendix B.

2.4.3.5.1 Summary

Many of the offences in the above statutes are "strict liability" offences. Usually, the only defence available to such charges is that the dam owner exercised due diligence to avoid committing the offence. The components of due diligence should be a part of virtually all dam owner decisions. Components include training, planning, qualified personnel, regulatory approval, and supervision and monitoring.
2.4.4 The Law of Nuisance

Nuisance is a field of tort liability that punishes those who unreasonably interfere with a landowner's use and enjoyment of his or her property or with the public's use and enjoyment of a public right of way. The act creating the nuisance need not be intentional or negligent, it must simply occur (Linden, 1993). However, as troublesome as the act may be, it is only a nuisance if it continues for an unreasonable time or in unreasonable circumstances. There are two kinds of nuisance: public nuisance and private nuisance, each described below.

The owners of land affected by the defendant's actions bring nuisance suits. The defendant is the person who caused the nuisance. This is usually the owner of the land from which the nuisance originated but it may be the occupier of the land (such as the owner of a dam on Crown land) or even an inheritor of the problem who permits it to continue (such as an owner who purchases an existing dam) (Linden, 1993).

Nuisance is often used today in environmental battles but can extend to other areas, including interference with riparian rights. An example of nuisance would arguably be dam construction and operation that results in negative impacts on downstream landowners by, perhaps, increasing loss of riverbank land because of a reduced sediment supply. In a real world example, the Mikisew Cree First Nation is, at the time of this writing, suing BC Hydro claiming, in part, that BC Hydro caused a nuisance by operating dams on the Peace River and reducing the flow in the river and so in the Peace-Athabasca delta.

\[^19\] Maitland v Raisbeck, [1944] K.B. 692 (CA)
2.4.4.1 Public Nuisance

The more widely known of the two types of nuisance is public nuisance which is a criminal offence and involves actual or potential interference with "public convenience or welfare" (Linden, 1993). For a nuisance to be public, a significant number of persons must be affected by the unreasonable act. For example, one possible test to determine if a nuisance is public is whether the nuisance is "so widespread in its range or indiscriminate in its effect that it is not reasonable to expect one person to take proceedings on his own responsibility to put a stop to it, but that it should be taken on the responsibility to the community at large". In British Columbia, unreasonable noise at a racetrack that affected 7 families was considered a public nuisance. A dam that adversely affects a number of property owners (for example, a riverside town) would conceivably be a public nuisance.

The Attorney General usually prosecutes public nuisances criminally although private prosecutions are possible (Linden, 1993). The Attorney General also usually brings civil proceedings with respect to a public nuisance. Private individuals may not usually bring such actions unless they suffered damages greater than the general public (Linden, 1993). There is a tendency for courts to consider public nuisance cases as if the obligation of the landowner causing the problem is to use reasonable care - essentially a question of negligence (Linden, 1993).

For the dam owner, releases which result in flooding or which restrict beneficial flooding may constitute a public nuisance if the releases are unreasonable. Theoretically, criminal prosecution and civil actions may result from such releases.

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20 Attorney-General v. PYA Quarries Ltd, [1957] 1 All E.R. 908 (CA)
21 AGBC ex. rel. Enton v. Haney Speedways Ltd. (1963), 39 DLR (2d) 48 (BCSC)
2.4.4.2 Private Nuisance

A private nuisance is the unreasonable interference with the use and enjoyment of a particular property. Actual damage must be caused. Liability continues for as long as the problem persists, regardless of the troublemaker's ability to stop or reduce it (Linden, 1993).

In an action for nuisance, the plaintiff must show unreasonable interference with the use and enjoyment of his or her property. In determining whether or not an action constitutes unreasonable interference, the court will weigh the gravity of the harm caused against the utility of the defendant's conduct (Linden, 1993). The gravity of harm is a function of the type and severity of the interference, its duration, the location of the affected land and its characteristics (whether it is, for example, a residential area, an industrial park, or a floodplain), and the sensitivity of the plaintiff's use of the land to the nuisance (Linden, 1993). The defendant's conduct is a function of the object or economic value of the activity causing the problem and the attitude of the defendant (Linden, 1993). Each of the components is discussed below.

2.4.4.2.1 Gravity of Harm

The defendant's interference with the plaintiff's property must be substantial. Inconvenience or minor discomfort is not sufficient to warrant a claim of nuisance. The harm or risk must be "greater than [the plaintiff] ought to be required to bear under the circumstances"\(^\text{22}\). Furthermore, the nuisance must be continuing or, if it occurs on only a single occasion, must be evidence of a dangerous situation (Linden, 1993).

\(^{22}\) Restatement of Torts, second, Comment G, p. 112
The character of the locale in which the nuisance occurs is also important as it determines the “appropriate standard of tolerance against which to measure the negligence” (Linden, 1993). What is a nuisance in a residential area may not be a nuisance in an industrial subdivision. Severe damage will often outweigh the impact of the locale on the court’s decision (Linden, 1993). Furthermore, and particularly significant on a floodplain, it does not matter that a nuisance predates the plaintiff’s arrival in the locale (Linden, 1993). Thus, a resident moving onto a floodplain does not accept the risk of flood nuisance simply because of the move.

Finally, the court will consider the plaintiff’s use of the property in question and may deny a remedy if it is a use that is unusually sensitive to the nuisance. This is so because the conduct of the dam owner need be governed only by the reactions of a normal person, not a particular land owner (Linden, 1993). Thus, a plaintiff with a particularly sensitive or delicate business is not entitled to damages if neighbouring businesses are not.

Floods, obviously, may cause significant harm to the land of floodplain residents and businesses. However, because dam owners are permitted at law to pass floodwaters over or around the dam, floods resulting from such passage will not usually constitute nuisances. A potential problem arises in the event that a spill for other than flood passage purposes (for example, to lower the reservoir rapidly for dam safety reasons) results in flooding. For such releases to constitute actionable nuisance, they would have to be of a continuing nature or be indicative of a dangerous situation at the dam such that similar releases may be required in the future. Although this scenario is unlikely, a poorly designed, built, or maintained dam may be cause for concern. In contrast with causing flooding, the Mikisew Cree action against BC Hydro described above claims that causing a

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21 Rattray v. Daniels (1959), 17 D.L.R. (2d) 134 (Alta CA)
reduction in flooding is a nuisance because the ecology of the affected area is thereby changed.

2.4.4.2 Utility of the Defendant’s Conduct

Fault on the part of the defendant is not an element of nuisance. Therefore, the conduct of the defendant need not be intentional or negligent (Linden, 1993). As a result, the question of reasonableness in nuisance is not the same as reasonableness in negligence (in which reasonableness is largely a question of foreseeability of harm). In nuisance, an activity is found to be unreasonable based upon the character and extent of the harm caused (Linden, 1993).

Once an activity is found to interfere with the property of another, the onus rests on the defendant to show that the use of his or her property was not unreasonable. In general, a landowner is entitled to reasonable use of his or her property, even if such use interferes with the neighbours. What constitutes reasonable use will vary with the circumstances. The nature of the defendant’s activity and its value to the community are factors to be considered in determining whether the defendant’s use was reasonable. However, such factors count for little if actual damage is done or a significant degree of inconvenience occurs (Linden, 1993). Thus, if power generation is perceived as having a greater value to society than irrigation, a hydroelectric utility may have greater latitude with respect to spills than a private irrigation dam owner.

2.4.4.2.3 Defences

Even if a dam owner is creating a nuisance, there may be one or more defences available that would prevent liability. These include legislative authority for the action giving rise to the nuisance, prescription (the right to carry out the activity because of long-standing practice), acquiescence by the floodplain resident or
business, unforeseeable acts of third parties such as sabotage, and, possibly, contributory negligence by the plaintiff.

2.4.4.2.3.1 Legislative Authority

"If a nuisance is the inevitable consequence of an activity which has been legislatively authorized, no action will lie"\(^{24}\). It is up to the defendant to show that the nuisance is inevitable given the exercise of all reasonable care in light of current scientific knowledge and practical feasibility\(^{25}\). This burden can be difficult to meet (Lucas and Franson, 1971) although it is possible in some circumstances. For example, in Ontario, flooding was caused by a dam built to regulate the level of Lake of the Woods\(^{26}\). The defence of legislative authority was upheld because federal and provincial statutes in accordance with an agreement with the US authorized the dam. The dam owner could not operate so as to prevent the flooding without breaching the international agreement (Lucas and Franson, 1971). Authorization to construct a project such as a dam includes the authorization to operate it\(^{27}\) although where a statute is merely permissive and the dam owner has discretion, that discretion must be exercised in strict conformity with private rights (Linden, 1993).

There are further limitations to this defence. If a dam owner exceeds the bounds of the relevant permit, there is no defence\(^{28}\). There is also no defence if there is no actual governmental authorization; a claim of benefit to the public at large is not

\(^{21}\) (1996) 4 Osgood Hall LJ 196

\(^{22}\) Manchester v. Fornworth, [1930] A.C. 171 (HL)

\(^{23}\) Brodie v. The King, (1946) Ex. 283; (1946) 4 D.L.R. 161

\(^{24}\) Allen v. Gulf Oil, [1981] 1 All E.R. 353 (HL)

\(^{25}\) Solloway v. Okanagan (1976), 71 D.L.R. (3d) 102 (BC)
sufficient (Linden, 1993). Also, neither negligent nor "unreasonable" behaviour will be protected\textsuperscript{29}.

Because all dams must be licenced under the Water Act, legislative authority exists for the use of a certain quantity of water for power generation and so for the inevitable consequences of that operation. However, that requires that reasonable care be exercised, including considering modern engineering and scientific knowledge (not unlike the requirements to avoid negligence). Proving that consequences are inevitable can be a heavy burden (Lucas and Franson, 1971).

2.4.4.2.3.2 Prescription

A prescriptive right to carry on a nuisance activity may be acquired if the activity has been carried on continuously, and been actionable, for at least 20 years (Linden, 1993). This means that the dam must have been constructed and flooding must have been occurring to the same or greater extent and volume for at least 20 years\textsuperscript{30}. The onus of proving this is on the dam owner. A dam owner should keep records of releases over the history of the dam as evidence to support a possible future defence of prescriptive right.

2.4.4.2.3.3 Acquiescence

Acquiescence requires overt consent or active encouragement of the defendant's activity\textsuperscript{31}. This has important implications for dam owners, particularly given the recent requirement to negotiate Water Use Plans to obtain new or amended water licences (see division 2.4.3.1). An Ontario court has held that a plaintiff who agrees to the construction of a dam forgoes the right to compensation for

\textsuperscript{29} Diversified v. R. (1982), 23 C.C.L.T. 156 (BCCA)

\textsuperscript{30} Fraser v. Vancouver, [1942] 3 D.L.R. 728 (BCCA)

\textsuperscript{31} McCallum v. Kent, [1943] 3 W.W.R. 489 (BCCA)
flooding. As Water Use Plans usually involve, at least peripherally, landowners and users of the floodplain, and as the Plans include specific agreements on some aspects of dam and reservoir operations, it is likely that express consent has been given to at least those releases contemplated by the Plan and, perhaps, to other releases as well.

2.4.4.2.3.4 Acts of Third Parties

A nuisance caused by a third party (not the owner or occupier of the land from which the nuisance originated) is still actionable unless the third party’s act was unforeseeable by the dam owner. For example, if children vandalize a dam, damaging a gate, which leads to flooding, the dam owner would not be liable unless the actions of the children were foreseeable. As third party acts with respect to dams are likely to be one-time events and nuisance must generally be an ongoing problem, it is unlikely that this defence is of much relevance to dam owners.

2.4.4.2.3.5 Contributory Negligence

It is not clear to what extent the acts of the plaintiff that contribute to the nuisance or exacerbate its effects are relevant to an action in nuisance (Linden, 1993). However, a BC court has held that where a nuisance by flooding was caused in part by the negligent failure of the plaintiff to warn the defendant of the danger, the plaintiff’s compensation should be reduced.

Note that simply moving to a floodplain, even if the mover is aware of the flood risk, does not constitute contributory negligence, at least as far as a claim in nuisance is concerned. Unless a dam owner has acquired a prescriptive right, a

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32 Pattison et al v. Prince Edward Region Conservation Authority, supra, n. 2
newcomer to the floodplain is entitled to reasonable and enjoyable use of the land, subject to the existing character of the neighbourhood (Linden, 1993). It should also be noted that *volenti non fit injuria*, or “voluntary assumption of risk”, is not a defence to nuisance.

2.4.4.2.4 Remedies

Dam owners should be acquainted with the potential consequences of an action constituting a nuisance and it is worthwhile at this point to briefly discuss the possible remedies available to a successful plaintiff in a nuisance action (as well as a negligence or strict liability suit). Plaintiffs may seek an injunction, damages, or both. Each of these is described below.

2.4.4.2.4.1 Injunction

An injunction is an equitable remedy (see division 2.3.1) granted on the basis of the court’s discretion. There are two types of injunctions: a “prohibitory injunction” requires the dam owner to refrain from carrying on a certain activity and a “mandatory injunction” directs the dam owner to do something to eliminate the nuisance. Injunctions are granted when the plaintiff shows that damages would not be an adequate remedy, usually because the nuisance will recur (Linden, 1993). Injunctions are only available if substantial injury has or will occur and the defendant claims the right to continue the offending conduct (Linden, 1993). Neither the public good (in the absence of legislative authorization) nor economic hardship to the defendant is likely to be a mitigating factor (Linden, 1993). Injunctions may be limited in scope and may apply controls to the nuisance or be accompanied by damages. The defendant is usually given time to abate the nuisance before the injunction takes effect (Linden, 1993).
2.4.4.2.4.2 Damages

Damages (a sum of money) are granted to the successful plaintiff if the injury or loss is adequately compensable in money or if an injunction would be too onerous for the defendant (Linden, 1993). The injury or loss suffered by the plaintiff need not be to person or land but could be for substantial interference with comfort, for commercial profits lost, as well as for loss or injury to personal property\(^\text{34}\) (Linden, 1993).

2.4.4.3 Summary

| Nuisance is an unreasonable interference with the use and enjoyment of land and entitles a successful plaintiff to an injunction or damages in compensation for losses. Nuisance requires a significant harm continuing over time or posing a real threat of serious harm. The defendant need not be negligent or act intentionally for a nuisance claim to succeed but the defendant's act must be unreasonable. A defendant will avoid some or all liability if he or she has statutory authority to create a nuisance, has acquired a prescriptive right to do so, has the consent of the plaintiff, is the victim of unforeseeable acts by third parties, or if the plaintiff negligently contributed to the problem. |

2.4.5 THE LAW OF NEGLIGENCE

Negligence is a tort with the primary purpose of compensating those whose injuries result from someone else's faulty conduct. An excellent list of the elements of negligence is given by Linden (1988):

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34 Personal property is property other than land or things affixed to land. Thus, a house is considered land but a car is personal property.
1. The plaintiff must suffer damage.

2. That damage must have been caused by the conduct of the defendant.

3. The defendant's conduct must have been in breach of the standard of care set by law.

4. The law must recognize a duty on the defendant to avoid causing such damage.

5. The defendant's conduct must be the proximate cause of the damage (that is, the damage must not be too remote or unlikely a result of the conduct).

6. The plaintiff must not have negligently contributed to the damage nor have voluntarily assumed the risk of damage.

This thesis considers each of these elements in turn from the point of view of the dam owner.

2.4.5.1 Damage

This is straightforward – the plaintiff must have suffered some loss or damage to property or injury to his or her person.

2.4.5.2 Causation

The defendant's conduct must cause the damage suffered by the plaintiff. Causation is determined using the "but for" test which holds that if the damage would not have occurred but for the defendant's action, then the conduct is a cause of the injury. Such causation must be shown on the balance of

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35 Joseph Brant Memorial Hospital v. Kozial (1977), 2 C.C.L.T. 170 (SCC)
36 Swanson Estate v. Canada (1991), 80 DLR (4th) 741 (Fed. CA)
probabilities – that is, the action was probably, not merely possibly, the cause (Linden, 1993). For example, consider a flood that damages property resulting in a claim by a floodplain resident that the dam owner's maintenance or operation was negligent. If the flood would have resulted in any event, the dam owner will not be liable as the maintenance or operation is not the cause of the damage. Causation may be inferred when common sense suggests it, even without strict scientific proof (Linden, 1993).

The requirement to prove causation is usually on the plaintiff but, if the defendant's conduct creates a risk which "is so unreasonable that injury is more likely than not"\(^{37}\), the onus may shift to the defendant to prove that the conduct was not the cause of the damage. This may apply in dam owner negligence cases where faulty design, construction, maintenance, or operation of the dam is claimed.

### 2.4.5.3 Standard of Care

Conduct is considered negligent if it breaches a standard of care fixed by law (Linden, 1993). The standard is always objective – it is the conduct expected of a fictional "reasonable or prudent person". However, who is a "reasonable or prudent person" varies with the defendant; for example, children are held to a different standard than adults and unskilled labourers to a different standard than professionals (Linden, 1993). Whether or not a person meets a standard of care depends upon the reasonableness of their actions and the knowledge they should possess about the possible consequences of their actions. Each of these components is examined below.

\(^{37}\) Nowsco Well Service Ltd. v. Canadian Propane Gas and Oil Ltd. (1981), 16 C.C.L.T. 23 (Sask. CA)
2.4.5.3.1 Unreasonable Risk of Harm

Whether or not the defendant’s conduct was that of the reasonable person depends on a number of factors. Firstly, it must not create an unreasonable risk of harm. The key here is not that the conduct be risk-free, but that it not create an unreasonable risk. In determining whether a risk is unreasonable or not, the court essentially employs a cost-benefit analysis, weighing the danger created against the social utility of the conduct. If the social value of the defendant’s conduct (for example, the operation of a dam) exceeds the damage caused, the defendant may be exonerated (Linden, 1993). The risk is the product of the probability of harm and the consequences or gravity of the harm. The social value is a function of the purpose of the conduct and the cost to the defendant to eliminate the risk. The relationship between risk and social value would be represented mathematically as:

\[ \text{risk} \leq \text{social value} \]  

or, in its component parts:

\[ \text{probability} \times \text{consequences} \leq f(\text{purpose}, $) \]  

In some US jurisdictions, this formula, excluding the purpose component of social value (not easily quantifiable), is actually used by the courts as part of a more typical cost-benefit analysis\(^{38}\). Each of the component parts of equation [2.2] is described below.

2.4.5.3.1.1 Probability

The probability of harm need not be on the order of “more likely to happen than not”, there need only be a substantial possibility of harm (Linden, 1993). For example, considering equation [2.2] one can see that a small probability might

\(^{38}\) *United States v. Carroll Towing Company*, 159 F. 2d 169 (2nd Cir. 1947)
result in a particular action being found unreasonable if, for example, the consequences are high or the cost to avoid the damage is low. Some examples may be useful to demonstrate this. In an Ontario case, a 12 year old was injured while crossing a 300-foot long, small diameter pipe suspended over a ravine. Barricades and warning signs protected the ends of the pipe. The pipe's owner was not found negligent because, given the measures taken to prevent access to the pipe, the probability of such harm occurring was very small\textsuperscript{39}. On the other hand, when a child on a busy footbridge was injured by an uninsulated wire located only inches from the bridge, the probability of harm was high enough to find liability\textsuperscript{40}.

2.4.5.3.1.2 Consequences

This is a straightforward assessment of the gravity of harm. Obviously, the more severe the potential consequences, the greater the risk of liability. As many dams are situated above developed floodplains, the potential consequences are significant. Indeed, the CDA Dam Safety Guidelines classify dams based upon the potential consequences of failure. Consequences include "impacts in the downstream as well as upstream areas of a dam", including loss of life, and socioeconomic, financial, and environmental effects (CDA (1), 1999).

2.4.5.3.1.3 Purpose

A high social value (the right side of equation [2.2]), of which purpose is one component, may overcome even substantial risk of loss and severe damage (Linden, 1993). For example, the Police are not held liable for damage caused

\textsuperscript{39} Shilson v. Northern Ontario Light and Power Company (1919), 15 S.C.R. 443

\textsuperscript{40} Glaster v. Toronto Electric Light Co. (1906), 38 SCR 27
during high-speed chases\footnote{Priestman \textit{v. Colangelo and Smythson}, [1959] S.C.R. 615, 19 D.L.R. (2d) 1} because of a perceived high social value to catching dangerous drivers.

\subsection*{2.4.5.3.1.4 Cost}

The lower the cost to the defendant to prevent damage, the greater the likelihood of liability being found (Linden, 1993). However, there are limits to the cost a defendant must incur. For example, public safety cannot justify requiring a railroad to build an overpass at every level crossing (Linden, 1993). This is essentially the cost component of a cost-benefit analysis.

\subsection*{2.4.5.3.2 The Knowledge of the Reasonable or Prudent Person}

A second component of the reasonable or prudent person analysis is the knowledge imputed to that fictional person. Professionals such as engineers are held to a standard of average competence. A Manitoba court indicated that engineers must meet the standard of:

"... discharge of skill consistent with the function discharged, that is, consistent with the measure of skill displayed by others reasonably competent in that profession touching matters of like kind. Perfection is not expected; the world of work, not the ideal of the debating area, is the standard"\footnote{Trident Construction \textit{v. W.L. Wardrop \& Assoc. Ltd.}, [1979] 6 W.W.R. 481 (Man. QB)}.

Note also that the reasonable person, even if not a professional, is expected to know when it is necessary to hire professionals to provide expert advice (Linden, 1993).
Thus, a dam owner is expected to meet the standards of a reasonably competent dam owner. In the case of a farmer with a dam designed to provide irrigation water, the owner would be expected to employ professional engineers to design, oversee construction, and advise on maintenance of the dam. In the case of a hydroelectric utility, the owner would be expected to meet the standards of reasonably competent hydrotechnical, structural, geotechnical, and other professional engineers.

The superior knowledge attributed to a dam owner also imposes an extra burden as he or she is expected to act reasonably as a result (Linden, 1993). For example, a person aware of danger has a duty to warn the appropriate people or agencies. Thus, a dam owner aware of the impending need to spill may have a duty to warn.

2.4.5.3.3 Customary Behaviour

To assist in determining the appropriate standard of care for the reasonable person, the courts consider customary behaviour.

2.4.5.3.3.1 Is Meeting the Industry Standard Enough?

If a defendant follows the industry custom, the court will usually find that the defendant's conduct meets the standard of care. However, the industry custom is not always acceptable because the existence of unreasonable customary practices does not reduce the duty of care. In a competitive environment such as that arguably likely to arise in the future of the electrical generation industry, there are economic factors which may impede the adoption of safer design, construction, maintenance, operation and other approaches, even if they are available and of reasonable cost. Nevertheless, "conformity to common practice in any given

43 Modern Livestock Ltd. v. Elgersma (1989), 50 CCLT 5 (Alta QB)
circumstances is *prima facie* evidence that the proper standard of care is being taken. However, blind reliance on such standards when the dam owner knows or reasonably ought to know that a higher standard is appropriate will not protect the owner (Binder, 1992). In the final analysis, the only real test for reasonableness is that of the reasonable or prudent man considering the foreseeability of the risk (Binder, 1992).

2.4.5.3.3.2 *Evolving Custom*

The rise of "new" approaches is significant for dam owners because the new approach may render the current custom a less than satisfactory standard of care. New precautions greater than those customarily in use must be adopted if it would be "unreasonable and imprudent" not to adopt them. Dam owners must be alert for new developments that change significantly the factors in equation [2.2].

2.4.5.3.3 *Failure to Meet the Industry Standard*

Failure to meet industry standards will likely result in liability although this is not necessarily so (Linden, 1993). For a defendant, it is difficult to argue that a standard to which most in the industry comply is economically unfeasible. Dam owners must also be careful not to fail to meet their own internal corporate standards as such failure is usually seen as damning by the courts (Linden, 1993).

2.4.5.3.3.4 *What Custom is Appropriate?*

A further question of concern for dam owners is: What custom should be followed? What if worldwide standards are different than Canadian standards? It

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is quite definite that one need follow only Canadian custom and, perhaps, only the custom in BC. Furthermore, the appropriate custom is the one in effect at the time of the act. For example, changes in hydrologic forecasting techniques would not render a dam owner liable for damages flowing from decisions made prior to the availability of those techniques. However, decisions made after that availability must incorporate those techniques or negligence may lie. For example, building a dam to meet current design standards is expected. But, should standards change, the dam owner may also need to upgrade the facilities. As an illustration, consider the following fact situation:

- Person A builds a dam in 1970 according to prevailing standards.
- In 1980 a flood damages Person B’s property.
- In 1981 new dam design standards suggest that the dam is now considered underdesigned.
- In 1982 B sues.

Because B is suing for damage that occurred prior to the new 1981 standard, A will not be held to that higher standard. If the flood had caused the damage in 1985, A would likely be held to the 1981 standard because he had time to effect necessary upgrades.

Making decisions to incorporate new technologies is not easy. It is not enough for a plaintiff to demonstrate that the custom followed by the defendant might have been made safer by another approach or that safety devices were available. The plaintiff must show that the custom is negligent.

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48 Hauck v. Dixon (1976), 10 O.R. (2d) 605 (HC)
49 London and Lancashire Guanantee and Accident Co. of Canada v. La Cie F.X. Drolet, [1944] S.C.R. 83
With respect to dams, the CDA’s Dam Safety Guidelines are an obvious source of custom. The Dam Safety Guidelines are an industry standard certain to carry weight with a court, particularly as the guidelines are updated to conform to new technologies and social obligations (such as emergency planning). Owners of dams to which the Dam Safety Guidelines apply would be wise to meet or exceed the standards contained therein.

2.4.5.3.4 Statutes and Government Policy

Another source of guidance to determine the appropriate standard of care is relevant statutes (such as the Water Act), regulations (such as the Dam Safety Regulation), and government policies. Breach of statutory provisions does not in itself constitute negligence but courts may look to statutes to determine if they contain a useful standard of care. Whether or not a court considers a statutory duty of care in deciding the outcome of a civil suit for negligence is in the court’s discretion. Of course, in a prosecution against a dam owner for violation of the statute, the legislated duty of care will apply. Government policies may also be considered by a court in trying to determine a reasonable standard of care.

Some of the legislation discussed above under “Current Legislation and Regulatory Requirements in British Columbia” (division 2.4.3) includes prescribed standards of care in certain situations. Section 21 of the Water Act requires a dam owner to “exercise reasonable care to avoid damaging land, works, trees, or other property” and to compensate victims of damage arising in connection with the dam and its operations. Section 6 of the Dam Safety Regulation specifies certain actions to be

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51 Ware’s Taxi Ltd. v. Gilliham, [1949] S.C.R. 637

52 James St. Hardware & Furniture Co. v. Spirzziri (1985), 51 O.R. (2d) 641


undertaken in an emergency involving a dam, including requiring the dam to be operated in a manner "that will safeguard the public, minimize damage to public infrastructure, property and works, including that not owned by a person responsible for a dam, and the environment".

Dam owners should also be aware that industry standards can become part of the statutory law by being incorporated into legislation or regulations or by being made conditions of licences, permits, or approvals. They are also of significance in obtaining financing or insurance and become benchmarks against which dam owners are judged by customers and the public (BC Hydro (5), 1999).

2.4.5.3.5 Due Diligence

Efforts by a person to meet the reasonable standard of care are often referred to as "due diligence". Division 2.4.3.5 includes a discussion of some practical aspects of meeting a due diligence standard.

2.4.5.4 Duty

No matter how negligent conduct may be, a defendant will not be held liable if no duty to take care is owed to the plaintiff (Linden, 1993). Whether a dam owner owes duty or not is a question of law, not fact, and therefore cannot be determined by a jury but only by a judge.

Courts generally find a duty to take reasonable care of "persons who are so closely and directly affected by [the] act that [the actor] ought reasonably to have them in contemplation as being so affected when [the actor is] directing [his] mind to the acts or omissions which are called in question"55. The Nova Scotia Court of Appeal framed it this way: "... there is such a duty only where the circumstances

of time, place and person would create in the mind of a reasonable man in those circumstances such a probability of harm resulting to other persons as to require him to take care to avert that probable result. In other words, there will be a duty to act when some reasonably foreseeable harm could arise from an act or an omission to act (Linden, 1993).

One type of duty that is particularly interesting for dam owners is that related to rescue. Does a dam owner have any responsibility to aid in rescuing floodplain residents if the owner negligently causes a flood? Generally, the law imposes no duty to lend aid to others in distress (Linden, 1993) but, where a person negligently places another at risk, there may be an obligation to lend assistance.

The issue of duty also arises with the adoption by a dam owner of an emergency preparedness plan (an EPP). The Dam Safety Regulation and government policies relating to water licences require many dam owners to prepare an EPP, particularly regarding failure of the dam. As a result, many dam owners will be actively involved in preparing such plans. Even the voluntary creation of an EPP may impose a duty on the dam owner to properly maintain and execute it. In general, a gratuitous promise to render aid does not amount to a duty to do so but, if people have come to rely upon some form of aid (for example, gratuitously warning people of high spillway releases), a duty to render such aid can arise (Linden, 1993). A US court has held that “if a defendant undertakes a task, even if under no duty to undertake it, the defendant must not omit to do what an ordinary man would do in performing the task”.

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56 Nova Mink v. Trans-Canada Airlines, [1951] 2 D.L.R. 241 (NSCA)
57 Northern Central Ry. Co. v. State (1868) 29 Md. 420
58 Zelenko v. Gimbel Bros. (1935), 287 N.Y.S. 134
The law in Canada is probably the same but the waters are somewhat muddied by an old Ontario case involving the City of Toronto. The city erected a gate to block access to a railway track crossing and usually closed the gate when a train was nearing. The City failed to close the gate on at least one occasion and a train struck a person. The court found that the City had no duty to keep the gate closed as operating the gate was a gratuitous undertaking. However, a few years later in Great Britain, a court held that where a railway company erected a similar gate, the railway "ought ... to have contemplated that if a self-imposed duty is ordinarily performed, those who know of it will draw an inference if on a given occasion it is not performed. If [the railway company wishes] to protect themselves against [that] inference being drawn they should do so by giving notice ...". The Supreme Court of Canada has put Canadian law back in line with the US and Great Britain, at least with respect to safety undertakings by the Crown. In one case, the federal government negligently allowed shipping navigation lights to shift location, leading to a collision. The court found that ships were entitled to rely upon the lights. In a case more directly relevant to a dam owner, a person was drowned in a boating accident after the boat went over falls created by works owned by the Crown. The Crown had placed a warning sign upriver but the sign had been knocked over and not repaired or replaced. The court held the Crown liable, in part, for failure to replace the sign.

In a water resources example from New Zealand, the plaintiffs applied for a building permit on a floodplain. The County Council had a habit of referring

59 Soulsby v. City of Toronto (1907), 15 O.L.R. 15
60 Mercer v. South Eastern & Chatham Railway Co., [1922] 2 K.B. 549
such requests to the Drainage Board, which usually advised whether there was a risk of flooding. In this case, the request was referred to the Board but no warning of the flood hazard was given. A permit was issued, a house constructed, and damage incurred in a subsequent flood. The court found that the Board had a statutory duty to approve plumbing and sewage proposals only. However, the Board, by its practice of advising the Council on flooding issues, had assumed a duty to provide such information.

Dam owners, therefore, must recognize that when they adopt EPPs or undertake to warn the public of hazards such as rapidly rising water, whether they do so gratuitously or by statutory requirement, they have a duty to make all reasonable efforts to carry out those responsibilities. This is particularly true for the government and Crown corporations such as BC Hydro.

An additional burden of duty may be placed on the Crown and Crown Corporations by statutory requirements. As noted above, gratuitous actions by the government, such as placing warning signs, can create a duty to maintain those actions. What about other government decisions? The courts tend to impose a duty on the government with respect to “operational, administrative, and business” decisions but not for “planning, discretionary, or policy” decisions (Linden, 1993). It is difficult to forecast the results of a specific situation however. For example, is a particular decision by BC Hydro regarding reservoir management an operational or a planning decision? The result depends upon the circumstances of each case although in BC the courts have provided some guidance:


dam

\[\text{Hill v. Vernon (1989), 43 M.P.L.R. 177 (BCSC)}\]
1. If the decision involves planning it could be said to be a policy decision. “Planning” in this sense is likely strategic, not operational, planning. Thus, reservoir operation planning is probably an operational decision.

2. A policy decision involves allocating resources and balancing factors such as efficiency or thrift.

3. The greater the discretion conferred on the decision making body, the more likely the decision made will be a matter of policy.

4. The setting of a standard is a policy function but implementation of the policy is an operational function.

5. Note that decisions made in the field may be policy decisions because policy making is often delegated to those who deal with problems on a daily basis.

2.4.5.5 Remoteness of Damage and Proximate Cause

A defendant, even if its actions are negligent, will not be liable unless the conduct in question is the “proximate” cause of the plaintiff’s loss. This means that the loss must not be too remote a consequence of the defendant’s action (Linden, 1993). For example, if a dam owner negligently causes a flood which damages a car which subsequently rusts which, in turn, leads to failure of the steering and a traffic accident, is the dam owner liable or are the mechanical failure and resulting traffic accident too remote a consequence of the flood?

This is an interesting area of the law of negligence that has gone through significant changes in recent years. In the early 1960’s the position was that if a
reasonable man could foresee the loss in question occurring as a result of his actions, then the damage was not too remote\textsuperscript{65}. For example, if it was reasonable to foresee the entire flood-rust-traffic accident chain from the example above, the damage was not too remote. The courts have retreated somewhat from this position (Linden, 1993). In 1963, a British court held that the reasonable man need not foresee the exact way in which damage would be caused but need only anticipate the general type of consequence\textsuperscript{66} (for example, a flood leading to traffic accidents). The Supreme Court of Canada has said that it is "enough to fix liability if one can foresee in a general way the class or character of injury which occurred"\textsuperscript{67}. Later, the courts retreated even further and held that liability may be imposed for losses that were not necessarily foreseeable but for which there was a possibility or real risk of damage\textsuperscript{68}. In other words, the test for remoteness became whether or not a reasonable man would realize that there was a real risk of damage from his actions or omissions (Linden, 1993)?

There is still debate over what constitutes a real risk but medical malpractice suits provide some guidance. In a BC case, a risk of fatality of 1 in 50,000 from a particular medical procedure was held to be a real risk that should be in the mind of a reasonable doctor\textsuperscript{69}. This suggests that very extreme precipitation events should be in the mind of a reasonable dam owner.

Other aspects of remoteness are also of concern to dam owners. One such concern is the "thin-skull problem". If a victim is particularly susceptible to a

\textsuperscript{65} Overseas Tankship (UK) Ltd. v. Mort's Dock & Engineering Co., [1961] A.C. 388 (PC) (this famous case is more commonly known as The Wagon Mound (No. 1))


\textsuperscript{67} R. v. Cote (1974), 51 D.L.R. (3d) 244 (SCC)


particular act, should the reasonable man be accountable for injury to such a person when a "normal" person would have suffered no injury? The term "thin-skull" comes from assault cases where a fist fight resulted in significant injury to one of the parties because of a weaker than normal jaw. A poorly built structure on a floodplain subject to frequent flooding might be a water resources example of a "thin-skull" plaintiff.

In nuisance, discussed in division 2.4.4, a particular susceptibility does not entitle a plaintiff to recover for his or her losses; the defendant is entitled to consider the "average" community in determining his or her actions. However, with respect to negligent acts, this does not apply. The negligent party must take the victim as found, unique sensitivities and all. Thus, persons suffering unique damage during a flood may be able to recover damages in negligence that they would not be able to recover in a claim for nuisance. Negligent acts therefore potentially expose the dam owner to greater liability than a nuisance.

Another area of potential liability exposure is to third party rescuers during a flood. In general, a negligent wrongdoer is liable to reimburse rescuers for losses incurred during rescue efforts (Linden, 1993). Indeed, persons trying to save their own property during a flood can sue if injured while doing so70. A BC court has held that this applies to any property and that it applies even if the rescuer voluntarily assumed risk of injury71. However, rescuers are only entitled to recover if they reasonably perceive danger to persons or property and if they are not foolhardy or negligent (Linden, 1993). Rescuers acting in the heat of the

70 Hutterly v. Imperial Oil Co. Ltd. and Calder (1956), 3 D.L.R. (2d) 719.
moment are expected to be no more than reasonable persons acting in the same
heat of the moment (Linden, 1993).

2.4.5.6 Contributory Negligence

The liability of the defendant for a negligent act may be reduced (or perhaps
eliminated) if the plaintiff was also guilty of negligence and so is partly responsible
for the loss. Contributory negligence provides a partial defence to a negligence
claim and reduces the amount to which the plaintiff is entitled in proportion to
the plaintiff's fault. For example, if the plaintiff received ample warning that an
impeding flood would inundate his house and he was capable of moving
possessions to safe ground but chose to do nothing, his own negligence would
reduce the dam owner's liability for damage to those possessions.

2.4.5.7 Liability for Negligent Statements

Although this is usually an issue for professionals (such as engineers) giving advice
to clients, it may also apply to statements given by dam owners, particularly
corporate owners. For example, negligent statements may be made in an EPP or a
Water Use Plan. A duty to use reasonable care in giving advice or in making
other statements arises because the speaker knows, or ought to know, that others
will act on the faith of an accurate statement. The requirements for a negligent
statement are:

1. there must be a “special relationship” between the dam owner and the
   plaintiff;

2. the representation must be “untrue, inaccurate, or misleading”;

3. the dam owner must have acted negligently in making the representation; and

4. the plaintiff must have reasonably relied on the representation to his or her detriment.

Governments have been held liable for giving negligent advice on “administrative, ministerial, and business issues” but not for “legislative or quasi-judicial duties.” Exercise of operational powers with a degree of discretion will attract liability but making policy decisions will not. However, as pointed out with respect to duty (division 2.4.5.4), determining which category a particular decision or advice falls into can be difficult.

Corporate dam owners or professional owners must be particularly conscious of statements made, for example in EPP or Water Use Plan discussions, to avoid making negligent statements. Corporations may be held to have the knowledge of engineering or other professionals. Crown corporations such as BC Hydro must be additionally careful as statements made by them may be treated in the same manner as statements made by the government.

2.4.5.8 Defences to Negligence

Although the defendant may have acted negligently, there are three situations that may prevent or reduce the defendant’s liability. These three are: contributory

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negligence by the plaintiff, voluntary assumption of risk by the plaintiff, and illegal actions by the plaintiff.

2.4.5.8.1 Contributory Negligence

As described in division 2.4.5.6, negligence on the part of the plaintiff that contributes to the loss will reduce the defendant's liability in proportion to the plaintiff's fault. See division 2.4.5.6 for an example.

2.4.5.8.2 Voluntary Assumption of Risk

An obvious potential use of this defence is to argue that by residing on a floodplain, the plaintiff has put him or herself at risk and must bear the consequences of that decision. Voluntary assumption of risk requires an agreement on the part of the plaintiff to exempt the defendant from liability. That agreement may be express or it may be implied but mere knowledge of the danger is not implied agreement. The plaintiff taking the risk of injury or property loss is not enough to create implied agreement – there must be an express or an implied agreement to waive any claim for negligence. Under these restrictions it is unlikely that a floodplain resident will be considered to have assumed the risk of dam owner negligence. However, as was discussed above under “The Law of Nuisance”, division 2.4.4, it may be possible to argue that those who participate in creating a Water Use Plan have given implied consent to flooding if the Plan deals with flood risk. It would be prudent for dam owners to include some form of waiver of rights to claim for negligence in Water Use Plans. Although the other parties are not likely to agree to any form of express consent, it may be possible to

78 Ibid, n. 77.
include language which implies consent or at least indicates something beyond mere understanding of the risks.

2.4.5.8.3 Illegal Activity

Plaintiffs suffering loss while engaged in illegal activity may be denied recovery (Linden, 1993). This is of possible interest to dam owners when faced with a claim, for example, by children illegally playing in a river and trapped by rising water or by a fisherman engaged in illegal fishing.

2.4.5.9 Remedies

See division 2.4.4.2.4 for a discussion of the remedies that may be sought by a plaintiff in a negligence suit.
2.4.5.10 Summary

The tort of negligence compensates a plaintiff for the dam owner's faulty conduct. For the conduct to be negligent the following criteria must be met:

1. The plaintiff must suffer damage caused by the dam owner's conduct.

2. The dam owner's conduct must be in breach of the standard of care that a reasonable or prudent person would exercise in the same circumstances given the foreseeability of the risk. In short, the dam owner must not create an unreasonable risk of harm. An unreasonable risk is one in which the probability of harm multiplied by the consequences of the conduct exceeds the social purpose or benefit of the dam and the cost to the dam owner to avoid the risk. Courts often look to industry or legislated standards to determine the minimum standard of care.

3. The dam owner must owe a duty of care towards the plaintiff. A duty is owed when harm to the plaintiff as a result of the dam owner's conduct is reasonably foreseeable or if the dam owner has created an expectation of duty in the mind of the plaintiff.

4. The damage suffered by the plaintiff must not be too remote a consequence of the dam owner's conduct. Damage is not too remote if a reasonable person would realize there is a real risk of damage from his or her conduct.

5. The dam owner has no defence to the claim, including contributory negligence by the plaintiff, an assumption of risk by the plaintiff, or illegal activity on the part of the plaintiff.
2.4.6 THE LAW OF STRICT LIABILITY (THE RULE IN RYLANDS V. FLETCHER)

2.4.6.1 Introduction

The field of strict liability imposes onerous obligations on dam owners. Strict liability requires that people compensate others for injury or damage inflicted, even in the absence of intention and negligence. In that way it is like nuisance but the act causing the harm need not be continuous. In essence, a defendant is liable for damage resulting from an unduly dangerous thing or activity inappropriate to the location (Binder, 1992).

Strict liability is based on Rylands v. Fletcher\textsuperscript{79}, an English court decision of 1868 and is often referred to as “the Rule in Rylands v. Fletcher” (probably a better name as the phrase “strict liability” also refers to a type of criminal offence (see division 2.4.3.5)). The defendant constructed a reservoir but, unbeknownst to him, it was underlain by abandoned mining tunnels. The full reservoir collapsed the tunnels allowing the water to flow through the abandoned tunnels into the plaintiff’s operating mine. The defendant had neither intentionally nor negligently caused the problem but was found liable because he brought onto and collected on his land a thing likely to “do mischief if it escapes”\textsuperscript{80}. Persons who do so must keep the thing (water in this case) under control. Should the water escape, the defendant is assumed liable for all the “damage which is the natural consequence of [the] escape”\textsuperscript{81}.

The Rylands case essentially established a new cause of action. It required that the defendant make a “non-natural” use of land and that the there be an escape of the

\textsuperscript{79} (1868) L.R. 3 H.L. 330; affg (1866) L.R. 1 Ex. 265.

\textsuperscript{80} Ibid, n. 79.

\textsuperscript{81} Ibid, n. 79.
collected material (Linden, 1993). “Natural” has subsequently been interpreted as a common or ordinary use of land rather than land in its “state of nature”, untouched by humans (Linden, 1993). A “non-natural” use is therefore a special, exceptional, or unusual use (Linden, 1993). The requirement that the water escape has come to be of little significance (Linden, 1993).

Strict liability today applies primarily to “ultrahazardous activities where risk of harm and magnitude of consequences are high” (Binder, 1992). But it is not applied to some hazardous activities, such as driving automobiles, which are widely undertaken (Binder, 1992).

Perhaps the most significant water resources case adopting *Rylands v. Fletcher* is *Greenock Corporation v. Caledonian Railway*. Although that English suit deals with the obstruction of a stream, not a dam, the decision spells out quite clearly the onus on a dam owner. The Greenock municipal corporation constructed a streamside park, including a children’s wading pool. The streambed was realigned and channeled in part through an inadequately sized culvert. Rainfall of “extraordinary violence” led to flood damage to the railway’s property. In an oft-quoted statement, one of the judges said:

“It is the duty of anyone who interferes with the course of a stream to see that the works which he substitutes for the channel provided by nature are adequate to carry off the water brought down even by extraordinary rainfall, and if damage results from the deficiency of the substitute which he has provided for the natural channel he will be liable.”

---

82 [1917] AC 556 (HL).
A second judge framed the dam owner's obligation as follows:

“A person making an operation for collecting and damming up the water of a stream must so work as to make [downstream residents] as secure against injury as they would have been had nature not been interfered with. And this is so although the water accumulated suddenly, or the fall was extraordinary or even unprecedented in quantity.”

Dams have been a popular source of strict liability cases. The Rule in Ryland v. Fletcher has been used to hold at least one dam owner in BC liable for escaping water. In *Kelley v. Canadian Northern Railway Company*, the defendant railroad owned a dam for the purpose of impounding water for its locomotives. A short distance downstream of the dam was a railway bridge also owned by the defendant. A delayed snowmelt, coupled with a deep snowpack and heavy rain, resulted in floods that blocked the dam spillway with debris. Fearing for the safety of the bridge if the debris were cleared and allowed to travel downstream, the defendant delayed taking action until the dam and portions of its abutments were overtopped. The combination of rising waters and increased erosion damaged Kelley’s property. The railway was held strictly liable for the damage.

In another water resources case, dykes on the defendant’s land protected both his property and the plaintiff’s from tidally induced fluctuations in river levels. The defendant breached the dyke to make improvements in an “aboiteaux”, a gate permitting a creek to outflow into the river but preventing inflow of river water. The opening allowed the land to flood for 2 weeks. The flooding either directly

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81 *Supra*, n. 9.

affected the plaintiff's land or blocked drainage of fresh water from the land, causing damage (it is unclear from the facts which occurred). The rule in Rylands v. Fletcher was found to be applicable and the defendant was held liable for the plaintiff's losses.

2.4.6.2 Defences to Strict Liability

As with the other tort causes of action discussed in this thesis, there are defences available in strict liability situations which, if applicable, save an otherwise liable defendant. They include consent of the plaintiff, default of the plaintiff, acts of God, deliberate acts of third parties, and legislative authority.

2.4.6.2.1 Consent

Express consent or implied consent of the plaintiff to the release or escape of water is a complete defence to a claim under the Rule in Rylands v. Fletcher (Linden, 1993). Establishing implied consent can be difficult and usually requires that there be some benefit accruing to the plaintiff because of the defendant's dam. For example, a tenant consents to the non-negligent escape of water collected by the landlord for the tenant's benefit. Similarly, if someone rents property near a quarry, they consent to damage arising from its normal operation in the absence of negligence. These cases suggest that there may be some argument that floodplain residents implicitly consent to the risk of non-negligent flooding, particularly if the dam benefits them. It is likely that most dams could be said to benefit residents as the dam provides some measure of flood control and may provide electricity, irrigation water, or other benefits. However, cases such as

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85 Carstairs v. Taylor (1871), L.R. 6 Ex. 217.
86 Thomas v. Lewis, [1937] 1 All E.R. 137.
Kelley suggest that merely living next door to a dam is not an implied consent to flooding.

In Pattison\textsuperscript{87}, a floodplain resident had taken pains to construct buildings at elevations above the peak level of an historic flood. This was found to be implied consent to floods with peak stage below that level. In that case, the dam owner had also succeeded in obtaining express written consent to the dam’s construction and operation.

2.4.6.2.2 Default of the Plaintiff

By alleging default of the plaintiff, the defendant is essentially claiming that the plaintiff was contributorily negligent (Linden, 1993). Like nuisance, but unlike negligence, the “thin-skull” rule does not apply and plaintiffs who are particularly sensitive to water damage may not be compensated. For example, no compensation was granted where the plaintiff’s mineshaft undermined the defendant’s canal, leading to a collapse and the flooding of the shaft\textsuperscript{88} because it was the plaintiff’s tunneling that caused the problem.

2.4.6.2.3 Act of God

When claiming act of God, the defendant argues that the loss was not due to his or her actions but due to an unforeseeable natural event such as an earthquake or an extreme rainfall event. This defence only applies to truly extraordinary events that cannot be foreseen (Linden, 1993). It is difficult to succeed with this defence, particularly given advancing scientific knowledge. Chapter 3 examines this issue in more detail.

\textsuperscript{87} Pattison et al v. Prince Edward Region Conservation Authority, supra, n. 2.

\textsuperscript{88} Dunn v. Birmingham Canal (1872) L.R. 7 Q.B. 244; aff’d L.R. 8 Q.B. 42 (Ex.Ch.).
2.4.6.2.4 Deliberate Act of a Third Party

Such things as sabotage will negate strict liability but not if such acts were foreseeable or could have been prevented by the defendant. Note that employees and contractors are not considered third parties (Linden, 1993).

2.4.6.2.5 Legislative Authority

Carrying on an activity authorized by the government may protect a defendant from the Rule in Rylands v. Fletcher provided that the harm arose as a necessary or inevitable result of the activity and provided that the harm could not have been prevented (Linden, 1993). If there was another way of doing things, the courts may well find the defendant strictly liable. This defence may be applicable to some floods but hindsight is likely to illustrate that options existed when decisions were made and that a different choice may have prevented damage. For more detail on this defence, review division 2.4.4.2.3.1.

2.4.6.3 Remedies

See division 2.4.4.2.4 for a discussion of the remedies likely to be sought by a plaintiff seeking redress by the Rule in Rylands v. Fletcher.

2.4.6.4 Summary

The Rule in Rylands v. Fletcher, also known as strict liability, holds a dam owner liable for ultrahazardous activities where the risk of harm and possible consequences are high. If impounded water causes harm, even if the dam owner was not negligent and did not intend to cause harm, he or she may be liable. Defences include the consent of the plaintiff to the dam, contributory negligence by the plaintiff, act of God, deliberate act of a third party, and legislative authorization of the dam.
2.4.7 BC HYDRO

The legal liability situation of BC Hydro, a Crown corporation owned by the Province, is significantly different than that of other dam owners. The corporation was created by its own statute, the Hydro and Power Authority Act, which confers certain immunities on the company. This is not unusual as the Crown has traditionally enjoyed immunity from most prosecutions and suits. By section 31 of the Hydro and Power Authority Act, BC Hydro cannot be found liable for nuisance or pursuant to the Rule in Rylands v. Fletcher unless its actions are negligent (BC Hydro (4), 1999). BC Hydro may be liable for other torts (section 30) and can be sued for damages but, perhaps, not for an injunction.

2.4.8 FLOODS

Floods in BC are generally one of the following three types (NRCC, 1989):

1. Spring snowmelt floods that occur in May through July, usually as a result of a deep snowpack and high temperatures.

2. Autumn and winter rains and rain-on-snow floods, usually following a period of cold temperature in early winter that extends a thin snowpack to lower elevations. A saturated warm front causes freezing levels to retreat to higher elevations, allowing condensation melt to add to the runoff. Such events are usually limited to the coastal and near-coastal areas of the Province.

3. Summer rain floods resulting from heavy rain, often with a snowmelt component. Such floods usually occur in smaller basins.
Floods may also be caused by ice-jams, rapid glacial melt, glacial lake outbursts, debris torrents, and failures of beaver and other dams.

Floods are probably the most dramatic source of potential liability for dam owners. In the ordinary course of dam operations by a prudent dam owner, liability is likely a risk only for a flood resulting from a dam failure although liability can be found in operational situations as well. For example, an Ontario dam owner was liable in negligence when the dam operator failed to open a spillway in time to prevent flooding.\(^{89}\)

In general, a dam owner is entitled to pass the natural flow of the watercourse but will attract liability if the dam or its operation makes the flood worse by, for example, releasing more than the natural flow. This is so because, if the natural flood is passed, the dam has not made the lot of the floodplain resident worse than it would naturally be. Of course, at common law, the riparian dam owner is entitled to have the natural flow pass from his or her property. Note, however, that this right may be modified by express provision in a water licence (requiring flood control or other operational measures) or in a Water Use Plan.

A dam owner may be exposed to liability by releasing more than the natural flow. This might occur because (1) a dam safety emergency requires rapid lowering of the reservoir; or (2) the reservoir receives not only the inflow from the watershed in which the dam is located but also receives waters diverted from another watershed. This latter problem is not likely to be a risk with projects commenced after 1995 because the Water Protection Act of BC\(^{91}\) prohibits the issuance of water licenses for such purposes.

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\(^{89}\) *Robinson v. Heplett*, [1939] 1 D.L.R. 783 (OSC)

\(^{90}\) See *Greenock*, supra, n. 82; *Smith v. Ontario & Minnesota Power Co. Limited* (1918), 44 OLR 43 (OCA); and *McCready v. Gananoque Water Power Co.* (1902), 1 OWR 438 (OCA)

licences to “construct or operate a large scale project [one designed to divert or extract a peak instantaneous flow of 10 m$^3$ or more a second (section 1(1))] capable of transferring water from one major watershed to another” (section 7(1)(c)). However, many watershed diversion projects predate that Act and the owners of such projects should take care to avoid this potential source of liability.

There is a possibility that operating a dam in part as a flood control project may lead to liability. In a US case\textsuperscript{92} a dam owner was held liable for a high spillway release even though it did not exceed the natural flow of the stream. The reason was that the owner had historically skimmed the peak of floods, leading floodplain residents to rely on reduced flows.

As a result of a dam owner’s right to pass the natural flow, wide scale flooding which does not endanger the dam may not be considered an issue by a dam owner. However, such flooding endangers lives and puts property at risk and even the best-managed dam may exacerbate the hazards associated with a flood. Dam owners may bear some responsibility in such cases for several reasons (Lemperiere, 1999):

- Providing a greater or lesser amount of flood control, including shaving the peak, creates an impression of safety on the floodplain, encouraging development. In extreme events much damage can be done. This is a problem in densely populated Asia.

- Opening a gate may cause rapid rises in water level even at low flow. Such sudden increases in stage, even at less than bankfull conditions, may endanger users of the river.

\textsuperscript{92} Kunz v. Utah Power & Light Co., 526 8/2d 599 (9th Cir. 1975)
• For ungated dams, the storage of part of a flood may result in a steeper downstream hydrograph than for natural flows. Discharge may increase rapidly in a short period.

Floods also run the risk of attracting claims of strict liability. A dam failure flood is an obvious strict liability situation.

Floods are also a major consideration in dam design because the structure must handle all foreseeable extreme events. Chapter 3 considers the question of foreseeability in more detail.

Floods may impact on the water quality downstream of the dam by, for example, introducing additional sediment to the water. Chapter 4 considers water quality.

Extreme floods may also trigger a dam owner’s EPP. This could be a relatively common occurrence if the EPP also includes provisions for high spillway releases. Such non-emergency situations are being included in more EPPs as a result of the Water Use Plan process. Chapter 5 considers impacts of proposed dam safety regulations in BC on the dam owner’s emergency planning.

Chapter 6 considers the issue of debris management. In an extreme flood event, large quantities of debris, including previously accumulated but not removed debris, can be washed over a dam and downstream. Such debris could conceivably aggravate flood damage.

Finally, Chapter 7 discusses the issue of fish habitat creation. High spillway release floods may significantly affect habitat downstream of the dam.
2.4.9 CONCLUSIONS

Dam owners are subject to legal control through both statutory and common law. Because statutory law often involves frequent interaction with government regulators, it is often in the forefront of dam owner planning. A dam owner only deals directly with the common law when a law suit is threatened or commenced. Although the concept of negligence is familiar to most people today, the other two tort causes of action discussed in this thesis, nuisance and strict liability, may be less familiar.

A diligent dam owner should be cognizant of both statutory and common law sources of potential liability. However, cognizance is only the first step to effective planning for legal liability risk management; the second step is determining an effective course of action given that knowledge. The remainder of this thesis focuses on several topical issues of concern for BC dam owners at the turn of the century. Those topics include foreseeability of extreme flood events (including probable maximum floods), potential liability stemming from alteration of water quality, obligations imposed by proposed new dam safety regulations, debris management, and fisheries habitat creation. Each of these will be examined with respect to the potential legal liabilities described above.
3.1 INTRODUCTION

"Dam safety" is the phrase often used to encompass the actions, including design decisions, needed to protect a dam against failure. The public's perception of dam safety management often differs from that of dam owners. The US Bureau of Reclamation (the USBR) defines a safe dam as one that does not impose unacceptable risks on the public (Salmon and Hartford, 1995, and USBR, 1989). Although the public seems willing to accept high loss of life from relatively frequent events which impact a small number of people, such as automobile accidents, it is sensitive to the risks posed by relatively rare high-impact disasters such as dam failures (Dubler, 1996). The potential economic and life losses associated with a dam failure, coupled with the public need for a higher degree of safety from such major events, requires a very rigorous standard of care of the dam owner.

One of the major causes of dam failure is the overtopping of the dam during an extreme flood event. Cluckie and Pessoa (1990) and Hawk (1992) both suggest that at least one-third of dam failures are the result of overtopping. However, Lave and Balvanyos (1998) counter that in the US, many dam failures occur during
filling of the reservoir and overtopping accounts for only 13% of failures. In any event, both design and operational decisions are part of the process of reducing the risk of overtopping. Two significant questions arise during this process:

1. What design and operational measures must be taken with respect to extreme events (or, “what to do about extreme floods”)?

2. What constitutes an extreme event for which one must plan (or, “what to plan for”)?

Design measures primarily involve ensuring that the dam’s spillway is adequately sized to allow passage of extreme floods of the appropriate magnitude. Such floods are referred to as the inflow design flood or the IDF. There are various methods in use to determine the IDF and those methods are described later in this chapter. Operational measures involve reservoir operation strategies that anticipate high inflow periods and adjust reservoir levels in an effort to ensure that an extreme event does not overwhelm the capability to safely pass water downstream of the dam’s outlet works, turbines (if any), and spillway.

From a legal viewpoint, to meet the standard of care of a reasonable and prudent dam owner, one must consider the largest extreme event that could be foreseen by a reasonable person. Once that magnitude is known, a decision must be made about what to do in the face of that hazard. Larger flood events, those of such size that no reasonable dam owner would foresee them, are “acts of God” and in the face of such events, a dam owner could not be liable in negligence or pursuant to the Rule in Rylands v. Fletcher (strict liability).

Flood magnitudes are often expressed in terms of their return period – the span of time, on average, within which a river is expected to experience one flood of at
least the magnitude in question. Thus, the 1-in-50 year flood (also referred to as the 50-year flood) is expected to be equaled or exceeded, on average, once every fifty years. The 1-in-100 year flood, being larger, is not expected to be equaled or exceeded as frequently. Unfortunately, this method of describing floods, while accurate and widely used, is often misleading to the layperson. Technically, the return period (T) is the reciprocal of a flood’s annual exceedence probability, or AEP, or the probability that a flood of that magnitude or greater will occur in a given year. The return period may therefore be described mathematically as:

\[
T = \frac{1}{AEP}
\]

[3.1]

Because the 1-in-100 year flood could occur many times within a 100 year period or for a number of years in a row (both statistically of low probability but not impossible or unprecedented), it is less confusing to refer to the flood’s AEP. The AEP of the 100-year flood is 0.01 or 1%. That is, there is a 1% chance per year of a flood of that magnitude or greater.

Because hydrological data such as flood flow and river stage has been collected for a relatively short period of time (100 to 200 years at best in BC), statistical analysis to determine AEPs of extreme floods is somewhat unreliable (NRC, 1985). In response, two other approaches to determining the IDF have evolved:

1. Hydrologists have devised deterministic methods, also known as meteorological or traditional methods, to estimate the “probable maximum flood”, or PMF, which could occur in a given watershed. The PMF is based upon a potential but realistic combination of “bad” or “worst-case” hydrometeorological circumstances. As such, it is a hypothetical flood or estimated “realistically worst case” flood. The
PMF is such a worst-case scenario that, as discussed below, there is considerable debate about whether it can be assigned an AEP or return period.

2. Risk analysts have applied cost-benefit techniques to spillway design. This approach evaluates the cost of spillways of various capacities and the estimated long-term losses (and so costs to the dam owner) associated with each capacity. The spillway design giving the lowest project cost, including the expected cost of failure, is then chosen (Dubler, 1996). Note, however, that although risk analysis evaluates the IDF in a manner different than deterministic analysis, it relies on statistical analysis.

Thus, the dam owner has statistical and deterministic tools available with which to assess the foreseeability of extreme floods and, with risk analysis, three tools to help decide what to do about them. But the question remains: where is the dividing line between the reasonably foreseeable event and an act of God? This chapter will examine that question and consider how well it is reflected in current dam safety regulations and industry practice. The next division summarizes current approaches to dam safety and determining the IDF. It is followed by a consideration of the legal aspects of foreseeability and a discussion of the resulting impact on dam owners. The chapter is completed by a summary of conclusions and recommendations.
3.2 DAM SAFETY

3.2.1 INTRODUCTION

To protect the dam from extreme floods, a spillway is built to pass the water from such events safely past the dam. During a very large event, the “spilling” or release of floodwater through the spillway may result in downstream damages approaching those that would have occurred had the dam not been in place. However, the consequences of a dam failure are likely to exceed those damages considerably (NRC, 1985) because of the sudden release of a massive flood wave and the addition of the stored volume of the reservoir to the floodwaters. Engineers and dam operators attempt to predict the magnitude of extreme floods to facilitate safe design and operation of the dam. Given such estimates, a moral, ethical, legal, and political issue arises: how much protection should be provided for a dam considering that extreme events can but may not occur during the structure’s life (NRC, 1985)? Because it is not possible (at least economically) to provide complete safety (and, in all likelihood, the public would not approve of the monolithic structures required), the objective of dam safety is usually to balance increased safety with the cost of that safety and reduce the risk to acceptable levels (NRC, 1985). This is similar to the concept of determining the appropriate standard of care in a negligence suit (see division 2.4.5.3.1) using equation [2.2]. There is an important difference however: dam safety addresses the risk to society at large (or at least on the floodplain) but the legal standard of care equation is usually applied to an individual plaintiff or small group.

One problem faced by the dam owner is that each of the components of the legal standard of care formula is at least somewhat indeterminable. The magnitude and timing of extreme floods, the potential consequences, and the social value of the
dam are all difficult to quantify (NRC, 1985). In dam safety planning, achieving a balance equitable to all stakeholders (including the dam owner, those who benefit from the dam, and those whose safety is at risk) is often difficult to achieve as well (NRC, 1985). The question of equity is often the reason a very extreme event such as the PMF is used in dam safety design (NRC, 1985) because it provides the greatest, yet arguably reasonable, safety. However, except for dams sited above large population centres, the use of a PMF design standard may not be economically justifiable – the cost may be too high notwithstanding the lower risk (NRC, 1985).

A review of dam performance history suggests that using the PMF as a design standard demonstrates reasonable care; however, many dams with spillways designed to pass less than the PMF have performed equally well (NRC, 1985). Is then the PMF the appropriate standard? Historic evidence suggests the PMF is a very conservative design parameter since, as implied by its definition, few natural events have approached it (NRC, 1985). Of course, for dams above populated settlements, a conservative design is viewed as appropriate by many people, particularly the floodplain residents (Dubler, 1996).

Yet, even if the reasonable maximum level of safety is desired, the choice of a PMF standard is not as clear-cut as might first appear. The PMF is a hypothetical flood based upon assumptions, facts, theory, and professional judgment (NRC, 1985). Furthermore, the calculation procedure is not standardized and different persons calculating the same PMF may justifiably end up with different values, largely as a result of different judgments about assumptions (NRC, 1985). Furthermore, if the PMF has a frequency (a matter of some debate - see division 3.2.3.1.1.5), it is likely less frequent than other societal hazards (such as injury from vaccinations or earthquakes) and so may unfairly penalize dam owners (Hampton, 1995). And, if
the PMF is not the appropriate measure, what level of safety is appropriate? Knowing the frequency of an extreme event does not, in and of itself, lead to a decision on the appropriate dam design. Finally, what should be done with existing dams which may no longer be able to safely pass the PMF or an appropriate lesser design standard?

This division will describe the techniques currently used in dam flood safety design. It begins with a description of each technique and the methods each technique uses to determine the IDF. Division 3.3 will consider the issue of foreseeability.

3.2.2 CURRENT DAM SAFETY AND DESIGN PRACTICES

3.2.2.1 Historical Development

The basic methods of determining design criteria for spillways have been in use since the early part of the 20th century. Developments since then have tended to be refinements rather than new techniques (NRC, 1985). The chronological development of IDF estimation techniques may be summarized as follows:

- Prior to 1900, designers of dams were limited by a lack of historical hydrological data and so relied on known past extreme flood events, often incorporating a factor of safety, to arrive at an IDF (NRC, 1985). It is interesting to note that the dam safety issue was somewhat less significant prior to 1900 because most of the dams of that era were low masonry or timber-crib structures which could withstand overtopping (NRC, 1985) and, perhaps, because of different population distributions, different beliefs about individual rights and safety, and because of a different value on human life.
As more hydrometeorological data became available, engineers began to use recorded extreme events, often transposing them from one regional watershed to another (NRC, 1985). A number of formulae were developed which related the maximum flood expected in a watershed to the size of the watershed. The calculation of IDF's based upon regional analyses of maximum flood peaks is still used today to compare observed and computed flood peaks (NRC, 1985).

In the 1930's formal statistical analysis of hydrologic data began (NRC, 1985). Frequency analysis of recorded events was used to estimate extreme event peaks. Unfortunately, the relatively short flood record did not allow for accurate estimate of long return period (low AEP) floods. Nevertheless, many standards (including the CDA's Dam Safety Guidelines) require the use of IDF's based upon specified AEP's, particularly for low hazard dams.

Beginning in the 1920's and proceeding through the 1930's engineers developed techniques to estimate the highest rainfall that could reasonably be expected in a given area at a given time of year (the probable maximum precipitation or PMP), recognizing that “observed maximum rainfall values could provide a better general indication of maximum flood potentials than flood discharges from individual watersheds” (NRC, 1985). The PMP approach included the need to transpose recorded storms to other, similar, basins (Forland and Kristoffersen, 1989). The development of the unit hydrograph in the late 1930's allowed the conversion of PMP values into streamflow or PMF values (NRC, 1985).
More recently, the concept of risk analysis has gained some favour. This technique determines and compares the cost-benefit ratio of floods of different magnitudes with spillways of different sizes.

There are two methods in use in BC today to define appropriate dam safety design standards. The prescriptive standard approach incorporates statistical and deterministic analysis coupled with professional judgment to create “dam hazard classes”. The perceived hazard of a dam places it into a hazard class that in turn leads to an IDF design standard. The second method is risk analysis – the weighing of costs, benefits, and risks. Although different in many respects, the approaches incorporate some of the same philosophical and technological aspects. The current practice in each approach is examined in the following divisions.

3.2.2.2 Prescriptive Standards: Dam Hazard Classification

Most, if not all, North American jurisdictions have dam safety standards based upon a dam hazard classification system. Although different jurisdictions may use different terminology and consequence limits for each class, all of the systems are based upon the “incremental” damage expected to result from a dam failure flood or an unscheduled release of water (Federal Emergency Management Agency (FEMA), 1998). Incremental damage is the difference in impacts that would occur due to failure or mis-operation of the dam over those that would have occurred without failure or mis-operation (FEMA, 1998). The expected level of damage determines the dam’s hazard classification. That classification then points to design standards determined by the regulator or the industry to be appropriate for the hazard. Higher hazard dams have higher design standards than low hazard dams. As Canada’s dam hazard classifications are descended from early work by the US Army Corps of Engineers, the USACE, it is worthwhile looking first at some representative US classification systems.
3.2.2.2.1 Dam Hazard Classification in the US

3.2.2.2.1.1 US Army Corps of Engineers

The dam hazard classification system was introduced by the USACE in 1976 and forms the basis for most such systems in use today (Bowles et al, 1996). The USACE system requires that the hazard classification of the dam be established by considering the expected incremental loss of life and expected incremental economic losses from a dam failure. The following table is used to determine the hazard classification:

<table>
<thead>
<tr>
<th>Hazard Classification</th>
<th>Loss of Life</th>
<th>Economic Loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>None</td>
<td>Minimal</td>
</tr>
<tr>
<td>Significant</td>
<td>Few</td>
<td>Appreciable</td>
</tr>
<tr>
<td>High</td>
<td>&gt; Few</td>
<td>Excessive</td>
</tr>
</tbody>
</table>

Table 3.1: US Army Corps of Engineers Hazard Classifications (Dubler, 1996)

The height of the dam and the volume of water impounded by it are then used to determine the dam size classification using the following table:
The IDF is then determined based on the hazard classification and the dam size using the following table:

<table>
<thead>
<tr>
<th>Hazard Classification</th>
<th>Large</th>
<th>Intermediate</th>
<th>Small</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>PMF</td>
<td>PMF</td>
<td>0.5 to full PMF</td>
</tr>
<tr>
<td>Significant</td>
<td>PMF</td>
<td>0.5 to full PMF</td>
<td>100-year flood to 0.5 PMF</td>
</tr>
<tr>
<td>Low</td>
<td>0.5 to full PMF</td>
<td>100-year flood to 0.5 PMF</td>
<td>50 to 100-year flood</td>
</tr>
</tbody>
</table>

Table 3.3: US Army Corps of Engineers Inflow Design Floods (Dubler, 1996)
Note that the definitions of PMF adopted by each of the agencies discussed in this chapter do not, for the purposes of this thesis, differ significantly from the CDA's definition set forth in the Glossary.

3.2.2.2.1.2 Federal Energy Review Commission

Since 1981, the US Federal Energy Regulatory Commission, FERC, has required US dam owners to evaluate dam safety by considering the hazard potential in the event of a dam failure (Hampton, 1995). If failure would threaten lives or cause significant economic damage, the dam must be able to withstand overtopping or the loading condition of floods up to the lesser of:

- the PMF; or

- the flood of sufficient magnitude that dam failure would not constitute any additional threat to the floodplain (Hampton, 1995).

An IDF of less than the PMF is permitted if the dam owner can present "a detailed explanation of the basis for the finding that a structural failure would not present a hazard to human life or cause significant property damage" (Hawk, 1992). The minimum standard is the 100-year event (Hawk, 1992). For low and intermediate classification dams, the IDF is the flood level beyond which dam failure would not significantly increase the threat to life and property above the threat imposed by the flood itself (Hawk, 1992). The FERC system therefore includes both prescriptive and cost-benefit aspects.

3.2.2.2.1.3 Federal Emergency Management Agency

Many federal and state regulators and industry groups have adopted unique classification systems. There are some significant variations in the definitions of hazard categories and the IDFs prescribed for a given category. In many cases, the
dam and reservoir sizes are not a factor in determining the hazard category (as illustrated by the FERC requirements) (Bowles et al, 1996). The problem of multiple classification systems using different terminology has led to an effort to standardize the classification system (FEMA, 1998). That standard system, proposed by the Federal Emergency Management Agency, FEMA, is presented in Table 3.4.

<table>
<thead>
<tr>
<th>Hazard Potential Classification</th>
<th>Loss of Human Life</th>
<th>Economic, Environmental, Lifeline* Losses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>None expected</td>
<td>Low and generally limited to owner</td>
</tr>
<tr>
<td>Significant</td>
<td>None expected</td>
<td>Yes</td>
</tr>
<tr>
<td>High</td>
<td>Probable. One or more expected.</td>
<td>Yes (but not necessary for this classification).</td>
</tr>
</tbody>
</table>

* roads, utility corridors, and other important infrastructure links

Table 3.4: FEMA Hazard Potential Classification System for Dams (FEMA, 1998)

The FEMA system uses the following definitions (FEMA, 1998):

- **Hazard potential**: the possible adverse incremental consequences that result from the release of water or stored contents due to failure of the dam or mis-operation of the dam or appurtenances.

- **Adverse consequences**: negative impacts that may result from the failure of a dam.

- **Probable**: likely to occur; reasonably expected; realistic.
Note that the FEMA classification does not depend on dam size or reservoir volume; even a small dam could pose significant risk to floodplain residents. Note also that the FEMA system ignores both "improbable" losses of life (such as the death of occasional recreational river users, passers-by, or other temporary users of inundated lands). It also does not consider the beneficial effect of an EPP, whether implemented or not (FEMA, 1998). The FEMA system, however, does not suggest an appropriate IDF for each classification.

3.2.2.2.2 Dam Hazard Classification in BC

BC does not have a statutory dam safety standard. However, MELP, the provincial government department responsible for dam safety, uses the industry standard set by the CDA in evaluating dam design and modifies it using the probability of failure (MELP (4), 1998). Currently, regulators rely on section 18 of the Water Act to impose safety requirements on dam owners. Recall that the proposed Dam Safety Regulation (see division 2.4.3.1.4) will, when in force, give MELP's dam safety officers express authority to address dam safety issues. That regulation does not, however, mandate a particular hazard classification scheme. This division will describe the CDA Dam Safety Guidelines and MELP's "Risk Based Classification and Monitoring" procedure.

3.2.2.2.2.1 CDA Dam Safety Guidelines

The CDA's Dam Safety Guidelines, sometimes referred to as the Guidelines, adopt an approach similar to that taken in the US. Dams are classified by the incremental consequences of failure and different design floods are applicable to each classification. It is interesting to note that the Guidelines require that each dam be classified by the "reasonably foreseeable incremental consequences of failure" (CDA(1), 1999). The CDA classification scheme is presented in Table 3.5.
Table 3.5: CDA Classification of Dams in Terms of Consequences of Failure (CDA(1), 1999)

The consequence (life safety or socioeconomic, financial, environmental impacts) that results in the highest consequence category rating determines the dam's classification. The appropriate level of each of the consequences, for example, the dollar value of "moderate damages", is established in consultation with regulatory authorities or, in the absence of such consultations, in a manner consistent with "societal expectations" (CDA(1), 1999). This is different than many US jurisdictions' "strictly by the numbers" approach.

Under the CDA Guidelines, dams are to be designed and evaluated to safely pass an IDF based upon the consequences of failure (CDA(1), 1999). New dams in the high or very high consequence categories should develop an IDF using both probabilistic and deterministic methods. Table 3.6 sets forth the IDF criteria for relevant consequence categories. There is no IDF standard for very low consequence category dams.

<table>
<thead>
<tr>
<th>CONSEQUENCE CATEGORY</th>
<th>LIFE SAFETY</th>
<th>SOCIOECONOMIC, FINANCIAL &amp; ENVIRONMENTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>VERY HIGH</td>
<td>Large number of fatalities</td>
<td>Extreme damages</td>
</tr>
<tr>
<td>HIGH</td>
<td>Some fatalities</td>
<td>Large damages</td>
</tr>
<tr>
<td>LOW</td>
<td>No fatalities anticipated</td>
<td>Moderate damages</td>
</tr>
<tr>
<td>VERY LOW</td>
<td>No fatalities</td>
<td>Minor damages beyond owner's property</td>
</tr>
<tr>
<td>CONSEQUENCE CATEGORY</td>
<td>INFLOW DESIGN FLOOD (IDF)</td>
<td></td>
</tr>
<tr>
<td>----------------------</td>
<td>-----------------------------------</td>
<td></td>
</tr>
<tr>
<td>Very High</td>
<td>Probable Maximum Flood (PMF)</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>Annual Exceedence Probability (AEP) between 1/1000 and the PMF*</td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>AEP between 1/100 and 1/1000*</td>
<td></td>
</tr>
</tbody>
</table>

* to compare with Table 3.3, convert AEP to return period using equation [3.1]

Table 3.6: CDA Usual Minimum Criteria for Inflow Design Floods
(CDA (1), 1999)

3.2.2.2.2 \textit{MELP Risk Based Classification}

MELP’s “Risk Based Classification and Monitoring” procedure, referred to in this division as the Procedure, considers both the consequences of failure and the probability of failure. The probability of failure considers the owner’s compliance history as well as the design, construction, maintenance, surveillance, and operation of the dam (MELP (4), 1998).

The failure consequence rating of a dam is determined using a table based on the CDA Guidelines. That system is presented in Table 3.7. Note that the high and very high consequence ratings are subdivided into high and low categories.
<table>
<thead>
<tr>
<th>Losses</th>
<th>Ranking</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmental &amp; Cultural</td>
<td></td>
</tr>
<tr>
<td>Economic &amp; Social Loss</td>
<td></td>
</tr>
<tr>
<td>Loss of Life</td>
<td>H2H &amp; VHL</td>
</tr>
</tbody>
</table>

**Table continued on next page:**

*Million (M) and 1000 (K):* Correspond to estimated fatalities.


### Table 3.7: Provincial Dam Classification - Consequence Rating Guide

<table>
<thead>
<tr>
<th>Losses</th>
<th>Potential for any loss of life</th>
<th>Potential for multiple loss of life</th>
<th>Loss of Life</th>
<th>Economic &amp; Social Loss</th>
<th>Environmental &amp; Cultural Loss</th>
<th>Guidance</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V(1)</td>
<td>Low</td>
<td>Very</td>
<td>Low</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td></td>
<td>developed</td>
<td>The inundation area is specifically</td>
<td>developed</td>
<td>The inundation area is specifically</td>
<td>developed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>low</td>
<td>developed</td>
<td>low</td>
<td>developed</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

Table continues from preceding page.
The failure probability rating of a dam is determined using Table 3.8. Three
general categories of guidelines for allocating the failure probability rating are used
(MELP (4), 1998):

1. Design, construction, and operation.

2. CDA Guidelines.

3. Dam owner record of operation and compliance.
### General Guidelines for Allocating Ratings
Last bullet applies primarily to Major Dams

<table>
<thead>
<tr>
<th>Rating</th>
<th>General Guidelines</th>
</tr>
</thead>
</table>
| **Large** | • Uncorrected design, construction, structural and/or operational deficiencies that could clearly lead to uncontrolled reservoir release.  
  • Owner exhibits reluctance to operate in a safe and timely manner, or is incapable of doing so; all unlicensed dams are allocated this rating.  
  • Design criteria and operating procedures fall below those required by current CDA guidelines for low to very high consequence dams. |
| **Significant** | • Uncorrected design, construction, structural and/or operational deficiencies that could potentially lead to uncontrolled reservoir release.  
  • Owner exhibits reluctance to undertake and report on annual inspection, or is incapable of doing so.  
  • Design and operation lacks redundancy, e.g. no back-up power for electrical gates.  
  • Design criteria and operating procedures fall below those required by current CDA guidelines for high to very high consequence dams. |
| **Small** | • Design and/or performance deficiencies may exist, but are actively monitored and are not expected to significantly increase failure potential over the near term.  
  • Design and operation exhibits redundancy.  
  • Designed, constructed, operated and maintained in a manner that satisfies the requirements of the current CDA guidelines for high consequence dams. |
| **Very Small** | • Dams that are breached, partially breached, reservoir drained or otherwise safeguarded.  
  • OR Satisfies in all respects the requirements of the CDA Guidelines for very high consequence dams. |

**Table 3.8: MELP Failure Probability Rating Guidelines**  
(MELP (4), 1998)

The final numerical classification or risk level of the dam is determined using Table 3.9. The levels have the following significance, ranked from highest risk to
lowest risk (MELP (4), 1998):

- Risk Level 1: Corrective action required; emergency preparedness is a high priority.

- Risk Level 2: Dam is cause for concern; the owner must upgrade or demonstrate why it is not necessary.

- Risk Level 3: Annual inspection and report required.

- Risk Level 4: Annual report required.

- Risk Level 5: Government regulation limited to ensuring risk level does not change.

<table>
<thead>
<tr>
<th>Failure Probability Rating</th>
<th>Very High</th>
<th>High</th>
<th>Low</th>
<th>Very Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VHH</td>
<td>VHL</td>
<td>HH</td>
<td>HL</td>
</tr>
<tr>
<td>Large</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Significant</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Small</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>4</td>
</tr>
<tr>
<td>Very Small</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Table 3.9: MELP Risk Level for Individual Dams
(MELP (4), 1998)
3.2.2.3 Risk Analysis

Limited funds and high costs to upgrade existing dams have encouraged risk-based analysis (Thompson et al, 1997). Advocates argue that risk analysis “is generally superior to traditional prescriptive standards in that it is a rational problem-solving method that addresses the cost-benefit question” (Dubler, 1996). The dam hazard classification system is said to be an unnecessarily conservative response to a perceived public abhorrence of dam safety risks (Dubler, 1996). Risk analysis has been slow to gain acceptance although, in BC, BC Hydro is an advocate of the approach (Salmon et al, 1997). Although BC Hydro safety standards are based on the CDA Guidelines, a risk analysis approach is used to select the criteria for considering seismic events (BC Hydro (8), 1999).

Risk analysis addresses three questions (Salmon and Hartford, 1995):

1. What can go wrong?

2. How likely is a failure?

3. What are the consequences?

Once these questions are answered, the expected cost of each mode of failure is calculated and a decision made as to the acceptability of those costs.

A variant of the risk analysis approach seeks to determine the flood flow beyond which the damage caused downstream is equal to that caused by a dam failure (in other words, the flood at which dam failure becomes irrelevant).
One of the difficulties with risk analysis is dealing with the question of loss of life and how it can be factored into an economic decision making process. Three approaches have been developed:

1. An assumption is made about society’s tolerance for life losses from dam failures. BC Hydro suggests an acceptable life loss of 0.001 lives per year per dam (Salmon and Hartford, 1995). This figure is used as an input to select the IDF (see division 3.2.3.1.3).

2. A dollar value is assigned to a life. Although people are often averse to this, a number of researchers have suggested values ranging from US$50,000 to US$8,000,000 (Dubler, 1996, referring to Buehler, 1975, Graham and Vaupel, 1981, and Lave, 1981).

3. The problem is ignored by assuming that EPPs will prevent any loss of life. Lave and Balvanyos (1998) argue that hurricane warning systems in the US have proven effective and so a warning system for floods should “all but eliminate ... deaths”. However, whether such an argument holds true for such different events is open to question.

3.2.3 INFLOW DESIGN FLOOD (IDF) DETERMINATION

3.2.3.1 Inflow Design Flood Determination Methods

Three primary methods are in use today to determine the IDF: the deterministic approach which estimates the PMF, the probabilistic approach which specifies AEPs or return periods for floods, and a risk analysis approach which seeks to compute and incorporate the economic costs associated with given floods into the IDF determination. The techniques used by each method to determine the IDF are examined briefly below.
3.2.3.1.1 The Deterministic Approach (the PMF)

3.2.3.1.1.1 The Basic Steps

Also known as the meteorological or traditional method (Forland and Kristoffersen, 1989), the PMF approach is considered more reliable than a probabilistic approach. However, current meteorological knowledge is still not precise and the PMF derived from it is an approximation (Forland and Kristoffersen, 1989). Equally valid calculations may lead to different PMF values (Forland and Kristoffersen, 1989).

Estimating the PMF essentially involves estimating the PMP, synthesizing a hydrograph of inflow to the reservoir, and routing that inflow through the dam (NRC, 1985). The Committee on Safety Criteria for Dams, National Research Council of the US, referred to as the NRC, summarizes the basic steps involved in determining the PMF as follows (NRC, 1985):

1. Divide the drainage area into subareas or subcatchments if necessary.
2. Select and calibrate a runoff model (often a recognized computer model such as HEC-1 (Shalaby, 1995) or the UBC Watershed Model).
3. Determine PMP (described in more detail below).
4. Arrange PMP increments into logical storm rainfall pattern.
5. Estimate surface detention and infiltration for each time interval (may be part of the runoff model).
6. Determine rainfall excess values by deducting losses (may be part of the runoff model).
7. Apply rainfall excess values to runoff model in each subarea or subcatchment.

8. Synthesize flood hydrograph for each subarea or subcatchment (including base flow and runoff from prior storms).

9. Rout flood for each subarea or subcatchment to the reservoir.

10. Rout reservoir inflow through reservoir storage, outlet works, turbines, and spillway to estimate storage elevation, discharge, tailwater elevation, and other parameters of interest for a preliminary PMF.

11. Conduct a sensitivity analysis on uncertain parameters to select a final PMF (Hampton, 1995).

Three aspects of this process are particularly important:

1. The conditions in the watershed immediately preceding the PMP. These “antecedent conditions” impact the runoff simulation and the flood routing through the catchment and reservoir. Subsequent storms may also be significant as the reservoir may have little or no storage capacity following the PMF.

2. Calculating the PMP.

3. Routing the flood.

Each of these is discussed below.
3.2.3.1.1.2 Antecedent Conditions and Subsequent Storms

The PMF, even though it is a hypothetical event, must be founded on a reasonable hydrometeorological basis. The conditions found in the watershed prior to the PMP rainstorm, called the antecedent conditions, are significant factors in the watershed's reaction to the PMP. Antecedent conditions of importance include existing snowpack (which may supply additional runoff), soil moisture (which impacts the infiltration of rainfall into the soil), vegetation (which also affects loss rates of rainfall and runoff characteristics), and reservoir level (which determines the storage available for the floodwaters and is, in part, a function of reservoir operation decisions made by the dam owner) (NRC, 1985). For example, it might be reasonable to ignore a "rain on snow" scenario if major storms in the dam's watershed occur in the autumn, after the snowpack has melted. However, that scenario should not be ignored in BC as severe storms do occur on a high snowpack (see the BC Hydro case described in division 2.4.3.3.3 and Appendix B for an example of such an event). Because the characteristics of every watershed are different, the dam owner must evaluate the antecedent conditions in the watershed to ensure that the assumed antecedent conditions are conservative but not unrealistic for the area (NRC, 1985).

Severe storms such as the PMP are often preceded or followed by other large storms. Preceding storms are part of the antecedent conditions and are often accounted for by assuming completely saturated antecedent soil moisture conditions (Shalaby, 1995) or, as FERC requires, using a 100-year storm three days prior to the PMP event (Taug, 1995). Following storms also need to be considered because the storage volume of the reservoir may be reduced at the time such a storm occurs. Accordingly, the design storage volume of the reservoir needs to account for antecedent, PMF, subsequent, and wave runup conditions.
3.2.3.1.1.3 *PMP Estimation*

The PMP forms the basis for determination of the PMF. The PMP is defined generally as the greatest depth of rainfall of a given duration reasonably possible over a given area at a particular time of year (see the Glossary for a more complete definition). The PMP is an estimated rainfall because a number of unknowns and unmeasured parameters still exist with respect to meteorological events (NRC, 1985). Various methods of calculation may yield different but equally valid estimates (Cluckie and Pessoa, 1990).

PMP estimates usually greatly exceed the rainfall amounts actually observed in the area (NRC, 1985). This is to be expected of a calculation to determine the maximum precipitation that might be experienced under the possible, but unlikely, assumed meteorological circumstances.

The basics of a PMP calculation may be summarized as follows:

1. Review historical rainfalls to determine maximum areal rainfalls and to determine the meteorological factors important to them (NRC, 1985) such as depth and duration of rainfall, isohyetal pattern, location of storm centres and storm orientation, and temporal rainfall distribution (Shalaby, 1995). New technologies, such as radar, may be useful (Cluckie and Pessoa, 1990).

2. Transpose the major storms within topographically and meteorologically homogeneous regions. Transposition is a method of creating data for the watershed under study by importing storms from other basins. This is useful if the dam’s watershed does not have a sufficient record of severe storms to allow PMP calculation.
Transposition can be particularly difficult in regions such as BC with large orographic influences (Forland and Kristoffersen, 1989). The scarcity of meteorological measuring stations in many mountain basins adds to the difficulty.

3. Adjust the rainfall to account for differences in atmospheric moisture in the watershed of interest. Moisture maximization considers the available moisture for a historic storm and whether more moisture might be available if the storm occurred at a different time (Hampton, 1995). Surface dew point information is commonly used (Hampton, 1995).

4. Smoothly envelop the resulting rainfall durationally and areally to provide consistency of data (Hampton, 1995).

3.2.3.1.1.4 Reservoir Routing

Water can be released from a reservoir through outlet works, turbines in a hydroelectric project, and spillways. Flood control dams are usually operated to limit the downstream flow to bankfull conditions until the flood control storage in the reservoir is exhausted (NRC, 1985). To maintain a certain reservoir level, other dams often maximize the release capacity in the outlet works before utilizing the spillway (NRC, 1985).

Flood routing uses some form of volumetric conservation equation based upon:

\[ \Delta I_t \cdot \Delta O_t = \Delta S_t \]  \hspace{2cm} [3.2]

where
\[ \Delta I_t = \text{change in reservoir inflow over time } t \]
\[ \Delta O_t = \text{change in reservoir outflow (discharge) over time } t \]
\[ \Delta S_t = \text{change in reservoir storage over time } t \]

The Muskingum method, a routing method familiar to most students of hydrology, is often used because of its simplicity and flexibility (Shalaby, 1995).

Reservoir routing and operations planning is often very complex, requiring judgment based upon forecasts of future events. An example of the complexities can be found in the BC Hydro case described in division 2.4.3.3.3 and Appendix B.

3.2.3.1.1.5 Additional Comments

One of the interesting aspects of PMF estimation is that, as our understanding of meteorology increases, the estimates of PMP for a given area tend to increase (NRC, 1985). It should be noted, however, that FERC has reportedly experienced a decrease in the PMF when making new PMF determinations (Hampton, 1995) although Hampton gives no explanation for this. An increasing estimate means that as time goes by and technical knowledge grows, the standard of care may rise. This may force dam owners to reevaluate previous designs and consider the need to upgrade spillways or take other measures to maintain the appropriate standard of care.

A second interesting aspect of the PMF is that there is some controversy over whether or not the probability of the event can, or should, be determined. Smith (1998) argues that rational decision making requires a risk assessment to ensure that society's risk tolerance is not exceeded. Priorities must be assigned to events such as the PMF to allow risk assessment and accurate communication. He argues
that frequencies can be calculated for the components of the PMF, often with confidence because the recurrence intervals are less than 100 years. Such frequencies allow the return period of the PMP and then the PMF to be calculated. Some studies have suggested PMF return periods in the millions of years (Hampton, 1995).

In support, Klemes et al (1992) point out that the traditional description of the PMF and PMP as maximum reasonable events is intellectually honest but “is not too helpful to the decision maker”. Without a probability Klemes et al argue, the dam owner has difficulties prioritizing remedial work on existing dams, maintaining uniform safety standards on new dams, and is unsure of the degree of conservatism in a design. Klemes et al find that “where data amenable to statistical analysis are available, it is feasible, in principle, to use [their approach] to estimate the order of magnitude of exceedance probability of precipitation in the range of the PMP”.

In rebuttal, Russell (1998) suggests that in situations where structural failure can be catastrophic, a bounding (or “no-risk”) approach rather than a cost-benefit approach is appropriate. As the PMF is a key component of a bounding approach, its frequency is irrelevant. Russell also doubts that the state of the art of today’s hydrology permits calculation of the frequency of a PMF with any accuracy. Cluckie and Pessoa (1990) suggest that methods for estimating PMF probabilities provide only order of magnitude accuracy, produce different results, and are extremely subjective.

3.2.3.1.2 The Probabilistic Approach

Many jurisdictions and industry standards (including the CDA’s Dam Safety Guidelines) require or allow the use of flood frequency analysis to determine the
IDF for lower hazard dams. Frequency analysis estimates a specific instantaneous peak flow using extreme value distributions (Lave and Balvanyos, 1998). From this information an inflow hydrograph must be calculated based upon the hydrograph of known historical floods or using an appropriate rainfall-runoff model (NRC, 1985). The flood can then be routed through the reservoir as described in division 3.2.3.1.1.4.

Because of the limited record length of flow data and because there are a large number of potential peak flow distributions, frequency analysis cannot provide good estimates of floods with return periods of more than 10,000 years (Lave and Balvanyos, 1998). Available data does allow confident estimates of events with return periods of 100 years or less (Lave and Balvanyos, 1998).

Another reported problem with frequency analysis is its reliance on the “bold postulate” that numerical flood parameters such as stage and peak discharge are random variables (Klemes et al, 1992). Critics argue that extreme events occur because of unusual combinations of components (Klemes et al, 1992).

3.2.3.1.3 The Risk Analysis Approach

There are a number of different variations of risk analysis but all rely on the calculated probability of dam failure. In general, the basic components of a risk analysis include:

1. Identification of events that could lead to dam failure (Salmon et al, 1997).

2. Assignment of probabilities to precursor events (Salmon et al, 1997).
3. Calculation of failure probability (Salmon et al, 1997). Sensitivity studies should be conducted to determine where the areas of greatest uncertainty lie (Salmon and Hartford, 1995).


5. Calculation of expected losses pursuant to each failure scenario (Dubler, 1996).

Lemperiere (1999) suggests that risk analysis may not be the most effective approach for all dams. His study found it effective for flood-caused failures but less effective for earthquake failure and sudden failures in tailings dams, hydraulic fill dams, and old masonry dams where failure probabilities are less well understood.

Three approaches to risk analysis are discussed in this division: the "societal acceptance" approach, the standard cost-benefit approach, and incremental damage analysis.

3.2.3.1.3.1 Societal Acceptance Risk Analysis

The societal acceptance assessment as exemplified by BC Hydro finds the smallest flood resulting in a predetermined maximum permissible expected loss and uses that flood as the IDF. The approach requires that expected losses (in dollars, as in the example, or in lives lost per year) be within society's limits of tolerance. Various studies have examined this question (Salmon and Hartford, 1995) and, as a result, BC Hydro has concluded that a societal risk of 0.001 lives lost per year per dam or $10,000 damage per year per dam is acceptable (Salmon and Hartford, 1995). For example, assume that a potential IDF could cause a dam to fail in either of two ways. Failure mode 1 has a probability of 0.001 and will cause $10 million
in damages and failure mode 2 has a probability of 0.000001 but will cause $1 billion in damage. The expected yearly damages at this IDF are $11,000 ($10 million x 0.001 + $1 billion x 0.000001) (Salmon and Hartford, 1995). As the expected yearly damages are above the societal acceptance value of $10,000, a larger IDF must be selected. The potential number of fatalities or the amount of damage can also be divided into the acceptable risk to yield the highest tolerable failure probability. In the above example, $1 billion in damages would require an IDF with an AEP of 0.00001.

3.2.3.1.3.2 Standard Cost-benefit

The standard cost-benefit approach uses the formula:

\[ B - C - R \]  \hspace{1cm} [3.3]

where B is the economic value of the benefits from flood control, power generation, irrigation, recreation, water supply, and other dam and reservoir uses, C is the costs of construction, operation, and maintenance, and R is the expected losses due to flooding (Lave and Balvanyos, 1998). Various potential IDFs are explored to determine which of them results in the greatest positive value.

3.2.3.1.3.3 Incremental Damage Analysis

Another variation of the risk analysis approach is incremental damage analysis which considers only the hydraulic effects of a flood (Dubler, 1996). Given a large enough flood, the downstream effects are the same whether the dam fails or not. Therefore, the IDF is determined by routing various floods past the dam with and without dam failure and selecting as the IDF the smallest flood for which the incremental damage due to failure is insignificant. Hawk (1992) illustrates this procedure in the following flowchart:
Assume that the normal reservoir level with normal streamflow conditions prevailing is the initial failure condition.

Conduct dam-break analysis and route the dambreak flood downstream to the point where the flood no longer constitutes a threat.

Is the incremental increase in consequences due to failure acceptable?

Could a failure at a larger flood inflow result in unacceptable consequences?

Select appropriate IDF on the basis of dam-break studies and incremental impacts on downstream sites, including sensitivity analysis of critical assumptions.

Assume a new (larger) flood inflow condition (up to the PMF, if necessary) as the new failure condition.

Figure 3.1: Incremental Hazard Analysis
(Hawk, 1992)

3.2.3.2 The IDF in Prescriptive Standards

The CDA Dam Safety Guidelines contain requirements with respect to both statistical and deterministic, or PMF, flood analyses. In general, statistical analyses must rely on sound statistical methods using reasonable data. The Guidelines require new statistical analyses if an unusual event is recorded after the IDF was determined or if the duration of the available hydrological data has increased by more than 50% since the last PMF calculation. This agrees with current
professional standards as demonstrated by the advice of Cluckie and Pessoa (1990) that periodic re-estimation of the PMF should be part of periodic dam safety analyses so as to incorporate new information and technologies.

The CDA's requirements for a PMF determination include (CDA (1), 1999):

- consideration of the most severe but reasonably possible combination of rainstorm, snow accumulation, melt rate, initial watershed conditions (such as soil moisture and lake and river levels), and pre-storm conditions;

- a revisitation of the analysis if an unusually large flood has occurred since the PMF calculation or if the watershed is modified so that the runoff characteristics are seriously affected (not defined); and

- calculation of the PMF for both snow melt and snow-free seasons.

During the snow melt season, three cases should be considered with the most severe becoming the PMF for that season (CDA(1), 1999):

1. Assuming a probable maximum snow accumulation combined with a severe rainstorm (1/100 AEP or less) and “prevailing storm temperature”.

2. Assuming the PMP combined with a high snow accumulation (1/100 AEP or less).

3. Assuming a probable maximum snow accumulation combined with a critically severe temperature sequence.
3.3 FORESEEABILITY

3.3.1 REVIEW AND ISSUES

In a suit against a dam owner for negligence, the plaintiff must show, among other things, that the dam owner failed to meet the appropriate standard of care (see division 2.4.5.3). To meet that test, the plaintiff must show that the dam owner's act or omission (for example, failing to provide a spillway of sufficiently large capacity) created an unreasonable risk of harm (see division 2.4.5.3.1). In determining whether or not an unreasonable risk of harm has been created, the court will determine the relationship between the risk and the social value created by the dam using equation [2.2].

In the case of a dam failure or potentially negligent high spillway release, the risk is comprised of the probability of a flood of this magnitude multiplied by the consequences. The social value is a function of the socioeconomic utility or purpose of the dam and the cost which the owner would have incurred to construct a sufficiently sized spillway. Of course, a court does not consider these issues in a mathematical way but weighs each factor in a qualitative manner.

As an example, consider an large hydroelectric dam situated just upstream of a small town. The dam's spillway is not capable of passing the PMF. Assume that the dam fails because of overtopping during a less-than-the-PMF flood with an AEP of $1 \times 10^4$ or a return period of 10,000 years and assume that the cost to upgrade the spillway to safely pass the PMF is $5 million. In such a case, the consequences are so significant that the social utility of power generation and the relatively low cost of the upgrade would, even with the relatively low AEP of the event, probably result in a court finding the dam owner negligent. Indeed, in this
scenario the dam owner would likely be in breach of the industry standard, the CDA Dam Safety Guidelines, for a very high hazard dam.

As another example, consider a small irrigation dam in a rural setting. Assume that the dam fails because of overtopping during a 1-in-100 year event (AEP = 0.01). Two cattle from a neighbour’s livestock herd are killed in the flood. In this case, the relatively high probability of harm may be offset by the relatively low consequences.

Also of concern in a negligence action is the question of remoteness – was the loss too remote a consequence of the dam owner’s act or omission (see division 2.4.5.5)? If a flood event is unforeseeable, the consequences flowing from it are too remote to be a foundation for legal liability. A decision to install a spillway designed to pass only the 1-in-10 year flood is almost certain to be negligent as failure is certainly foreseeable. But what about a spillway designed to pass a 1-in-100 year event? A 1-in-1,000? A 1-in-10,000? Foreseeability is also important in a claim based on the Rule in Ryland v. Fletcher (strict liability) (see division 2.4.6). One of the defences available in strict liability situations is showing that the event was an act of God (see division 2.4.6.2.3). At what return period, if any, does a flood become an act of God? This question is explored in the next division.

3.3.2 JUDICIAL DECISIONS

Early English decisions held that:

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93 Tomchak v. Rural Municipality of Ste. Anne and Rural Municipality of Tache (1962), 33 DLR (2d) (MCA)
• floods which are of a lower magnitude than historical floods and which might occur again are foreseeable\textsuperscript{94}, but

• if the loss could not be prevented by reasonable precautions, even if extraordinary measures make it possible to prevent the loss, the event is an act of God\textsuperscript{95}.

However, in \textit{Greenock Corporation v. Caledonian Railway}\textsuperscript{96}, referred to as the Greenock case, a suit involving obstruction of a watercourse (see division 2.4.6.1 for a full description of the facts), the British House of Lords rejected a claim of act of God with respect to a rainfall of “extraordinary violence”. Essentially, the Law Lords declared it the duty of a dam owner to provide a spillway capable of passing “extraordinary rainfall” because “floods of extraordinary violence must be anticipated as likely to take place from time to time”. Dams should be designed to safely pass even rain “unprecedented in quantity”. Unfortunately, an upper limit to “extraordinary rainfall” was not proposed but reference was made to older Scottish cases intimating that dams must provide complete safety and that extraordinary rain is never an act of God. By inference, no flood is an act of God according to the Greenock case.

In 1918 an Ontario plaintiff claimed that a dam owned by the Ontario & Minnesota Power Co. Limited exacerbated flooding of his land\textsuperscript{97}. The power company explained that heavy precipitation during warm weather on a deep snowpack led to a rapid melt (a possible PMF scenario!) and the highest water levels remembered in the area. The company argued that this constituted an act of

\begin{flushright}
\textsuperscript{94} \textit{Nichols v. Marsland} (1876), 2 Ex.D. 1 (CA)

\textsuperscript{95} \textit{Nugent v. Smith} (1876), 1 CPD 423 (CA)

\textsuperscript{96} supra, n. 82.
\end{flushright}
God. The Ontario Court of Appeal had little sympathy and ruled that "... it is to be expected that this concurrence of unfavourable conditions would occur at some time". Thus, Canadian courts appear to have adopted the strict Greenock requirements, at least in the early part of the century.

In the early 1960's the Seine River in Manitoba overflowed its banks during a flow of 4,600 cfs, some 2,600 cfs above the previous recorded high flow. The return period of the flood was estimated at 1-in-71 years. The floodwaters were impounded on the plaintiff's land by dykes owned by the defendant municipalities. The defendants claimed that the flood was unforeseeable. The Manitoba Court of Appeal recognized that this was the largest recorded flood in the history of the area and concluded that "the best of engineers could not, and did not, anticipate it". The court distinguished this situation from the Greenock case on the basis that Greenock applied to interference with a natural watercourse and the present case involved overland flow. In the end, the court believed "this flood was so great that it could not have been reasonably anticipated and was, therefore, [an act of God]". This decision seems remarkable given the high AEP (0.014) but it is significant that a flood was deemed an act of God. Unfortunately for dam owners, the court specifically said that the earlier dam related cases which held extreme floods to be foreseeable were not applicable. Thus, the value of the Manitoba decision in limiting owner liability for dam related floods is questionable.

The Pattison case (see division 2.4.6.2.1) involved a flood with an AEP = 0.01. The court in that case held that flood prediction methods in use in 1970 were not

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97 Smith v. Ontario & Minnesota Power Co. Limited (1918), 44 OLR 43 (OCA)
98 Tomchak v. Rural Municipality of Ste. Anne and Rural Municipality of Tache, supra, n. 93.
99 Pattison et al v. Prince Edward Region Conservation Authority, supra, n. 2.
sophisticated enough to justify an IDF greater than the 1-in-100 year event for that particular dam (a lake level control dam).

More recently, the court in the BC Hydro case\textsuperscript{100} (see division 2.4.3.3.3 and Appendix B), defined an act of God as an event "so extraordinary and overwhelming that the damage resulting therefrom could not be avoided despite all reasonable skill and forethought". In that case, high temperatures and rain on snow forced the dam owner to spill. That event was followed by a 1-in-100 year storm which, in turn, was followed by a 1-in-1000 year flood. The first event, with an unspecified AEP, simply changed the temporal distribution of reservoir inflows and so was foreseeable. The court said that because 1-in-100 year events are routinely planned for, the second event was foreseeable. With respect to the 1-in-1000 year storm, however, the court ruled that "there can be little question but that it was an act of God". Again, a relatively short return period flood was called an act of God. Again, however, the decision is of limited value to dam owners as the court's finding with respect to the 1000-year event was "obiter", a statement not forming a direct part of the reason for the ultimate decision (the defendant was acquitted because it acted with due diligence).

Thus, in BC, it appears that the act of God defence may be available for dam owners. It is unclear, however, given the paucity of decisions of higher Canadian courts, where the foreseeability line will be drawn. Some guidance can be obtained from a review of the situation in the US which has been the site of a number of cases related to dam failures, floods, and the act of God defence. An Idaho decision\textsuperscript{101} declared that:

\textsuperscript{100} \textit{supra}, n. 12.

\textsuperscript{101} \textit{Curtis v. Dewey}, 93 Idaho 847, 849, 475 P. 2d 808, 810 (1970)
“If, therefore, a person builds a dam embankment on or beside a waterway sufficient to withstand the maximum flow of water which might be expected, and his structure is destroyed by a flow which would not have been anticipated by a reasonably prudent man, then the resulting flood would be considered such an extraordinary flow of water as to amount to an ‘Act of God’ and that person would not be negligent and not liable for damages caused by the flood.”

In North Dakota, the test for act of God is102:

“Considering the rains of the past, the topographical and climatic conditions of the region and the nature of the drainage basin as to the perviousness of the soil, the presence or absence of trees or herbage which would tend to increase or prevent the rapid running off of the water, would or should a reasonably prudent man have foreseen the danger and provided against it?”

These definitions match the approach which would likely be taken in a BC court.

American decisions have interpreted the Greenock case to refer to “extraordinary rainfalls as experience shows are likely to recur”103. Thus, if floods of a similar magnitude have occurred in the past, the act of God defence will fail because the event was foreseeable; the defence is only available for truly unforeseeable events, not merely unusual but not unprecedented rainstorms (Binder, 1992). Binder (1992) identifies American judicial decisions holding that liability will be found if the flood losses could have been avoided or prevented by “human prudence,


103 Fairbury Brick Co. v. Chicago, r.1 & P.R. Co., 79 Neb 854, 860, 113 NW 535, 537 (1907).
foresight, and care reasonably to be expected" from a dam owner. Binder (1992) concludes that an act of God defence will fail if the storm is within the PMP or the flood within the PMF. In support, he cites the case of Barr v. Game, Fish & Parks Commission\(^ {104} \), a Colorado decision. In that case, the PMF was 200,000 cfs and the IDF adopted by the dam owner was 33,000 cfs on a river with a previously recorded peak flow of 27,500 cfs. The as-built spillway had a capacity of only 4,500 cfs. A flood with peak flows of 158,000 cfs occurred, with most of that water flowing over the dam. The defendants claimed act of God but the court held that the PMF was foreseeable, hence the particular storm was foreseeable, and so the defendant was liable in negligence for failing to provide an adequate spillway. As Binder (1992) notes in his analysis: “foreseeability is based not only upon the historical past, but also upon that which modern technology and science allows us to project into the future”.

In summary, the law appears to be fairly settled in the United States that the PMF is a foreseeable event. No dam failure in Canada has led to a reported case on this issue, but, given the British cases and the US approach, it seems likely that, in a dam safety situation, dam owners in BC should be prepared for possible liability because of flood events up to and including the magnitude of the PMF.

3.4 IMPACT ON THE DAM OWNER

3.4.1 THE IMPACT OF FORESEEABILITY

In the writer’s opinion, the view that the PMF is foreseeable in a legal sense is a reasonable conclusion given the way in which the PMF is calculated. Even if an AEP cannot be assigned to the PMF, the calculation process requires that

reasonable, and often preceded, component events be used. The only truly extraordinary aspect is the juxtaposition of the component events in the least favourable way. Although the probability of such juxtaposition is certainly remote, it is by definition reasonable and so foreseeable. It is important to note, however, that the calculation establishes a reasonable maximum, suggesting that even greater events, while theoretically possible, are unreasonable to expect and plan for.

The question might arise as to the uncertainly or variability inherent in a PMF calculation. If, for example, the PMF is 5,000 cms and a flood of 5,005 cms overtops the dam, should the dam owner be found negligent? Although other factors will be significant, a duly diligent approach to the PMF calculation is likely all that would be required of the owner.

It is important to bear in mind that the ultimate question is not foreseeability per se, but, given that foreseeability, what actions the reasonable person should take after considering the potential harm and the alternatives available (NRC, 1985). For example, should the dam owner design for the PMF in all cases, or to a lesser standard in some? The appropriate standard of care is a function of the risk created, the expertise of the dam owner, customary behaviour in the industry, and the due diligence of the dam owner. That standard of care will ultimately be determined by a court and so cannot be predicted with certainty. Industry standards such as the CDA Dam Safety Guidelines do, however, provide a minimum standard and such guidelines do require the PMF as the IDF for at least the highest hazard dams.

A further complication for the dam owner is the choice between two primary methods of determining the dam safety standard of care: the prescriptive standard
of the dam hazard classification system and risk analysis. Advantages and disadvantages of each method are described below.

3.4.2 **Prescriptive Standards**

Advantages of using prescriptive standards include the following list compiled by Dubler (1996) and expanded by the author:

1. Standards represent a procedure easy to teach and transfer to new engineers.

2. Standards provide consistency, as like projects have like criteria. Standards also provide a benchmark against which new developments may be judged.

3. Standards in use have been applied and accepted over time.

4. Any standard implies a level of risk which is generally understood and agreed on by the profession.

5. Standards provide a practical way of making decisions.

6. Standards integrate a large body of experience into a decision.

7. Standards may limit legal liability and demonstrate integrity on the part of the dam owner provided the owner meets or exceeds the standard. The prescriptive approach has the advantage of being an industry standard often recognized as conservative. Meeting such a standard is likely to be beneficial in the defence of a law suit.
8. Bowles et al (1996) suggest that the conservatism inherent in standards provides an additional factor of safety against further floodplain development.

9. Standards are economical to use as there are no study costs.

There are, however, problems with simply adopting such guidelines. Dubler (1996) and others identify the following problems:

1. The economic efficiency is unknown.

2. Standards may be obsolete.

3. Standards may limit design flexibility.

4. Standards may be irrationally based.

5. Standards do not promote a clear definition of the problem.

6. Standards tend to discourage innovation and may result in the engineer neglecting other aspects of dam safety for which standards do not exist (as, for example, a poorly designed spillway gate which, if overtopped, cannot be opened (Salmon and Hartford, 1995)).

7. Standards obscure information about risks, costs, and benefits.

8. Use of the PMF and PMP criteria suggests that the ability to predict extreme events is greater than it actually is and so leads to unrealistic expectations.
9. Use of the PMF may give the illusion of absolute safety. In fact, there remains an undetermined probability that larger flows may occur (Salmon and Hartford, 1995).

10. The division of hazards or consequences into three or four categories lumps dams which pose a hazard to a relatively small number of people with those which affect many more (Bowles et al., 1996). While this is of little relevance with respect to legal liability (where the question is risk to the particular plaintiff), it represents a very simplified cost-benefit approach and so may, in the economic sense, misallocate resources.

11. Bowles et al. (1996) argue that use of the classification system tends to promote potentially excessive conservatism as engineers adopt IDF's at the upper end of a category. Other writers disagree with this assessment. Salmon et al. (1997) suggest that the ranges within the CDA Dam Safety Guidelines recognize a gradation, reducing the importance of placing a dam in one category over another as both categories may require the same IDF.

12. The standards used for dam safety are more conservative than standards for other societal risks (Dubler, 1996) which may be unfair to the dam owner. For example, Dubler (1996) suggests that the return period for the maximum credible earthquake, the design earthquake for many dams, is generally between 500 and 1,000 years, making a dam 10 to 1,000 times more likely to experience the design earthquake than the design flood. Furthermore, as the IDF approaches the PMF the probability of an overtopping failure
approaches zero, or no risk. Critics argue that "no risk" is not a reasonable goal and ignores the economic considerations (Dubler, 1996).

13. Courts tend to compensate victims, particularly "innocent" victims of large corporations with deep pockets and a business motive (Binder, 1992). This effect is magnified when lives are lost or people injured. Thus, an industry standard or government regulation mandating a certain IDF that is less than the PMF runs a very high risk of being found unreasonable. This is especially true if lives are at risk or the plaintiff derives no benefit from the dam.

14. Standards make no differentiation for the financial situation of the dam owner. An impecunious owner with a high hazard dam (some fatalities and large economic losses) would almost certainly be financially ruined by a failure. Because any dam safety decision to construct a spillway of less than PMF capacity amounts to some degree of self-insurance (depending upon the risk), dam owners without significant financial resources may wish to carry some of that insurance by using an IDF higher than that suggested by the standard for their dam's classification.

15. Changes in floodplain conditions, such as the number of residents or expected economic losses, may change the classification of a dam and so the IDF.

Note also that the standard of care is usually higher for professionals or experts than for laypersons. Thus, a dam owner, who is likely to have employed an engineer at least for designing and overseeing construction of the dam, will be held
to an engineering standard with respect to the dam. As experts have a duty to stay current in their field, the dam owner must remain aware of advances in flood forecasting techniques. It should be obvious that continuing updates on the hazard classification of the dam are essential as well.

3.4.3 RISK ANALYSIS

Advantages claimed for the risk analysis approach include:

1. It is site specific (Dubler, 1996) and considers all modes of failure (Salmon and Hartford, 1995).

2. It provides an additional source of information for decision makers (Dubler, 1996). For example, risk analysis provides the relative likelihood of different failure pathways (Thompson et al, 1997).

3. It may identify aspects of the problem otherwise undetected (Dubler, 1996), such as the significance of uncertainties pertaining to the distribution of rainfall or other variables (Thompson et al, 1997).

4. It addresses the cost-benefit question, thereby saving money (Dubler, 1996). Lave and Balvanyos (1998) contend that this is especially true for existing dams which no longer meet the prescriptive standard. They suggest that the money saved by risk analysis could be better spent lowering losses from less extreme but more frequent floods.

5. It allows the assessment of the relative importance of hazards (Salmon and Hartford, 1995).

Risk analysis does have some disadvantages:
1. It is time consuming and expensive to perform (Dubler, 1996). However, Lemperiere (1999) suggests that risk analysis is practical for even medium and small dams if similar dams are combined within one analysis and the cost shared among them. He reports that this approach, initiated by regulators, worked well in France.

2. There is a lack of professional consensus regarding its application (Dubler, 1996).

3. It is difficult to estimate the probability of extreme events (which can also be a problem with prescriptive standards requiring a given AEP). The NRC (1985) reports that the occurrence of floods larger than those predicted by probability studies has discouraged the use of frequency analysis for estimating extremely rare floods. Estimates tend to change frequently as more flow data is collected over time (NRC, 1985).

4. It is difficult to accurately predict dam behaviour under extreme loads (Dubler, 1996).

5. Engineering judgment is said to be precluded (Dubler, 1996). In contrast, Salmon and Hartford (1995) feel that the probabilities used in calculations should be estimated by experienced engineers familiar with the dam and using event trees as a focus for engineering judgment.

6. Certain aspects of the problem cannot be easily quantified such as the value of lives lost or environmental degradation (Dubler, 1996).
However, other approaches may be available to deal with this problem – see division 3.2.2.3.

7. Economic considerations are not straightforward (Dubler, 1996). For example, the prevention of flood damage is an uncertain benefit. Although statistically the benefits approach expected values in the long run, the present value depends on the timing of the floods (NRCC, 1989). Interest rates are also difficult to forecast (NRCC, 1989).

8. Changing downstream conditions may render economic evaluations invalid (Dubler, 1996) and may force the dam owner to incur the expense of risk analysis again.

9. Lemperiere (1999) found that most risk analysis fails to consider human error which, he suggests, is a key factor in many dam failures.

10. Design trade-offs, such as those that result from cost-benefit or risk analyses, may be economically justifiable to the dam owner but, in the eyes of the trier of fact, especially a jury, such decisions may seem callous (Binder, 1992). Fortunately for BC dam owners, civil jury trials are rare in Canada relative to the US and it is unlikely that a defendant dam owner would choose to be tried before a jury, particularly given the technical nature of any defence it would raise. However, even a judge may be appalled by a blatantly wrong safety decision such as Ford Motor Company’s failure to fix the exploding gas tank on the Pinto model with a $10 part (Binder, 1992). Public condemnation of a dam owner is also likely to be significant, especially if lives are lost.
11. Risk analysis is arguably not yet an industry standard approach to dam safety issues. This has implications for consideration of the legal standard of care.

3.5 CONCLUSIONS AND RECOMMENDATIONS

The PMF constitutes the currently foreseeable extreme event and therefore forms the basis of determining a reasonable standard of care. Although engineers and businesses often adopt cost-benefit or risk analyses to evaluate the optimum economic approach to a problem, the economics of dam safety decisions are only one factor in the legal liability equation. Putting lives and property at some degree of risk may be economically justifiable but may not be legally justifiable. Smaller dam owners, particularly those with dams serving primarily private purposes, should carefully consider the potential liability associated with dam safety issues. All dam owners must, of course, include the cost of liability in their analyses and should bear in mind the likelihood of public condemnation likely to follow any loss of life.

Of the two approaches to dam safety, prescriptive standards are, from the legal point of view, to be preferred over risk analysis. The reasons for this are:

1. The standards incorporate the foreseeable flood (the PMF) for many dams, abandoning it only when the risk to life is small and incremental property losses are low.

2. The PMF is essentially (although not absolutely) a no-risk approach to dam building. This meets the legal standard of care and may meet the public's expectations of good business citizenship, reducing negative public relations impacts of flooding.
3. The CDA’s Dam Safety Guidelines are a recognized industry standard and comparable with others around the world. This is a good (although not guaranteed) basis for a defence in court.

4. The public relations costs of using less than what is often seen as a zero-risk approach to dam safety may be devastating to a dam owner. Risk analysis, although it may provide greater economic benefits to society and probably does so for the dam owner, is, from a legal viewpoint, the least satisfactory approach to dam safety for the following reasons:

1. It does not consider foreseeability and is unlikely to adopt the PMF as the IDF, increasing the likelihood of successful negligence claims.

2. It expressly acknowledges that there is a quantifiable, though perhaps socially justifiable, risk to lives and property. This establishes a dam owner’s foreknowledge of potential risk of harm, again increasing the likelihood of successful negligence claims.

3. It is an economic analysis which, depending upon the method, may be based upon public tolerances for hazards, not dam safety per se. Furthermore, it is not public tolerance of risk that is the issue in a negligence claim but rather the risk imposed on the individual plaintiff.

4. The approach might be interpreted as callous as it essentially advocates the dam owner providing the minimum safety he or she can afford (the cost to the dam owner of lower safety being the incremental flood...
losses). A deep-pocketed dam owner could therefore afford a lower standard of safety.

However, economic considerations play a significant role in the dam owner's decisions. Many owners may elect to self-insure by adopting the risk analysis approach in spite of additional expected legal costs. For most dam owners, it may be that the approach adopted will be to construct new dams to the prescriptive standard but use risk analysis to consider appropriate upgrades when the nature of the floodplain or hydrometeorological knowledge changes.

One final note: this chapter does not purport to comment upon the appropriate moral, ethical, or economic basis for dam safety decisions but has examined only the legal aspects of such decisions. Other considerations beyond legal issues may justifiably lead a dam owner to make decisions other than those recommended here.
4.1 INTRODUCTION

At common law, riparian owners have certain riparian rights to receive the flow of a watercourse onto their land in its natural state (see division 2.3.1). This includes the right to water in its natural quantity or flow and its natural quality, subject only to the rights of upstream riparian owners to withdraw water for domestic and other reasonable uses and to public rights of navigation (Thompson, 1984). Although the right to receive the naturally flowing quantity of water has been abolished by legislation (see division 2.4.2), statute law has not expressly dealt with the issue of water quality (Chessman, 1984). The riparian right to receive water in its natural quality probably still exists in BC today.

A dam affects the watercourse it regulates. This trite statement applies to both the flow of the watercourse and the nature of the water upstream and downstream of the dam. In the reservoir, velocity is reduced and an artificial lake created. The reduction in velocity reduces the sediment transport capacity of the watercourse leading to the deposition in the reservoir of sediment carried down from the upper reaches of the watershed. Such deposition withholds both sediment and nutrients, particularly phosphorus, from downstream waters. The creation of a lake also changes the ecology of the watercourse, potentially leading to murkier water as phytoplankton increase, to reductions in available nutrients due to uptake by
algae, and to reduced oxygen levels in the deeper portions of the reservoir as organisms die and decompose.

On the downstream side of the dam, the flow is limited to that released from the outlet works (often a low level outlet), the turbines, if any, and occasional flood releases through the spillway. Water released through low level outlets and turbines is generally water drawn from deep in the reservoir. Such water is usually colder and may have a concentration of dissolved oxygen different than the natural streamflow. Furthermore, released water carries a reduced sediment load which may deprive some downstream areas of natural deposition or accretion and may increase erosion in other areas.

Thus, a riparian owner along the dam’s reservoir or the reach downstream of the dam within which the river has not returned to a “natural” state, is potentially not receiving water in its natural quality. This may impact the riparian owner in a number of ways. For example:

- A municipality withdrawing drinking water may be pleased with cleaner, cooler water but the same municipality may have to undertake additional waste treatment measures because the reduced nutrient load restricts the river’s ability to assimilate waste.

- Riparian owners may experience increased erosion of their property or a reduction in nutrient deposition on floodplain lands.

- Recreational fishing may be reduced.

This chapter considers the mechanisms by which a dam and its reservoir affect the quality of water, the legal rights which a riparian owner may still have with
respect to quality, and reaches a preliminary conclusion regarding the legal implications for the dam owner.

4.2 THE AFFECT OF A DAM ON WATER QUALITY

Water quality problems may arise in reservoirs during the filling period and thereafter while the reservoir is operated.

4.2.1 RESERVOIR IMPOUNDMENT

When a reservoir is filling, little or no water is released downstream. This exacerbates the sediment and nutrient deprivation problems described in divisions 4.2.3 and 4.2.5. A further problem is the submersion of biomass (the plants existing within the pre-reservoir valley) and soils. The decomposition of the biomass may create dissolved oxygen problems (Zwahlen, 1998) as described in division 4.2.6. Clearing the reservoir bed and shoreline of plant life before filling helps prevent this problem (Zwahlen, 1998).

4.2.2 RESERVOIR OPERATION

Once the reservoir is full, it behaves very much like a lake (Zwahlen, 1998) although there are some significant differences. Straskraba (1994) studied a series of reservoirs in the Czech Republic and noted a number of qualitative and quantitative differences. Significant differences include:

- the maximum depth of a reservoir is at the dam but the deepest portion of a lake is usually near its center;

- the organic bottom sediments of lakes tend to be autochthonous in origin (derived from within the lake's ecosystem from, for example,
algae and higher aquatic plants) while those in reservoirs are allochthonous (derived from outside the lake's ecosystem from, for example, leaves, woody debris, and other terrestrial sources);

- lakes have longitudinal gradients created primarily by wind but the gradients in reservoirs are primarily flow-driven with some wind influence;

- the outlet of a lake is at the surface while the usual outlet of a reservoir is deeper (through outlet works or turbines); and

- reservoirs have a shorter water retention time than lakes, experience larger level fluctuations, and have more variable hydrodynamics.

Thus, reservoirs have many characteristics more in common with rivers than lakes (Horne and Goldman, 1994).

There are, however, similarities between reservoirs and lakes. For example, both develop vertical stratification with zones of different light, temperature, and quality characteristics. Zones of light include:

1. The photic zone within which plants (algae) can photosynthesize, releasing oxygen and raising the concentration of dissolved oxygen (Horne and Goldman, 1994). The photic zone is the uppermost layer of the reservoir.

2. The aphotic zone in which there is not enough light to allow photosynthesis. Oxygen reaches this zone by diffusion from the photic zone, by mixing of the two zones, or by input of fresh water. This zone, which is often the region from which water is released.
through outlet works or run through turbines, may be low in dissolved oxygen (see division 4.2.6).

Zones may also be classified by temperature, and often quality, into the relatively warm upper layer or epilimnion, the colder bottom layer or hypolimnion, and the thermocline, a relatively narrow band of rapidly changing temperature between the two (Horne and Goldman, 1994). Water for low level outlets and turbines is usually taken from the cold, deep hypolimnion water. Temperature stratification in BC lakes is typical only in the summer when the longer daylight hours and more intense sunlight heat surface waters. In the spring and autumn, surface waters cool, the thermocline weakens and winds mix the layers. Note that inflows help mix the zones throughout the year although inflows do vary seasonally.

4.2.3 SEDIMENT

Streams and rivers transport sediment of various sizes in various ways. Bedload (the larger particles and rocks) is generally moved by rolling or bouncing (saltation) which requires relatively high flow velocity (ASCE, 1975). Finer silts and clays are moved in suspension, kept in solution by turbulence and lift forces (Henderson, 1966). When velocity falls low enough, even the fine particles settle out. The low water velocity in the reservoir is insufficient to move bedload and is often low enough to allow suspended sediments to settle out (ASCE, 1975). These sediments may build up behind the dam and significantly reduce the volume of the reservoir over time or even threaten the structural integrity of the dam by increasing loads on the upstream face.

Along the shore of the reservoir, the deposition of fertile sediment can encourage plant growth, creating weedy shorelines which degrade property values (ASCE,
Similarly, shoaling may affect property values, convert beaches to mudflats, and impinge on fishing, boating, and other recreational activities (ASCE, 1975).

Water released from the dam is usually relatively sediment free. This improves the clarity of the water and may be beneficial for certain elements of an aquatic ecosystem and for recreation. However, it denies the lower reaches of the watercourse the sediment which would naturally be transported from the upper watershed. This may cause problems for riparian owners:

- Watercourses have a capacity or maximum amount of sediment that can be transported (ASCE, 1975). The relatively clean water released from the dam may be below that capacity and thus have a greater erosive power. This may result in increased bank erosion of riparian lands, causing a greater loss of property than would occur with an unregulated stream.

- The lack of sediment in water released from the dam may also reduce deposition of sediments at natural accretion locations downstream of the dam. Such an effect would reduce the rate of accretion to a riparian owner’s property where the property line is the bank of the watercourse. Additional erosion may result as the protective accretion deposits do not form. Major impacts may be felt over large areas; for example, the Aswan High Dam on the Nile River has caused the Nile delta to recede by blocking sediment transport (Horne and Goldman, 1994).

Sediments also play a role in the nutrient quality of water by acting as a source or sink of beneficial substances (Baldwin et al, 1998). Blocking sediment transport at
a dam may deprive the floodplain of important nutrients, particularly phosphorus (see division 4.2.5).

Continual releases through the outlet works can provide some sediment flushing although the volume is unlikely to equal that of the natural stream (Zwahlen, 1998).

4.2.4 Temperature

4.2.4.1 Releasing Cold Water

Water released through the outlet works or turbines of a dam is usually drawn from the middle or deep portion of the reservoir and tends to be colder than surface waters. That temperature differential may vary seasonally due to mixing (see division 4.2.2) or annually due to varying inflows. Straskraka (1994) reports that retention time has a “marked effect” on reservoir temperature structure. In high flow years, the unstratified inflow is powerful and may reach the depths of the reservoir, raising hypolimnetic temperature and reducing temperature stratification. Dry years, with lower, less powerful, inflows do not promote mixing and allow formation of a stronger thermocline.

Colder water can be deleterious to the aquatic ecosystem, including fish, and to riparian crops, such as rice, which rely on river water (Horne and Goldman, 1994). While the tolerance of crops is less likely to be a factor in BC, colder water may affect the recreational uses of the river (such as swimming and fishing) and, by altering the ecosystem, may affect the river’s aesthetic value.

4.2.4.2 Releasing Warm Water

In some cases, cool autumn weather may result in an epilimnion cooler than the hypolimnion. Water which has been run through turbines to generate electrical
power also tends to be warmer than the natural river water. “Warmer” water released from the hypolimnion or through turbines may delay freezeup downstream, changing the nature of the river’s ice formation regime (Prowse and Conly, 1998).

The formation of ice can be significant to riparian property and municipalities downstream of a dam. When the ice-front moves past a location, particularly in spring when higher flows may create and ice-jam, backwater effects may cause extensive flooding, even for relatively low flows. The elevation at which ice forms is a factor in ice-jam formation and is determined by river stage at freezeup. Delayed freezeup due to warmer water temperatures may result in ice forming at a different elevation than an unregulated river. Ice and ice-jams may, in addition to exacerbating or causing flooding, cause increased bank erosion.

4.2.4.3 Solutions

This problem can be difficult to deal with. One solution is a multi-level water intake for turbines or the low level outlet (Zwahlen, 1998). Surface water is mixed with hypolimnion water to moderate the temperature.

4.2.5 NUTRIENTS

Nutrients are inorganic substances essential for plant growth (primary production). Primary production is limited by the nutrient available in the lowest concentration. In fresh water, this is usually phosphorus although it can be nitrogen in some circumstances (Zwahlen, 1998). Nutrients are added to the reservoir by inflows, the addition of allochonolous organic matter, and the dissolution of nutrients in the shoreline sediments of the reservoir (Horne and Goldman, 1994).
4.2.5.1 Phosphorus

This nutrient usually limits productivity in fresh water ecosystems because of its relative scarcity (Horne and Goldman, 1994). Trapping phosphorus in a reservoir reduces the productivity of waters downstream and enhances productivity in the reservoir. Reservoirs trap phosphorus by:

- encouraging deposition of the sediment particles within which most phosphorus is carried (Horne and Goldman, 1994), and

- providing an environment more suitable for phytoplankton which consume phosphorus (Straskraba, 1994).

In some reservoirs, 80-90% of the phosphorus entering the reservoir is trapped (Straskraba, 1994) or at least delayed in its passage downstream (Horne and Goldman, 1994). Retention time varies with the season. During spring, autumn, and winter, when phytoplankton are fewer or absent, more nutrients pass through a reservoir.

Phosphorus is also important for terrestrial plants on the floodplain. Blocking its passage at the dam may have a negative effect on the levels of natural nutrients available to such plants (Dansie, 1995). The fertile Nile River floodplain has suffered from the loss of phosphorus-carrying sediments since the completion of the Aswan High Dam (Horne and Goldman, 1994).

4.2.5.2 Nitrogen

Nitrogen is largely transported in soluble form and its availability is heavily tied to inflows (Horne and Goldman, 1994). It is usually present in the form of nitrates (Zwahlen, 1998). Nitrates supply oxygen necessary for the decomposition of organic material in the water column and in the sediments lining the reservoir.
N₂, the byproduct of using nitrates as an oxygen source, is not directly useable by most plants (Laws, 1993). Nitrates can therefore be significantly depleted in reservoirs with high plankton concentrations as considerable quantities are used to decompose dead algae (Horne and Goldman, 1994). The reduction in flood volume due to control of the river by the dam also reduces the amount of nitrogen transported to downstream riparian areas and the floodplain.

4.2.5.3 Eutrophication

High levels of nutrients, coupled with high primary production (or net photosynthesis) can lead to "eutrophication" of the reservoir. A eutrophic reservoir or lake typically has an abundance of algae or phytoplankton as a result of high nutrient levels. In the summer, when light levels allow maximum photosynthesis, plankton populations can increase rapidly. As the algae photosynthesize, they consume nutrients and expell oxygen, possibly supersaturating the epilimnion with O₂. Algae blooms increase the turbidity of the water and may be large enough to form unsightly mats on the surface and cause foul odors. When plankton dies, the remains sink into the hypolimnion where they are decomposed, depleting the oxygen in the lower zone of the reservoir. If oxygen is eliminated, anaerobic decomposition will produce methane (Hajda and Novotny, 1996) and hydrogen sulphide (Zwahlen, 1998). Nutrients are locked in the reservoir bottom sediments with the decomposing plankton (Horne and Goldman, 1994).

Eutrophication usually results from high concentrations of phosphates, nitrates, and ammonia (Horne and Goldman, 1994). Reservoirs with agricultural, urban, or industrial lands within the watershed are at higher risk of "cultural eutrophication" as a result of nutrient rich farm, urban, and industrial runoff and waste (Zwahlen, 1998). Thus, eutrophication is often caused not by the dam per se
but by land use in the upstream watershed. Nevertheless, dam owners are often blamed for water quality problems resulting from these sources (Zwahlen, 1998).

Eutrophication problems are not limited to the reservoir. Releases of water with high concentrations of nutrients may cause plankton blooms downstream, directly affecting riparian owners with the eutrophication problems described above. Releases containing plankton may cause oxygen deficits downstream as the plankton die and decompose (Hajda and Novotny, 1996). In extreme cases, foul odors and taste, choking of water works and filtration systems, fish kills, and aesthetic degradation can occur downstream (Fukuju et al, 1998).

Eutrophication is not a significant problem for many reservoirs in BC for the following reasons (Zwahlen, 1998):

- little submerged biomass, particularly if the reservoir bed is logged before filling;
- cool air and water temperatures which slow decomposition and limit the primary production growth season; and
- seasonal turnover of reservoir waters which distributes nutrients and oxygen throughout the water column.

However, in regions such as the Okanagan, owners with small and therefore warmer impoundments or with agricultural or urban areas in the watershed may need to more carefully consider this issue.

4.2.5.4 Oligotrophication

Low nutrient levels can also cause problems in reservoirs. Oligotrophic reservoirs
have low primary production because of low nutrient concentrations. Some reservoirs, such as Arrow Reservoir on the Columbia River, are naturally oligotrophic but can be made more so through various mechanisms, including:


- Wide level fluctuations reduce littoral zone fauna and encourage faster deposition of phosphorus to the deeper parts of the lake (no explanation for this process offered) (Pieters et al, 1998, and Milbrink and Holmgren, 1981).

- The decomposition of spawned-out salmon can supply up to 50% of a watercourse's phosphorus load (Stockner and MacIssac, 1996). Reduced numbers of returning salmon deprive the watercourse of this source of nutrients. This is a significant problem in many BC lakes and reservoirs (Pieters et al, 1998).

- Climate changes and changes to the nutrient pathway through the lake can alter seasonal hydrographs and change circulation patterns, accentuating nutrient limitations in the epilimnion, changes in food web structure, and productivity (Pieters et al, 1998, and Stockner, 1997).

An experimental fertilization program is currently underway in Arrow Reservoir to counteract these processes and increase primary production (Pieters et al, 1998).

To the extent that a dam contributes to oligotrophication, a dam owner could be held accountable for changes to water quality both on the reservoir and
Dissolved oxygen is necessary for the metabolism of aquatic animals (Sale et al., 1991).

4.2.6.1 Lower Dissolved Oxygen

Dams and the associated reservoirs may lower the amount of oxygen in the water by the processes of decay described in division 4.2.5.3. Low dissolved oxygen concentrations are a greater problem in deep reservoirs as such reservoirs are more likely to stratify in summer (Sale et al., 1991). Oxygen in the hypolimnion is consumed by benthic organisms and by decomposers of algae settling from the epilimnion. Thermal stratification may also prevent inflows from refreshing the hypolimnion (Sale et al., 1991). The O₂ concentration in reservoir outflows depends on retention time, outlet depth, hypolimnetic oxygen levels, organic loading from inflows, and sediment oxygen demands (Sale et al., 1991).

Lower oxygen levels affect downstream water quality, aquatic habitat, recreation, and waste assimilation (Higgins and Brock, 1999). This can occur both in summer when plankton populations are high in the reservoir, and in winter when ice cover prevents the exchange of oxygen with the atmosphere (Horne and Goldman, 1994). Oxygen levels in eutrophic reservoirs may fall low enough to kill fish (Horne and Goldman, 1994), even in the epilimnion if wind or other mixing brings hypolimnetic water up (Zwahlen, 1998). Released water may also be below water quality standards (Higgins and Brock, 1999). In addition, the processes that make water anoxic (oxygen-poor) also tend to make it acidic, causing corrosion of concrete and metal (Zwahlen, 1998).
In BC, the water quality standard for the support of aquatic life requires instantaneous $O_2$ minimums of 5 to 9 mg/L (depending on the life cycle of significant organisms) and 30-day means of 8 to 11 mg/L (MELP(2), 1999)\textsuperscript{105}. Many dam releases do not meet these standards, particularly during the summer (Higgins and Brock, 1999).

A number of techniques are available to reduce or eliminate the problem. Low level outlet releases help draw a small amount of surface water into the hypolimnion, supplying some oxygen (Zwahlen, 1998). More technical solutions are offered by Higgins and Brock (1999) who summarize five techniques studied or used by the Tennessee Valley Authority in the US:

- **Turbine autoventing** using the subatmospheric pressure at the vacuum breaker outlet of some turbines to draw air bubbles into the draft.
- **Turbine air injection systems** forcing air into the water and raising dissolved oxygen concentrations.
- **Surface water pumps** forcing high-oxygen surface water to depth, essentially mixing the epi- and hypolimnions.
- **Oxygen diffusers** on the reservoir bed adding $O_2$ to intake waters.
- **Designing weirs** to help oxygenate released water.

\textsuperscript{105} Standards for dissolved oxygen for other purposes are deemed not necessary by the BC Government at the time of this writing.
Details of these techniques may be found in a WaterPower '97 conference paper by Brock and Adams (1997). Other techniques exist but are not enumerated here (see Sale et al, 1991).

4.2.6.2 Elevated Total Gas Pressure

A dam may also raise the gas, including dissolved oxygen, content of downstream water. Such water can be toxic to fish. Total gas pressures are raised when water from the reservoir is discharged through a spillway. During the discharge, the water entrains air and then plunges to depth in the stilling basin. Under elevated hydrostatic pressure the air, in the form of bubbles, is forced into solution at pressures of several atmospheres (Smith, 1974). The water becomes supersaturated with oxygen, nitrogen, and other gases. Fish extract the gases through their gills, the gas enters the bloodstream, and, if the fish moves to shallower or warmer water, the gas may come out of solution. When it does so, it forms bubbles that can kill or injure fish by blocking their blood vessels (Smith, 1974). This is essentially the same process by which human divers get the “bends”.

Supersaturation occurs naturally in rivers but is seldom a problem because turbulence and cascades provide for more rapid release of the dissolved gas (Smith, 1974). Reservoirs and stilling basins do not provide the turbulence needed to speed the gas release.

Elevated total gas pressures do not appear to affect water quality except with respect to fish. This may impact on a riparian owner’s recreational opportunities but, as fish are the property of the Crown, does not directly impact riparian lands.

Because of the fisheries aspects of this problem, various technical solutions have been developed, including:
• installing additional turbines to reduce spilling (Smith, 1974);

• transporting or directing fish around supersaturated reaches (Smith, 1974);

• installing flow deflectors in spillways to reduce the depth to which water plunges and to increase turbulence (Smith, 1974);

• adopting shallower, baffled spilling basin designs (Johnson, 1992); and

• adding a cascading weir downstream to provide turbulence (Johnson, 1992).

4.3 THE LAW

4.3.1 WATER QUALITY

4.3.1.1 Statutory Law

4.3.1.1.1 Water Quality Guidelines

Water quality standards in BC are promulgated by both the Ministry of Health and MELP. Pursuant to the Health Act\textsuperscript{106}, the Ministry of Health regulates drinking water standards and public bathing beaches with respect to public health aspects. Pursuant to the Environmental Management Act\textsuperscript{107}, MELP has created guidelines identifying maximum or minimum concentrations of various deleterious and beneficial substances permitted in specific watercourses or for

\textsuperscript{106} R.S.B.C. 1996, chapter H-179.

\textsuperscript{107} R.S.B.C. 1996, chapter E-118.
specific purposes. Standards exist for dissolved oxygen, many nutrients (including phosphorus and nitrogen), turbidity, and others. Temperature is not specifically addressed by a quality guideline.

Although the guidelines do not directly affect dam owners, they do illustrate the broad range of factors which comprise “water quality”.

4.3.1.1.2 Waste Management Act

The provisions of the Waste Management Act (referred to in this division as the “Act”) are described in detail in division 2.4.3.2. A dam owner must not introduce or allow “waste” into the “environment” nor cause “pollution” (section 3). Waste includes “effluent”, a substance which is capable of injuring any life form or damaging the “environment” (section 1). The environment includes the “air, land, water and all other external conditions or influences under which humans, animals and plants live or are developed” (section 1). Pollution means substances that substantially alter or impair the usefulness of the environment (section 1).

Does a dam owner contravene section 3 of the Act by releasing water with concentrations of sediment, nutrients, temperature, dissolved oxygen, or phytoplankton different than the natural stream? No reported judicial decisions have been found to directly answer this question. A successful prosecution would have to show that:

- water with such characteristics constitutes “effluent” or “pollution”; and

- the release of water through a dam constitutes a release into the environment.
It seems clear that water with higher or lower nutrients, temperature, or dissolved oxygen concentrations is capable of injuring life forms. Water with reduced sediment loads might be said to be capable of damaging the environment by depriving downstream accretion zones of sediment or by accelerating erosion in other areas. Therefore, it is not patently unreasonable to suggest that reservoir water may constitute effluent. Similarly, such water could arguably alter or impair the usefulness of the environment, perhaps “substantially”, and thus be considered pollution. Recall that the BC Hydro case (see division 2.4.3.3.3 and Appendix B) held that natural sediments washed into the watercourse by a high spillway release are “deleterious substances” under the Fisheries Act. Note also the BC Court of Appeal’s decision in *R. v. Seraphim*\(^{108}\) which held that, to be effluent, a material must be at least “capable of causing injury to man, property, or a life form”. The court also noted that the capability to injure is assessed on the facts of the individual case.

The question of whether or not reservoir waters are released into the environment is a more subtle question. Clearly, such waters are already part of an environment as part of the reservoir, are naturally occurring, and provide a medium or support for existing ecosystems. Could it be argued that water released into the downstream “environment” has entered a different “environment” in which it has potential to do damage? Is an anthropogenic transfer from one “environment” into another a breach of the Act? Or is this simply the case of the lake environment in one reach of the watercourse having a natural effect on a lower, riverine, environment? The answers to these questions are unknown at present but two interesting cases provide some guidance on what constitutes

\(^{108}\) *supra*, n. 11.
"environment". *R. v. Enso Forest Products Ltd.* involved an oil spill which was confined to ditches designed to catch such spills. Because the defendant's permit under the Waste Management Act did not cover oil, the defendant was charged with allowing waste to enter the environment. The court dismissed the charge on the basis that the spill was confined to land comprising part of the defendant's works. Such land is not part of the environment the court ruled. Therefore, discharges of waste, including effluent, on the dam itself would not contravene the Act if the spill went no further. Arguably, a discharge into the forebay, tailrace, stilling basin, or other water-containing portion of the works would not contravene the Act if the spill is confined to that area.

The above argument assumes, however, that the dam owner holds a valid Waste Management Act permit. *British Columbia (Minister of Environment, Lands and Parks) v. Alpha Manufacturing Inc.* involved a waste disposal company that had its permit to dispose of certain waste at a certain site canceled by the Ministry. The company continued to collect and store waste (although not dispose of it) at the site and the Crown sought a restraining order against such activity. The defendant, arguing the *Enso* case's line of reasoning claimed the site was not part of the environment. The court rejected the argument because works are only separate from the environment if a valid permit or approval exists.

**4.3.1.2 Common Law**

At common law, a dam owner causes pollution by doing something which changes the natural qualities of water, including its temperature (Hailsham, 1984). There can be little doubt that the physical and biological processes which occur in

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109 (1992), 8 CELR (NS) 253; 70 BCLR (2d) 145; 16 WCB (2d) 491 (BCSC); aff'd 12 CELR (NS) 221; 62 WAC 74; 85 BCLR (2d) 249 (BCCA)

110 (1996), 132 DLR (4th) 688 (BCSC)
a reservoir change the qualities of the water. The act of impounding water and causing "pollution" may therefore be actionable at common law as an infringement of riparian rights (Hailsham, 1984). Examples are discussed in division 4.3.2.1.

4.3.2 RIPARIAN RIGHTS AND WATER QUALITY

4.3.2.1 Case Law

Many judicial decisions exist with respect to a riparian owner's right to water in its natural quality. Most, however, involve the discharge of industrial or agricultural effluent into the watercourse. For example, in McKie v. K.V.P. Co. Ltd.\textsuperscript{111} a riparian owner sued for an injunction to stop a pulp mill from polluting the river. The court confirmed that:

"The proprietor of riparian lands has a right ... to see the flow of water through or by his land in its natural state, and if the stream is polluted or otherwise interfered with, so as to affect this right, by an upper riparian proprietor, the lower riparian proprietor who has suffered damage in law, though not in fact, may maintain an action for an injunction unless the person causing the interference with his right has a prescriptive right to do so."

There are several important statements in the preceding quote:

• The court held that, where an injunction is sought, it is not necessary that actual damage have occurred. The riparian owner need only show that his or her rights were violated.

• Note that the court used the phrase “polluted or otherwise interfered with” in describing the prohibited action. This may extend the bounds of what constitutes interference with quality beyond direct pollution and so may include, for example, deprivation of nutrients.

• The case suggests that any interference with natural quality is a breach of riparian rights unless the dam owner has acquired a prescriptive right to do so. In general terms, a prescriptive right is acquired if the dam is operated and affects water quality for at least 20 years. Many BC dams may, because of their age, have acquired prescriptive rights.

In a more recent example, riparian owners on an Ontario lake obtained an injunction halting a proposed speedboat regatta on the grounds that the event would diminish the “purity, wholesomeness and potability” of the lake water. This suggests that industrial pollution is not the only recognized threat to riparian quality rights. The decision is also significant because the court stated that the “economic necessities of the defendant are irrelevant” when riparian rights are violated.

In Britain, a colliery’s operation resulted in increased salinity of the water. A lower riparian owner’s crops withered when irrigated with the stream water. The court found the colliery liable for damages as it had affected the “natural state of purity” of the water. The judge quoted an old case which also suggests that increasing pollutant concentrations is not the only way of affecting riparian quality rights:

“Every riparian proprietor is ... entitled to the water of his stream, in natural flow, without sensible diminution or increase and without sensible alteration in its character or quality”\textsuperscript{114}.

Although no cases deal specifically with the effect of a dam, a number of decisions consider the effects of erosion, accretion, and removal on the sediment regime of a river. Both erosion and accretion may deprive land of its contact with water and so change its riparian character\textsuperscript{115}. Thus, depriving downstream reaches of sediment may result in floodplain residents gaining or losing riparian status. One would expect that an owner who lost riparian rights might seek compensation from the dam owner. However, such changes would have to be attributable to the dam and not to natural sediment transport processes. Unusual or unnatural events that deposit sediment do not contribute to accretion\textsuperscript{116} and the same reasoning would presumably apply to erosion - to constitute a change in the riparian land, the accretion or erosion must be natural and slow.

The removal of sediment from the streambed or shoreline is also actionable. In \textit{Servos v. Stewart}\textsuperscript{117}, the defendant’s dredging operation potentially increased the risk of erosion of the plaintiff’s lands. An injunction was granted and the court noted that “the fact that sediment might move naturally is no defence”. Therefore, although natural sediment transport is a risk which must be assumed by the riparian owner, unnatural movement is not.

\textsuperscript{114} \textit{Young v. Bankier Distillery Co.}, [1893] AC 691.

\textsuperscript{115} \textit{Queen’s County v. Cooper}, [1946] SCR 584.

\textsuperscript{116} \textit{Port Franks Properties Ltd. v. The Queen} (1979), 99 DLR (3d) 28 (FCTD).

\textsuperscript{117} (1907), 10 OWR 528, 15 OLR 216.
4.3.2.2 Possible Defences

4.3.2.2.1 At Common Law

Owners of dams more than 20 years old may have acquired the prescriptive right to alter water quality (see division 4.3.2.1). Recall, also, that upstream riparian owners are entitled to make reasonable use of the water, provided that it is returned to the watercourse. The dam owner may be able to successfully assert that changes to water quality are reasonable given the purpose of the dam.

4.3.2.2.2 Statutory Authorization

Although the Water Act does not specifically address the water quality issue, by section 5 of that Act a licence entitles its holder to use the specified quantity of water, to store water, and to “alter or improve a stream or channel for any purpose” authorized by the licence. It might be arguable that those provisions authorize consequential alterations in water quality.

4.4 CONCLUSIONS AND RECOMMENDATIONS

The common law riparian right to receive water in its natural quality is not dependent upon actual damage to the land of the riparian owner to found an action for an injunction (although, obviously it would be if the riparian owner sought damages). If the characteristics, including the temperature, of the water are changed, the quality has likely been changed and riparian owners have a basis for claiming infringement of their rights. Owners such as municipalities which rely on a watercourse for drinking water or waste disposal, or farmers who rely on irrigation water, would have a strong argument if the dam’s effect was to lower water below drinking water standards, impair the waste assimilation ability of the stream, or affect the growth of crops.
With respect to other claims, such as a homeowner's claim for aesthetic degradation or loss of foreshore sediments, a riparian owner would have to show actual or potential harm, probably of more than a minimal degree. Nevertheless, a risk does exist that riparian owners could cause significant difficulties for a dam owner who has not acquired a prescriptive right. It is possible that, but unknown whether, the defences outlined in division 4.3.2.2 would be successful.

From an engineering point of view, some of the potential problems are typically addressed for other reasons. For example, because of fisheries concerns dissolved oxygen is often the subject of discussion, planning, and agreement between the owner, DFO and MELP. Dissolved oxygen problems in particular can be remedied by technical solutions (see division 4.2.6). Other problems, such as nutrient reduction, plankton production, and sediment trapping, may be capable of technical solutions such as the fertilization of oligotrophic reservoirs to promote primary production, low level flushing to pass more sediment, or other solutions suggested in division 4.2. However, many water quality problems might best be dealt with through the Water Use Plan process or a more comprehensive watershed management agreement. Watershed planning is probably the only realistic solution to eutrophication of operating reservoirs (Zwahlen, 1998).

In summary therefore, there is some risk of legal liability associated with water quality and riparian rights. A dam owner should consider the effects of water quality not just in terms of fisheries but also with respect to riparian owners around the reservoir and downstream of the dam. Proactive design of a new dam and reservoir to address those issues amenable to a technical solution may limit potential legal exposure. Addressing quality concerns in a Water Use Plan or other stakeholder-negotiated document may prevent difficulties for existing dams.
Finally, dam owners might consider addressing these problems directly in their water licence although the ultimate efficacy of that approach is unknown.
Chapter 5

EMERGENCY PREPAREDNESS AND DAM OWNER RESPONSIBILITY

5.1 INTRODUCTION

Although dams in BC are constructed with safety in mind, the potential consequences of a dam failure are significant, particularly if the floodplain is developed. Accordingly, responsible owners of dams with downstream residents or businesses at risk typically implement some form of emergency planning to mitigate or avoid losses in the event of a dam failure.

Historically, the preparation of an emergency preparedness plan, or EPP, has been governed by standards established by industry and the individual dam owner. This led to a division of responsibility during emergencies between the dam owner and downstream response agencies such as the police. Recently, MELP’s Dam Safety group has proposed a new Dam Safety Regulation under the Water Act (that regulation is referred to in this chapter as the Regulation). The Regulation, if adopted in its present form, would change the historical division of responsibility during an emergency response, imposing burdens on dam owners that they are not well equipped to meet. This chapter examines the current practice in emergency response management for dams, the changes to that regime proposed by the Regulation, and the legal obligations of dam owners in emergency situations. The chapter concludes with a consideration of the ramifications of the proposed Regulation for dam owners.
5.2 DAM SAFETY EMERGENCY RESPONSE PLANNING

5.2.1 INDUSTRY PRACTICE

5.2.1.1 Canadian Dam Association Dam Safety Guidelines

The CDA is essentially an industry body (although membership is open to anyone) which provides a forum for the “exchange of ideas and experience in the field of dam safety” (CDA(2), 1999). The CDA publishes Dam Safety Guidelines, referred to in this division as the Guidelines, to promote consistent evaluation of dam safety across Canada, to ensure safe dams, to enable consistent evaluation of safety deficiencies, and to provide a basis for dam safety legislation and regulation (CDA(1), 1999).

The Guidelines provide that the dam owner has responsibility for dam safety and is specifically responsible for ensuring that an EPP is in place. Section 4.0 of the Guidelines sets out the suggested components of a dam owner’s emergency preparedness. The Guidelines require the dam owner to assume responsibility for identifying and evaluating potential emergencies, undertaking appropriate preventative or mitigating actions, and notifying appropriate people or organizations in accordance with an EPP. Provincial or local governments are to assume responsibility for warning floodplain residents of hazardous situations based upon information provided by the dam owner. However, the owner may need to notify residents directly if flood wave travel times are short. Dam owners are also responsible for joint planning with response agencies to create an effective EPP. Note that, except in exceptional circumstances, the Guidelines do not require the dam owner to prepare to notify individual floodplain residents directly or to plan, coordinate, or implement a public emergency response such as an
evacuation. Those tasks are left to downstream response agencies, such as the police, which are better able to perform them.

5.2.1.2 BC Hydro Approach to Emergency Preparedness

BC Hydro’s emergency planning complies with, and in many areas exceeds, the CDA standards (Cattanach et al, 1998). The corporation enumerates the specific steps in emergency response and recognizes responsibility for each step as described in Table 5.1:

<table>
<thead>
<tr>
<th>Step</th>
<th>Action</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Detection of an abnormal condition at a dam</td>
<td>Dam owner</td>
</tr>
<tr>
<td>2</td>
<td>Internal decision making regarding the severity and appropriate technical response to the condition</td>
<td>Dam owner</td>
</tr>
<tr>
<td>3</td>
<td>Notification of downstream response agencies in a manner appropriate to the risk</td>
<td>Dam owner and response agencies</td>
</tr>
<tr>
<td>4</td>
<td>Warning the public</td>
<td>Response agencies</td>
</tr>
<tr>
<td>5</td>
<td>Public response, including evacuation if necessary</td>
<td>Response agencies</td>
</tr>
</tbody>
</table>

Table 5.1: BC Hydro Emergency Preparedness Paradigm
(Cattanach et al, 1998)

Within this framework, the dam owner works with downstream response agencies and floodplain residents to agree upon what dam safety hazards warrant notification and what information should be provided in those notifications.

5.2.2 PROPOSED DAM SAFETY REGULATION

A draft “British Columbia Dam Safety Regulation” is being considered by the BC government at the time of this writing. The Regulation, which falls under the
Water Act, includes proposed provisions authorizing MELP dam safety officers to require a dam owner to prepare an EPP. See division 2.4.3.1.4 for a detailed discussion of the Regulation. With respect to emergency situations, the Regulation would require a dam owner to (section 6):

(a) operate in accordance with the EPP; or

(b) if no EPP exists, operate and initiate remedial actions to safeguard the lives and property of the public and the environment; and

(c) notify the Provincial Emergency Program and MELP; and

(d) notify “all persons who may be endangered by the failure of the dam” and “if reasonably necessary, advise those persons to vacate and to remove any property from the endangered area”.

Section 11 of the Regulation will make failure to comply with the Regulation an offence under the Water Act (see division 2.4.3.1.2).

Clauses (c) and (d) of section 6 of the Regulation clearly extend the responsibility of the dam owner into the realm of warning the public (step 4 in the BC Hydro emergency preparedness paradigm) and, perhaps, into the realm of public response (step 5 in the BC Hydro paradigm). Neither of these actions is, by current industry practice, the responsibility of the dam owner (except in specific circumstances).

There are many reasons why the dam owner does not have responsibility for those actions, including:
1. Warning the public requires an extensive and coordinated effort by many people intimately familiar with the floodplain. This may be particularly difficult if telephone service has been disrupted by an earthquake or other event. Response agencies such as the police are better prepared and equipped for such activities.

2. Maintaining a current database of residents and their contact numbers is problematic at best. A heavily developed floodplain could have tens of thousands of residents. Maintaining a current database would impose severe financial burdens on a dam owner.

3. Response agencies have plans and procedures for warning the public and coordinating disaster response. Duplication by the dam owner is inappropriate, inefficient, uneconomical, and may be hazardous. Public response should be an orderly, coordinated, and supervised activity to minimize delays, injuries, and property losses. Dam owners may aggravate evacuation difficulties by inappropriate actions.

In summary, the proposed requirements in the Regulation would impose new, onerous, and inappropriate obligations on the dam owner.

5.3 THE LAW

The legal duty owed by a dam owner to downstream residents is generally described in division 2.4.5.4. No duty to render assistance to persons in danger exists unless the dam owner's negligence places people in danger. In BC, the Court of Appeal has held that there is no duty to warn adults of the ordinary risks

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of everyday life. Thus, a dam owner has no general duty to warn floodplain residents of high spillway releases or even a dam failure if there has been no negligence on the part of the owner.

However, a specific duty to warn arises in certain situations (Linden and Klar, 1994):

1. If there exists a relationship of economic benefit to the dam owner. In the US for example, utilities, because of the economic benefits derived from sale of their product, have an obligation to warn (Linden, 1993).

2. If the dam owner created the dangerous situation. The law requires this if the defendant’s negligence caused the danger (Linden, 1993) but Linden (1994) suggests it may also extend to any defendant creating a dangerous situation, even in the absence of negligence. The mere impounding of water behind a dam may be such a situation (similar to the reasoning behind the Rule in Ryland v. Fletcher creating strict liability – see division 2.4.6).

3. If the dam owner voluntarily assumes a duty to warn or rescue so that the plaintiff comes to rely upon it. The adoption of an EPP is an example. The Crown and its agents (such as BC Hydro) may have such a duty by nature of their Crown status (Linden, 1993). See division 2.4.5.4 for examples.

4. If a statutory duty exists. This would be the case if the Regulation comes into effect in its present form.

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The courts have also found a nonfeasance (failure to act) to be a misfeasance (improper act) in many situations. For example, drivers who fail to brake or signal a turn are negligent even though they did nothing (Linden, 1993). Thus, the failure of a dam owner to give warning may be a misfeasance.

Finally, it is worth noting that even if a duty to warn exists, no liability will be found if there was insufficient time to give the warning.\footnote{Wedel v. O'Flaherty (1993), 27 BCAC 280, 45 WAC 280 (BCCA).}

5.4 CONCLUSIONS AND RECOMMENDATIONS

5.4.1 IN CASE OF DAM FAILURE

Because the dam owner has created a potentially dangerous situation by impounding water and, in many cases, has a beneficial economic relationship with the floodplain resident (as, for example, between a power utility and its customers or a municipality and its inhabitants), many dam owners do have a duty to warn of dam failure. In other cases, the existence of an EPP, assuming it is not a purely internal document, creates the expectation of warning and the reliance of the public on the dam owner to provide it. In any event, the callousness of a dam owner who anticipates or witnesses a dam failure but does nothing is likely to lead to a finding of misfeasance rather than nonfeasance.

Therefore, dam owners should accept responsibility for warning of dam failures and make appropriate plans to discharge that duty.
5.4.2 IN CASE OF HIGH SPILLWAY RELEASE FLOODS

In general, the dam owner probably does not owe a duty to floodplain residents to warn of non-negligent high spillway releases. The owner is entitled at law (barring agreements or statutory obligations to the contrary) to pass the natural flow of the stream. A flood event requiring spilling is, it might be argued, an "everyday" event for which adults at least assume the risk.

However, the dam owner may be in a beneficial economic relationship with floodplain residents or may have voluntarily assumed a duty to warn of such events (in an EPP or Water Use Plan for example). In such cases, a duty to warn of flooding does exist. The owner of a flood control dam, by definition, probably has assumed a duty to warn of flooding.

5.4.3 SCOPE OF THE DUTY

Based on the above, many dam owners have a duty to warn in the case of one or both of a dam failure and a high spillway release. Assuming such a duty exists, is the duty discharged by notifying the appropriate response agencies as contemplated by the current emergency planning paradigm? The answer is almost certainly yes, except in the case where the flood travel time is so short that the reasonable dam owner would be expected to contact floodplain residents directly. Given the expertise residing in modern response agencies and the assumption of emergency response responsibility by various levels of government, it is reasonable for the dam owner to notify those agencies best equipped and trained to warn the public and coordinate a public response. Furthermore, by limiting the scope of notification, the dam owner is freed to concentrate on preventing or mitigating the dam safety hazard as best as possible.
Therefore, dam owners should be prepared to notify the proper downstream response agencies of possible or actual dam failures. Dam owners should also be prepared to notify response agencies of high spillway releases expected to cause flooding if an economic benefit or a voluntary assumption of duty exists or if the dam owner is the Crown or an agent of the Crown. Dam owners probably do not need to notify individual floodplain residents except those in particular danger because of the short travel time of the flood wave to their location.

5.4.4 IMPACT OF THE REGULATION

Given the scope of the existing duty of a dam owner, the Regulation in its current form would expand the duty of the owner beyond what the law now requires. This would seem to be an inappropriate, uneconomical, inefficient, and a possibly dangerous change to the law. Dam owners should, of course, take note of and act upon whatever the final Regulation requires as it may impose a statutory duty beyond that now existing.
6.1 INTRODUCTION

"Debris" in the context of dam and reservoir management generally refers to organic (woody) debris consisting of floating logs, submerged but suspended logs, beached timber on the reservoir shore, and submerged fixed stumps and snags remaining on the reservoir bed after filling (Brown and Neilsen, 1992). Most of the debris in watercourses is woody. Perham (1987) reports that over 99% of the debris in Alaska's Chena River is woody. Floating debris originates from logging activity, debris torrents, landslides, watercourse bank erosion, and debris present during the filling of the reservoir (Brown and Neilsen, 1992). Floating debris moves with wind and water currents and hazards may appear or move suddenly. Fixed debris may be invisible just beneath the surface of the water. In this thesis, "debris" means only woody debris.

Debris presents a number of concerns to the dam owner and others:

- Debris poses a public safety hazard for recreation, including threats to the safe use of boats and aircraft.
- Debris may interfere with recreational and commercial navigation may be restricted.
Snags, particularly if tall and densely packed, pose a fire hazard and can be aesthetically unpleasant (Brown and Neilsen, 1992).

Floating debris may cause shoreline and bank erosion (Brown and Neilsen, 1992) or damage to docks and other shoreline works.

Clearing fixed debris along shorelines may increase soil erosion or allow soil movement (Brown and Neilsen, 1992).

Debris provides habitat for birds as well as terrestrial and aquatic animals. Clearing debris may negatively impact the ecosystem by removing habitat and food sources.

Dam performance may be compromised if discharge facilities, including spillways, outlet works, and penstock intakes, are blocked or rendered inoperable by debris (Brown and Neilsen, 1992). For example, if debris is not cleared from the intakes, power generation may be reduced (Hayashi and Erdmannsdorfer, 1991).

Dam safety may be threatened during flood events. BC Hydro has had several dams threatened by debris including the Alouette Dam when debris damaged the spillway during a 1955 flood and the Jordan Dam when debris plugged the spillway causing non-overflow portions of the dam to be overtopped in 1955 (Brown and Neilsen, 1992). Similar problems have been experienced in Norway and Sweden (Johannson and Cedarstrom, 1995). Floating debris in the reservoir may also be repeatedly knocked against the upstream face of the dam, displacing protective riprap (Perham, 1987).
• Debris washed through a spillway during a flood may pose a direct threat to life and property downstream and may jam, possibly causing or aggravating local flooding.

• Debris released through the spillway may cause safety hazards, erosion, fire hazards, and works performance degradation downstream (Perham, 1987). For example, a lower dam or a municipal water intake may be affected. Released debris may also jam on bridge piers or snag on the underside of a bridge deck, increasing local scour and water levels (Perham, 1987).

• Clearing debris is expensive. BC Hydro estimates that the cost of clearing Williston Lake (impounded by the Bennett Dam) was $130 million over the 25 year period ending in 1992 (Brown and Neilsen, 1992).

This chapter examines debris problems in the reservoir and downstream of the dam. It then considers the dam owner’s legal responsibilities with respect to debris and provides preliminary conclusions and recommendations. The question of debris as fish habitat is considered in chapter 7.

6.2 DEBRIS MANAGEMENT

6.2.1 IN THE RESERVOIR

Large woody debris, or coarse woody debris as it is also known, is a natural component of watercourses, particularly the low order mountain streams common in BC. Piegay (1993) notes reports from explorers in the Pacific Northwest in the 18th and 19th centuries describing the need to travel on ridges
because the streambeds were choked with snags for hundreds of metres at a stretch. Resource use, including clearing watercourses for navigation and timber transport, has reduced the amount of large woody debris in streams (Piegay, 1993).

A dam owner's first responsibility with respect to debris is to estimate the amount of debris expected during flood events. "Known" debris, which may be fixed or floating but is visible on or around the reservoir, can be quantified by direct observation (Brown and Neilsen, 1992). "Unknown" debris is new debris which will enter the reservoir during a storm (Brown and Neilsen, 1992). BC Hydro estimates unknown debris by considering the following factors (Brown and Neilsen, 1992):

- watershed forest cover, including tree type and fire or disease scarred areas;
- terrain, including reservoir slopes and geology;
- transport mechanisms, including watercourses, landslides, debris flows, and shoreline erosion;
- hydrology, including storm type and frequency, precipitation amounts, and snowmelt; and
- other factors including logging activity, road construction, wind, and debris storage in tributaries.

The most constant debris problem for the dam owner is the risk of floating debris jamming, blocking, or damaging the spillway or other outlet works. Such events are not uncommon if preventive measures are not taken. A study conducted in Sweden (Johannson and Cedarstrom, 1995) concluded that the behaviour of debris...
as it approaches a spillway can be predicted to some extent. Johannson and Cedarstrom found that single trees were turned by the current and safely passed the spillway opening but entangled trees did not generally do so. Debris behaviour was also influenced by adjacent open spillway gates. Multiple open gates increase the probability of debris jams by altering water flow directions and speed. Spillways with gaps of less than 10 metres between piers are especially vulnerable (Lemperiere, 1999).

Common solutions to debris problems in the reservoir and at the dam include:

- Collecting and removing debris where it is found throughout the reservoir, including the basin, shoreline, and open water.

- Installing debris booms to catch and hold debris at convenient points in the reservoir or immediately upstream of the dam; debris can be collected and removed when necessary. In Downton Lake, the reservoir impounded by BC Hydro’s La Joie Dam, a boom at a narrowing in the reservoir has in the past restrained up to several square kilometres of floating debris (Brown and Neilsen, 1992). Booms must have good stopping characteristics to prevent the escape of the first logs and must be sufficiently strong to withstand the forces exerted under storm conditions by large debris accumulations (Kennedy and Lazier, 1965).

- Designing or improving spillways to enable the safe passage of debris during flood events. Of course, allowing debris to pass through the spillway does not address downstream debris-related problems.
• Protecting the intakes for outlet works and penstocks with trash racks to prevent the "ingestion" of floating debris. Such protection is present at almost every dam. Racks must be cleaned when necessary, either by hand or by mechanical rakes. Compressed air bubbler systems are used at some dams to make cleaning easier (Perham, 1987).

• Collected debris is usually disposed of by burning where permitted, burial in an appropriate location, chipping, or trimming and cutting to length (Perham, 1987). Some collected debris is deliberately placed downstream as part of fish habitat enhancement projects.

6.2.2 DOWNSTREAM

Downstream of the dam, released debris behaves as it would in a natural river, traveling until deposited by receding waters or lodging on the river bank, bed, or other obstruction. Debris often aggregates to make masses or dams of woody debris. Such dams may occur every 10 metres in some channels (Gregory and Davis, 1993). Large woody debris masses may encourage localized erosion and, by producing larger pools, may raise local water tables and cause flooding (Gregory and Davis, 1993).

6.3 THE LAW

Several potential sources of liability for dam owners exist with respect to debris. These include:

• injury to persons or damage to property, such as boats, as a result of fixed debris in the reservoir;
• injury to persons or damage to property, including land, as a result of floating debris in the reservoir;

• injury to persons or damage to property resulting from the collection and disposal of reservoir debris;

• injury to persons or damage to property resulting from a dam safety incident, including dam failure, caused by debris; and

• injury to persons or damage to property as a result of floating debris passing through the spillway and traveling downstream.

6.3.1 Statutory Law

6.3.1.1 Water Act

Section 9 of the Water Act, referred to in this division as the Act, permits "changes in and about a stream" if such changes are authorized by licence, order, or approval, or are made in accordance with the Water Regulation, referred to in this division as the Regulation. Section 21 of the Act requires a dam owner authorized to make a "change in and about a stream" to exercise reasonable care to avoid damaging land, works, trees, and other property, and to compensate owners for damages arising from construction, operation, maintenance, use, and failure of the works.

Section 37(1) of the Regulation prohibits the making of "a change in and about a stream" except as authorized under the Act or in compliance with the Regulation. A change in and about a stream includes modifications to the land, vegetation, natural environment or flow of water in a "stream" and any activity within the

121 B.C. Reg. 204/88, as amended.
stream channel which may have an impact on the stream (Act: section 1). A stream includes rivers, lakes, creeks, and other watercourses. Reservoirs are not specifically mentioned but would probably be considered lakes.

Pursuant to the Regulation, the government may require the dam owner to apply for a licence or approval for the work (Regulation: section 37(3)). Changes in and about a stream must be "designed, constructed and maintained" so as not to pose a risk to life, property, or the environment (Regulation: section 38(2)). Furthermore, the dam owner must ensure that no deleterious substance, including sediment and debris (undefined in either the Act or Regulation), enters or is placed, used, or stored in the stream channel (Regulation: section 41(a)). Section 41(c) of the Regulation specifies that there can be no unauthorized "disturbance or removal of stable natural materials and vegetation [not defined in either the Act or Regulation]" that contribute to stream channel stability. Section 42(1) of the Regulation requires approval before removing or adding material or adding debris to a stream. Section 42 also requires the dam owner to ensure that natural materials and vegetation providing habitat or channel stability are protected.

Both the removal of debris from the reservoir and the placement of debris downstream as fish habitat are modifications to the natural (post-dam) environment and so constitute changes in and about a stream and are regulated by the Act. Dam owners must therefore ensure that debris management programs meet the requirements of the Act and Regulation, including having proper approval where necessary.

Note that there are certain situations, enumerated in section 44 of the Regulation, for which approval of a change in and about a stream is not required provided that the change is made in accordance with the Regulation and with terms and
conditions specified by a MELP field officer. Of particular relevance to debris management plans are sections 44(o), (p), and (u). The first allows construction or placement of erosion or flood protection under the direction of the Crown or its agents during a flood emergency declared under the Emergency Program Act.\(^{122}\) The second allows the Crown, its agents, and municipalities to clear debris from bridges and culverts during flood events if the debris creates danger to life or property. The third allows a public utility to do minor and routine maintenance on its works. This would include cleaning debris from trash racks and probably includes the removal and disposal of debris collected in booms or lodged or floating in the near vicinity of the dam. Finally, note section 44(j) of the Regulation which authorizes the Crown or its agents to undertake fish habitat restoration and maintenance activities. These provisions will exempt some of BC's larger dam owners from the requirement for approvals for some debris clearing activities.

The proposed Dam Safety Regulation does not directly address debris although aspects of debris management may be included in any Operations, Maintenance, and Surveillance Manual required for a dam.

**6.3.1.2 Waste Management Act**

Except to the extent that debris may comprise part of “effluent” (see division 4.3.1.2 for a discussion of released water as effluent) this statute does not directly impact on debris management.

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\(^{122}\) RSBC 1996, chapter 111.
6.3.1.3 Fisheries Act

The Fisheries Act, referred to in this division as the Act, contains a number of provisions relating to both debris management and debris as habitat. Provisions directly on point include sections 26, 35, and 36, described below.

Section 26(1) requires that at least one-third of a river or stream be left open and free of "logs or any material". Efforts to collect or restrain debris in streams must therefore be designed to leave open water. This requirement apparently does not apply to reservoirs or lakes.

Section 35 of the Act prohibits the "harmful alteration, disruption or destruction of fish habitat". Debris that is not floating is very likely to be fish habitat and, conceivably, floating debris could be as well. Therefore, unauthorized removal of debris could breach the Act.

Recall that section 36 of the Act prohibits the deposit of a deleterious substance into water frequented by fish (see division 2.4.3.3.2). A deleterious substance includes one which forms part of a process of degradation or alteration of water quality in a manner deleterious to fish. The Act allows the Minister to prescribe substances as deleterious and, in a number of regulations (see, for example, the *Potato Processing Plant Liquid Effluent Regulations*) has prescribed "biochemical oxygen demanding material" as a deleterious substance. There is, therefore, precedent for an argument by DFO that debris, which will decay and increase biological oxygen demand, would, if added to a watercourse, breach the Act. Labeling a naturally occurring substance deleterious is not uncommon. Recall that BC Hydro was charged when a spillway release washed riverbank sediments into the watercourse (see division 2.4.3.3.3 and Appendix B).

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Section 58 of the *Fishery (General) Regulations* provides a procedure for obtaining DFO authorization to alter fish habitat. Many dam owners are intimately familiar with this procedure.

In summary, the removal or placement of debris downstream of a dam requires DFO approval. Removal of debris constituting habitat in the reservoir also requires DFO approval. The issue of debris as habitat is considered more completely in chapter 7.

### 6.3.1.4 Navigable Waters Protection Act

Debris and debris collection booms pose an obvious hazard on navigable waters. Booms are specifically included in the "works" to which the Navigable Waters Protection Act, referred to in this division as the Act, applies. Recall that reservoirs are navigable waters, even if the original, natural watercourse was not navigable (see division 2.4.3.4). See division 2.4.3.4 for details of the Act and how it applies, in general, to debris booms. Specific provisions of interest with respect to debris include the "obstacles and obstructions" provisions, section 21, and the regulations under the Act. Each of these is discussed below.

The Act contains a number of provisions regarding obstacles and obstructions in navigable waters. Debris collected by a boom constitutes an obstacle or obstruction as defined in the Act. However, the Act requires the owner of the debris to take prescribed safety measures such as installing signal lights. As the dam owner is arguably not the "owner" of debris thus collected, it is arguable that the dam owner need not comply with those requirements. Note, however, that

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123 CRC, chapter 829.
124 SOR 193-53.
failure to take appropriate safety measures with respect to collected debris may be
negligent (see division 6.3.3).

Section 21 of the Act prohibits the deposition of “sawdust, edgings, slabs, bark or
like rubbish of any description whatever that is likely to interfere with
navigation” into navigable water or a watercourse which flows into navigable
water. Disposing of shoreline debris in the reservoir would certainly constitute a
breach of this provision. Debris collected by the dam owner should be removed
from the watercourse and disposed of elsewhere.

Section 6 of the Navigable Waters Works Regulation\textsuperscript{125} requires a dam owner
whose dam or boom causes debris to accumulate on the bed or surface of
navigable water to remove the debris “to the satisfaction of the Minister”. Dam
owners with works in navigable waters (which a reservoir becomes) are therefore
obligated to remove debris in the near vicinity of the dam and behind any booms.

Finally, note that a Ministerial approval for a boom is valid for 25 years.

6.3.1.5 Environmental Assessment Act

Section 4 of the Environmental Assessment Act\textsuperscript{126}, referred to in this division as the
Act, permits the Minister to prescribe by regulation those projects requiring an
environmental assessment review. Section 37 of the Environmental Assessment
Reviewable Projects Regulation\textsuperscript{127} prescribes as reviewable all projects resulting in
changes in or about a stream if they directly disturb 1000 metres or more of linear
shoreline or 2 hectares or more of foreshore or submerged land below the natural

\textsuperscript{125} CRC, chapter 1232.
\textsuperscript{126} RSBC 1996, chapter 119.
\textsuperscript{127} BC Reg. 1995/276, as amended.
boundary of a stream. It is possible that debris management programs would fall under this heading, requiring an environmental assessment.

6.3.2 INDUSTRY STANDARDS

6.3.2.1 CDA Dam Safety Guidelines

The Dam Safety Guidelines (CDA, 1999) have little to say about debris. They do require that debris "be managed in such a way that [it does] not constitute an unacceptable risk to dam safety". Trees and other substantial debris in the reservoir basin should be removed prior to filling. Activities, such as logging, which might contribute to debris should be monitored and dam owners should consider "removing substantial sources of debris from within the reservoir basin or controlling their entry into the reservoir".

6.3.2.2 Individual Standards

In general, dam owners are left to their own devices with respect to debris management plans. Aspects of the approaches taken by BC Hydro and other owners are described in division 6.2.

6.3.3 COMMON LAW

The broad principles of tort law, particularly nuisance and negligence, apply to debris management. Nuisance and negligence are described in detail in divisions 2.4.4 and 2.4.5, respectively. A closer look at each with respect to debris follows.

6.3.3.1 Nuisance

A nuisance occurs if the dam owner unreasonably interferes with the plaintiff's property. A debris collection boom that impounds debris in such a manner as to damage the plaintiff's riparian property, by, for example, causing erosion, may
constitute a nuisance. Collected debris which routinely escapes the dam owner's boom, passes through the spillway, and damages the plaintiff's downstream property, by erosion or otherwise, could also be a nuisance. It is unlikely that naturally occurring but uncollected debris which passes the dam with flood waters would pose a legal nuisance although it may be unwelcome to lower riparian owners.

To constitute a nuisance, the problems caused by debris must be more than mere inconvenience and must be either continuing or pose a significant danger. Because floating debris is a natural component of river flow, riparian owners are expected to tolerate at least "natural" quantities of debris washing up on or damaging their property. However, "extra" debris comprised of previously collected but escaped trees may be a nuisance.

The dam owner is also entitled to make reasonable use of its property, even if such use interferes with neighbouring land. A dam owner with a reasonable debris management program is less likely to be liable in nuisance. Also, recall that a use of property particularly sensitive to a nuisance may prevent a successful suit. Unfortunately, other defences may not be available to the dam owner as it is unlikely that he or she has:

- legislative authority to pass collected debris over the dam;

- a prescriptive right to do so; or

- the acquiescence of other land owners to do so.

Disposal of collected debris by burning could also create a nuisance. An appropriate regulatory approval for burning would likely allow the dam owner to
show legislative authority for any nuisance created. Nevertheless, dam owners should dispose of debris in a manner minimizing the consequences for their neighbours.

In summary, unless a dam owner collects but fails to properly clear and dispose of debris, a claim of nuisance is unlikely to be well founded. A reasonable debris management plan, properly executed, should prevent successful nuisance claims.

6.3.3.2 Negligence

6.3.3.2.1 Debris in the Reservoir

6.3.3.2.1.1 Fixed Debris

Negligence poses a greater risk of liability to the dam owner than nuisance. Firstly, failure to clear the reservoir basin of standing timber and other debris may be negligent if it is foreseeable that people will use the reservoir in ways which expose them to injury. Unless the reservoir is inaccessible to the public, a dam owner may reasonably expect boating, swimming, fishing, and other public uses of a reservoir. Private land owners around the reservoir could also be expected to undertake such activities. All of those people would be at risk of injury or property damage from uncleared fixed debris. It is possible that the cost of clearing the reservoir bed would be prohibitive and, in some cases, that may absolve the dam owner of liability, particularly if other protective measures are taken such as posting warning signs. Nevertheless, an uncleared reservoir basin is a likely invitation to liability.

6.3.3.2.1.2 Floating Debris

Freely floating debris is a natural hazard on any watercourse. Therefore, naturally freely floating debris in the reservoir is not likely to give rise to claims of
negligence against the owner unless the owner has undertaken to or created an expectation of removing such debris. Floating debris which entered the reservoir as a result of the dam owner’s action is likely to pose a negligence risk.

Floating debris collected behind a boom but not yet disposed of is another source of potential liability. Swimmers or boaters could be injured or suffer property damage as a result of collected debris. Such debris may also cause damage to riparian lands adjacent to the collection site. Because the dam owner has assumed control of the debris by catching it with the boom, he or she has a duty to act reasonably with respect to it. Section 21 of the Water Act (see division 6.3.1.1) imposes a statutory duty of care on a dam owner and section 6 of the *Navigable Waters Works Regulations* (see division 6.3.1.4) requires that an owner clear debris from booms to the satisfaction of the Minister. The standard of care found applicable by a court may exceed that outlined in the legislation (see division 2.4.5.3.4).

Due diligence by the dam owner includes prompt removal and disposal of all collected debris to minimize risk. That may not be possible on a frequent basis. In that case, dam owners should take additional steps to show due diligence. Visible warning signs on shore, and perhaps on the dam or even the boom itself if possible, would likely be expected. It may also be necessary to fix lights to the boom or the debris mass or post warning buoys in appropriate locations. Other steps may be apparent in specific situations, such as providing warnings through local media.

**6.3.3.2.2 Debris Passing the Dam**

The potential for liability for debris which passes the dam is less clear than that in the reservoir. The dam owner is entitled to pass the flood, including all elements,
such as debris, which make up the quality of its water. Thus, floating, uncollected debris, at least that which does not originate from actions of the dam owner, can probably be passed without risk of liability. However, if the dam owner has voluntarily or otherwise undertaken to prevent debris passing the dam by, for example, establishing a debris management program, and downstream residents have come to rely on such measures, there may be liability because of the consequential expectation in the minds of floodplain residents (see the discussion in division 2.4.5.4). Therefore, if the dam owner has a debris management plan in place, effort should be made to avoid any debris passing through the spillway. This is, presumably, the point of the management plan and so should not be a heavy burden on the owner.

If collected debris escapes the boom and passes the dam, the liability exposure is similar to the reservoir situation described in division 6.3.3.2.1. The dam owner, having assumed control of the debris by capturing it behind a boom, assumes a duty to take reasonable steps to avoid harm to others. Obviously a poorly designed boom which is unable to keep debris restrained during a flood event would increase the risk of liability for negligence. The design flood for boom design will depend upon the nature of the debris, watershed hydrology, and other factors. A reasonable dam owner would certainly obtain engineering services for the design. Perham (1987) and Kennedy and Lazier (1965) provide guidance on the proper design of booms.

Even a well designed boom may not be capable of holding all debris during a significant storm event. If debris escapes and causes damage, all of the usual requirements for a claim of negligence have to be met by the plaintiff, including showing proximate cause and failure on the dam owner’s part of meet the standard of care of a reasonable owner (see division 2.4.5). Whether or not a dam owner is
liable will depend upon the court's findings with respect to those requirements. In addition, a dam owner may have one or more defences available, including contributory negligence, voluntary assumption of risk, and illegal activity by the plaintiff (see division 2.4.5.8).

6.4 CONCLUSIONS AND RECOMMENDATIONS

Debris management may be regulated by DFO and MELP. Dam owners should ensure that all necessary approvals have been obtained before debris is collected, removed from, or placed in the watercourse (including the reservoir).

Liability exposure, particularly in negligence, exists with respect to fixed and floating woody debris in the reservoir and with respect to collected and escaped debris which makes its way past the dam. To protect against findings of negligence with respect to collected debris, the dam owner should ensure a properly designed boom and such other defensive measures as may be reasonable for the circumstances. A lower standard might be appropriate in a watershed with an undeveloped floodplain and little risk of harm.

An appropriate debris management plan and collection, protection, warning, and disposal facilities are the best defences against negligence claims. Such planning should begin before the reservoir is filled, allowing clearing of the bed and shoreline to minimize future problems. Booms must be adequate to resist storm-induced loads and should prevent the escape of collected debris, particularly if such debris could make its way past the dam. Proper warnings should be placed on shore, on the boom, and, if necessary, on collected debris. Collected debris should be removed from the reservoir as soon as possible and disposed of in a safe and appropriate manner.
Chapter 7

FISH HABITAT CREATION

7.1 INTRODUCTION

When a dam is built, the environment both upstream and downstream is altered. Upstream, a river environment is replaced by a lake; downstream, a previously natural river becomes regulated. Fish habitat may be altered, enhanced, or disrupted as a result. Habitat may also be created where none previously existed. For example:

- On the Bridge River, natural flows downstream of BC Hydro's Terzaghi Dam fluctuated too widely to permit salmon spawning\(^{128}\). However, the regulated river allowed a new salmon run to develop in that reach.

- The dam itself may become fish habitat. At BC Hydro's Keenleyside Dam, DFO found construction platforms erected in connection with upgrade work to be interfering with fish habitat on the upstream face of the dam.

- Habitat may also be deliberately created. Fish habitat enhancement projects, often involving the placement of large woody debris

\(^{128}\) Supra, n. 12.
structures in the watercourse, are becoming commonplace on many BC rivers.

This chapter focuses on a dam owner's legal obligations and liabilities associated with created fish habitat. It considers what constitutes habitat, examines statutory and common law applicable to this particular issue, and concludes with some recommendations for dam owners.

7.2 FISH HABITAT

7.2.1 DEFINITIONS

The Fisheries Act defines habitat as “spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes” (section 34). Habitat may also be defined in terms of ecological niches as “the geometric representation, in n-space, of all conditions in combination under which a species can perpetuate itself” (Beak Consultants Limited, 1993). A third definition defines habitat by its components. Beak Consultants Limited (1993) presents this definition schematically as shown in Figure 7.1.
Figure 7.1: Schematic Description of Fish Habitat Components

Fish Habitat
- Biotic
  - Food
  - Chemical
    - Dissolved Oxygen
    - pH
    - Nutrients
    - Pollutants
    - Water Temperature
    - Water Depth
  - Physical
    - Discharge
    - Morphometry
    - Substrate

Density
- etc.
  - Size
    - etc.
  - Species
    - etc.
  - Fish Habitat
The court in the BC Hydro case\textsuperscript{129} defined fish habitat as consisting of physical, chemical, and biological components, including factors such as gravel beds, streamside vegetation, water turbidity, aquatic insects, and benthic organisms. The court also gave a list of potential adverse habitat impacts arising from high spillway releases, including:

- increasing turbidity;
- moving gravel beds used for spawning;
- destroying food, including insects and benthic organisms;
- damaging streamside vegetation which provides shade and food for aquatic insects and organisms; and
- flushing fish out of the river.

What constitutes fish habitat is made more complicated by a tendency for different fish life stages to occupy different portions of a watercourse (Beak Consultants Limited, 1993). For example, anadromous salmon spawn in shallow, gravelly streams but spend most of their adult life in the open ocean. Thus, a particular area of a stream may be habitat for only a portion of the year.

7.2.2 CREATION OF HABITAT

Fish habitat may be created, expanded, or modified by a variety of methods. Beak Consulting Limited (1993) identifies a number of possible methods of creating or improving habitat, including:

\textsuperscript{129} Supra, n. 12.
• implementing hydrological controls such as flow regulation or reservoir water level management;

• linking fish habitat by fish passage devices such as fishways;

• modifying fish behaviour using behavioural barriers to repel fish from intakes or fish attractors to attract them to ladders;

• preventing fish entering intakes or channels using exclusion devices such as fish screens;

• artificially improving channel morphology and in-stream cover using weirs, large woody debris structures, and bank treatments;

• creating off-channel developments such as flow regulated side channels, groundwater channels, and floodplain channels, pools, and ponds;

• enhancing substrate by adding gravel catchment devices or sediment or by substrate cleaning;

• incorporating reservoir level stabilization and bottom-draw outlet structures into the project and by conducting drawdown zone revegetation;

• creating tidal channel, marsh, slough, island, and reef habitat;

• making water quality enhancements; and

• undertaking artificial propagation such as hatcheries and artificial spawning boxes.
An important concern with respect to habitat creation is the dam and watercourse capacity for fish passage. If fish are unable to survive the winter in the new habitat, or unable to move to suitable habitat, the benefits of increased production could be lost (Beak Consulting Limited, 1993).

Dam owners should also be aware that, in an effort to protect fish stocks by protecting habitat, DFO works under the principle of “no net habitat loss”. Using the provisions of the Act, DFO requires that unavoidable habitat loss be balanced by the dam owner providing new habitat, increasing the productivity of remaining habitat, or providing artificial production (Beak Consultants Limited, 1993).

7.2.3 SUMMARY

The range of fish habitat is extensive and could include the entire reservoir, including substrate, debris within the drawdown zone, the dam face which becomes an artificial reef or shoreline, and the downstream portions of the watercourse. Dam owners should be aware that even areas which are not habitat when the dam is constructed may become habitat over the life of the dam, subjecting the owner to obligations arising as a result.

7.3 THE LAW

Legal obligations with respect to fish habitat largely arise through statutes such as the federal Fisheries Act. Because the water, stream bed, and fish are property of the Crown, few common law concerns relate directly to habitat. Liability could be found, however, with respect to habitat destruction which affects the rights of specific groups to fish or with respect to habitat enhancements which become moving debris during a flood. It is conceivable that habitat destruction, alteration,
or creation could give rise to other common law liabilities; for example, a new habitat may encourage a population of predatory fish which affects nearby aquaculture projects. This division will consider the statutory law and some aspects of common law relating to habitat creation.

7.3.1 STATUTORY LAW

7.3.1.1 Fisheries Act

The Fisheries Act, referred to in this division as the Act, defines habitat in section 34(1) (see the definition in division 7.2). Other provisions of the Act are described in detail in division 2.4.3.3.2. Of particular relevance is section 35 of the Act which reads:

35(1) No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat.

(2) No person contravenes subsection (1) by causing the alteration, disruption or destruction of fish habitat by any means or under any conditions authorized by the Minister or under regulations made by the Governor in Council under this Act."

While many judicial decisions have referred to this section, it is usually with respect to a Ministerial authorization under section 35(2) and the need to conduct an environmental impact assessment. However, given the broad definition of fish habitat in the Act, there are likely to be few areas of the dam, reservoir and downstream reaches which do not constitute fish habitat.

In the BC Hydro case\textsuperscript{130}, the defendant power company argued that a salmon

\textsuperscript{130} Supra, n. 12.
fishery came into existence downstream of Terzaghi Dam only because regulation halted high flows in the lower reaches of the river. BC Hydro argued that DFO approval of the dam amounted to approval to pass high flows when necessary and to disrupt fish habitat by so doing. In rejecting this argument, the court agreed with DFO assertions that the Act applies to habitat regardless of how the fishery came into being.

The stage of the project may have an impact on DFO’s ability to regulate habitat. *Eastmain Band v. James Bay and Northern Quebec Agreement (Administrator)*\(^{131}\) involved a dispute over the environmental review of a portion of Quebec’s James Bay hydroelectric development. An issue arose over whether section 35 of the Act applied during the construction phase of the project or only during the operational or “carrying on” of the undertaking. Somewhat surprisingly, the court noted that there may be a distinction between “construction” and “operating” and so section 35 may not apply to the former. Regretfully, the court did not need to decide this issue but the door is open for a dam owner to argue that section 35 does not apply to the construction of a dam. By analogy, it may also be argued that the abandonment of a dam and extraordinary maintenance, such as a seismic upgrade, are also outside the scope of section 35. Routine maintenance is likely to be considered part of carrying on the undertaking.

7.3.1.2 Navigable Waters Protection Act

The provisions of the Navigable Waters Protection Act (see division 2.4.3.4.2) may impact fish habitat structures or other efforts by the dam owner to enhance habitat in navigable waters. In particular, an approval from the Minister may be required if the navigability of a reach will be affected by large woody debris.

\(^{131}\) (1992), 99 DLR (4th) 16 (Fed. CA).
structures.

7.3.1.3 Water Act

The concerns described in division 6.3.1.1 with respect to debris are applicable to habitat structures as such activities constitute a change in and about a stream.

7.3.1.4 Fisheries Act (BC)

Dam owners should remember that the Province also has legislation regarding fisheries. The BC *Fisheries Act* contains provisions requiring dams on designated waterways to include fishways and fish protective devices when required by the Minister (section 28).

7.3.2 COMMON LAW

Many of the comments in division 4.3.2 with respect to water quality and division 6.3.3 with respect to debris are applicable to habitat issues. The question of potential negligence for habitat enhancements involving large woody or other debris is similar to that with respect to debris management (see division 6.3.3.2). If a dam owner participates in habitat creation, he or she has a duty to exercise a standard of care reasonable in the circumstances. As with debris collected in a reservoir, large woody debris habitat enhancements could, depending upon location and other factors, reasonably be expected to impact swimming, fishing, and other uses of the watercourse. Habitat structures could also foreseeably become moving debris during a flood, threatening lives and property in the same manner as the floating debris described in chapter 6. The dam owner must take all reasonable steps to meet the duty to other users of the river and to floodplain residents.
MELP's Watershed Restoration Program has published a Technical Circular (MELP(3), 1997) which includes advice on specifications applicable to large woody debris habitat structures. D'Aoust and Millar (1999) have produced a Watershed Restoration Management Report (No. 8) for BC's Watershed Restoration Program that outlines in detail the design of and the performance and ballast requirements for large woody debris structures. Whether these specifications meet the necessary standard duty of care in a particular river will depend upon the circumstances in the watershed in question. For example, greater ballast may be required in a heavily populated floodplain or visible warnings may be necessary in a river frequented by kayakers.

7.4 CONCLUSIONS AND RECOMMENDATIONS

7.4.1 IN VOLUNTARILY CREATED HABITAT

Dams may create habitat in the reservoir and downstream by virtue of either the dam's existence or its operation. Habitat thus created is habitat subject to regulation under the Fisheries Act. This may impact operation of the dam, requiring, for example, that minimum flows be released for fisheries purposes or that releases be ramped down slowly to facilitate fish salvage operations. The dam itself may be impacted if it becomes habitat; maintenance or upgrades may require DFO approval if submarine portions of the dam will be affected. However, there may be a valid argument that DFO regulation does not extend to the construction, decommissioning, or significant upgrade portions of a dam's life.

The only solutions to the regulatory obligations created are to live with them or avoid them by preventing creation of new habitat. The latter response is likely to

\[132\] RSBC 1996, chapter 149.
be unpopular with DFO and others and may be illegal. However, it may be possible, for example, to use fish behavioural barriers on the dam face to repel fish from the area. Bubble screens or other devices used for that purpose around intakes might be effective. Given the area of even a small dam’s upstream face, such tactics may be uneconomical.

On the downstream side, habitat is likely to be created when regulated flows make habitation possible. A dam owner may wish to consider sizing or timing releases to discourage colonization. Releases might also be configured to provide a quality of water barrier to fish. For example, water too low in dissolved oxygen could be released or the water could be aerated as it is released to increase the dissolved oxygen content. Water too warm or too cold might be released. The economic cost of such releases may be too onerous for practical use and, if the actions killed fish, charges would likely result. Such actions may also infringe on riparian rights (see chapter 4).

Any tactics to discourage colonization by fish would be possible only in rare cases such as the downstream reach having no fishery prior to construction of the dam. Such tactics also carry public relations costs and may be illegal if “habitat” includes areas not yet inhabited by fish but which could be barring human interference. Therefore, it is recommended that dam owners accept that new habitat will be created by the dam and its operation and adopt an early and proactive position with DFO and MELP to minimize operational problems in the future.

7.4.2 DELIBERATELY CREATED HABITAT

Deliberately constructed habitat will be subject to regulation by DFO and MELP. If habitat enhancements are sufficiently large, environmental assessment may also be required.
Dam owners may also incur liability exposure through direct habitat creation programs. The implications here are similar to those with respect to debris described in the preceding chapter. These liabilities can be avoided by not participating in such programs and can be minimized by ensuring that constructed habitat meets an appropriate standard of safety for the watercourse in question. Professional engineering advice should be obtained prior to participating in a habitat enhancement project.
IN CONCLUSION

Dam owners operate their facilities in a highly regulated environment. Their activities, by their very nature, often create a hazard for or impact directly on residents of the watershed and the basin's environment. This thesis examines some key aspects of the legal regime within which such activities occur and considers five technical dam-related issues in detail. The purpose of the thesis is to provide dam owners, and particularly engineers, with general knowledge of that regime and with more detailed knowledge of the legal implications of the five technical issues and some of the common solutions to those issues. The reader will also gain an appreciation for some of the legal impacts of other technical issues not specifically considered in this thesis.

In particular, the thesis examines the following topics:

1. The general legal environment for dam owners including statutory obligations imposed by the Water Act, the Waste Management Act, the federal Fisheries Act, and the Navigable Waters Protection Act, and obligations imposed by the common law through riparian rights and the torts of nuisance, negligence, and strict liability. Examples applicable to dams are used to demonstrate basic principles.

2. Current approaches to dam safety decision making, including prescriptive standards and risk analysis, are examined from a legal perspective. It is concluded that today, strictly from a legal point of
view, prescriptive standards offer greater legal certainty than risk analysis as a basis for dam safety planning.

3. The effect of a dam on water quality and the possibility of infringing riparian rights to water in its natural quality are considered. It is concluded that changes in sediment and nutrient loads, temperature, and dissolved oxygen might, in some circumstance, form a basis for a legal action by riparian owners downstream of a dam or around a reservoir.

4. The current practice in emergency response planning and possible changes to that practice are explored in the context of a dam owner's emergency obligations. It is concluded that a proposed regulatory change will, if adopted, impose significant new legal, administrative, operational, and financial obligations on dam owners.

5. Methods of fixed and floating woody debris management are reviewed with a view to the legal implications arising therefrom. It is concluded that dam owners have a duty of care with respect to at least some debris in the reservoir and with respect to collected but escaped debris that passes the dam.

6. Finally, the obligations imposed on a dam owner when the facility itself or its operation results in the creation of fish habitat are examined. Deliberately created habitat, including large woody debris structures, is also considered. It is concluded that newly created habitat is subject to the same legal obligations as existing habitat. Deliberately created habitat may also create liability exposure if it becomes debris during a flood.
GLOSSARY

Throughout this thesis, the following words, acronyms, and phrases, whether capitalized or not, have the meanings indicated below unless otherwise stated.

AEP. **Annual exceedance probability**: The probability that an event of specified magnitude will be equaled or exceeded in any year (CDA(1), 1999).

BC. The Province of British Columbia, Canada.

BC Hydro. British Columbia Hydro and Power Authority, BC's largest electrical utility.

CDA. The Canadian Dam Association, an amalgamation of the Canadian Dam Safety Association and the Canadian National Committee on Large Dams.

**Constitution Act.** The *Constitution Acts, 1867* and 1982, R.S.C. 1985, Appendix II, No. 44, as amended. These Acts, together with the *Canada Act, 1982*, comprise the constitution of Canada. The most significant of these Acts for purposes of this analysis is the *Constitution Act, 1867*.

Dam. The CDA defines dams to include all barriers constructed for the purpose of enabling the storage or diversion of water, water containing any other substance, fluid waste or fluid tailings and all works incidental to, necessary for, or in connection with, the barrier (CDA(1), 1999). Note that in the absence of publicly unacceptable consequences of failure, the CDA does not include in the definition of "dam" barriers impounding less than 30,000 m$^3$ or less than 2.5m in height. Although many of the comments in this thesis apply to all "dams" as defined by the CDA, this thesis considers and is intended to apply only to dams impounding water.

**Dam owner.** The dam owner is the person or legal entity (including corporations, organizations, government departments, public utilities, or other entities) which is ultimately responsible for the design, construction, operation, maintenance, safety, and decommissioning of the dam. The dam owner may hold legal title to the dam site, the dam, or the reservoir or may simply hold a licence to operate the dam.
Dam Safety Regulation. The British Columbia Dam Safety Regulation, a proposed regulation under the Water Act. A draft of the Regulation is available on the World Wide Web at:

“www.elp.gov.bc/wat/dams/regs.html”.

Dam Safety Guidelines. The CDA’s Dam Safety Guidelines.

DFO. Department of Fisheries and Oceans: the federal government department responsible for the administration and enforcement of the Fisheries Act.

EPP. An Emergency Preparedness Plan for a dam. An EPP may be required pursuant to the Dam Safety Regulation.

Extreme event. An event (usually a rainfall or the resultant flood for the purposes of this thesis) which has a very low AEP (CDA(1), 1999).

Failure (of dam). In terms of structural integrity, the uncontrolled release of the contents of a reservoir through collapse of the dam or some part of it (CDA(1), 1999).


Hazard. A threat or condition which may result from an external cause (usually a flood for the purposes of this thesis), with the potential for creating adverse consequences to persons, property, or the environment (CDA(1), 1999).

Hydro and Power Authority Act. The Hydro and Power Authority Act, R.S.B.C. 1996, chapter 212, as amended.

IDF. Inflow design flood: The most severe inflow flood (including volume, peak, shape, duration, and timing) for which a dam and associated facilities are designed (CDA(1), 1999).

Incremental consequences of failure. Incremental losses or damage which dam failure might inflict on upstream areas, downstream areas, or at the dam,
over and above any losses which might have occurred for the same natural event (usually a flood for the purposes of this thesis) or conditions, had the dam not failed (CDA(1), 1999).

Legislature. The legislative body of a Province of Canada. This body is referred to as the Legislative Assembly in BC but not in all other Provinces.

MELP. Ministry of Environment, Lands & Parks, British Columbia.

Minister. Use of the term “Minister”, without specifying the government department which he or she heads, refers to the Minister responsible for fulfilling the ministerial duties under the legislation in question. The responsible Minister is usually defined in the statute.

NRC. The Committee on Safety Criteria for Dams, National Research Council of the United States.

NRCC. National Research Council of Canada.


PMF. Probable maximum flood: An estimate of the hypothetical flood (including peak flow, volume and hydrograph shape) that is considered to be the most severe “reasonably possible” at the dam site at a particular time of year, based on relatively comprehensive hydrometeorological analysis of critical runoff-producing precipitation (including snowmelt if pertinent) and hydrologic factors favourable for maximum flood runoff (CDA(1), 1999).

PMP. Probable maximum precipitation The greatest depth of precipitation for a given duration meteorologically possible for a given size storm area at a particular location at a particular time of year, with no allowance made for long-term climatic trends. The PMP is an estimate of an upper physical bound to the precipitation that the atmosphere can produce (CDA (1), 1999).

Outlet works. The combination of intake structures, conduits, tunnels, flow controls, and energy dissipation devices (CDA (1), 1999) to allow the
release of water from a dam other than by the spillway or through the turbines of a hydroelectric dam.

Reservoir. The CDA defines reservoir as the body of water, fluid waste, or fluid tailings which is impounded by one or more dams, inclusive of its shores and banks and of any facility or installation necessary for its operation (CDA (1), 1999). For the purposes of this thesis, only the body of water portion of the CDA definition applies.

Release ("high spillway" or "of water"). The intentional, unintentional, controlled, or uncontrolled release of water from a reservoir via the dam’s turbines or outlet works or the spillway, but not including the release of reservoir water by dam failure.

Return period. The reciprocal of the AEP.

Risk. The CDA defines risk as a measure of the probability and severity of an adverse effect to health, property, or the environment. Risk is estimated by the mathematical expectation of the consequences of an adverse event occurring (i.e., the product of the probability of occurrence and the consequence) (CDA (1), 1999).

Spillway. The weir, channel, conduit, tunnel, chute, gate or other structure designed to permit discharges from the reservoir other than by outlet works (CDA (1), 1999).

US. The United States of America.

USACE. The US Army Corps of Engineers.

USBR. The US Bureau of Reclamation.


Watercourse. "Watercourse" includes streams, creeks, rivers, lakes, reservoirs, ponds, sloughs, marshes, and other bodies of flowing water but does not include water bodies affected by ocean tides. The words "river", "creek", and "stream" are used synonymously with each other and "watercourse" throughout this thesis.

Water Use Plan. A document often required under the terms of a Water Act licence. A Water Use Plan defines operating parameters to be imposed on a dam as a result of stakeholder negotiation (MELP (1), 1998).
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MELP. See Ministry of Environment, Lands and Parks, Province of British Columbia.


Ministry of Environment, Lands and Parks, Province of British Columbia:


NRC. See “Committee on Safety Criteria for Dams, National Research Council”, above.

NRCC. See “National Research Council Canada”.


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USBR: see United States Bureau of Reclamation.


APPENDIX A: LEGISLATION AFFECTING ENVIRONMENTAL ACTIVITIES OF DAM OWNERS

(BC Hydro (1), 1999)

Agricultural Land Commission Act (BC)
Canada Water Act (Federal)
Canada Wildlife Act (Federal)
Canadian Environmental Assessment Act (Federal)
Canadian Environmental Protection Act (Federal)
Creston Valley Wildlife Act (BC)
Criminal Code (Federal)
Dogwood, Rhododendron, and Trillium Protection Act (BC)
Ecological Reserve Act (BC)
Emergencies Act (Federal)
Environment and Land Use Act (BC)
Environment Management Act (BC)
Environmental Assessment Act (BC)
Explosives Act (Federal)
Fish Protection Act (BC)
Fisheries Act (Federal)
Fisheries Act (BC)
Fisheries Renewal Act (BC)
Forest Act (BC)
Forest Land Reserve Act (BC)
Forest Practices Code of British Columbia Act (BC)
Greenbelt Act (BC)
Hazardous Products Act (Federal)
Health Act (BC)
Heritage Conservation Act (BC)
Highway Act (BC)
Hydro and Power Authority Act (BC)
International River Improvements Act (Federal)
Land Act (BC)
Land Title Act (BC)
Migratory Birds Convention Act (Federal)
Mines Act (BC)
Motor Vehicle Act (BC)
Municipal Act (BC)
National Energy Board Act (Federal)
National Parks Act (Federal)
Navigable Waters Protection Act (Federal)
Occupiers Liability Act (BC)
Offence Act (BC)
Park Act (BC)
Park (Regional) Act (BC)
Pest Control Products Act (Federal)
Pesticide Control Act (BC)
Pipeline Act (BC)
Range Act (BC)
Soil Conservation Act (BC)
Transportation of Dangerous Goods Act (Federal/BC)
Utilities Commission Act (BC)
Waste Management Act (BC)
Water Act (BC)
Water Protection Act (BC)
Weed Control Act (BC)
Wildlife Act (BC)
Workers’ Compensation Act (BC)
APPENDIX B: SUCCESSFUL DEFENCES AGAINST CHARGES UNDER THE FISHERIES ACT

This paper was written by the author for a graduate Civil Engineering course at the University of British Columbia in 1997.

Abstract

British Columbia Hydro and Power Authority ("Hydro") was charged with several violations of the Fisheries Act (the "Act") as a result of spills from Terzaghi Dam in 1991. In July, 1997, Mr. Justice Lamperson of the Supreme Court of British Columbia rendered his decision in R. vs. British Columbia Hydro and Power Authority. This paper considers the impact of that decision on water resources engineers. It firstly reviews the facts of the case, including the hydrologic factors and the specific charges brought against Hydro. The paper then considers the defenses raised by Hydro and the Court's ruling on each of those defenses. The final section of the paper suggests four significant impacts this decision has on the conduct of engineers engaged in water resources work which may impact federal fisheries.

This paper is not intended as legal advice and should not be relied upon as such.

Introduction

Hydro's Bridge River hydroelectric system (the "Bridge System") has been in operation since 1960 and includes, on the Bridge River itself, Downton Reservoir, impounded by La Joie Dam, and Carpenter Reservoir impounded by Terzaghi Dam. La Joie Dam has a generating station but Terzaghi Dam does not. Tunnels divert water from Carpenter Reservoir through the mountains to the adjacent Seton River drainage basin. There is a generating station ("Shalalth") at the outfall of the diversion tunnels. The Seton basin contains several other components of the Bridge System which are not relevant to this paper.
Terzaghi Dam does not allow fish passage. Prior to its construction, the federal Department of Fisheries and Oceans (“DFO”), which administers the Act, recognized that an existing run of 200 salmon in the Bridge River would be destroyed by completion of the dam. Nevertheless, construction was approved. There was no historical salmon run below the site of Terzaghi Dam because of frequent high flows. Following construction of the dam, flow in the Bridge River was reduced to nil immediately downstream of the dam. Groundwater and other sources restore sufficient flow to permit salmon spawning several kilometres downstream of the dam. As a result, a salmon run has developed below the dam.

Fish habitat is easily damaged by high flows which can increase sediment load, move gravel spawning beds, destroy food sources for fish, and damage riverbank vegetation which provides habitat for insects upon which fish feed and shades the stream. Juvenile fish may also be flushed out of the river (British Columbia Hydro, p. 12). In 1991 the Bridge River watershed experienced high inflows due to a high snow pack and several severe storms. In response, Hydro conducted three large spills from Terzaghi Dam. Each of those spills damaged fish habitat and killed fish. DFO charged Hydro with three violations of the Act.

Facts and Charges

Hydro generates monthly inflow forecasts for the Bridge basin between February and September each year. These forecasts are based upon average temperatures and precipitation and predict the volume of inflows in cfs days and as a percentage of the historical average. The forecasts for April and May are usually very accurate because the extent of the snow pack is known. The August forecast is typically the least accurate because inflows in that month are almost exclusively precipitation. Hydro also generates five day forecasts using Environment Canada weather predictions. (British Columbia Hydro, p. 14-15).

In the spring of 1991 the snow pack in the Bridge basin was considerably higher than normal. To minimize future storage problems, Hydro ran the Shalalth generators at maximum capacity (5400 cfs). By early May, inflows in the Bridge basin exceeded outflows and Carpenter Reservoir started to fill. Hydro sequentially shut its Shalalth and other Bridge System generators down in early June for maintenance. As a result, outflows were lower and reservoir storage was reduced at a greater rate for several weeks.
In mid-July, a three day temperature spike followed by heavy precipitation resulted in inflows exceeding projections. Additional water had to be released into Carpenter Reservoir through La Joie Dam. By late July Hydro concluded that a release from Terzaghi Dam would be necessary. After consultation with DFO, a spill of 2800 cfs commenced on July 24 and ended on July 31 when Hydro determined that a safe amount of available storage had been achieved in Carpenter Reservoir. Fish salvage operations were carried out following cessation of the spill.

Between August 7 and 12 a 1-in-100 year storm occurred in the basin. That storm was not predicted by Environment Canada. Hydro determined that another spill was necessary from Terzaghi Dam and, after consultations with DFO, let the reservoir rise to free spill height. On August 9 Hydro determined that an additional spill through the spillway was necessary for protection of the dam. The controlled spill was gradually reduced when circumstances permitted and fish salvage operations were carried out. The spill peaked at 8500 cfs and by August 28 had been reduced to 50 cfs.

On August 29 a 1-in-1000 year storm event occurred. Environment Canada again failed to predict the storm. Another combined free and controlled spill was required from Terzaghi Dam. The spill peaked at 7500 cfs and was reduced in stages beginning September 7 to facilitate fish salvage.

Hydro admitted that these spills killed fish and damaged fish habitat but argued that the spills did not appear to have a significant impact on the fishery based upon the numbers of salmon returning in subsequent years. Hydro also pointed out that before the dam existed there was no fishery downstream of the dam site because of high flows. In August, 1991, inflows to the basin peaked at 29,000 cfs, all of which would, historically, have flowed down the Bridge River.

Hydro was charged with one count each of killing fish, damaging habitat, and introducing a deleterious substance (sediment) into water frequented by fish. The relevant provisions of the Act are:

Section 32: “No person shall destroy fish by any means other than fishing except as authorized by the Minister or under regulations made by the Governor in Council under this Act”.

Section 35(1): “No person shall carry on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat”.

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Section 36(3): "... no person shall deposit or permit the deposit of a deleterious substance of any type in water frequented by fish ...".

Violations of these sections are strict liability offences. The Crown need only prove that the violations occurred and the onus then shifts to the defence to prove on the balance of probabilities that its defences apply (British Columbia Hydro, p. 23).

Hydro’s Defences

Hydro raised a number of defences to the charges. Most of those defences were unsuccessful and were dealt with by the Court as follows:

1. Defence of implied exception: Hydro argued that other sections of the Act dealt specifically with hydroelectric projects and therefore Hydro was implicitly exempted from the sections under which it was charged. The Court dismissed that argument, stating that the sections Hydro referred to did not "exempt the dam owner from the general regulatory provisions of the [Act] and allow spilling at will regardless of the reasons or consequences" (British Columbia Hydro, p. 25).

2. Ministerial authorization and estoppel: Hydro also argued that by allowing the dam to be constructed, especially when doing so destroyed a salmon run, the DFO implicitly authorized spills and so was estopped from prosecuting Hydro for such events. The Court rejected this argument on the basis that to grant an exemption requires "active consideration" by the Minister "with respect to certain specific acts" and because allowing the argument would be tantamount to giving the operation of Terzaghi Dam immunity from laws designed to protect fish, which would be going too far (British Columbia Hydro p.27).

3. Abuse of process: Hydro further argued that, by allowing construction of the dam and destruction of the then existing salmon run, DFO acquiesced to that destruction and to Hydro’s method of operation. Charges had never been laid before and the defence argued this prosecution was politically motivated. The Court found the absence of prior charges to be irrelevant and found no evidence to suggest that the prosecution was so oppressive or vexatious as to constitute abuse of process (British Columbia Hydro, p29).
4. Necessity: Hydro attempted to convince the Court that there was no reasonable legal alternative but to spill because the weather made those spills unavoidable. The Judge suggested that this argument may have been valid for the second and third spills but did not make a definite ruling on this point as he had already found that Hydro had successfully made the defence of due diligence (discussed below) (British Columbia Hydro, p. 38).

5. No damage to habitat: Hydro argued that spills are an integral part of the downstream habitat and so could not be said to have altered or damaged it. The Court ruled that DFO can insist that the dam be operated so as to protect the existing fishery as much as possible and that the dam be operated in a manner which considers fish as well as electricity generation (British Columbia Hydro, p. 39).

6. Sediment is not a “deleterious substance”: this claim was based on the argument that a deleterious substance under the Act is a new, foreign substance. The defence argued that moving an existing substance already in the riverbed does not contravene the Act. The Court found Hydro’s spills to be analogous to a person washing silt into the river which would contravene the Act. The Court also expressly found silt to be a deleterious substance (British Columbia Hydro, p. 40).

7. Vested rights: Hydro also argued that, because the dam was operating prior to the coming into force of the relevant sections of the Act, Hydro had secured a vested right to operate the dam for electrical generation. The Court, however, found that Parliament has the right to regulate activity coming within its sphere of power, even if it suppresses a person’s right of utilization (British Columbia Hydro, p. 42).

The defence also claimed that the high inflows which led to the spilling were an Act of God and therefore Hydro could not be held responsible. For this defence to apply, Hydro had to demonstrate that the storms were unforeseeable in the sense that they were “so extraordinary and overwhelming that the damage resulting therefrom could not be avoided despite all reasonable skill and forethought” (British Columbia Hydro, p. 37). The Court rejected this claim with regards to the first and second spills. The first spill was the result of high temperatures and rain which caused the snow pack to melt earlier than usual. This simply changed the distribution of the inflows said the Court. The second spill was necessary after a 1-in-100 year storm. The Court found that because 1-in-100 year events are routinely planned for that storm could not be said to be unforeseeable. However, with respect to the third storm, a 1-in-1000 year event, “there can be little question but that it was an act of God” (British Columbia
Hydro, p. 37). These findings had no impact on the final decision as the Court found that the defence of due diligence applied in this case.

Hydro’s main defence required that it prove on the balance of probabilities that it exercised all due diligence to prevent the commission of the offence. The Court adopted a summary of the appropriate test provided in an earlier decision: "...more than the care of an ordinary citizen is demanded. In the very least, the care must reflect the diligence of a reasonable professional possessing the expertise suitable to the activity in issue..." (Northwood, p. 293). Justice Lamperson opined that this meant "an accused must take all reasonable steps to avoid harm. However, that does not mean an accused must take all conceivable steps" (British Columbia Hydro, p. 31).

The Court then considered the evidence of the expert witnesses who had testified on behalf of each of the accused and the Crown. Although the Crown witness suggested an operating procedure that would have avoided the spills, the Judge found that “decisions on how to manage dams and their reservoirs, although based on detailed and sophisticated calculations, are in the end matters of judgment which equally competent people may exercise differently” (British Columbia Hydro, p. 36).

The Court concluded by finding that “even if [Hydro’s] judgment could have been exercised differently, it does not follow that [it] failed to use due diligence” and that Hydro, in the circumstances of this case, had exercised due diligence (British Columbia Hydro, p. 37). Accordingly, Hydro was found not guilty on all counts.

The decision of Mr. Justice Lamperson has been appealed by the Crown but detailed grounds for the appeal had not been filed as of mid-December, 1997.

Conclusions

There are at least four significant findings in this case of interest to water resources engineers:

1. Water resources facilities and operating methods which predate the Act or upon which DFO has been consulted are not exempt from the three sections of the Act under which Hydro was charged. Engineers should not rely upon consultation with DFO for protection but should seek appropriate Ministerial approval if warranted.
2. Sediment washed into a river as a result of high flows caused by spills is a deleterious substance for purposes of the Act. This finding is almost certainly extensible to other introductions of sediment caused by engineering or engineered activity.

3. 1-in-100 year storms, and other events which are “routinely planned for” cannot be considered acts of God. However, 1-in-1000 year events may be. Unfortunately the Court did not narrow this range but the key is undoubtedly the words “routinely planned for”. This suggests that design inflow, flow and other parameters will not be considered acts of God, no matter how infrequent. Engineered structures and operation guidelines must be adequate to handle such events while avoiding damage to fish and their habitat. Note that setting low design parameters will not likely provide an act of God defence if higher design parameters are typically used.

4. *Fisheries Act* charges can be avoided, or at least successfully defended against, by the exercise of due diligence in engineering operations. This requires the exercise of care appropriate to a professional with relevant expertise in the issues at hand. This means that judgments can be made which, in hindsight, may be wrong provided that the judgment is based upon an appropriate professional level of care. There is, of course, the danger that, over the long life of a water resources project, errors in judgment will be made which do not meet that standard. Efforts to make operational decisions based in part on a professionally developed “checklist” may help to ensure such lapses do not occur.

**References**


APPENDIX

FACULTIES, SCHOOLS, AND PROGRAMS OFFERED
Schools:

Architecture.................................................M.Arch. M.A.S.A.
Nursing..........................................................Ph.D. M.S.N. M.Sc.

ARCHITECTURE see Applied Science, Faculty of

ARTS, FACULTY OF

Departments:

Anthropology and Sociology..............................Ph.D. M.A.
Asian Studies...................................................Ph.D. M.A.
Classical Archaeology........................................see Classical, Near Eastern & Religious Studies
Classical, Near Eastern & Religious Studies........Ph.D. M.A.
Classics..........................................................see Classical, Near Eastern & Religious Studies
Creative Writing..............................................see Theatre, Film and Creative Writing.
Economics.......................................................Ph.D.
English............................................................Ph.D. M.A.
Film..............................................................see Theatre, Film and Creative Writing.
Fine Arts.........................................................Ph.D. M.A. M.F.A.
French.............................................................see French, Hispanic, and Italian Studies
French, Hispanic, and Italian Studies................Ph.D. M.A.
Geography.........................................................Ph.D. M.A. M.Sc.
  - Atmospheric Science Programme......................See listing below.
Germanic Studies.............................................Ph.D. M.A.
Hispanic and Italian Studies..............................see French, Hispanic, and Italian Studies
History..........................................................Ph.D. M.A.
Linguistics......................................................Ph.D. M.A.
Philosophy......................................................Ph.D. M.A.
Political Science.............................................Ph.D. M.A.
Psychology......................................................Ph.D. M.A.
Religious Studies............................................see Classical, Near Eastern & Religious Studies

Social Work....................................................see School of Social Work and Family Studies
Theatre and Film..............................................see Theatre, Film and Creative Writing
Theatre, Film and Creative Writing.....................Ph.D. M.A. M.F.A.

Schools:

School of Social Work and Family Studies M.S.W.

ATMOSPHERIC SCIENCE PROGRAMME........................Ph.D. M.Sc.
(Under the joint sponsorship of the Departments of Geography and Earth and Ocean Science).

AUDIOLOGY AND SPEECH SCIENCES see Medicine, Faculty of
FAMILY AND NUTRITIONAL SCIENCES ........................................... see School of Social Work and Family Studies under the Faculty of Arts and the Faculty of Graduate Studies

FORESTRY, FACULTY OF ................................................................. Ph.D. M.Sc. M.F. M.A.Sc.

(Including programs in Forest Resources Management, Natural Resources Conservation, Forest Operations, Forest Science, and Wood Science and Industry)

GRADUATE PROGRAM IN BIOLOGY ........................................ Ph.D. M.Sc.

GRADUATE PROGRAM IN COMPARATIVE LITERATURE .......... Ph.D. M.A.

GRADUATE PROGRAM IN GENETICS ...................................... see Genetics Graduate Program

GRADUATE PROGRAM IN HEALTH SERVICES PLANNING .......... M.Sc.

GRADUATE PROGRAM IN OCCUPATIONAL HYGIENE ............. M.Sc.

GRADUATE STUDIES, FACULTY OF

ATMOSPHERIC SCIENCE PROGRAMME .................................. Ph.D. M.Sc.

(Under the joint sponsorship of the Departments of Geography and Earth and Ocean Science).

Experimental Medicine Program ....................................... Ph.D. M.Sc.

Genetics Graduate Program ........................................ Ph.D. M.Sc.

Graduate Program in Neuroscience .................................. Ph.D. M.Sc.

Graduate Program in Occupational Hygiene ....................... See School of Occupational & Environmental Hygiene


Schools:

Community and Regional Planning .................................... Ph.D. M.A.P. M.Sc.P.

Library, Archival and Information Sciences ....................... M.A.S. M.L.I.S.


Social Work ........................................................................ see School of Social Work and Family Studies

School of Social Work and Family Studies ....................... M.S.W.

School of Occupational & Environmental Hygiene ............ M.Sc. Ph.D.

HUMAN KINETICS ............................................................... see Education, Faculty of

INTERDISCIPLINARY STUDIES ........................................ Ph.D. M.Sc. M.A.

(N.B. not "Dept. of ______")

LANDSCAPE ARCHITECTURE PROGRAM .......................... see Agricultural Sciences, Faculty of

LAW, FACULTY OF ................................................................. Ph.D. LL.M.
Departments:

Astronomy ................................................................. see Physics and Astronomy
Botany .................................................................. Ph.D. M.Sc.
Chemistry ................................................................. Ph.D. M.Sc.
Computer Science .................................................. Ph.D. M.Sc.
Earth and Ocean Sciences ...................................... Ph.D. M.Sc. M.A.Sc.
Engineering Physics ................................................... M.A.Sc.
Geological Sciences ................................................... see Earth and Ocean Sciences
Geophysics ................................................................. see Earth and Ocean Sciences
Mathematics .............................................................. Ph.D. M.Sc. M.A.
Microbiology and Immunology ................................ Ph.D. M.Sc.
Oceanography ............................................................. see Earth and Ocean Sciences
Statistics ........................................................................ M.Sc. Ph.D.
Zoology ........................................................................ Ph.D. M.Sc.

SOCIAL WORK .............................................................. see Graduate Studies, Faculty of

TRANSPORTATION AND LOGISTICS ................................... see Commerce and Business Administration, Faculty of