BENEATH THE SURFACE

Aboriginal Rights and Mining Law in British Columbia

EAGLE
Environmental-Aboriginal Guardianship through Law and Education

Environmental Mining Council
of British Columbia

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EAGLE was established to empower First Nations to protect the environment in their territories. To accomplish this vision, EAGLE has embarked upon a strategy based on two inter-related avenues: legal services and education. EAGLE donates legal services in the form of advice and litigation to First Nations throughout British Columbia. We rely upon the strengths of aboriginal law combined with environmental law, to prevent and reduce the harm caused by resource exploitation, and to ensure government and industry compliance with aboriginal rights and laws.

Because "knowledge is power", we provide legal and practical information and skills through our Education Program to increase understanding of resource use and laws and their relationship to aboriginal rights. We hope that through this strategy of legal services and education, we provide First Nations with the means to "level the playing field" when addressing resource use in their territories.

EAGLE, founded in 1997, has been a project of Sierra Legal Defence Fund. EAGLE's board, composed of First Nations leaders and lawyers, manages and guides EAGLE with cultural, political and spiritual concerns. EAGLE is in the process of becoming an independent entity.

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Introduction

Introduction

These materials have been prepared by EAGLE for use at EAGLE's Education Program workshops, and for use as a general reference tool for First Nations in British Columbia. The goal of these materials is to assist aboriginal peoples in their efforts to protect their territories and rights when faced with mining developments in their territories.

This publication provides an overview of:

- aboriginal rights law in Canada,
- the laws that govern mining in British Columbia, and
- provincial policies relating to mining and First Nations.

It also explains mining processes, and discusses some of the potential impacts of mining activities on land and water. Knowledge of some of these risks, it is hoped, will assist First Nations to make informed decisions regarding proposed mineral exploration and development in their territories. An awareness and understanding of the law that governs mining in British Columbia, and of the constitutional protection of aboriginal rights, should assist First Nations in developing strategies to address mineral exploration and mining developments in their territories. The materials also include cases studies and discuss some of the approaches First Nations have used to work with industry and government when mine developments occur in, or are proposed for, their territories.

EAGLE's publications are offered to provide a basic understanding of aboriginal law and environmental and natural resource laws. This publication is educational, and does not constitute legal or other professional advice.

Law is constantly evolving. EAGLE does not warrant the accuracy or completeness of these materials and specifically cautions users against reliance upon the accuracy of cited legislation and case law. Use precedents only as an initial reference point. Do not rely on these materials to the exclusion of other resources or without carefully considering their applicability and the advice of a lawyer.

Chapter 1
Aboriginal Rights, Aboriginal Title and Treaty Rights

1. Aboriginal Rights, Aboriginal Title and Treaty Rights[1]

This section briefly highlights some of the implications that aboriginal and treaty rights may have for mining in British Columbia. Canada's Constitution protects aboriginal and treaty rights under s. 35(1) of the *Constitution Act, 1982*, and s. 109 of the *Constitution Act, 1867*. As the Constitution is the "Supreme Law" of Canada, all federal and provincial laws must comply with it. In interpreting the meaning of these constitutional provisions, the courts have developed certain standards of conduct and imposed those standards on governments in their dealings with aboriginal peoples and their territories.

Canada's Constitution protects aboriginal and treaty rights under s. 35(1) of the Constitution Act, 1982, *and s. 109 of the* Constitution Act, *1867.*

In the context of mining, we can divide the discussion into two general issues. The first relates to the province's granting of minerals and rights to minerals to mining companies and explorers, and asks whether the province has the property in the minerals that it purports to give away or sell to others, particularly since Aboriginal title has not been dealt with throughout most of British Columbia. The second issue relates to the effects of mineral developments discussed in later chapters, and asks whether the province can authorize activities that harm the lands and waters that sustain First Nations in the exercise of our aboriginal and treaty rights.

a. Whose Minerals?

As will be seen in the discussion of British Columbia's mining legislation in chapter 3, the province, through its legislation, gives minerals and rights to mineral deposits to mining companies and explorers. It should go without saying that the province can dispose of (give away or sell) only that which it owns. An issue raised by the constitutional recognition of aboriginal title and treaty rights is, therefore, whether and to what extent British Columbia, or the "Crown", owns the minerals

The province can dispose of (give away or sell) only that which it owns.

within provincial boundaries. British Columbia was not an empty piece of land when Europeans arrived on its shores. It was already occupied by various indigenous nations, who held and governed over their territories. While ignored for many years, Canada's courts now recognize this fact, along with its legal implications.

Aboriginal title is a right to the land itself, including the minerals underneath the land.

In *Delgamuukw*, the Supreme Court of Canada held that aboriginal title is a right to the land itself, including the minerals underneath the land. It is therefore a property interest in the lands and resources, both above and below the surface. Aboriginal title includes the right to make land use decisions. Aboriginal title continues in at least most of British Columbia, because First Nations, for the most part, have never ceded or surrendered lands to the Crown, have never entered into treaties with the Crown, and were never conquered by Europeans.

First Nations who signed treaties many years ago may still hold title to the minerals.

Where treaties were entered into, it is unclear whether the Crown actually acquired the minerals. The written text of the historical treaties, entered into the mid- to late-19th century, contain "surrender" clauses, which, according to the government and some courts, resulted in the extinguishment of all aboriginal rights and title. However, the courts have recently recognized the validity of oral history and the importance of considering the historical context to discover the true agreement. Oral history usually paints a different picture of the agreement between the parties. In some cases, both the oral history and the recording of the negotiations by the Crown's own representatives, reveal no discussion of minerals or underground resources. In the absence of discussions regarding mining or title to minerals during treaty negotiations, First Nations who signed treaties many years ago may still hold title to the minerals as an existing aboriginal title right.[2]

The province may be acting unconstitutionally when it grants interests to mining companies and authorizes mining developments on lands where aboriginal title continues.

Are the province's laws under which it disposes of mineral resources and authorizes mineral exploration and development valid and applicable throughout British Columbia? In at least some instances, the province may be acting unconstitutionally when it grants interests to mining companies and authorizes mining developments on lands where aboriginal title continues. These dispositions and autho-

rizations are provided for under provincial legislation (see Chapter 3), but the province may not rely on its legislation to the extent that the legislation, or the province's actions under the legislation, are not in compliance with the Constitution, including s. 35(1), which protects aboriginal and treaty rights, and s. 109, which provides that the province's title is burdened or limited by aboriginal title. Therefore, in situations where the government has authorized mineral exploration or development that appears to be inconsistent with or contrary to aboriginal title or rights, and government has neither obtained the First Nation's consent or accommodated their interest in the lands, aboriginal peoples may be able to challenge the government action in court.

Does this mean the province can never authorize mineral exploration or development on aboriginal title lands? This issue is not yet settled, but the *Delgamuukw* decision suggests that in certain circumstances, the province will be permitted to infringe aboriginal title if the infringement can be "justified". The "justification analysis" is outlined in section (b) below.

Are First Nations entitled to develop the minerals located within their territories? Not necessarily. *Delgamuukw* held that aboriginal title does not include the right to use lands in a manner that destroys the nature of the relationship between indigenous peoples and their lands (the "inherent limit"). For example, mining a hunting ground would not be a valid exercise of aboriginal title if the mining would preclude hunting on those lands in the future. To engage in such an activity, the court held that aboriginal people must first surrender their title to the Crown. This raises the question whether government can be acting lawfully in disposing of minerals within a First Nation's unsurrendered territory, or allowing those lands to be mined, where mining might destroy the people's relationship to the land, without obtaining a surrender or consent from the First Nation.

The "inherent limit".

Aboriginal title, like all aboriginal rights, is a collective right which must be exercised by the people as a whole. This means that an individual citizen of an aboriginal society may not rely on aboriginal title to mine for per-

Aboriginal title is a collective right which must be exercised by the people as a whole.

sonal profit without authorization from the nation. The mining must take place in accordance with the nation's title, laws and decision making.

b. The Exercise of Aboriginal and Treaty Rights Depends on Healthy Ecosystems

The exercise of Aboriginal and treaty rights, including for example, rights to hunt, trap, gather, fish and engage in spiritual ceremonies, often requires healthy ecosystems. The courts have held, for example, that a right to fish includes a right to healthy fish habitat (*Saanichton*). As is discussed in chapters 5 and 6 of these materials, mining can have serious impacts upon lands and waters.

A right to fish includes a right to healthy fish habitat.

The exercise of aboriginal title also depends on healthy ecosystems, at least to a certain degree and in certain circumstances. For example, say an indigenous people decides that they would like a certain area to be used for eco-tourism, or to remain intact for spiritual practices. If the province authorizes a mining development that scars the land and damages the water. The relationship the people have with the land could be damaged. In addition, the indigenous nation is effectively barred from making the land use decision, which is an exercise of aboriginal title.

Enforcing aboriginal rights and title possibly can preclude, or require changes to, mining activities.

Can aboriginal peoples use their rights to preclude or minimize the damage to ecosystems which often results when mining projects take place? Enforcing aboriginal rights and title possibly can preclude, or require changes to, mining activities.

If a First Nation has decided that it will support a mining project if certain conditions (e.g., protection of water resources) are met, then consultation processes may provide an opportunity for meeting those conditions. If the First Nation has ideas about how their rights and interests can be protected while allowing the project to proceed, they can offer alternatives to government and industry, who might be willing to make the necessary

changes rather than risk the First Nation challenging the development in court.

"Justification Analysis"

The courts apply the following analysis, or series of legal tests, to determine whether the province, by its actions or through its legislation, has acted unconstitutionally as a result of interfering with aboriginal rights, treaty rights and/or aboriginal title (*Sparrow*).

1. *Is an aboriginal right likely to be affected?* The onus in court is on aboriginal peoples to prove the right in question.

Aboriginal Title: Exclusively occupied the lands in question in 1846.

(a) To establish aboriginal title to a particular area, First Nations must show that their ancestors exclusively occupied the lands in question at the time of the Crown's assertion of sovereignty over British Columbia in 1846 (*Delgamuukw)*. Exclusive occupation does not mean that no other people lived in that territory, but rather that the First Nation had the right to exclude others. Two or more First Nations may be able to demonstrate "shared exclusivity". Aboriginal title can be established by reference to the facts of occupation and of First Nations' relationship to their territory, and by reference to their nation's laws.

Aboriginal Rights: the custom, practice or tradition is centrally significant to the aboriginal culture, or makes the society what it is.

(b) Aboriginal rights are seen by the courts as rights to engage in activities, and so the courts focus on specific activities in determining whether the claimed right exists. The test is whether the custom, practice or tradition claimed to be an aboriginal right is centrally significant to the aboriginal culture, or something that makes the society what it is (*Van der Peet*). The custom, practice or tradition must be engaged in today, and have been engaged in at the time of contact with Europeans, though the exercise of rights may evolve over time. Aboriginal rights can be related to a particular area (e.g., fishing a particular stream); these rights are considered to be land-based rights.

Treaty rights.

(c) Treaty rights are determined with reference to the written text, the oral terms and promises, the oral history regarding the treaty and its meaning to the aboriginal signatories, and the historical context sur-

rounding the treaty (*Badger*). Generally, the courts have held that treaties must be interpreted liberally in favour of aboriginal peoples, that no sharp dealing on the part of the Crown is to be tolerated, and that treaties should be given an interpretation that is consistent with how the treaty would have been understood by the aboriginal parties. Treaties may or may not extinguish aboriginal title, and they usually include a guarantee that the indigenous parties will be able to continue to exercise rights to hunt, trap and fish.

Treaties should be given an interpretation that is consistent with how the treaty would have been understood by the aboriginal parties

2. *Was the right extinguished by surrender or federal legislation before 1982?* The federal legislation must reveal a "clear and plain intention" to extinguish the right. In other words, the legislation must clearly state that the intention of the legislation is to extinguish the right. The onus is on the government to demonstrate that the right has been extinguished. The provincial government does not have any authority to extinguish aboriginal rights (*Delgamuukw*).

Extinguishing Rights: Federal legislation must reveal a "clear and plain intention."

3. *Has the right been infringed?* Here the onus is on aboriginal peoples. Generally, an interference with the exercise of a right is an infringement. The courts ask the following questions:

Infringement: An interference with the exercise of a right.

    - *Is the limitation unreasonable?* An example of a reasonable limitation provided by previous court decisions, is a licensing requirement where the license is free and readily available.
    - *Does the regulation impose undue hardship?* An example of undue hardship is where, as a result of the government decision or action, aboriginal peoples must spend significantly more time, effort or money to exercise a right, such as a fishing right.
    - *Does the regulation deny to the holders of the right their preferred means of exercising the right?* An example would be a gear restriction that denies First Nations their preferred method of fishing.

The courts have not addressed the question of what constitutes an infringement of aboriginal title, but we can speculate from what the courts have said about the nature of aboriginal title; any of the following may qualify as an infringement:

- Interference with the right to exclusively occupy the territory (e.g., when the province authorizes a mining company to exclusively occupy aboriginal title lands for exploration or development without the First Nation's consent);
- Interference with aboriginal peoples' land use decisions (e.g., when the province authorizes a mining development on lands the First Nation has decided to use for activities that cannot co-exist with mining, such as spiritual practices or eco-tourism);
- Interference with aboriginal people's relationship with their lands (e.g., cutting off access to part of the territory, or allowing an open pit mine on hunting grounds).

First Nations may wish to participate in the determination of whether their rights are being infringed.

First Nations may wish to participate in the determination of whether their rights could be infringed, as opposed to leaving that assessment to government or the mining company. This approach may be expensive, however, because it usually requires hiring experts to conduct studies, as well as gathering information from elders and people whose use of the land may be interfered with. To date, the courts have not imposed on government an obligation to fund aboriginal peoples' independent assessments of projects. Sometimes, government and/or industry will agree to fund a cooperative assessment.

Justification.

4. *Can the government justify the infringement and therefore save its actions?*

The objective must be "compelling and substantial".

(a) *Does a valid legislative objective exist?* To be valid, the objective must be "compelling and substantial". The courts have indicated that a broad range of government objectives will qualify, including:

- conservation;
- agriculture;
- forestry;
- building infrastructure;
- economic development; and
- public safety.

It is not enough for government to identify a valid legislative objective. Rather, an infringement of an aboriginal right will only be justified if the means used to achieve the objective (the proposed development) upholds the honour of the Crown.

5. *The honour of the Crown.* The government bears the onus of showing that it has upheld the honour of the Crown, and that its actions and the infringement are consistent with the Crown's fiduciary responsibilities owed to aboriginal peoples (i.e., their duty to safeguard aboriginal peoples' interests). In determining whether the honour of the Crown has been upheld, the courts consider the following:

Determining whether the honour of the Crown has been upheld.

   - whether the infringement was necessary in order to achieve the objective;
   - whether as little infringement as possible has occurred, or whether, on the other hand, the government could have chosen a less intrusive means of achieving the objective;
   - whether aboriginal peoples and their rights were given priority to the resources and of allocating the resources;
   - whether aboriginal rights and title have been accommodated, where accommodation is possible;
   - whether there has been fair compensation; and
   - whether government, prior to making the decision, adequately consulted with affected aboriginal peoples.[3]

If the court agrees that the province has *unjustifiably* infringed aboriginal rights, the court can find the law in question to be invalid or inapplicable in the particular

circumstances, and can overturn government decisions that give mineral interests to third parties or that authorize third party mining developments. The province may find that justifying an infringement of aboriginal title, particularly where the province assumes full ownership of minerals and gives exclusive rights to those minerals to a third party, is impossible. Also, government may find it impossible to justify an infringement if it has authorized an activity or development which would result in putting the lands in question to a use that is inconsistent with, or could damage or sever, the people's relationship with their land (see the discussion of the "inherent limit" in Section a above). These issues remains unresolved, because the Supreme Court of Canada has indicated that the province may justify such infringements of aboriginal title, but has yet considered this question in the context of a specific infringement.

The court can find the law in question to be invalid or inapplicable in the particular circumstances, and can overturn government decisions that give mineral interests to third parties or that authorize third party mining developments.

One of the key obstacles today facing aboriginal peoples who wish to protect their territories is the court's reluctance to impose obligations on government until aboriginal peoples conclude treaties or establish their title (or rights) in court. The government's position, that it may assume full ownership of lands and resources (and that it may authorize developments that pose a threat to aboriginal peoples' rights, lands and resources) until such time as aboriginal peoples establish the nature and extent of their title and rights in court, or until such time as government concludes treaties with First Nations, is questionable. However, the lower courts have ruled both in favour and against this position. This remains an unsettled issue that, so far, has been addressed only in lower courts, and will need to be resolved by higher courts such as the B.C. Court of Appeal or the Supreme Court of Canada.

The government's position, that it may assume full ownership of lands and resources until such time as aboriginal peoples establish the nature and extent of their title and rights in court, or until such time as government concludes treaties with First Nations, is questionable.

Case Law

Delgamuukw v. *British Columbia*, [1998] 1 C.N.L.R. 14 (S.C.C.).

R. v. *Badger*, [1996] 2 C.N.L.R., 77 (S.C.C.)

R. v. *Sparrow*, [1990] 3 C.N.L.R., 160 (S.C.C.)

R. v. *Van der Peet*, [1996] 4 C.N.L.R., 177 (S.C.C.)

Saanichton Marina v. *Claxton*, [1989] 3 C.N.L.R., (B.C.C.A.)

Notes

[1] For a more comprehensive discussion of aboriginal rights and title, see EAGLE's Workshop Materials, "The Nature and Scope of the Crown's Fiduciary and Constitutional Obligations to Consult with Aboriginal Peoples".

[2] It may be that at least some aboriginal peoples who signed treaties still have aboriginal title to some or all of their territories (not just minerals). One view is that what was agreed to in the historical treaties, such as Treaty 8 in northeastern British Columbia, is a form of shared title and jurisdiction. In other words, according to this view, the indigenous nations did not surrender their title, but also did not retain an exclusive title. They agreed to share the lands in question with the settlers.

[3] For a discussion of the duty to consult see EAGLE's Workshop Materials, "The Nature and Scope of the Crown's Fiduciary and Constitutional Obligations to Consult with Aboriginal Peoples".

Chapter 2

Jurisdiction Over Mineral Exploration and Development

2. Jurisdiction over Mineral Exploration and Development

In 1867, three of the former British colonies joined to form Canada. They decided to form a federation, creating a new federal government (the central government) as well as provincial governments (regional governments), the latter being a continuation of the former colonies. The *British North America Act, 1867*, which is now the *Constitution Act, 1867* created the Dominion of Canada and provided the framework under which the other colonies and territories subsequently joined Canada.

The British North America Act, 1867, *which is now the* Constitution Act, 1867 *created the Dominion of Canada and provided the framework under which the other colonies and territories subsequently joined Canada.*

One function of the *Constitution Act, 1867* is to establish the rules of federalism, including the division of property and legislative authority (the power to make laws) between the federal government and the provinces. Parliament is the federal law-making institution, and provincial Legislatures are the provincial law-making bodies. The Constitution also sets out limitations on provincial and federal powers, including the limits imposed as a result of pre-existing aboriginal rights and title, and treaty rights.

The Constitution is the supreme law of Canada, which means that all federal and provincial laws must conform to it. Laws not in compliance with the Constitution are invalid or of no force and effect.

Laws not in compliance with the Constitution are invalid or of no force and effect

a. Provincial Jurisdiction over Mining and Mineral Resource Revenue

For the most part, the provincial government has or assumes jurisdiction over mining in British Columbia. At the time of confederation in 1867, the property in and the proceeds arising from Crown lands (including exploration fees, rents, royalties) were assumed to belong to the local colonial governments, and so the provinces

retained this property interest. Section 109 of the *Constitution Act, 1867* states that:

> All Lands, Mines, Minerals, and Royalties belonging to the several Provinces … shall belong to the several Provinces … in which the same are situate or arise, subject to any Trust existing in respect thereof, and *to any Interest other than that of the Province in the same.*

As between the federal and provincial governments, the provinces own the mineral resources within their boundaries, and have the right to collect royalties from their development.

The meaning of this section is that, as between the federal and provincial governments, the provinces own the mineral resources within their boundaries, and have the right to collect royalties from their development. This section, however, includes an important limit on provincial ownership or title, namely aboriginal title. Aboriginal title is an example of an "interest other than that of the Province". This is significant for First Nations in British Columbia because it means that, as a matter of constitutional law, the province is not allowed to dispose of mineral resources or to obtain royalties from mining activity until the land and/or minerals that are the subject of the mining activity are disencumbered of any existing aboriginal title (*St. Catherine's Milling*).

Provincial ownership of mineral resources is "subject to" aboriginal title.

Before 1982, the federal government could extinguish aboriginal title by passing legislation that clearly and plainly intended to extinguish aboriginal title, or by entering into a treaty or otherwise obtaining of a surrender of title from the aboriginal people. Since 1982, Parliament can no longer pass legislation to extinguish aboriginal title. Government can acquire the aboriginal interest only through agreement. The provincial Crown owns all ungranted lands and minerals within the province's political boundaries, *subject to* the burden of aboriginal title. In British Columbia, where few First Nations have entered into a treaty, aboriginal title may exist over much of the province.

The executive power entitles the province to manage and dispose of its minerals, and to impose terms and conditions on any disposition.

As owner of lands or minerals, the province, like other owners, can exercise power over mineral resources. This power is referred to as government's "executive" power, as opposed to "legislative" power, which is the power to make laws. The executive power entitles the province to manage and dispose of its minerals, and to impose terms and conditions on any disposition.

The province of British Columbia currently takes the position that it will not acknowledge aboriginal title until it is proven in court or negotiated by treaty. As a result of this position the Province treats all mineral lands as though they are free of any conflicting title or property interest and thus available for allocation of mineral exploration and development rights, and as a source of provincial revenue.

The province of British Columbia will not acknowledge aboriginal title until it is proven in court or negotiated by treaty.

The province also has exclusive legislative authority with respect to exploration for, and development, management and conservation of, mineral resources in the province whether or not owned by the province (s. 92A(1), *Constitution Act, 1867*). The province also has authority over mineral exploration and development in the province by virtue of its general legislative authority over "the management and sale of the public lands belonging to the province" (s. 92(5)), "property and civil rights in the province" (s. 92(13)), "local works and undertakings" (s. 92(10)), and "generally all matters of a merely local or private nature in the province" (s. 92(16)).

To summarize, mineral developments in British Columbia will usually be regulated by the laws of British Columbia, though it remains uncertain whether those laws comply with the constitution. Those laws, discussed later, include laws governing exploration, prospecting, staking claims, mine development approvals, environmental assessment and regulation, mine closures and remediation.

b. Federal Jurisdiction Over Mineral Exploration and Development

Under s. 91(1A) of the *Constitution Act, 1867*, the federal government has authority over mining where exploration or development occurs on federal Crown lands (e.g., military property, national parks). The federal government also may have some regulatory authority over mining activity on provincial lands where the activity poses a threat to fish or fish habitat (s.91(12)), poses a threat to migratory birds and their habitat, interferes

The federal government has authority over mining where exploration or development occurs on federal Crown lands.

A mining project can be subject to both federal and provincial regulation.

with navigable waterways (s.91(10)), or where a mine development crosses provincial boundaries. In these circumstances, federal approval, and an environmental assessment under the *Canadian Environmental Assessment Act* may be required. Federal authority can thus impose limits on provincial authority and a mining project can be subject to both federal and provincial regulation.

The federal Parliament also has legislative authority over "Indians and lands reserved for Indians" ... [and] gives the federal government the primary constitutional responsibility to safeguard aboriginal peoples' interests in their lands.

The federal Parliament also has legislative authority, under s. 91(24) of the *Constitution Act, 1867*, over "Indians and lands reserved for Indians." The phrase "lands reserved for Indians" includes reserve lands and aboriginal title lands. The Supreme Court of Canada, in *Delgamuukw*, concluded that s. 91(24) carries with it the jurisdiction to legislate in relation to Aboriginal title and Aboriginal rights, including Aboriginal rights that relate to land. It also gives the federal government the primary constitutional responsibility to safeguard aboriginal peoples' interests in their lands, though in the past the federal government has not interfered with the operation of provincial mining legislation that poses a threat to aboriginal interests.

The federal government's unwillingness to interfere with the operation of provincial mining legislation may be a breach of its fiduciary obligations. That Parliament has legislative authority over "lands reserved for Indians" does not mean that the federal government owns those lands, and as discussed further in the next section, arguably does not also preclude aboriginal authority to make laws with respect to mineral developments.

c. First Nations' Jurisdiction over Mineral Exploration and Development

Above, we discussed the division of property and legislative authority between the federal and provincial governments, as dictated by Canada's Constitution. *What does this division mean for aboriginal jurisdiction or authority to make laws with respect to mining?*

Crown title is subject to aboriginal title.

First, as mentioned above, Crown title is subject to aboriginal title. The province does not have the full inter-

est in or ownership of minerals (which enables it to dispose of the minerals in return for royalties), until the aboriginal title interest is acquired from the First Nation, or some accommodation or agreement is reached which allows the mineral disposition.

The extent of First Nations' law-making authority likely will not be clarified until First Nations make laws and attempt to enforce them on resource companies.

The extent of First Nations' law-making authority is still being fleshed out in the courts and likely will not be clarified until First Nations make laws and attempt to enforce them on resource companies. In a recent decision of the Supreme Court of British Columbia, however, the court held that the division of powers in the Constitution is only exhaustive as between the federal and provincial governments (*Campbell*). Any pre-existing aboriginal right of government or right to make laws continues.

Aboriginal title gives aboriginal peoples the right occupy and possess their lands and use them according to their own discretion.

As discussed in the previous chapter, aboriginal title gives aboriginal peoples the right to occupy and possess their lands and use them according to their own discretion, that is, to make land-use decisions (*Delgamuukw*). This right, arguably, includes the right to make and enforce laws regarding mineral exploration and development on aboriginal title lands. However, as discussed in the previous chapter, this right would not always give a First Nation the final decision on mineral developments within their territory for two reasons. First, First Nations may not rely on aboriginal title to make land use decisions that authorize mineral developments that are inconsistent with the peoples' relationship to the lands. Second, the federal government, and perhaps the provincial government, can infringe upon aboriginal title where they can demonstrate that the infringement is justified. Nonetheless, First Nations should have some decision-making authority over mining in their territories.

d. Mining on Reserve Land[1]

Before the colony of British Columbia joined the Canadian federation, the colonial government, for the most part, placed First Nations in the province on reserves without any negotiated settlement, treaty or surrender

of First Nations' lands. As discussed earlier, under section 91 (24) of the *Constitution Act 1867*, the federal government has exclusive jurisdiction over "Indians and Lands reserved for Indians". Upon British Columbia entering Confederation in 1871, Indian affairs were transferred to the federal government.

Subsequent agreements provided for the transfer of reserves to the federal government to hold in trust for the use and benefit of the First Nations who occupied them. The federal government was to collect proceeds from the sale of reserve lands and use them for the benefit of the First Nations.

The Crerar-Carson Agreement ... provincial laws govern the administration, control and disposal of most minerals found on reserve lands.

In 1943, the federal government and British Columbia entered into the Crerar-Carson Agreement (the "Agreement") to address the issue of rights to minerals on reserves. The Agreement was made into law through *The British Columbia Indian Reserves Mineral Resources Act*, S.C. 1943-44, c. 19 and the *Indian Reserves Mineral Resources Act*, S.B.C. 1943, c.40. Under the Agreement, provincial laws govern the administration, control and disposal of most minerals found on reserve lands. The Agreement does not apply to aggregates (sand or gravel). The Agreement requires approval from both the Department of Indian Affairs and Northern Development and a provincial Gold Commissioner before prospecting can be carried out on a reserve.

The province collects all revenues from any sale or disposition of mineral claims on reserves.

The province collects all revenues from any sale or disposition of mineral claims on reserves. The province retains half the revenue and the other half is held by the federal government in trust for the use and benefit of the Indian Band(s). Unfortunately, the provincial government has taken the position that the revenue-sharing provisions of the Agreement do not extend to the mineral tax that is now the main source of revenue from mining in British Columbia. Thus the 50/50 split on paper translates into zero revenue for Indian Bands. This discourages Indian Bands from consenting to mineral surrenders. The normal practice of the federal government is to refuse to accept surrenders of minerals covered by the Agreement until negotiations to replace it have been completed[2].

An important aspect of mining on reserve lands is that, for a mineral resource to be disposed of to a developer, the First Nation must surrender its interest in those minerals, and thus can say no to the development, or, alternatively, impose conditions on the surrender and, therefore, the development. Only the federal government can accept a surrender. Once a First Nation absolutely surrenders its interest in reserve lands or resources, the province gains the full ownership of the lands and resources in question, and has exclusive legislative authority over mineral developments on the surrendered reserve lands. A designation allows a lease or grant of a right or interest in reserve lands without a surrender. The Crown is in a fiduciary relationship with First Nations, which imposes certain obligations on the Crown in dealing with surrendered (or designated) lands, including making efforts to obtain a fair price. The Crown must comply with any terms of the surrender.

For a mineral resource on reserve lands to be disposed of to a developer, the First Nation must surrender its interest in those minerals. Thus a First Nation can say no to the development, or, alternatively, impose conditions on the surrender and, therefore, the development.

The federal government exercises control and management of reserve lands under the *Indian Act*. The Minister of Indian Affairs and Northern Development must approve the exercise of most Band Council powers. The Minister's approval is required for removal of minerals from a reserve. The *Indian Act* (s. 58(4)) authorizes the Minister to dispose of sand, gravel and clay without a surrender or designation, but the Minister must obtain the consent of the Band Council and the proceeds must go into Band funds.

The federal government exercises control and managment of reserve lands under the Indian Act.

Cases:

Campbell v. British Columbia, 2000 BCSC 1123.

Delgamuukw v. British Columbia, [1998] 1 C.N.L.R. 14 (SCC).

St. Catherine's Milling and Lumber Company v. The Queen, [1988], 14 App. Cas. 46 (P.C.).

Legislation:

British North America Act, 1867, ss. 91(A) 91, 92, 92(A), 109.

British Columbia Indian Reserves Mineral Resources Act, S.C. 1943-44, c. 19.

Indian Reserves Mineral Resource Act, S.B.C. 1943, c. 40.

Indian Act, s. 58(4).

Other References:

Barry Barton, *Canadian Law of Mining* (Calgary: Canadian Institute of Resources Law, 1993).

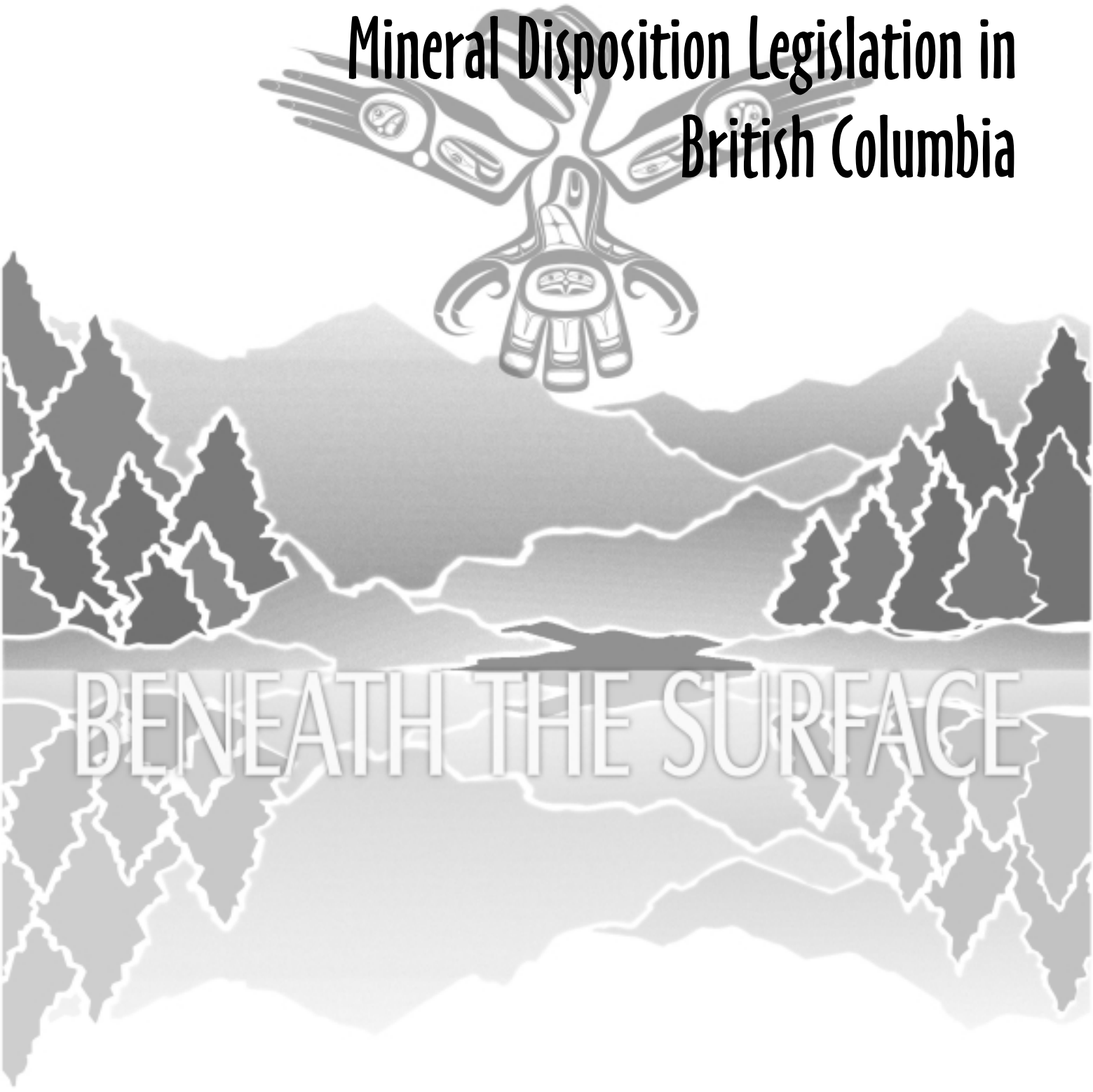
The Crerar-Carson Agreement, 1943.

Notes

[1] This section was written by Wayne Garnons-Williams and Cheryl Sharvit.

[2] See Barry Barton, *Canadian Law of Mining* (Calgary: Canadian Institute of Resources Law, 1997) at 97.

Chapter 3
Mineral Disposition Legislation in British Columbia



3. Mineral Disposition Legislation in British Columbia

This chapter and chapter seven provide an overview of two types of legislation regarding mining:

- disposition legislation, which sets out the rules for obtaining rights to minerals, and
- legislation regulating mining activity (i.e. permitting and environmental protection legislation).

Disposition legislation sets out the rules for obtaining rights to minerals.

British Columbia's *Mineral Tenure Act* (the "*MTA*") is the legislation under which the province disposes of minerals and rights to minerals, except for "aggregates" (e.g., sand and gravel). Aggregates are disposed of under the *Land Act*. The primary sources of legislation regarding regulation of mining activity are the provincial *Mines Act*, *Waste Management Act*, *Environmental Assessment Act*, and, depending on the circumstances, other provincial and federal legislation.

a. Crown Granted Mineral Claims and the "Mineral Tenure Act"

As discussed in the previous chapter, with the exception of lands owned privately under a Crown grant such as fee simple title, lands held by the federal government (e.g., reserves, military bases), and lands proven in court to be subject to an existing First Nation's aboriginal title, British Columbia assumes that all lands are provincial Crown lands, or lands owned by the Province. Most land in B.C. remains "public" land. Like most Canadian governments, British Columbia has a policy of reserving to itself mineral rights when disposing of lands. Thus, leaving aside for the moment the issue of aboriginal title discussed in previous chapters, while someone may own the surface of an area of land (i.e., private and not public or Crown land), likely, the Crown owns (as between itself and the private surface owner) any minerals that lie beneath the surface. Mining tenures under the *MTA* are the means by which the government grants

British Columbia has a policy of reserving to itself mineral rights when disposing of lands.

rights to public or Crown minerals, or disposes of mineral resources to miners.

Until 1957, miners could acquire "Crown-granted mineral claims". While no longer issued, some of these claims still exist (e.g., the Tulsequah Chief Mine in the Taku River Tlingit First Nation's territory). The nature and extent of rights granted under Crown-granted mineral claims are dictated by the terms of the grant and the mining legislation that was in force when the grant was first issued (usually all minerals, precious and base). A Crown-granted mineral claim is a permanent tenure (right to hold), and a "fee simple" interest. This means that the owner of the grant actually owns the mineral underneath the ground, even while they remain under the ground. The owner has a right to access and remove those minerals. The owner being denied access to the minerals is an expropriation, which means that the grant owner must be compensated (*Tener, Falkoski*).

A Crown-granted mineral claim is a permanent tenure and a "fee simple" interest.

Some provisions of the *MTA* deal separately with ordinary metallic minerals and placer minerals. If the mineral is found in particles in a deposit of sand, gravel or broken rock (usually in the bed of a stream), it is a *placer* mineral (usually gold). If the mineral is "in the place or position in which it was originally formed or deposited" then it is not a placer mineral. When dealing with a gravel mine, the *MTA* does not apply. Gravel mines are discussed below.

Placer minerals are those found in particles in a deposit of sand, gravel or broken rock.

How does a First Nation find out about mines and mineral rights in their territory? The province has 24 mining divisions. Each division has a gold commissioner, and the province has one chief gold commissioner. The office of each gold commissioner maintains a record of each claim recorded and each lease issued within the division. Anyone can search the record of a mineral title, if they pay a search fee of $2.50. We note that the records cannot be relied on conclusively. According to one commentator, "It is impossible to know with any certainty who owns mineral claims in British Columbia."[1] The local gold commissioner's office is nonetheless a good starting point. Crown-granted mineral claims are registered in the Land Title Office.

The office of each gold commissioner maintains a record of each claim recorded and each lease issued within the division. Crown-granted mineral claims are registered in the Land Title Office.

British Columbia's mineral disposition legislation, like most in Canada, is based on a "free entry" system. The free entry system was introduced in North America in the 1800s as a result of the "gold rushes". During most of the California gold rush, for example, no mining legislation existed. This lack of legislation posed a problem for miners who wanted security and were concerned about a lack of orderliness in the rush for gold. At first, the miners themselves developed a method of self-regulation, which took the form of a free entry system of rules.

The free entry system was introduced in North America in the 1800s as a result of the "gold rushes".

This free entry system was adopted when Canadian mining law was developed in the late 1800s to early 1900s, and it is still in place in B.C. today. The free entry system is designed to encourage mineral exploration, development and production. The system was a tool for opening lands for development, and for encouraging mining and the search for mineral deposits, all of which require financial output.

The free entry system is designed to encourage mineral exploration, development and production.

Thus, British Columbia's regulation of prospecting and mining activity is based on the premise that lands that may contain minerals should be explored and lands found to contain minerals should be mined. The highest and best use of mineral-bearing lands is assumed to be mining, though the same lands may be valued for other, incompatible purposes and uses. Matters like the depletion of natural resources, economic and environmental sustainability and the impact of the mining process on communities and cultures take a back seat. As one commentator put it, "Laws and customs dating from the nineteenth century are often relics of the drive to open up the frontier and fill up the countryside, and still tend to emphasize the *disposal* of land and resources."[2] British Columbia's legislation thus continues as though B.C. was a "frontier".

B.C.'s prospecting and mining regulations are based on the premise that lands that may contain minerals should be explored and lands found to contain minerals should be mined.

Four central features characterize most free entry systems:

Four central features of free entry systems.

1. Few or no qualifications are required to be a miner;
2. All lands in which the minerals are in public (Crown) ownership are open for staking;

3. A right exists to acquire title to the minerals by the physical act of "staking" a claim; and
4. A right exists to proceed to develop the mine.

i. Qualifications Needed To Acquire Rights To The Resource

To locate and record mineral claims or placer claims in B.C., one must be a "free miner".

Few qualifications are required.

To locate and record mineral claims or placer claims in B.C., one must be a "free miner", which means one must hold a free miner certificate under the *MTA*. Few qualifications are required to become a free miner. Any person 18 years or older who is a Canadian resident for at least half the year, "who demonstrates…. a minimum prescribed standard of knowledge respecting mining exploration and integrated resource management principles in British Columbia" and pays a $25.00 fee, and any Canadian corporation who pays a $500.00 fee must be issued a free miner certificate. The "minimum prescribed standard of knowledge" is knowledge of:

- the legislation and regulatory requirements for acquiring, locating, recording and maintaining claims;
- the rights acquired upon location of a claim;
- the lands on which the free miner may not enter;
- notice requirements; and
- limits on production from a claim.

The legislation contains no definition of "integrated resource management principles."

ii. Lands Available For Staking

The first step in the exploration process is to stake a claim to lands that are potentially mineral bearing

The first step towards establishing a mine is to explore for minerals. The first step in the exploration process is to stake a claim to lands that are potentially mineral bearing, so that no one else may explore for minerals within the staked area.

As noted above, B.C.'s mining regime presumes that mining is the highest and best use of the land. With a few exceptions, all lands containing Crown minerals

are open for exploration and a person who holds a free miner certificate can enter any such lands for the purpose of exploring for minerals (including placer minerals) without being a trespasser. The *MTA* does not acknowledge the value of undeveloped land. The *MTA* does not contemplate that because of their non-mineral values, some lands should not be developed even though they contain minerals. A free miner need not apply for permission to explore a particular area of land, and need not even give notice of his or her plans to carry out exploration activities, unless a *Mines Act* permit (discussed below) is required.

With a few exceptions, all lands containing Crown minerals are open for exploration.

The *MTA* contains no requirement to identify aboriginal title lands or to preclude or restrict mineral exploration and development on aboriginal title lands or lands over which title is disputed. Equally absent from the legislation is any system requiring free miners to seek permission from or even consult with aboriginal peoples in whose territory the free miner is exploring for minerals.

The MTA contains no requirement to identify aboriginal title lands.

Because British Columbia will not acknowledge First Nations' title until First Nations prove title in court, where a dispute arises between a First Nation and the Province over title to lands and minerals, and where aboriginal title continues to exist but has not been proved in court, the province considers those lands and minerals to be available for staking. This view poses problems for treaty or other land claims negotiations,[3] and may also pose problems if First Nations seek to prove title in court, because the province generally will not remove existing tenures for treaty or land claim settlements, and the court may refuse to remove or overturn a mining claim or lease acquired before the litigation.

Where aboriginal title continues to exist but has not been proved in court, the province considers those lands and minerals to be available for staking.

Regarding the option of compensation, for many First Nations, money cannot replace the land. For this reason, it is advisable to put mining companies or explorers searching for minerals in First Nations territory, or who have staked a claim in this territory, on notice of aboriginal title over the lands in question, and let them know that they "proceed at their own risk." First Nations may,

Put mining companies or explorers on notice of aboriginal title.

First Nations may, as an exercise of aboriginal title, make laws prohibiting mining on certain lands and/or providing for a process of applying for rights to mine.

as an exercise of aboriginal title, make laws prohibiting mining on certain lands and/or providing for a process of applying for rights to mine in aboriginal title lands. If the companies and the province refuse to abide by such laws, as is likely, aboriginal peoples wishing to enforce their laws will be required to bring or defend legal challenges in the courts. Short of a constitutional challenge of the *MTA*, which may require proof of aboriginal title, and therefore a long and expensive trial, opportunities may exist to remove lands from those available for staking pending resolution of the title issue.

MTA Exemptions

The *MTA* automatically removes the following lands from those that a free miner may enter freely in order to explore for minerals and placer minerals:

(a) land occupied by a building;

(b) the yard of a dwelling house;

(c) orchard land;

(d) land under cultivation;

(e) most land lawfully occupied for mining purposes other than exploration and location;

(f) most protected "heritage property";

(g) land in provincial parks (except with specific authorization); and

(h) land in recreation areas (unless specific authority is granted).

Notably, aboriginal title lands do not fall within the express exceptions that block the right of entry and staking of mining claims. In contrast, legislation in the Yukon specifically allows the government to withdraw lands from mineral exploration and development if it is of the opinion that those lands are required for the settlement of land claims.

Where aboriginal title exists it includes the minerals in or under those lands.

Where aboriginal title exists, the minerals in or under those lands are included in the aboriginal title. This means that the province does not have full ownership of the minerals, and without full ownership, the province

cannot lawfully dispose of the minerals or rely on them as a source of revenue.

Without recognition of First Nations' title and/or jurisdiction over those lands, a First Nation may deny free miners access to lands if the lands fall within one or more of the exceptions set out above. For example, a First Nation could establish buildings or orchards or could cultivate lands within their territories in an attempt to deny access to miners. This approach will likely result in litigation, however, because B.C. does not recognize the existence of aboriginal title until proven in court and may therefore commence proceedings against the First Nation, claiming that the First Nation is trespassing when, for example, a First Nation builds structures on lands British Columbia considers to be Crown lands. As well, some uses may be considered inappropriate for the lands in question.

LRMP / Parks / First Nations land designations.

Another option, best done before claims are staked, is to try to establish the area as a park or recreation area, under provincial legislation. This option may require sitting on Land and Resource Management Planning ("LRMP") table discussions, to seek consensus with various "stakeholders", including community groups, government agencies and industry representatives. One alternative approach may be for a First Nation to pass its own laws establishing protected areas, and then come to the LRMP table with this law and/or designations seeking the other stakeholders' consensus. This law and the provincial law could then operate together to prevent mining activities, at least until the title issue is resolved. First Nations should be aware that lands designated as parks may limit First Nations' activities that may occur in the parks.

Special provisions for recreation areas.

Recreation areas established under the *Parks Act* can be subject to special provisions of the *MTA*. Recreation areas are designated by cabinet. The Recreation Area Regulation specifies approval requirements for exploration, development and mining work. A free miner who holds a claim or lease in a recreation area must give security for each area over which a reclamation or resource use permit is issued.

Lands can be set aside as a reserve for a national park, pending resolution of aboriginal rights and title disputes.

The *National Parks Act* prohibits mineral exploration and development in national parks and national park reserves. Under the *National Parks Act*, lands can be set aside as a reserve for a national park, pending resolution of aboriginal rights and title disputes (e.g., Gwaii Haanas). The Act applies to prohibit mining as if the reserve was a park, but aboriginal peoples can continue to engage in traditional resource harvesting.

Mineral Reserves.

Another option is to convince the government to establish a mineral reserve. The Minister of Energy and Mines can establish a mineral reserve, and in so doing can:

- prohibit free miners from locating or recording mineral claims and leases;
- permit locating and recording under certain circumstances and/or subject to certain limitations; and
- prohibit a mining activity either absolutely or under specified circumstances.

First Nations may be able to use Mineral Reserves to withdraw land from those available to free miners for staking.

The Minister can carry out any of these things either generally or with respect to certain minerals only. While mineral reserves are usually created to protect infrastructure or allow for construction, operation and maintenance of works such as transmission lines and pipelines, the legislation does not expressly limit the creation of mineral reserves to these types of purposes. First Nations may be able to use this method of withdrawing land from those available to free miners for staking, in order to set aside lands in anticipation of land claim settlements.

A withdrawal will not cancel an existing claim; it will only suspend work.

A withdrawal removes the lands in question from those available for exploration and development. Any withdrawal must take place before a claim is staked; a withdrawal will not cancel an existing claim, although it suspends work on the claim. To withdraw lands permanently, the government would need to expropriate the claim, and compensate the claim holder.[4]

If claims have already been staked over lands that the government subsequently determines are needed for another purpose (e.g., settlement of land claims), government may be required to buy the claimholder's interest

or expropriate it and compensate for the expropriation. This requirement, therefore, is a disincentive on the province to withdraw lands over which claims have been staked. If the province establishes a provincial park, and expropriates the rights of a recorded holder of a lease or claim by precluding mineral development, the province will be required to compensate the miner or mining company, in an amount equal to the value of the rights expropriated.

Compensation and expropriation requirements are a disincentive to withdraw lands over which claims have been staked.

iii. Self-Initiated Acquisition of Rights

When a miner's prospecting activities lead her or him to believe that the lands contain minerals worth developing, and therefore more in-depth investigation is warranted, the miner will stake the land to prevent others from exploring within its boundaries. This staking prevents other miners from appropriating the benefit of exploration work.

Staking prevents other miners from appropriating the benefit of exploration work.

In British Columbia, a free miner acquires a claim by being the first to locate and stake a claim on the ground, followed by recording the facts of the staking and paying a fee. This is a "self-initiated" process for acquiring rights, as opposed to, for example, obtaining a forestry tenure, in which case a person trying to acquire rights must apply to the government for a tenure and the government makes a decision whether to grant the tenure that creates the right.

A free miner acquires a claim by being the first to locate and stake a claim on the ground.

In British Columbia, a free miner can enter land without seeking permission, and need not give notice when entering for the purpose of staking a claim. The gold commissioner cannot refuse to record a free miner's claim, and the *MTA* and provincial policy do not require or allow a gold commissioner to accommodate or consider aboriginal title and rights at this stage[5].

A free miner can enter land without notice or seeking permission.

By staking and recording the claim, the free miner becomes entitled to all minerals and placer minerals underneath the ground within the boundaries of the claim, to the exclusion of all other miners. The claim gives the miner the exclusive right to explore for minerals within the boundaries of the claim and to develop

The free miner's entitlements and rights.

the claim and put it into production. The purpose of providing a right to stake a claim is to encourage prospecting and exploration for minerals in light of the risks and expenses of exploration and development. Unlike other resources such as trees, the location of minerals is uncertain and considerable work and expense goes into finding minerals. By staking a claim on the ground, the miner is notifying other miners that he or she is the only one allowed to explore for and develop minerals underneath the staked ground.

The MTA *allows the gold commissioner to refuse to record a claim if he is not satisfied that there exists "open ground for the claim.".*

Once a free miner has staked a claim, the gold commissioner must record that claim. However, the *MTA* allows the gold commissioner to refuse to record a claim "until the free miner confirms to the satisfaction of the gold commissioner that there exists open ground available for the claim". While the provision is intended to prevent a free miner from staking land over which a claim has already been staked by another miner, lands subject to unextinguished aboriginal title are arguably not "open ground" available for staking a claim. First Nations wishing to prevent the staking of claims in their territories or in a particularly sensitive or important area, could put the gold commissioner on notice, prior to the staking of claims, that the lands in question are not open ground available for staking claims. If a claim is then recorded on those lands, the First Nation could try to invoke s. 40 of the *MTA* and make a complaint to the chief gold commissioner that a claim has been located or recorded contrary to the *MTA*. The complainant must pay a $200 fee and make the complaint in a specific form set out in the regulations.

Arguably aboriginal title lands are not "open ground."

A complaint can be made to the chief gold commissioner, regarding claims located or recorded contrary to the MTA.

Any complaint must be made within one year after the claim is recorded. The chief gold commissioner must review the complaint and either accept it for consideration or reject it. If accepted, the chief gold commissioner may investigate the complaint or require written submissions from the complainant and the claim holder. The chief gold commissioner can dismiss the complaint or cancel the record of the claim. As far as we are aware, as of the time of writing, no First Nation has tried to have a complaint heard under this section; the gold commissioner could decide that he or she can resolve disputes

only between free miners. In that case, the First Nation would need to look to the courts for relief.

Physical process of staking a claim.

To stake a claim, a free miner erects posts to mark the boundaries, puts information on the posts and blazes lines between the posts. To stake a mineral claim, the free miner places four posts in the ground to mark each corner of rectangular or square claims of anywhere from 25 to 500 hectares. The claim is divided into 25ha units. The free miner marks each post with metal tags identifying the claim (compass bearing and distance to other posts), locator, dates of commencing and completing the location, and the number of claim units. One of the corner posts is the "legal corner post", and the description on this post determines the boundaries of the claim. The free miner must also place posts at 500m intervals between the corner posts, to mark the entire boundary line. Standing trees along boundary lines are blazed (a chunk of the tree is cut out), and the underbrush is cut, or, if not in a treed area, the line between the posts is marked as permanently as conditions permit. Where posts cannot be staked, cairns (mounds) of stones are used.

While the four-post system is the primary method of staking claims in British Columbia, free miners can stake smaller claims, up to 500m by 500m (25ha), by erecting two posts.[6] The line between the two posts is the "location line" and is marked by blazing standing trees and cutting underbrush, or by marking the line as permanently as conditions permit. Both posts are marked with metal tags, including the name of the claim and locator and the distance between the post and the boundary of the claim on either side of the location line.

A placer claim cannot exceed 1,000m x 500m and is marked using two posts to which a metal tag is attached. The tag identifies the claim name, locator name, date and time of staking and the distance to the right or left of the location line. Blazing and marking requirements are similar to those for mineral claims.

Generally, once a claim is recorded, the government cannot decide that the lands are more valuable for another purpose inconsistent with mining, unless it

Once a claim is recorded, the government cannot change the use of the lands without compensation.

compensates the claim holder. For example, the province gave Royal Oak Mining $29 million in compensation when the area that included the Windy Craggy copper deposit was designated a provincial park. (See case study: Lessons from the Environmental Assessment Process of the South Kemess Copper/Gold Mining Project.)

Rights of a claim holder

A free miner who holds a recorded claim or lease may: use, enter and occupy the surface of a claim or lease for the exploration and development or production of minerals or placer minerals, including the treatment of ore and concentrates, and all operations related to the exploration and development or production of minerals or placer minerals and the business of mining.

The free miner has a right to enter public or private lands.

The free miner has a right to enter public or private lands unless one of the exceptions noted under "Lands Available for Staking" applies. This right leads to disputes between free miners and surface owners and occupiers.

The miner must compensate the owner of the surface for any loss or damage.

The miner must compensate the owner of the surface for any loss or damage to the land resulting from entry, occupation or use of the land for location, exploration, development or production. A mediation and arbitration board resolves disputes between mineral titleholders and surface owners that the gold commissioner cannot resolve.

Before a free miner disturbs the surface he must give written notice to the surface owner.

Before a free miner uses mechanical equipment that disturbs the surface he must give written notice to the surface owner. The *MTA* defines "owner" to mean the government for lands owned by the government, or, for privately held lands, the person registered in the land title office as the owner of the land. This definition would appear to exclude First Nations from entitlement to compensation for loss or damage to aboriginal title lands, since First Nations interests are not registerable in the land title office. However, the gold commissioner can settle disputes between a miner and any person who, in the gold commissioner's opinion, "has a material interest in the surface." This broader language should include First Nations with rights and/or title to the area in question.

The gold commissioner can settle disputes between a miner and anyone who "has a material interest in the surface."

Mining Right of Way.

The *Mining Right of Way Act* seeks to guarantee miners access to their claims. With written consent of the Minister of the Environment (or if the land is in a Provincial forest, a permit from the Minister of Forests), a recorded holder may use Crown land for a right of way[7]:

- to construct, maintain and operate facilities necessary for the exploration, development and operation of a mineral title;
- to load, transport or ship ores, minerals or mineral-bearing substances from a mineral title; or
- for the transportation of machinery, materials and supplies into or from a mineral title.

Before authorizing the entry, the Minister of Environment or Forests may do any or all of the following:

(a) require a copy of the plan, particulars and information which the miner must provide to the Minister (see below);

(b) require additional plans, particulars and information;

(c) require modification of the width of the right of way proposed by the recorded holder after reviewing the plan, particulars and information filed by the recorded holder; and

(d) require other modifications in the plan.

The miner may take and use private land for a right of way without the consent of the owner of the land.

The miner may take and use private land for a right of way without the consent of the owner of the land. However, before taking or using land for a right of way, the miner must:

(i) file with the Minister of Mines a plan showing the land proposed to be taken or used, with particulars and information that the Minister may require, including particulars and information on the location, design, construction, operation, maintenance and abandonment of the facilities to be placed in the right of way and costs of the facilities and related environmental information; and

(ii) obtain written approval of the plan, particulars and information from the Minister.

The Minister may require modification of the width of the right of way.

The Minister may require modification of the width of the right of way proposed by the recorded holder after reviewing the plan, particulars and information filed by the recorded holder. While a miner may not be stopped from accessing the claim, modifications of the plan may be required.

A recorded holder is entitled to use any existing road but must first serve written notice and provide compensation.

A recorded holder is entitled to use any existing road, whether on private or Crown land for these same purposes, but must first serve written notice on the owner or operator, of the intention to use the road, and if the road was not built under the *Mining Right of Way Act*, compensate the owner or operator. A free miner may use such roads to locate a claim without providing notice.

The free miner may cut, damage or destroy timber by hand-held tools for the purpose of mineral exploration without a permit.

A claim holder will explore for minerals to determine if minerals are located under the surface of the claim, and if so, whether a mine is economically viable. The free miner may cut, damage or destroy timber by hand-held tools for the purpose of mineral exploration without a permit. The *Mines Act*, discussed more fully below, requires miners to obtain a permit from the Chief Inspector of Mines before undertaking any exploration or production activity involving mechanical disturbance of the ground or excavation. Examples of exploration activities requiring a permit are:

- drilling;
- trenching;
- excavation; and
- blasting.

The period of a claim is one year, but is renewable upon certain conditions.

A claim runs for a period of one year, and is renewable every year as long as the holder pays a recording fee and either carries out exploration and development work (prospecting, exploring, surveying, drilling, bulk sampling) of a specified value ($100 per 25 ha for a hard rock mineral claim and $500 for a placer claim), or pays that amount instead. Work done in excess of this amount can be credited toward work needed to maintain the claim

in the future. If the work is not done and the money not paid, the miner can lose the claim.

"Special use permit".

The *MTA* requires a claim holder to obtain a "special use permit" under the *Forest Practices Code* to cut down trees and make constructions necessary to gain or maintain access for mining exploration in the claim area. A special use permit is usually required to build roads to gain access to the claim, or to clear an area for a base camp or helicopter landing site. If the miner has a permit issued under the *Mines Act* for exploration, and receives the Chief Inspector's approval, the *MTA* provides that a claim holder or lessee cannot be refused a special use permit for the construction of access to the mineral title for exploration, unless issuing that permit would be inconsistent with a higher-level plan under the *Forest Practices Code*.[8] The Chief Inspector can refuse approval after considering practicable alternative means of access to the claim.

Chief Inspector can refuse approval after considering "practicable alternative means of access" to the claim.

The District Manager (Ministry of Forest) can make the permit subject to conditions.

If the mining company has chosen a route to which a First Nation objects, they may wish to take this opportunity to suggest an alternative route, and advise the inspector of any less harmful or objectionable routes. The District Manager (Ministry of Forest) can make the permit subject to conditions they determine necessary to conserve forest resources and the natural environment, and may require clean up or restoration of the lands subject to the permit. In addition, the District Manager may require a free miner to deposit money to ensure conditions of the permit are met. Communities can use the consultation process to ensure that the deposit is adequate, particularly if water or fishery resources may be affected (see South Kemess case study).

Communities can use the consultation process to ensure that the deposit is adequate to protect resources.

A claim or leaseholder must, on request, be issued either a free use permit or a license to cut, under the *Forest Act*. A free use permit allows the mining company to cut timber for things such as claim posts. The permit or license can be subject to terms and conditions.

Limited production without a lease.

A free miner who has staked a claim may put the mine into production without a lease so long as he does not produce more than 1,000 tonnes per year of ore from a mineral claim or 2,000 m^2 of pay-dirt from a placer

claim. This level of production is considered part of development, carried out to determine whether to put the mine into full production. A lease is required to produce more than 1,000 tonnes per year of ore or 2,000 m^2 of paydirt.

b. Right to a Lease and to Put the Mine into Production

The mine lease allows for the creation and operation of the mine.

The final element of the *MTA* and free entry regimes is the right to a reward for exploration efforts and expenditures; that is, the right to obtain a lease and produce a mineral deposit. After carrying out exploration including geological testing and assessments, the claim holder decides whether the minerals in the ground are worth mining. At this point, if cost efficient, the company will seek a mine lease to move from exploration into development and then production. The mine lease allows for the creation and operation of the mine.

Two kinds of leases: one for hardrock minerals and one for placer minerals.

The *MTA* provides for two kinds of leases, one for hardrock minerals (mineral lease), and one for placer minerals. The chief gold commissioner designates lands as mineral lands in respect of which placer leases may be issued, if he is satisfied that:

- the value of the placer minerals in that land warrant the designation; and
- the issue of placer leases over them would not be contrary to the public interest.

Mining Lease Requirements.

To obtain a mineral lease, the company must be in possession of a mineral claim in good standing, post a notice of intention to apply for a mining lease in the gold commissioner's office and in a local newspaper, pay a prescribed fee, and complete a survey of the claim. While the chief gold commissioner must issue the mining lease, he or she may impose conditions on the lease. The division gold commissioner will recommend conditions to the chief gold commissioner. Upon seeing a notice in a local paper, anyone who wants input into conditions on a mining lease can write to the gold commissioner in the division, and to the chief gold commissioner as well. In practice, however, leases in British Columbia usually

While the chief gold commissioner must issue the mining lease, he or she may impose conditions on the lease.

contain few conditions or terms, and simply require the lessee to comply with the legislation.[9] A mineral lease has a term of 30 years. The lessee is entitled to a renewal of the lease if "required for a mining activity".

Placer lease requirements.

After applying to the division gold commissioner and paying a fee, the holder of a placer claim is entitled to a placer lease. The placer miner must provide a plan of a survey of the area of the lease. Notice of intention to apply for a placer lease is posted in the office of the gold commissioner of the division, and as with mining leases, terms and conditions may be imposed. A placer lease has a 10-year term and is renewable if required for a mining activity. A leaseholder (mineral and placer) must pay an annual rent to the government of British Columbia.

A lease is a more secure form of tenure than a claim.

While a claim automatically lapses when the work requirements are not met (and money is not paid in lieu of work requirements), no automatic consequence exists when a lessee fails to comply with the legislation or with terms or conditions, or fails to pay rent. The Minister may, but is not required to, cancel the lease after giving the lessee notice and an opportunity to comply. A lease is therefore a more secure form of tenure than a claim.

A lease is an interest in land and therefore compensation must be paid if it is expropriated.

A lease is an interest in land and therefore compensation must be paid if it is expropriated. A lease conveys to its holder the minerals or placer minerals within and under the lands covered by the lease. Therefore, success in a challenge to a lease will be difficult, because taking away a lease will be perceived as a substantial loss to the company, especially if the company was not put on clear notice upon or before staking the claim.

Time restrictions are in place for challenging a lease.

Time restrictions are in place for challenging a lease. If a person claims a right to the minerals or placer minerals in a claim that forms the basis of an application for a lease, that person must commence a proceeding in the Supreme Court of British Columbia within 80 days after the notice of intention to apply for a mining lease was posted, or 21 days after the date of the posting of a notice of intention to apply for a placer lease, except in the case of fraud. While this section is meant to govern

disputes between miners, it may restrict the time within which First Nations can challenge a lease on the grounds that the First Nation has a right to the minerals.

Once a lease is issued, the MTA provides that its validity cannot be challenged.

Once a lease is issued, the *MTA* provides that its validity cannot be challenged. This provision does not, however, preclude a constitutional challenge. Nonetheless, as time passes, the company will spend increasing financial resources and effort to develop the claim, and therefore, the courts will be more hesitant to grant relief against the mining company.

The free miner may need a license or permit under the Land Act.

To occupy Crown land to look for minerals, or construct a road, bridge, airstrip, etc., the free miner may need a license or permit under the *Land Act*. In order to ensure access to lease holders, the *MTA* provides that the lease holder cannot be refused a disposition of surface rights under the *Land Act*, if:

(a) The Minister of Energy and Mines certifies that the surface rights are or will be required for a mining activity;

(b) and the mining lease is located on land that:

(i) is unreserved land owned by the government;

(ii) is not lawfully occupied for a purpose other than for mining; and

(iii) is not protected heritage property.

A mining lease located on lands over which aboriginal title continues may not be located on "unreserved land *owned by the government*". If lands are occupied by First Nations in accordance with aboriginal title or in the exercise of aboriginal rights such as hunting rights, such lands may be "lawfully occupied" for a purpose other than mining. To challenge a decision to issue a license or permit, a First Nation would commence "judicial review" proceedings under the *Judicial Review Procedure Act*.

Challenging a decision to issue a license or permit.

Section 16 of the *Land Act* empowers the Minister to temporarily withdraw Crown land from disposition under the *Land Act* for any purpose the Minister considers advisable in the public interest. The *Land Act* also per-

mits the Minister to designate a portion of Crown land for a particular use or for the conservation of natural or heritage resources, and to impose any terms or conditions the Minister considers necessary or advisable on the use of land so designated. The lands are withdrawn from any disposition which is not compatible with the purpose for which the lands are designated. The Minister can limit the surface rights and impose terms and conditions, and can require payment.

The Land Act *empowers the Minister to temporarily withdraw Crown land from disposition for any purpose "in the public interest."*

If a First Nation is aware of cultural heritage resources in an area where a company is exploring for or developing minerals, or if the area is particularly important to the nation, and the values or use of those lands are inconsistent with mining activity, the First Nation may be able to preclude the exploration or development, or to restrict the miner's use of the area. If the Minister of Energy and Mines considers that all or part of an area is, or contains, a cultural heritage resource[10] or that the surface area, or the right to, or interest in, the minerals or placer minerals, should be used for purposes other than a mining activity, the Minister may, by order, restrict the use of surface rights, or restrict the right to or interest in the minerals or placer minerals. No compensation is payable as a result of such an order.

Cultural heritage resources.

C. Aggregate Mines[11]

Unlike the case of metallic minerals and placer minerals, the government does not consider rights to aggregates (sand and gravel) to be separate from ordinary title to land. Hence, the regime for the disposition of rights to metallic and placer minerals under the *Mineral Tenure Act* does not apply to aggregates.[12] Aggregates on privately owned land is normally considered to be part of the title to the land itself. Before a company can mine aggregates on Crown land, the government must issue tenure to that land.

The government does not consider rights to aggregates (sand and gravel) to be separate from ordinary title to land.

The Land Title Branch administers the registration of private land in B.C. Ownership of private land is registered at the Land Title Office, the records of which are publicly accessible. To determine ownership of specific

Ownership of private land is registered at the Land Title Office, the records of which are publicly accessible.

private land, companies known as title search agents can be hired to speed the search process. Obtaining an account with BC Online will enable a user to search the Land Titles Database directly. (A minimum deposit of $100 is required.) If no Land Title Office is located near to a First Nations community, the local Government Agent can perform land title searches.

Extraction on Crown land requires the issuance of tenure under the *Land Act*, under the jurisdiction of the Ministry of Environment, Land and Parks ("MELP"). In 1998/99 the provincial government created the British Columbia Assets and Land Corporation ("BCAL") to administer tenure on Crown land. There are two types of tenure for aggregate mines:

Two types of tenure for aggregate mines.

- licenses of occupation; and
- leases.

A license provides non-exclusive *access to land.*

A license provides non-exclusive access to land; that is, it does not grant the holder the right to prohibit public access to the Crown land. A license cannot be registered against land title and does not require a survey.

A lease gives the holder the right to exclusive *use of land for a designated purpose.*

A lease is a stronger form of tenure that gives the holder the right to exclusive use of land for a designated purpose. A lease can be registered against the title of the land and requires a survey of the area by the applicant. Leases are issued where:

- substantial investments or improvements are made on the land for permanent facilities; and/or
- it is necessary to define specific boundaries of an activity to minimize conflict with other operations.

The *Land Act* prohibits the outright sale of Crown land for aggregate operations.

Terms of licences and leases.

Most aggregate operations receive a five-year license of occupation; a ten-year replacement license may be issued after the initial license. (Note that the length of the lease is not tied to the life of the mine and often may exist for a shorter period, meaning that a company will be required to reapply for tenure during the life of the operation.) A lease may be issued in cases where a

tenure of longer than five years is required, or where the land must be surveyed for other purposes. Most leases have a term of ten years but may have a term of up to twenty. Conditions of the tenure agreement will normally require that the applicant pay property taxes, an annual rental fee and a royalty on the material produced. Failure to pay royalties as prescribed in the tenure document is a breach of contract and can result in the cancellation of the tenure.

Evaluating tenure applications.

In evaluating tenure applications (and in monitoring existing tenures), BCAL considers:

- safety standards;
- land-use compatibility; and
- environmental sensitivities of the land.

Most applicants are required to advertise their proposal in local newspapers and in the B.C. Gazette. Advertisements must clearly describe:

- the tenure location;
- the proposed activities; and
- any rights that may be granted.

BCAL Consultation.

Prior to making a tenure decision, BCAL consults with other government agencies, local government, community groups and First Nations. BCAL's referral methods include:

- referrals to other agencies;
- advertising applications and inviting comment;
- public meetings; and
- presentations, working groups and other applicable methods.

Aboriginal Interest Assessment Procedures.

In an attempt to meet its consultation obligation to First Nations, BCAL has developed Aboriginal Interest Assessment Procedures (AAIP), based on the province's Consultation Guidelines (see Chapter 8).

Aboriginal Relations Land Officers.

The Aboriginal Relations Section of BCAL consists of a manager in Victoria and an Aboriginal Relations Land Officer in each BCAL Regional Office. Aboriginal Relations Land Officers meet with First Nations representatives to discuss specific issues related to Crown lands. As well, they consult with First Nations, as required by the AAIP, and respond to inquiries from First Nations regarding BCAL activities, procedures and programs.

A land management plan forms part of the tenure agreement.

BCAL refers applications to MELP to obtain a technical assessment of environmental impacts, including those on wildlife and water quality. MELP's recommendations are incorporated into a land management plan, which forms part of the tenure agreement.

The land management plan may specify:

- constraints on activities or developments;
- requirements to protect the environment (such as training or fencing);
- measures to minimize potential resource use conflicts; and
- conditions established in response to local First Nation concerns.

Failure to meet these conditions constitutes a breach of the tenure agreement and could result in penalties or cancellation of the tenure.

BCAL usually defers to local government regarding whether and how a proposed operation should proceed.

BCAL usually defers to local government discretion regarding the fundamental decision as to *whether* a proposed operation should proceed, and to the Ministry of Energy and Mines (MEM) regarding decisions about *how* it should proceed, as defined in *Mines Act* permits (see below); but is responsible for land use and aggregate allocation decisions on both issues.

The province has a strong interest in maintaining aggregate supply (in particular, the Ministry of Transportation and Highways). In granting tenures, BCAL may be responsive to this interest.

Municipal and local government concerns.

Municipalities and local governments are likely concerned with land use and community plans and the

concerns of local residents regarding noise and pollution from gravel mining. Further, they often receive little compensation for the costs and risks associated with noise and truck traffic from aggregate operations within their boundaries.[13]

Cases:

British Columbia v. *Tener*, [1985] 1 S.C.R. 533

Falkoski v. *Osoyoos (Town)*, [1995] B.C.J. 857 (S.C.)

Other References:

B. Barton, *Canadian Law of Mining* (Calgary: Canadian Institute of Resources Law, 1993).

A. Tussing, "An Economic Overview of Resource Disposition Systems" in N. Bankes & J.O. Saunders, eds., *Public Disposition of Natural Resources* (Calgary: Canadian Institute of Resources Law, 1993) 19.

C. Chambers and M. Winfield, *Mining's Many Faces – Environmental Mining Law and Policy in Canada* (Toronto: The Canadian Institute for Environmental Law and Policy, 2000), available at http://www.cielap.org.

Notes

[1] B. Barton, *Canadian Law of Mining* (Calgary: Canadian Institute of Resources Law, 1993) at 426.

[2] Arlon R. Tussing, "An Economic Overview of Resource Disposition Systems" in Nigel Bankes and J. Owen Saunders, eds., *Public Disposition of Natural Resources* (Calgary: Canadian Institute of Resources Law, 1984) 19 at 19.

[3] Sometimes a mineral find will trigger a "staking rush". For example, in 1994, one of the world's richest nickel, copper and cobalt finds was located in Innu territory. This find triggered a staking rush, and in 1995 over 250,000 claims were staked, covering almost half of the Innu territory. The rush left behind many abandoned camps. See the "The Innu Nation and Inco's Voisey's Bay Nickel Mine/Mill" case study in "Between a Rock

and a Hard Place", reproduced as Appendix A to these materials.

[4] The Mining Rights Compensation Regulation, for example, deals specifically with compensation of claim and leaseholders for an expropriation under the *Parks Act*.

[5] Only when a mining permit is being sought under the *Mines Act* does a policy exist requiring consultation with First Nations.

[6] Recreation areas have a special 1-post staking procedure.

[7] The right of way may be across, over, under or through the lands in question.

[8] Regarding higher-level plans, see West Coast Environmental Law's *Guide to Forest Land Use Planning*.

[9] Barton, *Canadian Law of Mining*, at 338.

[10] The Act defines "cultural heritage resource" as follows: "an object, a site or the location of a traditional societal practice that is of historical, cultural or archaeological significance to British Columbia, a community or an aboriginal people."

[11] This section was written by Greg Simmons.

[12] Dimension stone and rock used for decorative purposes is considered a mineral under the *Mineral Tenure Act*.

[13] The courts have ruled that soil removal fees imposed by municipalities must be related to direct costs of aggregate removal to the municipality. The only cost recognized to date is maintenance of roads damaged by gravel truck operation. Whether communities can seek compensation for other impacts of aggregate operations is not clear.

Chapter 4
What is Mining?

4. What is mining?

Mining involves the discovery and removal of materials from beneath the earth's surface.

Mining involves the discovery and removal of materials from beneath the earth's surface. These materials include minerals, which may be metals (e.g., gold and copper) or non-metals (e.g., coal, asbestos, gems, gravel). This document will focus primarily on the mining of metals, with some reference to sand, gravel and stone (aggregate).

The earth is composed of more than 100 basic substances, known as elements.[1] For the most part, elements of interest, e.g., metals, are mixed in with dozens of other elements, and it is not possible to economically separate them. Occasionally, however, large amounts of particular metals are concentrated in a small area.

Ore is a mixture of minerals from which one or more metals may be extracted at a profit. The body of material containing the ore is called a *deposit*. Ore deposits are rare, geological oddities (*anomalies*).

Ores are frequently classified according to the nature of the valuable metal.

- In *native* ores the metal is present in its elementary or pure form. Gold and platinum are found in this form.
- In *compound* forms of metals, the metal is combined with other elements like sulphur (the compound is called a metal sulphide), oxygen (metal oxides), carbonates, silicates and chlorides, among others. In Canada, many ore bodies contain metal sulphide ores.

Metals can occur in concentrated bodies (*massive* deposits), in veins, or in loose (*unconsolidated*) deposits, e.g., gravel deposits on stream beds. If the latter type of deposit contains metals, it is called a *placer* deposit, and it is mined using placer mining methods. Massive deposits are mined using *hardrock mining* methods, which include open pit, underground or solution mining. These methods are described below.

Non-metals also occur in solid forms, e.g., bedrock, and unconsolidated deposits, e.g., sand and gravel. In BC, the industrial mining of sand, gravel and stone is known as *aggregate mining.* The methods used to remove aggregate materials are similar to metals, and will be discussed briefly on page 61.

The following sections a & b will explain in general terms the types and stages of mining. Also included are the major potential impacts and issues encountered with the various operations. Most of the issues mentioned will be elaborated on in section b.

a. Types of mining

Mines range in size from small operations, which may produce less than 100 tonnes of ore per day, to large mines, some of which move hundreds of thousands of tonnes of ore and wastes per day.

The main methods for extracting metals today are: open pit, underground, solution and placer mining.

The main methods for extracting metals today are: open pit, underground, solution and placer mining. The chosen method depends on the form, size and depth of the target mineral deposit.

Up until the mid-1900s, underground mining (discussed in the following section ii) was the most common method of extracting massive deposits. But with the post-World War II advances in technology, the development of larger, more powerful bulldozers, shovels and trucks made it feasible to move the vast amounts of waste rock and ore required in low-grade open-pit operations. Today, open pits are the least expensive type of mine, and they are every developer's first choice where an ore body is located close to the surface.

In 2000, there were 12 operating metal mines (9 open pit and 3 underground) and 8 coal mines in BC.

i. Open Pit Mining

Open pit mining methods are primarily used to mine hardrock metal deposits. Typically, open pit mining

begins with removal of vegetation and soil, and proceeds with extensive blasting and removal of non-target rock (*waste rock)* to reach the desired ore deposit. The materials above the ore deposit that have to be removed are known collectively as *overburden*.

Both waste rock and ore must be broken up before they can be removed. This is done by blasting the target materials. Explosives are loaded into drilled holes, and large volumes of ore and rock are broken in a single blast. The removal of the broken ore and waste rock is usually done by electric shovels in the large operations, and by rubber-tired diesel front-end loaders in the smaller operations. The materials are then loaded into trucks, rail cars or conveyor belts, and hauled out of the pit. As upper-level ore is removed, benches, which look like steps, are cut into the walls of the mine to provide access to progressively deeper ore. These benches then act as transportation routes for vehicles.

The ore is unloaded into a primary crusher, and crushed material is stored in coarse ore bins or on the surface in *stockpiles*, prior to shipment to the mill. At the mill it may be further crushed and then put through a series of processes that remove waste and concentrate the metals of interest (explained on pages 82-85). Alternatively, the ore may be taken to a leach-pad area, where chemicals are applied to the piles of broken-up ore to remove the desired metals. This process, called *heap leaching*, is described on page 85.

Impacts and issues

- Land disturbance. In the early days of mining, a 12 m^2 shaft may have been sunk several hundreds of metres to access an ore body, leaving very little trace of activity on the earth's surface. Today, an area of several square kilometers or more may be sacrificed in order to expose the same ore body by open pit mining methods. In addition to the area disturbed by the pit, a huge surface area must be sacrificed for disposal of waste rock, because most of the rock encountered as the pit develops is of no economic value. It is not uncom-

In addition to the area disturbed by the pit, a huge surface area must be sacrificed for disposal of waste rock.

mon for the area of land covered by waste rock to equal or exceed the area sacrificed to the pit. Moreover, large areas may be covered by disposal sites for ore processing wastes (*tailings*), and disturbed by the development of roads and power line corridors.[2] (See Chapter 6, pages 183-184 for more details). In most cases, the open pits will leave permanent scars on the landscape.

- Creation of large volumes of waste rock. Open-pit mines produce about fifty times more waste rock than underground mines. For example, open pit mines may move tens to hundreds of thousands of tonnes of waste rock per day, while underground mines generally move less than 1000 tonnes per day.

- The wastes may lead to water contamination. Waste rock usually contains low levels of metals that, over time, can leach out and contaminate water courses. The waste rock may also contain sulphide ores, which can create long-term contamination through a process called acid mine drainage (see Chapter 5, pages 119-128 for a detailed explanation of this process).

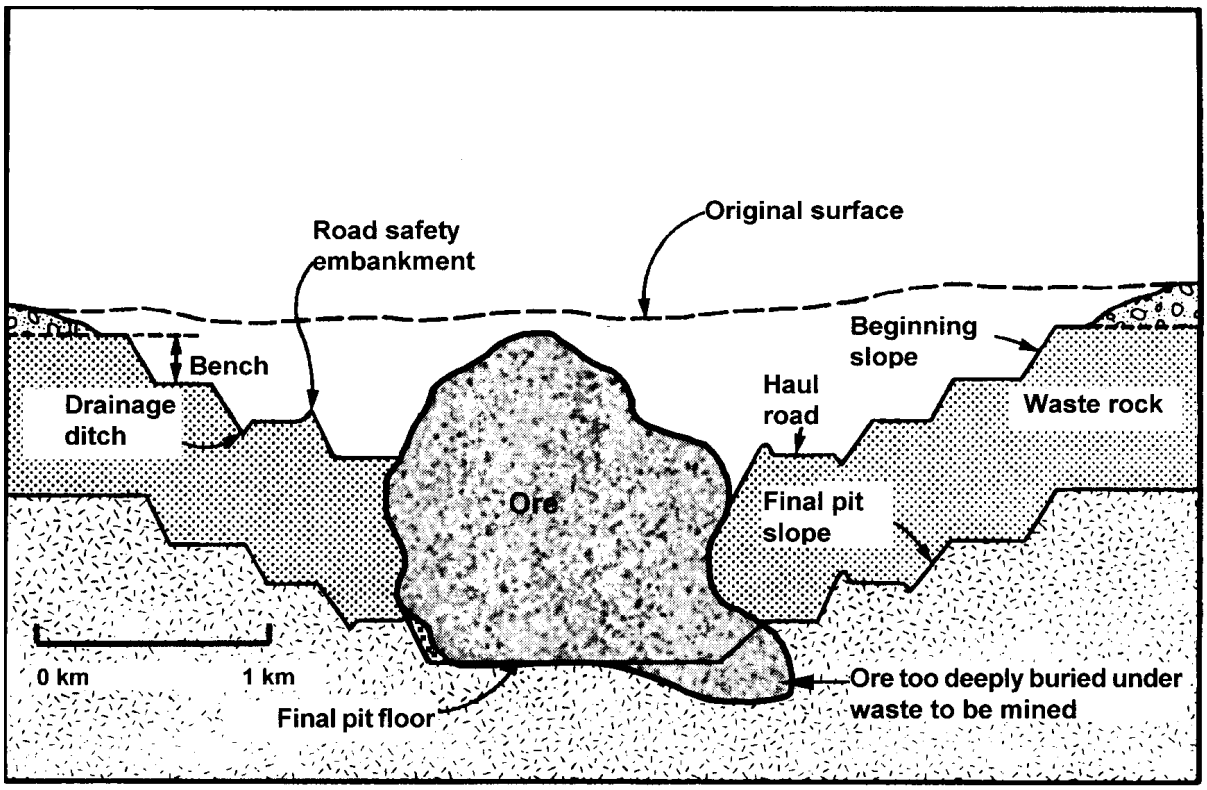
- Slope instability may create hazards. The problem of slope stability occurs with pit walls, waste dump slopes and other engineered structures such as tailings storage areas (which are generally constructed from rock materials from the mine site). Rock and soil engineers determine, based on rock characteristics, a "safe" slope for pit walls and waste embankments. Miscalculations can lead to slumping of walls, endangering workers. In the long-term, after the mine has closed, pit wall stability may remain a hazard to people and wildlife. Also, because of the steep slopes, some waste rock dumps and pit walls may be difficult to reclaim.

- Pit water may be contaminated, or lead to groundwater shortages. As an open pit develops, water-bearing layers of rock (*aquifers*) may be encountered. This water, in addition to storm and snowmelt, will accumulate in the pit. Because working surfaces in the pit must remain dry, the water is typically removed by pumping it to the surface. Often the water is of poor quality (e.g., may carry metals dissolved from the pit walls), and

may require treatment to remove the metals before releasing it to the environment. Furthermore, the interception of aquifers may impact local water supplies, e.g., dry up local groundwater wells and surface waters fed by springs.

- Other effects include noise from blasting and machinery, and potential contamination from machinery fuel, lubricants and chemical spills.

Figure 1. Open pit mining



ii. Underground mining

When an ore body is located deep beneath the earth's surface it may be less expensive to send workers underground to break up the ore and haul it to the surface, than to remove hundreds or thousands of metres of waste rock to reach an ore body using open pit methods.

The first step in underground mining is the development of an entry-way into the earth to reach the ore

The first step in underground mining is the development of an entry-way into the earth to reach the ore body.

body. The initial access to the ore may be horizontally, through the side of a hill (an *adit*), or vertically down, through a *shaft*. From the main entry-way, other horizontal (*drifts*) or diagonal (*ramps*) passages are cut at various depths and angles to access the ore body.

Workers use drills and explosives to break up the ore while underground. In some operations some of this work is done by computerized machinery, e.g., in situations that are deemed too dangerous for human-operated drills.[3]

Depending on the size of the ore body and the strength of the surrounding rock, the area from which the ore is removed (the *stope*) may be left empty (*open stoping* method). Alternatively, the stopes may be filled in (*closed stoping*) with waste rock, mill tailings or other materials like cement to provide sufficient support for areas above the mined-out cavities.

The ore is brought to the surface via the shafts or adits. After the ore is removed from the ground it is crushed, concentrated, and refined. (See pages 82-86 on Ore Processing.)

Impacts and issues

- Generally, underground mines create less environmental disturbance than open pit mines. Surface disturbance is less than with open pits, and less waste is generated because it is costly to haul it to the surface.
- Water issues are still a concern. Some waste rock may require surface disposal, and as with open-pit wastes, if the rock contains sulphide ores acid generation and metal leaching may contaminate nearby water courses (see Chapter 5). Similarly, exposed materials underground may create water contamination. Also, similar to open pit mines, underground mines can intercept aquifers.
- The ground above the mined area may sink or cave in (a process known as *subsidence*).

- Underground miners may be exposed to more dangerous situations than open pit miners, e.g., cave-ins; poor air quality; and explosions.
- Underground methods are almost always more expensive than open pit mining. Companies will sometimes dismiss the underground mining option as being impossible, when really it is technically possible, but more expensive. For example, people in the Northwest Territories wanted a company called Diavik to look at alternative method of mining diamonds. Diavik proposed a massive open pit. That method would maximize profits, but also posed the greatest potential harm to the water and surrounding environment. One of the reasons Diavik dismissed the less intrusive method of underground mining was because it would not provide sufficient shareholder value.[4]

Underground methods are almost always more expensive than open pit mining.

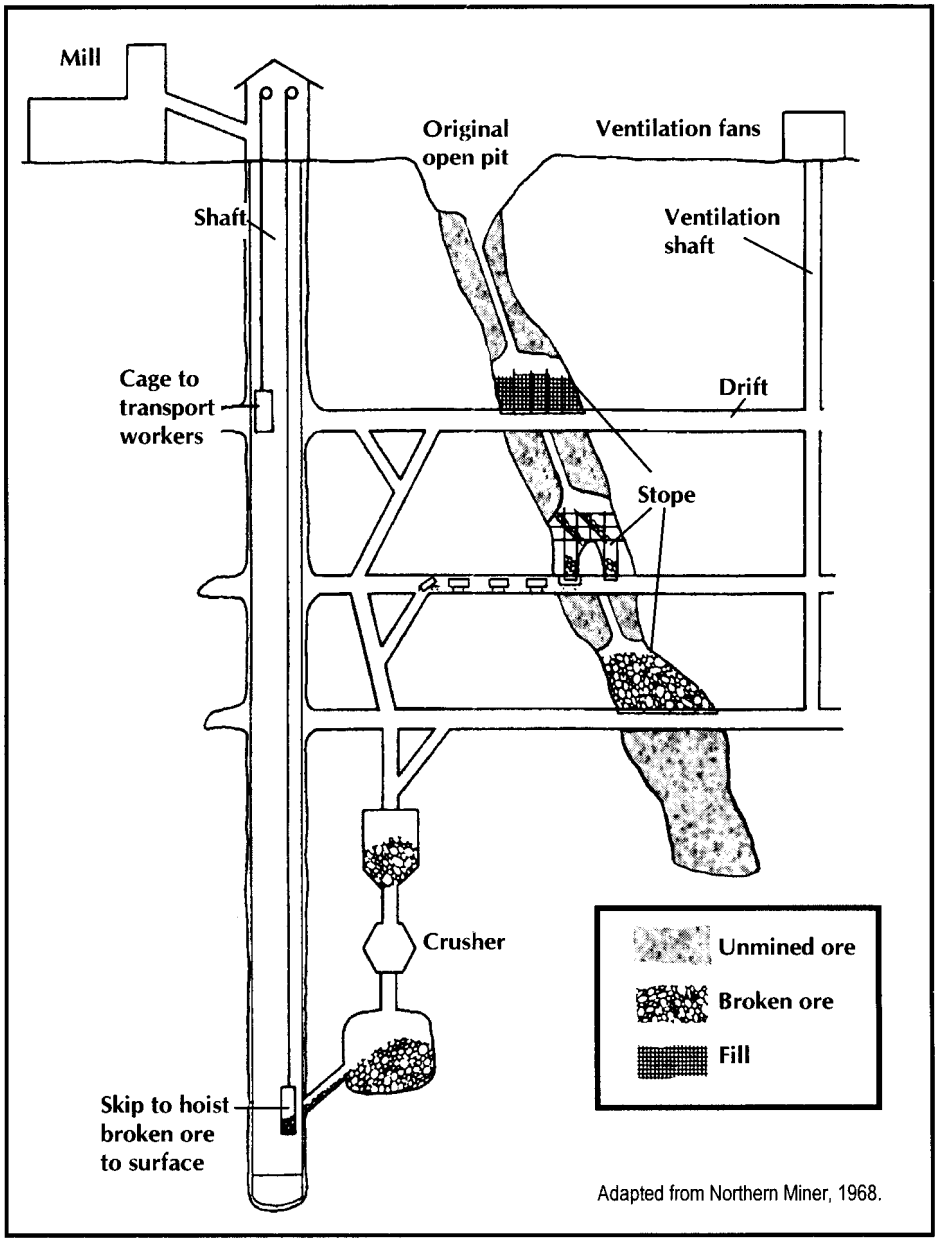
- Other effects are the same as for open pit mines (see Figure 2).

iii. Solution mining

A third method of removing metals from the ground involves the use of chemical solutions to dissolve (*leach)* the minerals from an ore deposit. The ore is not removed from the ground. Because it is left in place or "in situ" this method is sometimes referred to as *in situ* leaching. (Sometimes ore is mined by underground or open pit methods, and chemicals are applied once the ore is piled aboveground. This is a method of mineral processing called *heap leaching*, which will be discussed in section "Ore Processing" on page 82.)

The solution mining method involves drilling into intact rock and adding a leaching solution (usually a dilute acid), which penetrates the ore and dissolves the metals. Because the natural porosity of most rocks is too low for rapid, pervasive penetration of leach solutions, it is often necessary to fracture the rocks artificially, e.g., using explosives, to increase the amount of contact between ore and the leaching solution.

Figure 2. Underground mining



The metal-rich (*pregnant*) solutions are collected from beneath the leached area, and are pumped to concentration or processing plants.

Solution mining techniques are used for extracting uranium and easily dissolvable materials such as potash and salt, but they are not yet commonly used for extracting metals. Solution mining has been used in some parts of Arizona, Nevada, and New Mexico to recover copper. At this time, solution mining is not used at any British Columbia mines.

Impacts and issues

There is concern that this method is not yet well enough understood, nor has enough experience been gained to apply it to high-grade ore deposits and ensure that the metals will be effectively recovered and that groundwater contamination will be prevented.

- Leaching solutions, besides freeing the target metal, also mobilize other metals, potentially raising their concentrations in groundwater to unsafe levels. Unless carefully controlled, the solutions can migrate outside the immediate mining area and contaminate nearby aquifers.

iv. Placer mining

Placer mineral deposits occur with sand, gravel and rock. The metals in placer deposits were once part of solid ore deposits, but through time earth processes such as erosion revealed the metals. The exposed metals were then picked up and transported by flowing water or ice, and laid down in streambeds away from the place where they were formed. The small particles or nuggets of metals are relatively easy to access, as they occur at the earth's surface.

There are two types of placer mining used in North America: (1) mining with mechanized earth-moving equipment and (2) suction dredging in streams.[5]

Placer mining with mechanized earth-moving equipment typically involves removal of any vegetation and soil, followed by excavation of gravels from a short (100s of metres) stretch of an existing[6] or historic stream. The metals, primarily gold, are separated using sluices. Reclamation generally involves replacement of gravel, topsoil and establishment of vegetation.

Suction dredging is a technique that uses a pump to essentially vacuum up sediments from the stream bottom. The sediments are then processed in a floating sluice. Suction dredges can be small enough to be "recreational" one-person operations.

Once the gravels have been excavated, the most common method for removing the metals involves moving the materials through an elongated trough called a sluice box. The separation of gold or other metals in a flowing stream of water is known as sluicing. Water is routed through the box, and the box is vibrated. The lighter minerals wash away, while the heavier minerals, like gold, settle to the bottom of the box.

Placer production has represented 3.5% of BC's total gold production in the last twenty years. In BC, the largest placer developments were in the Cariboo and the Atlin areas, although there has been some renewed interest in Cassiar and Omineca regions.

Impacts and issues

- The main impact from placer mining is the temporary or permanent destruction of habitat for fish and other aquatic organisms. Health of aquatic life can also be directly affected by an increase in suspended sediments and turbidity of stream water (see pages 143-145 for more detailed impacts from stream sedimentation).
- The gravelly waste piles left behind are often difficult to reclaim, as they contain very little organic matter to act as a rooting medium for plants.

- There is the potential for stream or groundwater contamination, if mercury or other chemicals are used to extract the metals from the sediments.

v. Aggregate mining

The term *aggregate material* refers to sand, gravel and quarried rock. Aggregate materials are major constituents of concrete and asphalt, and thus, are important for the construction of roads and buildings.[7]

The term aggregate material *refers to sand, gravel and quarried rock.*

In British Columbia there are approximately 2,000 active aggregate pit operations producing approximately 50 million tonnes of sand and gravel per year. This output is valued at over $170 million annually and is estimated to directly employ more than 4,000 people.[8]

The most important sources of sand and gravel are river channels, floodplains, and previously glaciated terrain. The granular and unconsolidated aggregate materials (sand and gravel) are usually found as surface deposits in or near streams because loose materials that enter streams are washed downstream by flowing water. The ability of waters to carry aggregate materials is related to the velocity of the flow. Fast flowing water can carry large particles. As the waters slow down, e.g., at river bends or near the mouth of the river, some of the materials are deposited. Aggregate deposits that not found near flowing water may have been left behind by ancient rivers or by retreating glaciers.

Aggregate deposits tend to contain mixes of sand, gravel and larger-sized particles. There is often considerable variation in quality in a single deposit: some parts might be mostly sand, while others contain more gravel and boulders.

The distribution of different sized materials (e.g., sand versus gravel) will often determine the mining sequence. Several different areas of the deposit may have to be excavated simultaneously to get the necessary mix of fine and course aggregate to meet producer specifications.

Aggregate deposits are mined using a variety of methods: pit mining, dredging and quarries.

1. Pit mining

Pit mining, which is similar to open pit mining, typically occurs when there is an inland deposit of aggregate material. Normally, topsoil is scraped and stockpiled, often as protective berm (an elongated mound of soil or rock). This soil should be adequately protected so that it can be used in site reclamation.

The sand and gravel are extracted using a combination of scrapers, bulldozers, and front-end loaders, and hauling is done by trucks.

The ultimate design and configuration of the pit depends on the type and shape of the deposit. Most are shallow (30 metres) and irregularly shaped. They are similar to quarries in that they require stockpiles, a settling pond, and a plant area. Related to, but not usually considered a mining operation, are *borrow pits*, which are smaller, more numerous, and tend to be side-hill excavations.

2. Dredging

Dredging involves the continuous removal and processing of materials from the bottom of a body of water. The dredge consists of a floating platform that supports machinery mechanically dig or use suction to remove the materials. The dredge may also support equipment that can segregate different types or sizes of materials.

The mouth of the Fraser River, which becomes extremely shallow due to the constant deposition of sand and fine materials, is periodically dredged to keep shipping channels open.

Bedrock may be mined for aggregate if sand and gravel deposits are not available.

3. Quarrying

Bedrock may be mined for aggregate if sand and gravel deposits are not available or if features of the bedrock type make it preferable for product specifications. Bed-

rock quarries are also the best source for angular boulders used for erosion protection and landscaping.

Extraction is similar to open pit mining, but the pits are not as deep (they rarely exceed 50 metres). Bedrock quarries are developed by using controlled explosions. A well-designed blast will turn the rock into rubble with very little displacement, and with minimal waste rock generation. The rock is then generally screened and crushed to meet contract specifications.

4. Further processing

After mining occurs, there may be the need to crush, screen and wash the materials, but there is usually no need to chemically process the aggregate to get a final product (as required with metal ores). Smelting and refining are not required for non-metallic materials.

Impacts and issues

Aggregate operations are generally smaller, and pose fewer environmental risks than metal mining operations.

- Aggregate operations are generally smaller, and pose fewer environmental risks than metal mining operations. Poorly managed aggregate operations, however, may have significant environmental impacts, particularly if sediment is allowed to enter watercourses. As will be discussed on pages 143-145, sediment can be harmful to fish and fish habitat.
- Dredging can increase sediment load in rivers through resuspension of particles. The increased sediment in the water column can physically eliminate aquatic plants and animals, and destroy fish spawning and nursing areas. It may also alter river channel hydrology function and hydrologic function and stability.
- Aggregate operations can be dirty, noisy, unsightly and unsafe.
- Large quantities of overburden may have to be removed and stored prior to extracting the desired material. Exposed aggregate and topsoil increase the potential for dust and erosion. Therefore, it is important to salvage and properly store topsoil (for reclamation

purposes). Storage should be done in such a way to ensure that materials do not erode and wash into streams.

- Heavy gravel trucks are usually noisy and disturb humans and wildlife along their route. Their size and slower acceleration retards traffic flows. Large aggregate trucks emit exhaust fumes that can degrade local air quality. Roads break down faster under the weight of heavy trucks necessitating more frequent repairs or replacement. Disruptions, however, tend to be fairly localized – if the materials are used close to the source of extraction.

Dust from the crushing operations, or along trucking routes, can affect air quality and visibility.

- If fine materials are excavated, they can be dispersed by air to surrounding areas. Dust from the crushing operations, or along trucking routes, can affect air quality and visibility.
- Aggregate cannot be produced without disturbing the natural environment. An obvious impact of aggregate production is the creation of pits, quarries, or mines. Reclamation of the mined-out areas is of critical importance to communities near the aggregate deposits. The most acceptable solution for the community, and perhaps the most economical for the producer, is to plan the rehabilitation of the area prior to mining. This method would allow mining to progress while concurrent reclamation is performed on mined-out areas. The primary goal is to return the land to beneficial use.
- What might look like a 10-year project on paper may turn out to be a longer-term venture. Many pits and quarries may be operated only intermittently in response to local demand.[9] Consequently, adjacent land-owners or communities may not know for certain when the site may be active or when it may be finally reclaimed.
- Quarries, which can create steep, high walls of rock, with poor drainage, may limit post-mining uses other than recreational (e.g., lakes).
- Streams and rivers will replenish their supply of aggregate materials, as long as upstream sources of the materials and the rivers' flows do not change signif-

icantly. Aggregate operations do have the potential to greatly exceed the regenerative capability of the stream system, and change the shape and size of streambed, as well as the rate of flow in a river. For example, between 1980 and 1992, dredging activity in the Fraser River exceeded the river's regeneration capacity. Intense dredging through private borrow operations along with channel improvement dredging lowered the bed elevation from 3 to 5 metres in most reaches.[10]

- Due to the high bulk and weight, and low value of sand, gravel and crushed stone, transportation costs are important in determining the economic competitiveness of a deposit. The economic viability of a deposit tends to be dependent, therefore, on its distance from markets.
- Aggregate is relatively inexpensive at its source. Although sand and gravel may have to be crushed, screened or washed to meet specifications for different uses, these processes are usually simple and cheap. Crushed aggregate may cost 25% to 35% more than equivalent sand and gravel sources.
- Delivery – which is usually by truck – often accounts for much of the cost of supplying aggregate to a construction site. Since trucks are usually charged out on an hourly basis, hauling distances and traffic congestion affect delivery costs. Rising fuel prices are also a factor.

b. Stages of mining

Almost all mining operations share common stages or activities, which fall into the following categories: exploration, development, ore production and mine closure.

i. Exploration

The primary objective of exploration is to find an ore body that is economically profitable to mine.

The primary objective of exploration is to find an ore body that is economically profitable to mine. Exploration can be divided into some general stages, which

include: prospecting, further exploration, target identification, bulk sampling and pilot plants.

1. Preliminary Exploration/Prospecting

The initial step in exploration is the search for clues to the presence of potential mineral deposits.

The initial step in exploration is the search for clues to the presence of potential mineral deposits (*prospects*). The objective during the prospecting stage is to identify a target worthy of further testing by more expensive exploration methods.

Prospecting usually begins with a review of all available, relevant data on a particular site (e.g., maps, photographs, government reports on the geology of the region).

After reviewing the information on a particular site, a prospector will usually visit the site or observe it from the air. The prospector looks for a combination of unique geologic conditions, or unusual soil and vegetation effects that differ from their surroundings. A departure from the norm is called an *anomaly*, and finding an anomaly could indicate an ore deposit. For example, plants growing in areas with unusually high concentrations of metals may have visible health effects such as deformed or discolored leaves, or unusual size. In one region, the discoloration of the leaves of a common tree, observed while flying over the area, led to the discovery of a major new copper district.

Once an anomaly has been located, some digging may occur to obtain more evidence that there are potentially valuable minerals at the site. Depending on the information gained through prospecting, a decision may be made to proceed to an exploration program.

Impacts and Issues

Prospecting generally causes very little environmental damage. Although some soil disturbance may occur during prospecting, most physical work, such as digging and drilling, is left to the exploration stage. The most

significant impacts are related to the use of motorized vehicles (noise, fumes, vegetation and soil disturbance in non-roaded areas).

2. Further Exploration

If a company decides to proceed with exploration, a plan is usually developed and a geologist appointed. There are a number of exploration methods that a geologist has at his or her disposal. These methods include digging trenches and pits; or lower impact approaches, such as geochemical sampling and geophysical surveys.

Trenches, pits and exploratory shafts

Many types of ore break down readily at the earth's surface (i.e., when exposed to wind and water they *weather*). The weathered materials must be removed if the true character of the mineralization is to be determined. Consequently, preliminary exploration work may include removal of surface materials (*trenching*) to expose and determine the presence and mineral make-up of the underlying rock.

Preliminary exploration work may include removal of surface materials.

Trenching can be done with either a backhoe or a bulldozer. Backhoe trenching is becoming more popular in serious exploration work because it is possible to dig trenches cleanly and quickly with backhoes in a variety of locations where a bulldozer would not perform well.

From an environmental standpoint, backhoe trenching is preferable because backhoes cause less surface disturbance than bulldozers. Restoration of the surface following backhoe trenching is quite simple, and it is possible to selectively place the topsoil to one side and pile the deeper material to the other side so that the trench can be refilled, reversing the excavation process after geologic inspection and sampling of the trenches. It is impossible to exactly restore the surface to original contour, because the excavated material expands as much as 20 percent or more, resulting in overfilling of the trench by this amount.

To uncover historic or present-day stream-bed (*alluvial*) material suspected of containing minerals, shallow pits are dug to depths of 3-5 metres. To investigate deeper deposits, exploration shafts up to 30 metres may be excavated.

Geochemical sampling

When an ore deposit located at or near the surface has been weathered, some of the metals move into the soil, water, and even plants. By analyzing the chemical composition of the rocks, soils, water and vegetation, it is possible to get some insight into whether or not they have high concentrations of certain elements, which may suggest that there is an ore deposit below the surface.

- Rocks: Perhaps the most common detailed geochemical exploration method at present is the collection of rock chip samples, which are analyzed to determine if significant patterns or high metal values exist.

- Water: The geochemistry of surface and underground water is another exploration tool. Samples from springs, wells, and streams may contain trace amounts of metals in solution, indicating that the water has come in contact with a concentration of the metal, perhaps an ore deposit.

Streams may contain trace amounts of metals in solution.

- Air: Various air "sniffing" devices are used in mineral exploration. Airborne, vehicle-mounted, and sample station detectors have been designed to measure such indicators as mercury vapour, sulphur dioxide, and radon gas in atmospheric and soil air, which may betray a weathering ore deposit below the surface.

- Vegetation: Plant material is sometimes analyzed to determine trace metal content. This method has been used successfully where the needles of pinyon pine have been found to contain unusual amounts of uranium over deposits of this metal.

- Soils: Because soils are partially composed of weathered material from underlying rock, analysis of soils can reveal a pattern of increased metal values if the rock below contains an ore body. The method, however, is far from infallible, and there are many variables

that are either highly unpredictable or imperfectly understood.

Geophysical surveys

In geophysical surveys, various instruments measure physical properties of the rocks such as magnetism, electrical conductivity, density and radiation. These instruments are carried by technicians walking over the ground, or are installed in aircraft.

Impacts and issues

Generally, the environmental impact from exploration is minimal. If conducted with little consideration for environmental protection, however, there can be significant localized effects.

Generally, the environmental impact from exploration is minimal.

- Creation of roads, survey grids and trenches may lead to erosion and streams sedimentation. Road access to remote exploration sites may involve clearing trees, creating stream crossings, and developing of borrow pits for road-construction materials. In cases where roads are not built, off-road vehicles may also impact soil and vegetation. Similarly, the cutting of gridlines and large trenching operations can cause extensive damage, making regeneration of the area more difficult to achieve.
- Airborne surveys cause temporary noise effects over large areas. Aircraft can cause wildlife disturbance on a much larger scale than land traffic because of their higher speed and ability to pass over all types of terrain. The degree of disturbance depends on frequency of flights, flying altitude and type of aircraft; the health and species of animals; time of year; and vegetation cover.
- Noise disturbance and fumes from bulldozers and other equipment may impact animal and human communities.
- Visual impacts may result from roads, grids and trenching.

3. Target Identification

Exploration continues with target identification, which focuses on confirming the presence, size and nature of a deposit. To do this, detailed rock samples are required.

Diamond drilling (so named because the drill bit is made of diamond) is the primary means of bringing rock samples to the surface. Commonly, diamond drilling is done only after other methods of exploration (e.g., geological mapping, geochemical surveys) have been used to pinpoint the best possible drill targets, because drilling is a major expense, costing $50 or more per metre.

Diamond drills can bore down thousands of metres through solid rock.

Diamond drills can bore down thousands of metres through solid rock, providing a continuous rock sample. Water is usually the drilling medium, although compressed air, crankcase oil, or kerosene may be used in certain situations. The rock is cut by a donut-shaped bit embedded with industrial diamonds. Every few metres, a cylindrical rock sample, called the drill core, is pulled out of the hole. As well, the material ground up by the diamond bit (*sludge*) is carried up around the drill rod to the surface. The core is placed in compartmented boxes and taken to the field office. In some cases, the sludge is carefully collected and saved as an important part of the drill sample.

Geologists can learn a lot by studying drill core, which provides a sample of the types of rocks that lie hidden below the surface. They look for valuable minerals in the core, and if the samples have a promising show of metals the cores may be sent to a laboratory for detailed chemical analysis.

To gain a sense of the extent of the deposit, drilling is usually done by marking out a grid on the ground so that a sample location or drill hole site can be accurately pinpointed. The distance between drill sites is site-specific, but may be tens of metres or less in some geologic situations. In forested areas, the grid is marked with cut lines, where small trees are cleared and large ones are marked. In open areas, the grid lines are usually marked with posts.

A drilling program should provide some or all of the following information:

1. The depth, size and shape of the ore deposit. These factors will affect the choice of mining method, as well as mine design and layout.
2. The average grade of the deposit and total tonnage of material that can be called ore within prescribed economic limits.
3. The mineral make-up of the deposit, and the consistency of the mineralization. If the types of metals vary greatly within a deposit, there may be the need for separate handling or processing.
4. The location of waste rock, which helps to determine mine design and layout.
5. Qualities of the rock that may affect blasting or ripping characteristics, bench level intervals, pit wall stability, and need for secondary blasting.

Impacts and issues:

Exploration activity is initially spread thinly over a vast area. Normally, very large areas are covered by the prospecting and exploration stages, and a great number of possible targets are identified. Few of these targets are drilled, still fewer are drilled intensively to delineate the deposit, and only a handful will be developed into mines.

- It is important to note, however, that the cumulative effect of thousands of kilometres of access roads cut through vegetation and surface soils may cause considerable erosion, sedimentation and wildlife disturbance on a regional scale.
- Most surface disturbance results from the construction of access roads and drill sites. Where large deposits are being investigated, building access roads for drills is a major undertaking because of the large size of the equipment. These roads can be extremely unsightly because they are so closely spaced and often traverse

Most surface disturbance results from the construction of access roads and drill sites.

steep hillsides where roads would not typically be located.

- Drilling fluids, waste water, fuels, oil and increased sediment load from roads may contaminate nearby water sources or groundwater. The potential for groundwater contamination can be decreased by implementing practices such as sealing holes and the proper disposal of drill cuttings.

Sedimentation of streams may occur if drilling mud is not carefully controlled.

- Drilling sludge may cause a particularly unsightly and enduring blemish on the surface, and sedimentation of streams may occur if drilling mud is not carefully controlled while the work is in progress. Sludge is usually allowed to settle out in the bottom of a crude pit called a mud sump, which often overflows on hillside operations leaving an unsightly smear of light-colored drill cuttings down the slope.
- Drilling can utilize thousands of litres of water per day.
- Depending on the size of the drilling program, there may be impacts associated with provision of accommodations for employees (vegetation and soil disturbance; disposal of human waste and garbage). Also, recreational activities, such as hunting, fishing and snowmobiling can extend the effects of the exploration project beyond the camp boundaries.

4. Bulk Sampling

In most exploration work there is a need for large, representative samples of the ore deposit. These bulk samples provide a final check on the grade of the deposit, as well as materials for determining the best method for processing the ore to separate target metals from waste rock. Bulk sampling may also yield other valuable data for use in planning mine and haulage facilities, and waste disposal. Typically, large-scale bulk sampling is undertaken in the last stages of exploration.

Samples obtained from most exploration drilling are not completely satisfactory in preparing representative bulk samples. The small samples are too finely ground by

the drill, and in other ways are unreliable as a sample for investigation of breaking, handling, and processing characteristics.

Because of the large amount of material required, bulk samples are usually collected underground. The undesired surface chemical and physical effects of weathering can be avoided, and there is less problem in controlling fly-rock when large samples are broken by blasting in confined underground openings.

Impacts and issues

- As with other exploration activities, surface and subsurface disturbances and potential erosion and sedimentation result from the collection of bulk samples for metallurgical testing.
- Drainage through waste dumps on the surface may be a continuing source of sediment, metals and sometimes acidic water to local watercourses. If the ore samples taken during the bulk sampling program contain sulphide rocks, they may need to be properly disposed of in order to prevent acid mine drainage and metals leaching into the environment (see Chapter 5, pages 119-128 on acid mine drainage).

5. Pilot Plant

To determine the milling procedures necessary to concentrate the ore, a pilot plant may be constructed. Tests are performed using a few hundred kilograms of ore from the drill cores. In a major project, underground bulk sampling provides sufficient ore to operate a pilot plant with a capacity of 50 to 100 tonnes per day for several months.

Pilot plant tests provide a general idea of the crushing, grinding, milling and metallurgical procedures.

The pilot plant tests provide a general idea of the crushing, grinding, milling and metallurgical procedures needed to efficiently separate out and concentrate the metals. It is also possible to determine the effects that a change in one part of the process will have on another, as well as the overall efficiency of the process. Infor-

mation gained from the pilot plant results feeds into the design of the full-scale plant. Costs of construction, operating costs, and waste disposal problems can be determined for use in broad planning and in the final feasibility study.

ii. Development

The development phase of mining can be broken into four broad areas of activity: evaluation and feasibility studies; engineering and environmental design; environmental impact assessment and public inquiry; and construction.

1. Feasibility Studies

Once the grade, tonnage, shape and nature of the mineral deposit is determined, other factors must be considered. The main concern is whether or not the ore body is rich enough to cover the costs of developing and running the mining operation, and generate sufficient profits for investors.

Is the ore body economic to mine?

The formal feasibility study includes an economic analysis of the rate of return that can be expected from the mine at a certain rate of production. Some of the factors considered during such an economic analysis are:

- tonnes in the deposit
- ore grade
- sale price of the metal
- mining rate (tonnes per day)
- cost of mining and milling per tonne
- cost of transporting fuel, supplies and employees to and from the mine site, and shipping out the end product
- capital cost of the mine, mill and associated infrastructure such as roads and power lines

- cost of exploration, development, waste disposal and reclamation
- royalties
- tax rates

The price of the target metals, which fluctuate based on global demand and supply, can make or break a project.

Certain variables can have a significant impact on the economic viability of the project. For example, the price of the target metals, which fluctuate based on global demand and supply, can make or break a project. In most cases this information will be entered into computer programs that generate different scenarios based on changes in metal prices or tax rates. The output from these models will calculate things like cash flow generated by the mine and the rate of return on investment.

The cash flow generated by the mine must often not only cover the cost of developing the project in question, but also be great enough to finance a company's other exploration projects, pay for past failures, and contribute to the mine's portion of main office and general overhead. If a company has a number of attractive investment opportunities, the rate of return from the proposed mining venture may be compared with the rate expected on a different mining venture elsewhere, or with some other business opportunity unrelated to mining.

Every organization has a limit to the amount of funds available for new capital investments and a minimum acceptable rate of return on investment. As a general rule of thumb, a mining project must have better than a 15 % rate of return to be considered by a major company. (An individual investor commonly expects a 30-50 % rate of return to consider investing in a mining venture.)

Can financing for the project be obtained?

Once the project has been deemed economically feasible, the owner of the ore deposit must determine if they, themselves, have enough money at their disposal to develop the project, or whether they will require outside financing. Alternatively, the owner may decide to try to sell the property.

Those who discover deposits are often different from the ones who actually develop mines. Mineral exploration companies are often classified as junior or senior (*major*) companies. The *juniors* are smaller companies that often make their money by exploring in new areas or with new technologies in previously explored areas. Most juniors do not have operating mines that generate cash to put into a new development. They make their money by selling shares in their company, which is not a guaranteed source of income.

Junior companies may not have any experience in developing mines.

Generally, after discovering a promising deposit, juniors either try to sell the property to a major company or negotiate a partnership (*joint venture*) with a major, because often junior companies do not have sufficient cash flow to develop a mine. Also, junior companies may not have any experience in developing mines. An example of a joint venture is when an owner of an ore deposit agrees to share the profits with an operator who provides the capital and know-how to develop the mine.

Major companies benefit from having juniors perform exploration work because they do not have to invest in the riskiest part of the initial exploration (proving up a potential prospect).

2. Engineering and Environmental Design of the Mining Operation

If a decision is made to develop a mine, there is still a lot of work ahead of the company. Prior to applying for necessary permits or participating in the Environmental Assessment process, a mining company must have a fairly detailed knowledge of what will be involved in mining the ore deposit.

During this stage, the responsibilities shift from geologists and economists to mining engineers, hydrologists and biologists. These people begin to develop the detailed plans for the mining operation. They also collect information on the present environmental conditions (*baseline data*) at the potential mine site, to determine the potential impacts of the operation, and develop plans to avoid or decrease (*mitigate*) the impacts.

Typically, the design and planning of the mining operation involves several steps:

- Selecting a mining method: the physical nature of the ore and surrounding rock, and the shape and structure of the ore body determine the mining method used and the mine drainage problems that may be encountered.
- Selecting the ore processing system, based on the pilot plant results.
- Collecting baseline environmental information for the site (local topography, drainage, water availability and quality, climate, wildlife species and numbers, soil stability).
- Determining mine layout (i.e., the location of facilities and waste disposal sites): this should be based on environmental considerations (e.g., can the mine be situated to avoid critical wildlife habitat), as well as engineering and mechanical challenges and transportation options.

3. Regulatory Requirements

If a company determines that it is economically profitable to mine a deposit, certain regulatory approvals and permits must be obtained. These requirements are outlined in Chapter 7.

4. Construction

Once a project has secured sufficient financing and the regulatory requirements have been met, development of the mine site can begin. The construction stage involves providing infrastructure (e.g., power, roads, and water) to the site, and preparing the mine site for ore extraction.

Once a project has secured sufficient financing and the regulatory requirements have been met, development of the mine site can begin.

Power

The requirement for electricity in mining operations is usually large from the development stage onward, when essentially all power is electrical except for mobile

units, such as trucks. Large open pit and underground developments usually involve contracts with power companies and public utilities for the new transmission lines necessary to bring outside power into the property. At smaller properties, or those in very remote locations far from low-cost sources of electricity, diesel generator sets may be installed within the mine-mill plant complex. The principal considerations are a site suitable for unloading and storage of bulk fuel, distance of transmission of power, and position of the plant away from residential areas because of the noise.

Access

If the ore deposit is located in a remote area, access to the site may be by road, rail, air or a combination of transport routes. For example, at the Kemess mine in north-central BC, supplies and ore concentrate are shipped via road, but employees are flown into the site.

Water

Most mines use large quantities of water for drilling, milling and slurry lines, as well as for drinking and washing. Since mill water is often contaminated with wastes and chemicals, mines often recirculate process water in a closed system through the mine facilities to reduce demand and to avoid having to treat the water to remove the contaminants.

Facilities

Before mining can occur, support facilities (e.g., offices, housing, maintenance shops, fuel bays, and mineral processing facilities must be constructed.

Regardless of the mining method, certain mining facilities are common to all projects.

Regardless of the mining method, certain mining facilities are common to all projects:

- The ***mine plant*** generally contains a storage area, an employee change house, a compressor, machine shops, warehouses and possibly ore storage, loading and shipping facilities. The plant is usually situated near an access road, well away from streams.
- The ***mill*** usually includes warehouses; loading/unloading and weighing facilities; ore crushing, blend-

ing and storage units; the ore treatment plant, and possibly the power plant. It is usually positioned between the mine and the waste rock disposal area, and as close to the mine as possible to reduce ore handling costs.

- Extensive ***parking areas*** may be required if the employees travel to work by automobile. When space is restricted, remote parking areas are serviced by shuttle buses to take the workers to the working area. If the mine is in a very remote region, temporary housing and meal facilities may be provided for mine workers, construction contractors and visitors.

Site preparation

Sites are prepared for the eventual storage of waste rock, tailings, overburden materials, and heap leach areas (if necessary). This might involve creating flat surfaces, and diverting water around the sites (to minimize the possibility of water contamination from the waste materials).

The ore body is prepared for ore extraction. For open pit mines, this involves stripping the overlying vegetation, soils and waste rock material. Waste rock materials are placed in dumps, or are used as construction materials on the mine site. It is common for roads to be built from waste rock.

Deeper deposits designed for underground mining are developed initially by gaining access to the mineralization through vertical or inclined shafts or horizontal adits. Underground drifts, crosscuts, raises, and ramps are excavated to provide the access needed to mine the ore.

The outer extent of land disturbance (*footprint*) of the mining operation is essentially defined at this point.

Impacts and issues

The development phase is when the major disturbances at a mine site begin to occur.

The development phase is when the major disturbances at a mine site begin to occur. Consequently, it is during

this phase that most of the decisions concerning environmental protection should be made.

- Disturbances include construction of roads, buildings and power lines; sinking of mine shafts; and stripping of vegetation and soil to form a working area.

Equipment movement is greatest during the mine construction phase.

- Equipment movement is greatest during the mine construction phase. Consequently, the resulting direct soil and vegetation disturbance, altered drainage patterns, potential for erosion and washing of soil into streams and lakes (*sedimentation*), atmospheric dust and noise are also likely to be at their highest levels.
- Topsoil removed during clearing activities should be saved for re-use during reclamation.
- The ground beneath any facilities must be suitable for support of building foundations, and the area should be free from risk of landslides, avalanches, or unusual runoff during the various flood seasons.
- Increasingly, there is recognition of the need to characterize the nature of the soils and overburden materials. Waste materials should be properly analysed before they are disposed of or used in construction projects. Roads at the Huckleberry mine were constructed from waste rock that was later determined to have the potential to release metals and acid. At the Kemess mine, the materials used to build haul roads were also poorly selected: they contained a high amount of silt, which, years later continues to wash out of the roadbed and into streams.
- Noise and light pollution can disturb nearby human and animal populations.

iii. Production

When a mine begins to extract ore it has entered the production phase. But the steps involved in producing a marketable product go beyond simply digging the ore from the earth. The target metals must be separated from the bulk of the waste materials (*the beneficiation process*),

and then sent to a smelter or refinery (*for further refining*), to create a pure metal product.

1. Ore Extraction

Extraction of ore encompasses a series of events, which may include: the removal of the ore from the ground; the initial separation of waste material from the ore; and a certain degree of crushing to allow for easier transportation of ore from the mine to the mill.

Almost every mine, whether open pit or underground, uses the same basic operations to remove ore.

Even though every ore deposit is different, generalizations can be made about hardrock mining operations. Almost every mine, whether open pit or underground, uses the same basic operations to remove ore from the ground: drilling, blasting, loading (*mucking*), and transporting (*hauling*).

To access the ore, explosive materials are placed in drilled holes and are detonated. After blasting, the fragmented rock (*muck*) is usually loaded into trucks and hauled to the mineral processing facility or primary crushers.

As mining progresses, open pits are excavated on the surface or a maze of underground openings or voids (*stopes*) are created. In some cases, stopes are backfilled with waste material, either for convenience or to enhance structural support.

Impacts and issues

- Waste dumps, heap leach piles and tailings ponds all create potential environmental problems. Surface wastes are subject to wind and water erosion, as well as chemical reactions (e.g., acid mine drainage, discussed in Chapter 5), which could lead to the release of toxic metals and acid into the environment.
- See pages 52-65 for impacts related to specific mining methods.

2. Ore Processing ("Beneficiation")

Some minerals, such as coal and salt, and aggregate materials like sand and gravel, are ready to use almost as soon as they are mined. It may be necessary to wash or treat these substances in different ways to enhance their quality, but their properties remain essentially unchanged. Metals, conversely, usually occur in combination with other materials, which means that they must be put through physical and chemical processes, to separate the desired metal from the unwanted ore constituents.

Beneficiation is the first phase in creating a pure metal product from the mined ore.

Beneficiation is the first phase in creating a pure metal product from the mined ore. At the end of the beneficiation phase, a metal may still not be in its pure, elemental form (i.e., it may still be chemically bound to other compounds like sulphides). The final refining phase of processing, called extractive metallurgy (discussed in the next section), involves the creation of a pure metal product.

The beneficiation phase involves three main steps: crushing and grinding; milling; and dewatering.

Crushing and grinding

The first step in the beneficiation process, often referred to as *communition*, usually involves primary crushing, which breaks up the ore into coarse pieces. The ore then moves through a secondary crusher, which grinds it into particles fine enough for milling.

Milling

After crushing, the ore is ready for some form of milling, to separate the valuable minerals from the waste rock. The product of a milling operation is a *concentrate*. Concentration can be achieved through: flotation; gravity separation; magnetic separation or hydrometallurgy.

1) Flotation: the ground up ore is usually mixed with water, which makes it easier to pump the material into huge vats (*cells*). Air and processing chemicals (*reagents*) called frothers (e.g., diesel or pine oil) are pumped into cells that contain the slurry, which creates bubbles. A second reagent, known as a *collector*, is added to the

solution. The collector causes the mineral particles to stick to the rising air bubbles. Other reagents called depressors can be added to stop unwanted minerals from attaching to the bubbles. The air bubbles carrying the desirable minerals are skimmed away by paddles, and the solution is filtered to remove water and concentrate the metals.

The waste product (*tailings*) from the milling process is a mixture of chemicals, fine rock particles, and non-target metals. Water is often added to create a liquid waste product (*slurry*), which enables the wastes to be transported more easily to a tailings disposal area (*impoundment*).

In Canada, this is the most widely used method for processing metal ores that contain sulphides.

2) Gravity separation: one of the oldest methods, this is no longer used except for certain ores that do not respond well to flotation (e.g., iron, some gold and silver, asbestos and coal). This method is used when the target minerals are considerably heavier or lighter than the host or waste materials. The ground-up ore is passed through a box called a jig. Water is pumped in from above and below, and the pulsating water causes heavier materials to settle out. The lighter materials stay on top of a screen.

3) Magnetic Separation: involves using a strong magnetic field to concentrate and clean iron ores and other minerals that do not respond to flotation.

4) Hydrometallurgy or *leaching*: involves using water (or a water-based solution, e.g., a weak acid) to dissolve (extract) the metallic compound and separate it from the waste materials. Leaching is an increasingly common extraction practice.

Leaching is an increasingly common extraction practice.

Most often, it involves adding a cyanide solution to gold-bearing ores, or a sulfuric acid solution to low-grade copper ores. The leaching solutions (*lixiviants*) can be sprayed on top of huge, open-air piles of broken ore (*heap leaching*), to crushed ore stored in vats (*vat leaching*), or to waste rock or tailings (*dump leaching*). Low-grade copper mines often use some form of dump

leaching for recovery of small amounts of copper contained in overburden and waste.

Cyanide is now the chemical of choice for gold heap and vat leaching.

- Cyanide is now the chemical of choice for gold heap and vat leaching throughout the world. First used on a large scale in the 1970s, cyanide allows gold flecks to be separated from extremely low-grade ores. Cyanide is extremely effective, and can combine with up to 97% of the gold, including particles that are too small to be seen by the naked eye. As little as 1 ounce of gold can be extracted from 3,000,000 ounces of low grade ore. Often, the ore used in a gold heap leach operation can be leached without crushing, or it is crushed only fine enough to allow the lixiviant access to most of the mineral grains. The avoidance of the crushing phase, which is energy intensive and therefore expensive, also contributes to making heap leaching an extremely cheap way to extract metals.

In gold heap leaching, the ores are usually piled atop clay or plastic-lined pads, and sodium cyanide solution is applied. It trickles down (*percolates*) through the ore, dissolving fine particles of gold. The pregnant solution is collected at the base of the pad, and is piped to a pregnant solution pond, where it is held until it can be piped to a processing plant where the gold is separated from the solution.

In the processing plant, the most common method of capturing the gold from the solution is by passing the solution through a carbon filter, which picks up the gold. Gold is washed from the carbon with a solution of cyanide and caustic soda, and then recovered by electrolysis or by precipitation with zinc dust.

The remaining cyanide solution, now largely free of gold (known as the *barren* solution) is often re-used. The barren solution is often stored in outdoor ponds (*recycle ponds*) until it can be reapplied to a new heap.

Dewatering

The concentrated product from the beneficiation process is generally a slurry, which contains large amounts of water. In order to isolate the metal concentrate the

water must be removed. One common method involves pumping the slurry to a settling tank, where it is separated into a thick pulp and water. Chemicals called flocculants may be added to help settle the finer particles. Finally, the bulk of the remaining water is removed by passing the thickened pulp through a fabric filter, which essentially traps the solid, concentrated ore particles.

Impacts and issues:

- Crushing and grinding operations produce noise and airborne particulates (fine materials that remain in the air). Rubber liners can be installed in grinding mills to greatly reduce the noise.

- Large amounts of water are required in the separation processes. While much of this water can be recycled, some may have to be discharged. If flotation is used, the discharged water will contain chemical reagents, as well as low levels of metals. Sometimes chemical reagents are first extracted for reuse or disposal, but this is not always the case.

- Whether the processing water is discharged or recycled, most of it is initially held in a pond or series of ponds to allow for settling out of the solid particles, or permit treatment for removal of toxic constituents. In these ponds, some water will be lost through natural processes (seepage, evaporation) and will eventually enter the environment. The quantity of water lost is a function of many variables including effectiveness of the design and construction of the impoundment, climatic factors, soil properties and proximity to watercourses.

- The major environmental problem associated with beneficiation is the disposal of mill tailings. The high water content of most tailings, and the creation of *slimes*, which are very fine particles that do not readily solidify, increase the instability and vulnerability of tailings to water erosion. The effectiveness of an impoundment in settling-out the tailings materials, and degrading the processing chemicals or other toxic

The major environmental problem associated with beneficiation is the disposal of mill tailings.

substances depends on the length of time that the materials remain in the pond.

- During the mining process, rocks containing heavy metals (e.g., cadmium, copper, lead, manganese, mercury, silver, zinc) are removed from their original underground locations. In both waste rock piles and tailings ponds, these rocks are exposed to new environmental conditions—the heavy metals that would have remained stable indefinitely are exposed to oxygen and water. Under these conditions, the metals may leach out of the rocks or tailings. If the materials contain sulphides they may create acid (see section on acid mine drainage in Chapter 5), and the metals may become more mobile and create a health hazard. The concentrations of chemicals, metals and acids are not always high enough to pose potential damage to living organisms, and tailings do not always cause environmental problems. But if tailings do contain high levels of certain substances, there is the potential that without proper containment, treatment and disposal, they may pose a threat to wildlife and contaminate water courses.

Water may have to be treated to remove the toxic substances.

- If the concentration of chemicals or metals in processing water is too high, water may have to be treated to remove the toxic substances before it is discharged to the environment. See Table 6 which provides some information on the toxicity of certain chemical reagents; and pages 130-135 for impacts related to metal toxicity.

3. Further Refining/Extractive Metallurgy

The metal products created through beneficiation almost always require further processing. Whereas beneficiation involves the mechanical and physical alteration of the ore, extractive metallurgy involves the modification of the chemical nature of the minerals, to separate the metal from its sulphide or other compounds (e.g., oxides, silicates, carbonates). Usually, the final stages of refining occur at smelters and refineries, which are almost always situated away from the mining operation,[11] in

a location with lower energy production costs (further refining requires huge amounts of energy) and better transportation facilities to aid in the distribution of the final product.

The purpose of further refining is to remove the last of the impurities.

The purpose of further refining is to remove the last of the impurities and recover the metals contained in the concentrate. At the end of this process, a pure metal product is obtained for commercial use.

The smelting and refining methods used to obtain a metal from concentrate include: pyrometallurgy, electrometallurgy and hydrometallurgy. Often metals are extracted using more than one of the following processes.

Pyrometallurgy

In most cases, as temperatures increase, metals tend to be less attracted to sulphur and oxygen. Pyrometallurgy uses high temperatures in blast or reverbatory furnace to separate a metal from its sulphide. During this step, enough heat is applied to melt the ore concentrate. Some minerals are vaporized, and can be recovered by distillation in kilns or furnaces.

Smelting is a common form of pyrometallurgy. During the smelting process, heat is applied, and substances called *fluxes* (e.g., silica, borax or soda ash) are added to dissolve out impurities. The result is a liquid metal product, and a liquid waste product known as slag.

Because of the expense, usually only high-grade ores are smelted. In Canada, most of the ores treated this way are sulphides containing pyrite and pyrrhotite (iron sulphides).

Electrometallurgy

In this method, electrical energy is used to separate the metal from its ore. There are two primary ways for using electricity to extract metal from ores. The first involves the use of an electric current (*electrolysis*), while the second uses electrically generated heat (*electrothermic methods*).

Electrolysis is most widely used for refining copper, lead, zinc and nickel ores. Aluminum is processed this way at the Kitimat smelter in northern BC. Simply put, an electric current is passed through a cell containing a solution of the metal compound (e.g., copper sulphate) and a liquid known as an electrolyte (e.g., sulphuric acid). The current causes the copper (or other metal) to migrate toward and attach to a metal plate (a *cathode*), while the impurities remain in solution, fall to the bottom of the cell, or bind to an anode. Electrowinning is a form of electrolysis.

Electrothermic methods, such as electric arc furnaces or electric retorts, are often considered a form of pyrometallurgy, since it is the heating effect and not the electric current that is of importance. Electric heating has a number of advantages over using hydrocarbon-based fuels (e.g., gas, oil) to heat the ores. For example, electrical heat allows for more accurate temperature control, and there is no requirement for air to support combustion. As a result, electrothermic methods may lead to a more efficient process with less heat loss, decreased gas emissions and no pollution related to the burning of hydrocarbons.

Hydrometallurgy

As mentioned above, hydrometallurgy involves dissolving the metals directly from the ores using a variety of acids. Leaching can also be used to further refine ore concentrates. Because leaching does not have large energy requirements, hydrometallurgical refining can take place at the mine site, which reduces further reduces the energy costs of transporting the concentrate to a smelter or refinery.

Impacts and issues

- Because many metal ores contain sulphides,[12] the refining of ores inevitably leads to the production of sulphur wastes. These wastes are usually in the form of sulphur dioxide gases, which can lead to the formation of acid rain. Instead of being released to the atmosphere, this sulphur can be converted to sulphuric acid or other

useful compounds (e.g., fertilizers) that can be sold, if the company decides that the benefits of so doing justify the costs.

- In addition to sulphur dioxide, pyrometallurgy may result in the emission of heavy metals to the atmosphere. Significant amounts of copper, lead, nickel, zinc, cadmium, arsenic, cobalt, iron, antimony and mercury have been measured around smelters in Canada. Plants can accumulate these metals, and some may suffer from decreased growth or death. Some plants are able to develop a tolerance for high metal concentrations, and accumulate metals in their tissues. Consequently, animals feeding on the vegetation may experience health problems. (See example on page 132.)

Pyrometallurgy may result in the emission of heavy metals to the atmosphere.

- A great deal of energy is required, especially for electrometallurgical methods.
- The waste products from pyrometallurgy, slags, are usually potentially less toxic than wastes from the beneficiation stage.

iii. Closure and reclamation

1. Closure

It is not uncommon for mines to close temporarily, if, for example, the demand for the product decreases or metal prices drop, making the operation unprofitable. In almost all cases, when temporary shutdowns occur all equipment and buildings are maintained in working condition in anticipation of reopening the operation.

Eventually, however, when a mineral deposit has been mined out, or the grades of ore that are left are no longer deemed economic to mine, the operation will close permanently. Closure typically involves the removal of all buildings; although occasionally the mill complex will remain active, to service other mines in the region. All safety and health hazards must also be removed, so

Table 2.

Metallurgical method	Environmental Advantage	Environmental Disadvantage
Pyrometallurgy	Minimal liquid wastes, lower energy requirements	Less pleasant working environment. Fine grinding is necessary, which requires large amounts of energy. Chemical reagents are required for flotation process. Sulphur dioxide air emissions may occur.
Hydrometallurgy	Little discharge to the environment if performed on a closed-circuit basis (e.g., vat leaching). Tailings generally less finely ground than for pyrometallurgy. Low energy requirement relative to other methods.	Waste solutions may be released to environment.
Electrometallurgy	Produces high-purity products. High degree of control possible.	Large amounts of electric energy are required. Production of some toxic gases. Possible toxic chemical wastes to air. Generally has to be used with pyrometallurgy or hydrometallurgy.

shafts and adits should be sealed shut, and contaminated materials should be disposed of properly.

Disruption to the environment is unavoidable when taking minerals from the ground. Accompanying mine closure, therefore, are reclamation activities such reshaping slopes to increase stability and improve their appearance; and revegetation of the site.

Disruption to the environment is unavoidable when taking minerals from the ground.

In some cases, a site cannot be closed. There are cases where water contamination is so severe that all water leaving the site will have to be treated for the foreseeable future. In cases where long-term treatment situations exist, somebody (the company, the government, nearby communities) will have to keep monitoring the site. Mining, in these cases, is not a temporary use of the land.

2. Reclamation

The demand for reclamation of disturbed lands has increased in recent years because the public, as well as industry, have recognized that healthy land and water resources are essential for the well-being of present and future generations. Most jurisdictions acknowledge that for the privilege of mineral extraction, industry bears a responsibility for rehabilitation. All mines in BC are required to conduct reclamation activities, which are intended to restore the impacted areas to useful, safe environments. (Regulatory obligations related to closure and reclamation are outlined in Chapter 7.)

It is next to impossible to restore mined land to the identical condition that existed before mining occurred. The end goals of reclamation should therefore be the attainment of a stable ecological state that does not contribute to environmental deterioration and is consistent with surrounding aesthetic values.

Before a company can fully close and walk away from a site, all scheduled reclamation should have been completed and safety of the area ensured. Mining companies should plan for reclamation and closure well in advance of the projected closure date. Through comprehensive

environmental planning, mining companies can execute closure with mindful concern for health and respect for ecological needs. The more thought that is put into handling and managing wastes during operation, the less it will cost to ensure that when the mine closes the potential for contamination from waste rock piles and tailings impoundments is reduced. Chapter 6 (pages 192-196) elaborates on the concept of planning for closure and reclamation.

Impacts and issues

- Reclamation today does not mean that the area will be returned to its pre-mining condition. The BC *Mines Act* requires that "the land surface shall be reclaimed to an acceptable use that considers previous and potential use."

- Whatever the defined post-mining land uses, a mine should not be closed until reclamation has been completed. It may take several years before lands and waters reach a stable, self-sustaining state. In the years after mining ceases, monitoring should continue until local communities and government regulators are satisfied that reclamation has been successful. This may take 5-10 years or more to determine.

Reclamation activities can and should take place while mining is occurring.

- Reclamation activities can and should take place while mining is occurring.

- Soils in many northern regions are thin, and the growing season is short. Establishing vegetation may, therefore, be difficult. Similarly, the potentially high metal content of waste rock dumps and tailings areas may prove too toxic an environment for the re-establishment of plants. In this case, a cover of topsoil may be required to provide a more hospitable rooting medium.

- In some circumstances reclamation may never be fully accomplished, for example, if long-term water collection and treatment systems are required to deal with contaminated waters. At some sites, long-term moni-

toring and maintenance (for hundreds to thousands of years, or *in perpetuity*) will be necessary.

- Acid mine drainage (AMD) sites poses specific challenges for reclamation, because once AMD starts it cannot be stopped. Reclamation of AMD sites, therefore, is a long-term commitment. The best way to deal with AMD is to prevent it from ever starting. Methods of managing wastes to reduce the risk of water contamination are discussed on pages 148-160.

- Covers made from soil and synthetic materials are often used to prevent acid generation by minimizing entry of water and air. Covers may not last forever, especially poorly designed covers. In the short term, the covers may work, but after 5, 10, or 20 years, problems could arise. If acid begins to be generated in buried wastes, the soil above can eventually become contaminated, killing vegetation and accelerating erosion and AMD. Sites that are not AMD generators, but that might potentially "go acid," must be very carefully reclaimed (see page 195). Long-term monitoring of the effectiveness of covers may be an important factor to include in reclamation and closure plans.

c. Community involvement

Each stage of mining has potentially adverse impacts on natural and social environments; economic and cultural conditions; and human health of nearby communities and mine workers. At each stage, communities may want to create a dialogue with the company and government regulators to try to determine if and how mining will proceed.

Table 3. Opportunities for community involvement during various stages of mining

Exploration **Potential impacts with each stage of mining**	**Land:** erosion from trail/road and trenching erosion; access-related over harvesting and fishing; habitat disruption. **Water:** sedimentation; acid mine drainage; camp sewage and garbage disposal. **Air:** noise pollution.
Issues to consider	This is the stage when community members may want to make their views known to exploration companies and the government regarding certain lands that they do not want to see developed, or certain safeguards that the community would want to see if mining development is to occur. For example, before a company enters the advanced exploration stage, you may want to request that they collect baseline environmental data to know the pre-mining conditions at the site. That way, if there are impacts from the exploration project, the company, government and your community has an idea of what reclamation must be done to return the site to an ecologically stable state.
Opportunities for community involvement	Community members can talk to government officials to find out which companies are operating in your territory, and where the activity is occurring. Companies can be contacted directly, to discuss their activities. It is best to alert both the company and government to your concerns (in writing) as early as possible.

Environmental Assessment (EA) **Potential impacts with each stage of mining**	The application to develop a mining project goes through government review and public consultation. Impacts are minimal during this stage, unless exploration is continuing at the site.
Issues to consider	This is the stage when communities have the greatest opportunity for influencing the mining project. ▪ To date, the EA process for mining projects has had its difficulties. Common complaints include insufficient technical information and review of the projects; lack of baseline data on wildlife and plant inventories, cultural sites, etc.; lack of requirement for detailed plans (e.g., sediment control, waste handling plans, etc). The latest critique (which led to a quashing of an EA certificate) was that the BC EA process failed to examine the impact of the Tulsequah Chief mining project on the sustainability of the Tlingit culture. ▪ Identify existing resources that are important to your community. Document the species of fish, birds and other animals (and approximate numbers, if possible); document wildlife habitat areas and travel pathways; map important cultural sites; water supplies; and areas important for food and medicinal plants. ▪ You may want to go on a site visit with the company and government officials. Find out where the mine, mill and other buildings, roads, ponds, waste rock dumps, tailings impoundment, etc. will be located; and how large of an area will be disturbed. Think about how the locations of the various mine components might impact the land, water, and wildlife. ▪ Impact – Benefit Agreements (IBA). If your community decides that mining is an acceptable use of the land, this is the time to state your desires of the company. This may involve job guarantees, training for community members; royalties; etc. It is worthwhile to review IBAs that other communities and companies have developed, and talk to those First Nations involved to find out their experiences with the agreements (they might have suggestions on what worked well, and what they would have done differently).

Opportunities for community involvement	There is an opportunity for First Nations to be part of the project committee that reviews the mining project application. This gives your communities the opportunity to convey your concerns to government officials and the company; to request further studies; to suggest changes to mine plans; to demand better mitigation plans; etc. You will want to review the project application carefully. Hiring technical consultants can be extremely useful at this stage. **Geologists** – can indicate whether the types of ore and rock present might create problems for waste disposal, milling, reclamation. E.g., do they have a high potential to create acid mine drainage. **Hydrologists** – can identify where the water in the region comes from, and where waters from the mine will flow; where the company expects to get water for the mine (who will be affected if the water is used); which water resources have a likelihood of becoming contaminated; the chances that floods or avalanches will threaten impoundment stability and water retention. **Economists** – can review the estimates made by the company to determine if the mining operation is really economically profitable; at what metal price will the project cease to be economic; and whether metal supply and demand trends support the need for the proposed project. **Biologists –** can identify critical habitat areas that might be impacted by a mining operation. Can identify and document the variety of animal and plant species present. **Botanists** can identify important plant species. **Engineers** – can determine if the mine plan seems reasonable, or if there are safer, more environmentally sound ways to design the mine and milling operations.

Development **Potential impacts with each stage of mining**	**Land**: construction of roads, power lines, clearing of overburden and building sites may lead to erosion; disruption of wildlife habitat; loss of cultural heritage sites. **Water**: sedimentation from earth-moving operations may impact aquatic life. **Air**: noise from heavy machinery; dust ; light pollution.
Issues to consider	From the development stage through to closure, monitoring is a key factor contributing to the success of a well-designed project. If potential environmental problems are noticed early enough, often measures can be put in place to avoid disasters. ▪ There are usually a number of firms contracted to carry out the variety of tasks that occur simultaneously during the development stage. During construction, there may be road construction crews; engineering firms working on tailings dam construction and other earth-moving projects; contractors building the mill and other buildings, and several more independent contractors. The movement of so many vehicles and activities of so many different groups makes it difficult for the company to monitor the impacts that each operation may be having on the environment (if that is even a priority for the company).
Opportunities for community involvement	Because of the level of activity and potential for significant environmental impacts during the construction stage, some mines have environmental monitors on site to oversee the multitude of activities. Communities should have a say in the selection of the monitor. The monitor should be independent, not an employee or a consultant selected by the company, to ensure adequate scrutiny of the operation. The most desirable situation is for a full-time, independent monitor, paid for by the company, throughout the entire construction stage. It is important to have clear terms of reference for the duties of an independent environmental monitor (e.g., what power does the person have to stop a company from carrying out destructive practices; to whom does the monitor report – governments, the company, etc.).

Production **Potential impacts with each stage of mining**	**Mining and Milling** **Land**: destruction of plant and wildlife habitat; long-term scars on the land (aesthetic impacts). **Water**: water use may change local water balance (e.g., dry up streams). Contamination may result from leaks, spills, seepages from tailings ponds, heap leach pads, sedimentation, and AMD/metal leaching. There may be an impact on fish and aquatic organisms. **Air**: noise pollution from equipment movement; blasting; wind borne dust; light pollution. **Smelting and Refining** **Land**: impact on vegetation from slag and smelter emissions. **Water**: contamination from chemical spills or airborne contaminants. **Air**: heavy metal air pollution from smelters; sulphur dioxide emissions may cause acid rain.
Issues to consider	During the production stage a full monitoring program should be in place. Water samples should be collected to determine any impacts on waters downstream from the mine. Water analyses will tell you whether the concentrations of certain substances (e.g., metals, chemicals like cyanide) are higher than the mine is allowed to discharge. Collection of aquatic insects can be done to see if there have been changes from pre-mining numbers and species diversity. Fish counts can be done. Fish flesh can be sampled to see if any accumulation of metals has occurred. Stability of containment ponds, waste rock and tailings impoundment slopes should be routinely checked for seepages and erosion. Reclamation activities should be underway (and monitored). ▪ There are requirements set out in the various permits that govern activities on the mine site. But in these times of government cutbacks on environmental protection, the frequency of mine site inspections and government monitoring has been severely reduced. In some cases, Ministry of Environment staff are only inspecting mine sites once a year.

Opportunities for community involvement	Communities can have a role in the monitoring of mining operations. One model to consider is to ask that an independent body be established to monitor the activities of the company and compliance with regulatory requirements. This was done for the Ekati diamond mine project in the Northwest Territories. During the EA process, it was determined that the Ekati mine had the potential to affect fish and caribou populations in the region, and the traditional territories and land-based economies of four groups of Aboriginal peoples. The *Independent Environmental Monitoring Agency* (IEMA) was established to serve as an independent public watchdog on environmental management issues at the mine, which began operations in April 1997. The IEMA is run by a 7-person board and a small staff in Yellowknife. The relevant Aboriginal groups selected 4 of the board's members. The mining company, BHP, and the federal and territorial governments jointly selected the other three, in consultation with the Aboriginal groups. In the first two years the federal and territorial government contributed to the funding; but as of the third year, BHP assumed the full cost (approx. $450,000 Cdn). The IEMA was designed to perform a number of tasks, which include: ▪ providing an effective way to bring the concerns of aboriginal peoples and the general public to BHP and the government. ▪ compiling and analysing environmental quality data, and making recommendations on: short-term, long-term and cumulative impacts; government compliance monitoring reports and BHP self-assessment reports; environmental plans and programs; annual reports and environmental impact reports; and the integration of traditional knowledge and experience of aboriginal peoples into environmental plans and programs. A second possibility is developing your own monitoring program. This was done by members of the Ross River First Nation in the Yukon.

Closure **Potential impacts**	**Land**: revegetation failure, thus, no improvement to wildlife habitat. **Water**: seepage of toxic solutions into ground and surface water; contamination from acid mine drainage; loss of fisheries habitat. **Air**: wind borne dust from dry tailings.
Issues to consider	At this stage, reclamation activities should be monitored. Waste rock dumps and tailings impoundments should be carefully monitored, especially if there is a chance that acid mine drainage might develop. Water sampling programs should continue for several years after the actual mining operation permanently shuts down.
Opportunities for community involvement	Public liaison committees have been established to oversee closure planning and reclamation activities. An example is the Sullivan Public Liaison Committee, which was set up to assess Cominco's Sullivan Mine closure and reclamation plan and make recommendations to the BC Ministry of Energy and Mines. The broad aims of the committee are to ensure long-lasting environmental protection and community sustainability. The committee is composed of representatives from the Ministry of Energy and Mines, Ministry of Health, BC Ministry of Environment, Environment Canada, Cominco, City of Kimberley, the United Steelworkers union local, the Ktunaxa-Kinbasket First Nation, Kimberley Chamber of Comerce, Bavarian City Railway, Sullivan Mine Interpretive Centre Society, East Kootenay Environmental Society (EKES) and concerned individuals. The Committee has no budget of its own.

The following section is a list of general questions that may help to guide your thinking about the project, and your discussions with a mining company.

Mine Site

- Is the mine located in key wildlife habitat, or critical habitat for any species? Is the area in or near habitat of threatened or endangered species? Will fisheries be impacted?
- Have adequate baseline data on wildlife, fisheries, plant life and cultural sites been collected?
- How will any effects on land and water be avoided, minimized or mitigated?
- What will be the post-mining land use options?

Mining Methods

- How will ore be mined (open pit or underground methods)?
- Will the mine operate seasonally or year-round? Will the operation be active 24-hours-a-day, 7-days-a-week?
- How will the ore be processed?
- How will the ore be transported to the mill?
- What chemicals or reagents will be used to recover the metal?
- Where will the waste rock be dumped? What measures will be taken to ensure a stabilized dump?
- Where will the disposal site for mill tailings be situated? Will a tailings impoundment be required?
- Are there contingency plans that outline what measures will be taken in the event of tailings line breaks, tailings impoundment failures or overflows, or sediment pond overflows?

Water Quality

- What are the potential sources of water pollution? How will they be controlled?

- Will acid mine drainage be a potential problem? If so, how will it be controlled?
- Where will water quality monitoring wells be installed or sampling sites be located?
- How often will data be collected, and what will the samples reveal (e.g., metals, sediment/turbidity, hydrocarbons)?
- How will sedimentation be controlled? Especially during the construction stage? Has a plan been developed? How will contractors be made aware of these environmental protection requirements?
- Will catchment basins and seepage ponds be constructed to catch sediment and seepages from the tailings impoundment?
- Are there contingency plans, in the event that some of the control structures fail?
- Will flocculants be used to settle sediments? If so, what flocculants? Are they non-toxic?

Water Requirements

- How much water is required for the operation? How will it be used?
- What are the proposed sources of water for the mine? (surface water, groundwater)?
- What are the existing uses of those water sources?
- What are the possible risks to the water sources from the operation?
- Will water be recycled in a closed circuit, or will it be discharged to the natural environment during the life of the operation?
- Has a water balance been done?
- Have adequate baseline data been collected?

Transportation/Access:

- How will access be provided to the mine (road, rail, air, water)?

- What are the proposed access routes to the mine?
- Will existing roads will be used or will new ones need to be constructed?
- Will roads or bridges need to be upgraded to handle the amount of traffic and the heavy loads?
- Who is responsible for maintaining and upgrading the roads?
- What is the erosion potential of the soils along the proposed routes?
- How will erosion be controlled? Will erosion and sedimentation be monitored along these routes?

Power Requirements

- How much power will be required by the operation?
- Will electricity be provided by power lines or diesel generators?
- How will diesel be transported to the site?
- If hydro electricity is used, does a power line have to be constructed? Who will pay for it? What is the proposed route (does it have the potential to impact streams)?
- Will the work along these corridors be monitored for impacts to streams, i.e., to ensure proper erosion controls and clearing methods? Which government department will be overseeing the monitoring and inspections along the power line route?

Hazardous Materials

- What hazardous materials will be used?
- How will they be transported?
- How and where will fuel be stored?
- What measures will be taken to prevent accidents? Has an Emergency Spills Prevention Plan been developed?
- How will employees be trained to deal with spills?

- Will transportation routes follow creeks, rivers or other water resources?
- Have contingency plans been developed to prevent and clean up spills into creeks, rivers or other water resources?

Air Quality

- What are the potential sources of air pollution and how will they be abated?

Noise and Light

- How much noise pollution will result from drilling, blasting, movement of large equipment, crushers, air compressors, etc.?
- How will noise be controlled? How will it be monitored?
- What is the maximum allowable decibel level?
- Will night lighting for the operation likely disturb nearby residents and wildlife? How will this be mitigated?

Reclamation

- How will the site be reclaimed and to what post-mine use?
- Will topsoil be saved? If so, where will it be stored and how will it be stabilized?
- What is the time frame for completed reclamation?
- Will the reclamation bond be adequate to cover the costs of reclamation should the company go bankrupt?
- What are the criteria for release of the bond? Does the public have a say in the matter before the bond is released?

Monitoring

- Will there be an on-site environmental coordinator employed by the mining company?

- Will there by an independent environmental monitor paid for by the company?
- What are the regulatory requirements for monitoring at the mine?
- What are the plans for monitoring air and water quality; impacts to wildlife and fish; roads; stability of structures (dumps, tailings impoundments, etc.)?
- What contaminants will be monitored?
- How often will monitoring results be reported?
- Who does the sampling?
- Who reviews the results? What mine employee(s) and which government agencies review the data?
- Are companies required to report, in writing, any non-compliance with permits?
- Who is notified if there are non-compliance problems?
- What are the reclamation and monitoring requirements in the even of a temporary shutdown?

Notes

[1] Everything in the world is composed of these 100+ elements. Elements cannot be broken down into any other substances, and each element has a unique set of properties. Elements can combine with other elements to create compounds, which are entirely new substances, with new characteristics. For example, chlorine (a gas, chemical symbol Cl) can combine with sodium (a silvery, white solid, chemical symbol Na) to create sodium chloride (NaCl), which is common salt.

[2] For example, the power line corridor for the Kemess mine in north-central BC is 380 km long. Power line construction resulted in the removal of 300,000 cubic metres (10,000 logging truckloads) of timber, and the construction of 1,400 power transmission towers.

[3] This is being done at one of the Inco operations in Sudbury, Ontario.

[4] O'Reilly, K. Nov. 13, 1999. "New mine, old pattern – north ignored." Edmonton Journal.

[5] In BC, placer mine operations must be located 10 metres away from the active stream channel (except where streams have been declassified).

[6] In BC, placer mining operations cannot be situated within a stream. They must be located 10 m away from the stream banks, unless a special authorization is granted.

[7] Sources for section 1.1.5: Marshall, I.B. 1982. Mining, Land Use and the Environment. Volume 1. A Canadian overview. Land Use in Canada Series No.22. (Ottawa: Environment Canada, Lands Directorate); Managing Aggregate, Cornerstone of the Economy, Report of the Aggregate Advisory Panel to the BC Ministry of Energy and Mines. March 27, 2001.

[8] BC Ministry of Energy and Mines statistics. (http://www.em.gov.bc.ca/mining/geolsurv/surficial/aggproj.htm)

[9] Managing Aggregate, Cornerstone of the Economy, Report of the Aggregate Advisory Panel to the BC Ministry of Energy and Mines. March 27, 2001. p. 4.

[10] Seabrook, P. and Wollenberg, J. 1996. Lower Mainland Aggregates Demand Study, Volume 1. Prepared for the BC Ministry of Employment and Investment. p.13.

[11] For example, the Kitimat aluminum smelter owned by Alcan gets its raw product (bauxite) or smelter feed from Australia.

[12] Ripley, E.A., et al. 1978. The Environmental Impacts of Mining in Canada. (Centre for Resources Studies, Queens University). p. 51

[13] Ripley, E.A., et al. 1978. The Environmental Impacts of Mining in Canada. (Centre for Resources Studies, Queens University). p. 52.

Chapter 5
Mining and Water

5. Mining and Water

Water has been referred to as mining's most common casualty.

Water has been referred to as *mining's most common casualty*,[1] and with good reason. Mining takes its toll on water resources during all stages of development. From exploration through to closure, water can be consumed, diverted and polluted, and the resulting impacts can be severe and have long-term effects on organisms that live in water (*aquatic* life), and organisms that live on land (*terrestrial* wildlife), including human populations.

Table 4. Rough estimates of frequency of various impacts related to mining[2]

Type of Impact	Frequency of Impact
Surface water contamination	70 percent of cases
Groundwater contamination	65 percent
Soil contamination	50 percent
Human health impacts	35 percent
Flora and fauna damage	25 percent

Large quantities of water are consumed during most stages of mineral production. In regions where supplies are limited, or in seasons when water levels are low (e.g., summer/winter), water may have to be imported from sources outside the mining area to meet mineral production needs. If the water is drawn from streams or lakes, the habitat of aquatic organisms could be negatively affected. For example, a drop in water level in the summer will lead to higher water temperatures and lower flows, which in turn may create conditions that are inhospitable to some organisms.

Also, mining activities can waste huge amounts of water,[3] making it unavailable for other uses. This can present problems in regions where mining competes with agriculture and municipalities for limited water supplies.

Although a mine's consumption of water can have a significant impact on water resources, by far, a mine's greatest threat to water comes from its potential to contaminate surface and subsurface (*groundwater*) water. Thus, mining contaminants and their potential impacts on the environment will be the primary focus of this section.

Water Pollution

The release of contaminated water to surface and groundwater is the most frequent source of mine-related pollution.[4] Transported by water, mining's pollutants can spread hundreds of kilometres from the source of contamination.

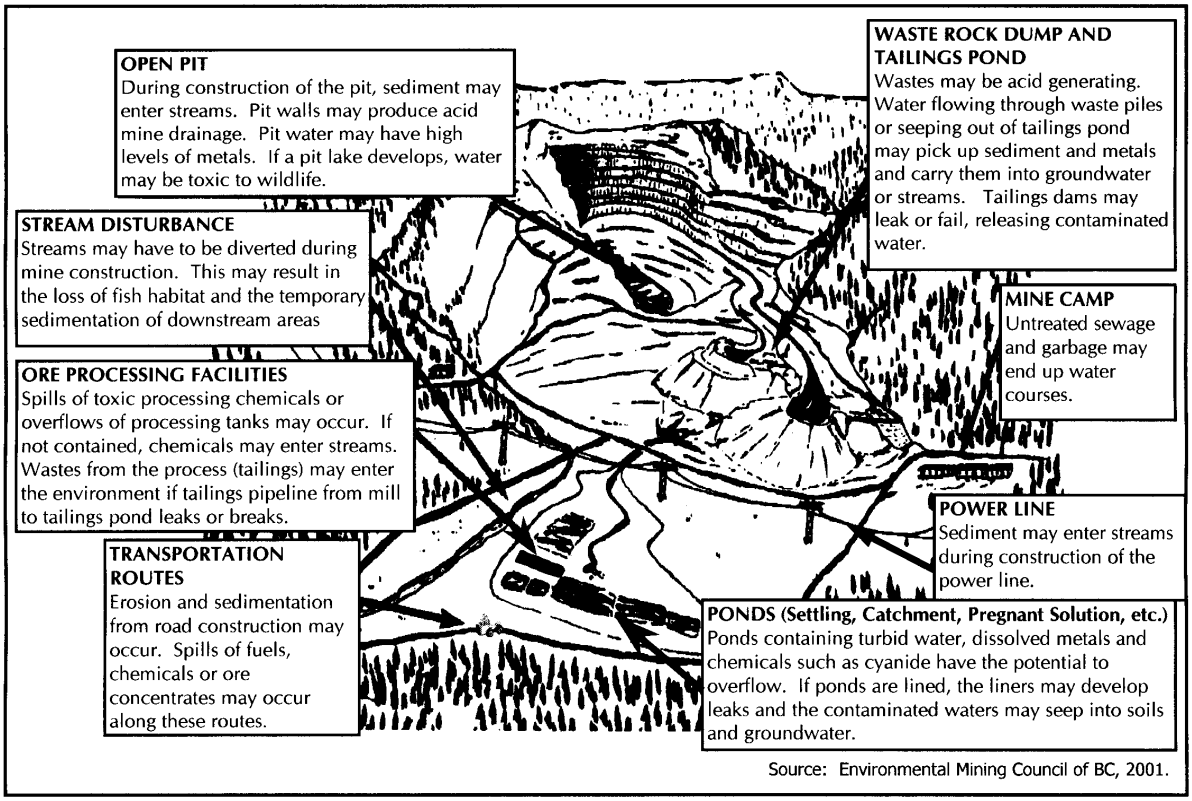
The following sections provide an introduction to the types of substances that can potentially contaminate water both on and off of a mine site; what the potential impacts are; and how water contamination might occur. Finally, some ideas on prevention and mitigation of water contamination will be presented.

a. Major Sources of Contamination

There are many opportunities for accidents to occur, such as spills, overflows and leaks.

- According to records kept by the Ministry of Environment, Lands and Parks (MELP),[5] between January 1, 1998 and August, 2000, there were more than 30 spills related to mine sites in the northwest part of the province (Skeena Region) alone. These spills included diesel, hydraulic oil, tailings, process chemicals, and ore concentrate. More than half of the spills were the result of equipment failure, and about a quarter of the spills resulted from human error.[6]

Figure 3. Points in mining process where contamination is likely to occur



Source: Environmental Mining Council of BC, 2001.

i. Fuels

Fuel spills and leaks are a problem from exploration through to mine closure. The equipment and heavy machinery required in modern-day mining requires huge amounts of fuel. These fuels must be transported to the site, transferred to fuel storage facilities, and pumped into vehicles and tanks. Accidents, unfortunately, sometimes occur due to human error and equipment failure (see Table 5).

Furthermore, proper care is not always taken in the disposal of fuel containers, such as barrels and drums. The Canadian landscape is littered with caches of drums left behind by miners in search of minerals. It is much easier to leave the empty drums behind than to properly bury them or haul them back to be reused or recycled.

- During the exploration rush to find nickel that occurred in Labrador, there were thousands of fuel drums and

propane cylinders abandoned across Labrador's countryside. An environmental monitor for the Labrador Inuit Association reported five confirmed fuel spills from barrels leaking into the ground and helicopters dropping drums into the sea.[8]

Table 5. Examples of diesel spills occurring on mines sites in Skeena Region.[7]

Date	Quantity (litres)	Mine	Cause of spill
18-Jun-97	13,500	Golden Bear	human error – unattended fuel tank overflowed
27-Jan-98	75	Golden Bear	equipment failure – leaky fuel truck
14-Sep-98	95-190	Golden Bear	human error – loader knocked over a 500-gallon tank, which was thought to be empty
22-Oct-98	1,000	Snip	equipment failure – fitting line came off while diesel was being pumped to pump house
20-Feb-99	115	Snip	equipment failure – hose leaked during transfer of fuel from plane to portable tanks
18-Oct-99	200	Huckleberry	human error – service truck filled at filling station and overflow occurred
26-Oct-99	1,600	Golden Bear	human error – unattended fuel tank overflowed
14-Mar-00	55-110	Eskay Creek	human error – tank overflowed in powerhouse

Impacts related to fuel spills:[9]

- Oil kills birds in many ways. If the oil gets on their bodies, the birds may die from loss of insulation. They may also be directly poisoned if they ingest the oil, and the toxic effects can be passed on to their offspring. Even worse, oil on water can actually attract birds.

- Fish are especially sensitive to oil in water during early life stages. Eggs may not hatch and young fish may die. Adult fish, being more mobile, are often able to avoid areas of heavy contamination. Oil, however, dissolves and disperses when it enters a watercourse, and because of this, it may be difficult to avoid. Consequently, low concentrations of oil or other fuels may be taken up through fish gills or may be eaten, and could

accumulate in fish livers, gall bladders and stomachs. This may result in tainting of the flesh, making the fish unacceptable for consumption. Depending on the amount of oil or fuel that enters the water body, fish, because they can break down small quantities of oil and other fuels, may be able to clean themselves of the contaminants completely within weeks of exposure.

Photo 1. Barrels at an abandoned exploration site.

ii. Process Chemicals

Chemicals used in ore processing must be transported to the site. The most common way is to truck them in by road. Consequently, the opportunity for accidents during transportation is a concern, especially in mountainous or remote regions.

- The Kumtor gold mine in Kyrgistan, which is 30%-owned by Saskatoon-based Cameco, has had three accidents in the past few years. In one truck accident, which occurred in May 1998, two tonnes of deadly sodium cyanide were dumped into the local river system. Hospital officials in Kyrgyzstan attributed four deaths to cyanide poisoning as a result of the spill.

- In 1981, there was a sulphur dioxide spill at Equity Silver Mine in northern BC. The chemical found its way into Buck Creek, and as a result residents living nearby were warned to stop drinking the water from the creek.[10]

Upon safe delivery to the mineral processing facility (the *mill*), the chemicals are pumped into a series of tanks (a *circuit*). Ground-up ore travels through the circuit, and desired minerals are extracted from the ore. Contamination can occur within the mill building if pumps break down or tanks overflow. Usually, these spills are contained within the building, and the spilled materials, which contain the valuable minerals and reagents, are pumped back into the process circuit.

- In 1998 and 1999 there were four spills in the mill at the Huckleberry mine:[11]

    1. January, 1998: 6,000 litres of mill process water were spilled due to a plugged drain. The spill was contained within the mill.

    2. June, 1998: 15,000 litres of process water spilled when a plugged line caused thickener to overflow. The spill was contained in parking lot.

    3. April, 1999: 1,000 litres of thickener water spilled when the thickener tank overflowed. The spill was contained in the immediate area; no watercourses were affected.

    4. October, 1999: 5,000 litres of process water were spilled when a power outage resulted in water accumulating in the mill basement. The process water spilled over into parking lot. Some of the water then went into a ditch that eventually flowed to a settling pond. Contaminated soil in the parking lot had to be disposed of and the site reclaimed.

Some companies capture and re-use a large portion of the reagents. Furthermore, often the water used in the processing of ores is treated to remove many of the harmful substances before being pumped in the tailings slurry to an impoundment.

Photo 2. Tailings in their slurry form, being discharged to the Endako Mine tailings impoundment

iii. Chemicals used in mineral processing

Table 6 lists some of the chemicals used in greatest volume in the metal mining processes for several of the main metals (gold, copper, silver, zinc).

iv. Leaky Structures and Impoundments

Many waste materials must be contained either temporarily or permanently.

On mine sites, many waste materials must be contained either temporarily or permanently. An example of temporary storage is water that is impounded to allow sediment or other substances to settle out before the water can be discharged to the environment. Similarly, temporary ponds are constructed for cyanide heap leach operations. Both the pregnant solution and the recycled cyanide are held in outdoor ponds for the duration of the mine's life.

Permanent storage facilities are often required for tailings, as mentioned in the section on ore processing in chapter 4. These impoundments may involve the construction of earthen/rock dams or berms; and tailings themselves are sometimes used as dam construction materials. Tailings impoundments may range from small ponds, accepting a few tonnes of wastes per day, to

Table 6. Toxicity of selected chemicals used in high volumes at mine sites[12]

Reagent	Lethal or Harmful Concentration (ppm)	Organism
Ammonia	5000 – 10,000	Exposure for more than 30 minutes considered fatal for humans.
Calcium oxide	--	No data on acute inhalation toxicity are available.
Chlorine	40 to 60	May cause serious damage (cases where it has been lethal) within 30 to 90 minutes
Hydrochloric acid (i.e., hydrogen chloride)	75 – 150 mg/m^3 (50 – 100 ppm) 15 – 75 mg/m^3 (10 – 50 ppm) 15 mg/m^3 (10 ppm)	Work is impossible. Work is difficult but possible. Work is undisturbed.
Copper sulphate	0.14	Lethal to trout
Potassium permanganate	5.2	Lethal to trout exposed for 24 hours.
Sodium cyanide	0.05 0.08	Trout, 100% mortality when exposed for 24 hours. Minnows, 100% mortality when exposed for 24 hours.
Sodium sulphide	1.8	Lethal for salmonid fish (e.g., trout, salmon)
Sulphur dioxide	50 to 100 1000 ppm for 10 minutes; or 3000 ppm for 5 minutes	The maximum concentration for exposures of 0.5 to 1 hour. Fatal to humans.
Sulphuric acid	--	Lack of relevant acute toxicity data for workers exposed to concentrations above 5 mg/m^3.

large tailings dams, which enclose several square kilometres and receive tailings at rates exceeding thousands of tonnes per day.[13] In other cases, tailings are stored in previously excavated mine pits or deposited in underground workings.

Photo 3. Tailings impoundment at the Sullivan Mine, BC

Tailings water, cyanide solutions and other impounded wastewater can migrate from a mining site into nearby water sources if:[14]

1. pipelines delivering tailings or cyanide solutions to the impoundments break or leak;
2. heavy rainfall or snowmelt cause ditches, impoundment reservoirs or heap leach ponds to overflow;
3. unlined, or poorly designed/constructed impoundment areas allow seepage to groundwater; or
4. human errors lead to spills or other discharges.

- In 1992, more than 11,000 litres of tailings sludge containing arsenic, cyanide, copper, lead and other chemicals were accidentally discharged by Royal Oak Mines in the Northwest Territories. A tailings pipe overflowed, and tailings escaped from the mill building. The contaminated slurry eventually overflowed a drainage ditch and migrated into Baker Creek and then Great Slave Lake, which is used by local aborig-

inal and non-aboriginal people for swimming and fishing. The company was fined $5000.[15]

- In February, 2000, there was a break in a cyanide saturated tailings dam in Romania. Close to 100 million litres of water laced with cyanide and heavy metals spilled from the containment reservoir operated by the Aurul gold mine near Baia Mare, and entered a nearby creek spreading into the Tisza and Danube rivers. The spill was described by Hungarian officials as the worst environmental disaster to afflict the region since the leak from Ukraine's Chernobyl nuclear power station in 1986. Fish, wildlife, micro-organisms and plants were killed the length of one of Central Europe's most important river systems. Hungary alone pulled 85 tonnes of dead fish from the Tisza.

v. Waste Rock and Mine Workings

Waste rock

Although a less obvious source compared to toxic processing chemicals, the actual rocks and soil that are removed to reach the target ore body can pose a great threat to water resources. Environmental damage may occur when surface waters, rain or water from melted snow flows over and through waste rock and earthen piles created during the mining process. Water can pick up soil and rock particles. If a large amount of soil is washed into a stream, it can negatively impact resident organisms (see section on sedimentation, pages 142-145). Waters coming in contact with waste rock can also react to form acids and dissolve heavy metals (this is known as acid mine drainage, and will be discussed on pages 119-128). These substances can then be carried into rivers, streams and groundwater, where the pollutants may cause serious environmental problems.

- For decades, the waste rock dumps at the Bingham Canyon Mine in Utah have been leaching heavy metals and sulphates into the groundwater. The contaminants move in a fan-shape *plume*, away from the mine, covering an area 180 km^2. The contaminated plume threatens

the water supply of a Salt Lake City suburb of 70,000 residents. The company has already been forced to provide alternative water sources to some of the residents.[16]

Mine workings

As with waste rock, the open pits and underground areas from which the ore is extracted (*mine workings*) have the potential to create long-term water quality problems. The pit and underground walls contain exposed metals, which can leach out over time. The exposed areas may also contain acid-generating rock.

Mine workings have the potential to create long-term water quality problems.

Many mines burrow so deep into the ground that they are below the water table (the level below which the earth is continually saturated with water). Shallower mines may not reach the water table, but may hit layers of groundwater[17] (*aquifers*).

While mining is occurring, working areas in pits and underground workings must be kept dry, so any groundwater or surface runoff entering the working areas must be pumped out and discharged at the surface (a process known as *dewatering*). The pumped waters are sometimes piped to tailings storage areas, or they may be sent to infiltration ponds, which allow the water to be reabsorbed into the ground. The pumped water frequently contains significant quantities of dissolved metals, which can be toxic to various organisms, and thus, may require treatment prior to discharge or recycling.

If there are cracks (*fractures*) in the pit walls and underground workings, which is highly possible due to the effects of blasting as well as natural fracturing, contaminated waters may be able to flow through the fractures and enter groundwater systems.

- It was initially thought that the contaminated waters flowing from Mt. Washington mine site on Vancouver Island could be contained by covering and adding lime to the acid-generating waste rock pile. But the solution, unfortunately, is not that simple. The open-pit walls are also acid-generating, and fractured,[18] which means that as groundwater flows into the pit

it reacts with the sulphide-bearing rocks and oxygen to produce sulphuric acid. The fractures in the bedrock also allow contaminated water to flow out of the pit, into the shallow groundwater. This acidic, metal-bearing groundwater eventually resurfaces,[19] thus becoming a threat to surface water quality.

If pit walls are not fractured, and walls are composed of rocks that do not allow much water to flow through, open pits may fill with water and become *pit lakes* at the end of the mine life, when dewatering ceases. The concentration of metals and other contaminants in the pit lake may become a long-term water quality issue, especially for migratory birds and terrestrial wildlife. For example, waters of the Berkeley pit in Butte, Montana, killed a number of migrating snow geese that used the lake as a stopover in 1995.[20]

Photo 4. Berkeley Pit, Montana

b. Specific Pollutants and Their Impacts

The following section describes some specific pollutants and potential impacts that might occur if these substances enter water systems. It should be noted that while there is reasonable understanding of the short-term health impacts of large doses of certain chemicals on specific organisms, virtually nothing is known about the long-term effects of low levels of most chemicals. Also, we have little understanding of the potential effects

when a number of substances are combined and chemically interact with each other.

i. Acid Mine Drainage

Creation of acidic water is one of the most serious problems related to mining.

The creation of acidic water is one of the most serious problems related to mining activities. Acidic waters can kill many organisms. More importantly, however, acidic waters can enhance the weathering of rocks, and dissolve and mobilize (*leach*) metals contained in those rocks. The metals can often pose more of a threat to life-forms than the acid itself (metals leaching is discussed below).

Acid is generated when some rocks that contain sulphur (chemical symbol S), referred to as sulphides, are exposed to oxygen and water. The main culprit is usually iron pyrite (chemical symbol FeS_2), which is also known as "fools gold." Examples of other metal sulphides that contribute to acid generation include lead sulphide (galena), zinc sulphide (sphalerite), and iron copper sulphide (chalcopyrite).

When sulphur, oxygen and water come in contact with each other, a series of chemical reactions takes place. The net result is the creation of acid, among other products.

For example, pyrite reacts with oxygen and water to form iron (Fe), sulphate (SO_4^{2-}) and acid (H^+).

$$4FeS_{2(s)} + 14O_{2(g)} + 4H_2O_{(l)} \text{ ---> } 4Fe^{2+}_{(aq)} + 8SO_4^{2-}{}_{(aq)} + 8H^+_{(aq)}$$

The above reaction is a naturally occurring process known as *acid rock drainage* (ARD).

Mining, however, can increase acid generation well beyond what would naturally occur. During mining, ore is dug up, broken down, and crushed. This exposes sulphide minerals, which would otherwise be sealed beneath the ground, to the air and water needed to set off and sustain the reaction. Acidic drainage occurring at mine sites is known as *acid mine drainage* or AMD for short.

Box 1. Acids and Bases[21]

We encounter acids and bases every day. Common acids include battery acid, lemon juice and vinegar. Common bases include household detergents and chemical plumbing drain cleaners.

Acids are chemical compounds that can react with metals and other substances to "eat them away" or damage them. Sulfuric acid is a strong acid that will eat a hole in a piece of iron, as well as eat through your clothes and skin. It is contained in car batteries, and is used in processing some ores. Acids also have a sour taste – in fruit, there is something called citric acid, which is a weak acid.

Bases are chemical compounds that have a caustic (cutting) action on plant and animal tissue. One example of a base is lye, which is the grease-cutting material used in early forms of soap. Bases feel slippery to the skin, as can be experienced with soap. They tend to have a bitter taste. A base may also be referred to as *alkali* or *alkaline*.

Almost every liquid that we encounter is either an acid or a base – except for distilled water. Pure, distilled water is neither acidic nor basic; it is *neutral*.

Pure water consists only of water molecules, which are two hydrogen (H) atoms and one atom of oxygen (O) bonded together. Under certain conditions, the bonds in a water molecule can break, producing a positively charged hydrogen ion (H^+) and a negatively charged hydroxide ion (OH^-), which is a combination of hydrogen and oxygen.

It is the presence of the hydrogen and hydroxide ions that make something acidic or basic. Other compounds will break apart into ions when mixed with water. If they release H^+ or OH^- when the bonds are broken, then they will contribute acidity or alkalinity to the solution.

Acids are compounds that break into H^+ and another compound when placed in an aqueous (mainly water) solution.

Bases are compounds that break up into OH^- and another compound when placed in an aqueous solution.

How Acidity is Measured – The pH Scale

pH is a way to express the acidity or alkalinity of a water solution. The pH scale goes from 0 to 14. Distilled water is 7, right in the middle. Acids are found between 0 and 7. Bases are from 7 to 14. Most of the liquids you find every day have a pH near 7, either a little below, or a little above. Any solutions at the

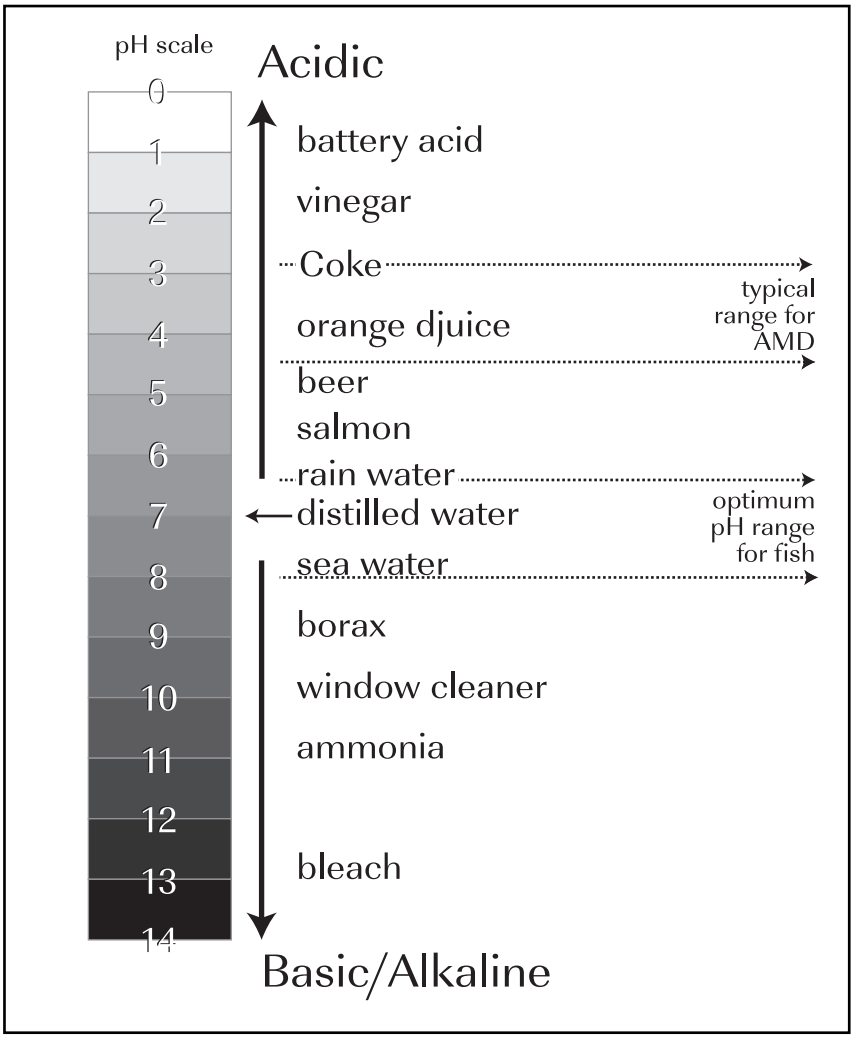
extremes of the pH scale, e.g., pH close to 1 or 14, are hazardous to our health and safety.

The pH scale is actually a measure of the number of H^+ ions in a solution.

Acids are solutions that have an excess of H^+ ions. If there are a lot of H+ ions, the pH is very low.

Bases are solutions that have an excess of OH^- ions. If there are a lot of OH- ions, that means the number of H^+ ions is very low, so the pH is high.

The pH scale is logarithmic, which means that a change of one pH unit is equal to a 10-fold change in acidity. For example, battery acid (pH 1) is ten times more acidic than vinegar (pH 2), a hundred times more acidic than Coca Cola™ (pH of 3), and a million times more acidic than pure water (pH 7).



The mere presence of sulphur-bearing or sulphide minerals does not always result in serious impacts to the environment. The natural environment (soils, water, vegetation) can reduce some of the acidity created by AMD. There are certain rocks that chemically react with acidic waters and decrease the acidity (i.e., the acid is *neutralized*). These neutralizing rocks types are said to be *alkaline*. The most common neutralizing rocks are the carbonate (CO_3) minerals (e.g., calcium carbonate, which is also known as calcite; and limestone, which is composed of more than 50% calcite).

The potential for sulfide rock to generate acid is strongly related to the abundance of alkaline material in the rock. For example, rock containing 5 % sulfide minerals may not generate acid due if there is an abundance of calcite in the rock that is available for acid neutralization. Another rock sample containing less than 2 % sulfide minerals might generate a considerable amount of acid if no neutralizing minerals are available.[22]

Often, however, AMD overwhelms nature's defenses. If the surrounding rocks and soil are unable to neutralize the acid generation, there is a high potential for significant environmental impacts.

Table 7. Some common minerals and expected acid or alkaline impact on drainages[23]

Mineral	**Reactions and projected water quality impacts**
Quartz	Non-reactive
Feldspars	Mildly reactive; some alkalinity
Clays, micas	May serve as neutralizing agent
Calcareous material (calcium, magnesium carbonate), e.g., calicite, limestone, dolomite, marble	Soluble in water; produces alkalinity that can neutralize AMD.
Siderite (iron carbonate)	Produces alkalinity initially, but turns acidic with iron oxidation
Sulphide-bearing metallic ores (e.g., pyrite, pyrrohotite, chalcopyrite, sphalerite, marcasite, arsenopyrite)	Produce acidic, metal-rich drainage that is high in sulphate

1. What does AMD look like?

As acidic waters flow away from a mine site, they become diluted with fresh water, and the acidity of the water is reduced. Also, acidic drainage may encounter carbonate minerals that neutralize the acid. In either situation, metals that were dissolved in the AMD form solid metal compounds that drop out of the water (*precipitates*).

For example, dissolved iron (chemical symbol Fe) will react with fresh water (chemical symbol H_2O) and will precipitate out of solution as iron hydroxide (chemical symbol $Fe(OH)_3$).

$$Fe^{3+}_{(aq)} + 3\ H_2O_{(l)} \text{ ---> } Fe(OH)_{3(s)} + 3H^+_{(aq)}$$

The precipitate, $Fe(OH)_3$, formed in the above reaction is often referred to as *yellow boy*. It is an unsightly, slimy, yellow or orange colored solid. Other metals produce different coloured precipitates. These substances can coat the bottoms and banks of rivers and streams, discolour the water, and extend several kilometres downstream from a mine site, creating a negative impact on many living organisms in the stream.

2. Onset, acceleration and longevity of AMD

Onset: It may be years before AMD starts to occur. The lag time for the onset of AMD may vary from one year to more than a decade.[24]

- The Samatosum mine near Kamloops, BC, is a good example of delayed onset. The mine operated from 1989 to 1992. It was supposedly designed and constructed to prevent AMD, and according to the best predictions the mine should not have produced AMD. But in 1996, four years after the mine had shut down, the waste rock dump began to generate acid. And the AMD problem at Samatosum is getting worse. Since 1996, the metals in the seepage have increased, and the waters have become more acidic, indicating that the AMD process is accelerating.[25]

Photo 5. AMD at the Equity Silver Mine, and precipitates from AMD at the Baker Mine

Acceleration: The acceleration of acid generation at the Samatosum mine is not unique. Once AMD begins, it tends to get worse. The oxidation of the most reactive sulphide minerals, such as pyrite, can, in turn, induce the oxidation of less reactive minerals. As the chemical reactions proceed, temperature and acidity increase, which further intensifies the rate of the reactions. Also, there are certain bacteria, e.g., *Thiobacillus ferro-oxidans*, that thrive in these hot, acidic environments, and help to accelerate the reactions. In other words, once the acid generation process has started it almost impossible to stop.

AMD is a long term problem

Longevity: AMD is a long term problem. As long as the sulphide materials contained in waste rock piles, underground mines and tailings piles are exposed to air and water, they will continue to generate sulphuric acid. AMD can continue at a mine site for decades or even centuries until the sulphide material is completely leached out. There are ore bodies in Sweden that were mined in the 1700s that are still acid-generating. One AMD expert is not aware of any identified acid-generating mine that has stopped generating acid mine drainage on its own.[26]

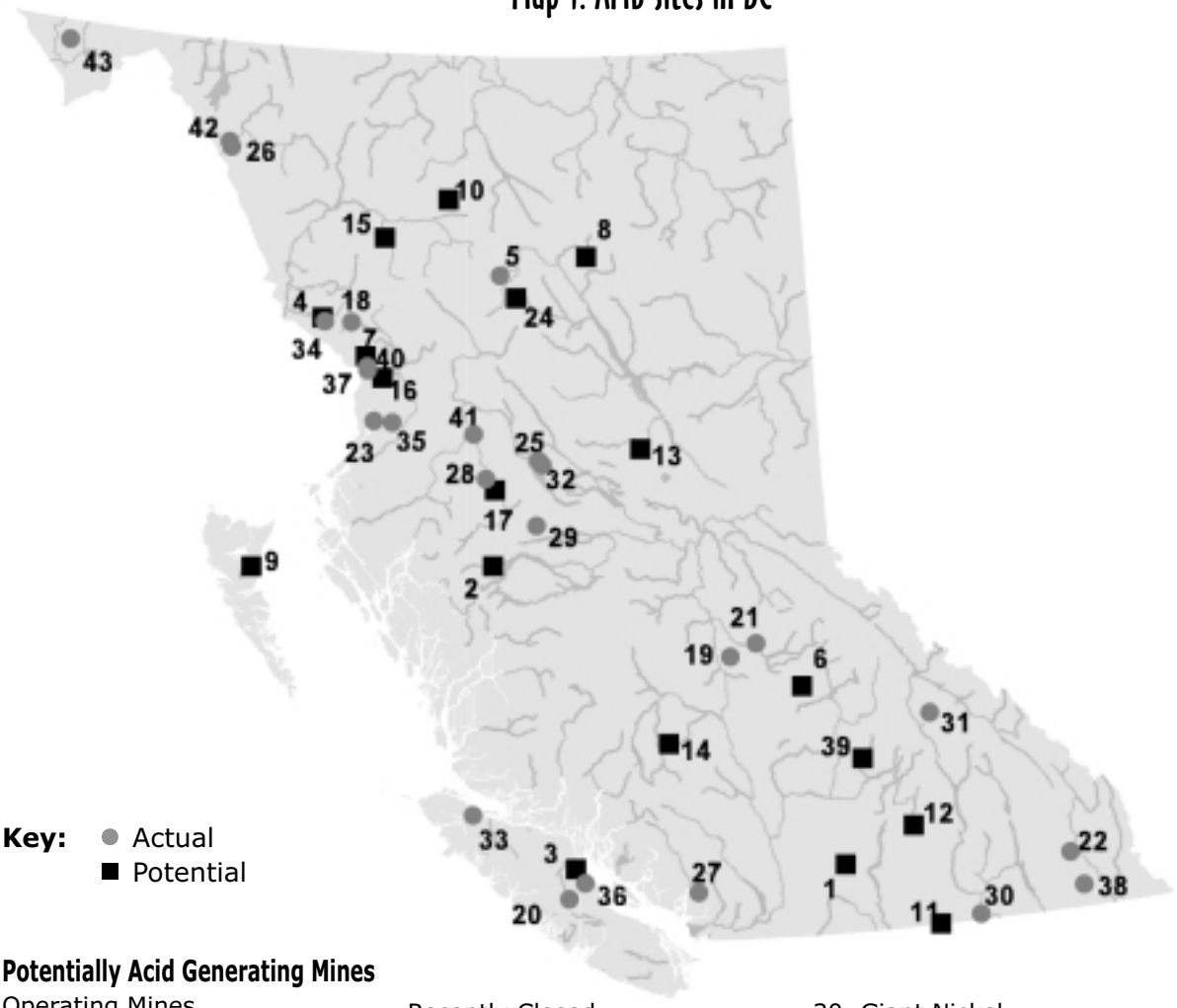
3. Extent of the AMD problem

It is possible that your community will be confronted with the problem of acid mine drainage because most of the base metals, precious metals (e.g., gold, silver, platinum), and uranium found in Canada occur in association with sulphur.[27]

In 1994, there were approximately 1.8 billion tonnes of acid generating tailings and 700 million tonnes of acid-generating waste rock in Canada, and the cost of cleaning up all of the AMD sites was estimated to be $5.25 billion.[28]

In BC, there are 25 known AMD sites, and 18 mine sites where there is the potential for AMD.

Map 1. AMD sites in BC



Key: ● Actual ■ Potential

Potentially Acid Generating Mines

Operating Mines

1 Elk
2 Huckleberry
3 Quinsam
4 Snip
5 South Kemess

Proposed Mines

8 Cirque
9 Harmony Gold (Cinola)
10 Kutcho Creek
11 Lexington
12 Lumby Muscovite
13 Mount Milligan
14 Prosperity (Fish Lake)
15 Red Chris
16 Red Mountain
17 Telkwa Caol
42 Tulsequah Chief (Redfern)

Recently Closed

6 Boss
7 Scottie Gold

Known Acid Generating Mines

18 Eskay Creek
19 Gibraltar
20 Myra Falls
21 QR Gold
22 Sullivan

Closed/Abandoned

23 Anyox
24 Baker
25 Bell
26 Big Bull
27 Britannia
28 Duthie
29 Equity
30 Giant Nickel
31 Goldstream
32 Granisle
33 Island Copper
34 Johnny Mountain
35 Kitsauilt
36 Mount Washington
37 Premier
38 Saint Eugene
39 Samatosum
40 Silver Butte
41 Silver Standard
42 Tulsequah Chief (Cominco)

Exploration Site

43 Windy Craggy

Sources: MEI Acid Rock Drainage Policy, June 1997; Draft Guideline for Metal Leching and ARD at Mine Sites in BC, BC Ministry of Employment and Investment, Reclamation Section; BC Minfile, BC Ministry of Employment and Investment, Geological Survey Branch

The cost of cleaning up these sites can be enormous. Below are two examples of AMD sites in BC that have yet to be cleaned up.

Mt. Washington in BC: To date, this acid mine drainage site has cost provincial and federal taxpayers and the local community an estimated $60 million (the federal government has spent millions of dollars in studies at this site, and a $2 million/year local salmon and cutthroat trout fishery has been destroyed).[29] The annual cost of perpetual treatment of AMD at this site is likely to be more than $6 million.[30]

Britannia Mine in BC: The former Britannia mine, which ceased operating in 1976, is one of the worst sources AMD and metal pollution in North America today. During the spring runoff, more than a tonne of copper, zinc and other metals flow into Howe Sound in a single day. Costs to treat the acidic, metal-laden waters and clean up the site have been estimated at $60 million to $75 million. Recently, a plan was developed, which involves past owners contributing millions of dollars to the clean-up of the Britannia site.[31] If all goes well, clean-up will begin in 2002.

Impacts related to AMD

AMD is a problem for two reasons. First, the acidity itself causes conditions that are toxic to organisms. In many acid mine drainage streams, the pH (see box 1 for definition of pH) is so low that the streams are essentially devoid of life. Second, the metals dissolved under acidic conditions can enter the aquatic environment where they can be toxic to various organisms (the impact from metals will be discussed below).

Acid mine drainage is typically 20 to 300 times more acidic than acid rain,[32] often having a pH as low as 3, which will kill all aquatic life.[33] Fish have an optimal water pH range between 6.5 and 8. Even when concentrations of acid are not strong enough to kill fish and other aquatic animals, they can have a significant impact on stream ecology. Below a pH level of 5, most plants are severely impaired, and cattails, which are the

most acid-tolerant aquatic plants, tend to predominate. Bottom dwelling algae are similarly affected. At a pH of 5, species diversity decreases. And because fish and wildlife feed on the plants and algae, they are directly impacted when their food sources disappear.[34]

Box 2. Toxicity

Toxicity is essentially the ability of a substance to cause a harmful effect. There are two main types of effects:

Acute effects are the adverse reactions felt following a single exposure to a substance.

Chronic effects are felt when organisms are exposed to low levels of toxic substances over a long time period. The exposure can be on a continuous or intermittent basis.

Acute and chronic effects can be lethal (cause death) or sub-lethal (do not kill, but impair the health of an organism, e.g., result in injuries, tumours, reproductive problems, birth defects, etc.).

ACUTE TOXICITY TESTING

The acute toxicity of a substance on aquatic organisms is commonly determined using the LC50 test, so named because it determines the concentration of a substance in water that will kill 50% of the organisms placed in the solution within a period of 96 hours (Lethal Concentration for 50"). Usually, the toxicity of undiluted mine-water is tested - if more than 50% of the organisms die within 96 hours, it is a failed LC50 (i.e., the effluent is considered acutely toxic). If less than 50% of the organism die, the LC50 is a pass. That means that if there are 100 fish put into a tank with mine effluent and 51 live and 49 die, the effluent is not considered to be acutely toxic.

ii. Metals

Leaching of metals into the aquatic environment is one of the most significant environmental concerns related to mining,[35] and is perhaps the most deadly form of water contamination.[36]

Metals are present in ore bodies, mine tailings, waste rock, dusts and airborne emissions from smelting and refining. Pure water (pH of 7) can dissolve some metals from rocks. But when acidic water comes in contact with

ores, waste rock materials or tailings, it has a far greater ability to dissolve portions of rock and leach out metals. This can be an extremely destructive process. If the polluted waters are not adequately contained, the metals can be carried by water and escape into the natural environment during snowmelt and periods of high rainfall. Similarly, metals emitted by smelters can be deposited in streams and lakes.

Metals can also enter watercourses as a result of spills of the concentrate, during transportation from the mine site.

- Between June 1998 and April 2000, there were nine spills of copper concentrate on the Omineca Access Road, which services the Kemess Mine.[37] In one incident, six bags of concentrate spilled into a tributary of Moosevale Creek, which is a major tributary of the Sustut River.[38] The mine's own testing revealed that copper levels in the creek rose to more than 33 times the allowable level for aquatic environments following the spill. Moosevale Creek has populations of steelhead, salmon, bull trout and rainbow trout. According to the Ministry of Environment, Lands and Parks, the spill was the result of a near-calamity on December 30, 1999, when a fuel truck and ore truck almost collided. A collision was avoided, but in the process the ore truck slid off the road. The site was cleaned up and the creek dredged out, and subsequent monitoring was undertaken.

Metals can pose a long-term water quality problem.

Unlike carbon-containing (*organic*) chemicals, which can break down over time, metals never break down. Their inability to degrade over time is why metals can pose a long-term water quality problem. Metals that find their way into streams or lakes will gradually precipitate out (settle to the bottom) and accumulate in sediments. Metals that have settled on stream bottoms can be remobilized by a change in water chemistry (e.g., change in pH) or by an increase in stream flow. Over time, metals can migrate hundreds of miles away from their original source. The long-distance effects may not be lethal, but organisms or the offspring of organisms exposed to

these metals may be deformed, show impaired behaviour, or reproduce less successfully.

- Butte, Montana, was the largest copper producer in the United States from the 1880s to the 1940s. It produced about 430 million tonnes of copper ore. Prior to the installation of a tailings pond in 1950s, about 100 million tonnes of tailings and smelter wastes were dumped into tributaries of the Clark Fork River. Stream sediment near Butte contains at least 100 times more copper than average background values for that part of the world. Anomalously high values of copper are found as far away as Lake Pend Oreille, 550 km downstream. Metals from the sediments are now finding their way into aquatic plants and animals. Each rainstorm or increase in the flow of the stream stirs up the sediment, making new metals available to the system. There is enough metal in the streams for this process to continue for hundreds of years. The only real solution to the problem may be the complete removal of the contaminated sediment.[39]

- The US government has found elevated levels of mercury in bass and catfish in the Bear and South Yuba River watersheds of the Sierra Nevada Mountains in northern California. The mercury is a byproduct of the Gold Rush that occurred in the region nearly 150 years ago.[40]

Impacts related to Metals

Mineral tailings and abandoned mines are huge reservoirs of toxic heavy metals. In many places in North America there have been massive fish kills and the removal of aquatic life from miles of pristine stream directly downstream from problem mines.

- The abandoned Mt. Washington copper mine on Vancouver Island operated for only a few years, and yet the impacts of the operation will be felt for decades or even centuries to come. Mining exposed acid generating waste rock dumps and fractured pit walls to air and water, creating a long-term acid generation problem. The acidic waters flowing from the site leach

out copper, which is the "dreaded enemy" of young salmonids (coho, pink and chum salmon fry, and cut-throat and steelhead fry). The site releases enough copper into the environment to eliminate salmon and steelhead runs in the Tsolum River some 10 km away. It has been estimated that a $2 million/year salmon and steelhead fishery in the Tsolum has been wiped out largely from the activities of this one small mine.[41]

For many metals, it takes only small amounts to kill all of the fish in a stream, or poison a community's water supply.

For example, the government of BC has set a guideline that says that drinking water should contain no more than 500 micrograms (µg) of copper per litre (L) of water. It takes the equivalent of only one teaspoon of copper spread among the 385 water-filled bathtubs to exceed that guideline.[42]

The following table outlines the maximum quantities of certain metals per litre of water that the province of BC has set to protect human and aquatic health.[43]

Table 8. BC Water Quality Criteria for selected metals

	Maximum allowable concentrations for drinking water (µg*/L)	**Maximum allowable concentrations to protect freshwater aquatic life (µg/L)**
Copper	500	2 to 26**
Lead	50	3 to 330 **
Mercury	1.0	0.1
Molybdenum	0.25	2.0
Zinc	5000	33 to 265**

* there are one million micrograms in one gram

** higher concentrations are allowed as $CaCO_3$ in water increases

- If the AMD was left untreated at the Equity Silver Mine in northern BC, people would no longer be able to drink the water. Copper levels in Buck Creek (the drinking water source for area residents) would be 750 times higher than the recommended level, and arsenic 20 times the recommended limit for drinking water.[44]

Depending on the concentration and length of exposure time, metals will affect organisms in different ways. For example, at high enough concentrations and short exposure times (24-96 hours), a metal may damage an organism's respiratory system, resulting in death.

At low concentrations over long periods of time, metals contamination may lead to severe health problems that may not manifest themselves for years, and death may be caused by accumulation of metals in internal organs. The effects caused by sublethal concentrations include changes in: growth, development, swimming performance, respiration, circulation, behaviour and reproduction. [45]

Suppression of growth and reproduction occurs widely among aquatic organisms exposed to relatively low metal concentrations. Freshwater plants tend to be more resistant than fish, although considerable variation in sensitivity exists between different species.[46]

As seen from the Table 9, many metals or metal compounds are known to cause cancer (they are *carcinogens*).

When consumed by living organisms, metals can build up in living tissue (*bioaccumulate*) and be passed through the natural food chain.

- A recent study found that streamside willows were able to tap into metals-contaminated river water, take up cadmium, and store it in their foliage. Ptarmigan who fed on the willow accumulated high levels of cadmium from that food source. These ptarmigan were found to develop brittle bones; lay fewer and more fragile eggs; and raise fewer young and have higher mortality rates than healthy birds.[48]

Table 9. Relative toxicity of various metals and their effects on health[47]

Metal	Some facts about the metal	Effect on health
Antimony	Similar properties to arsenic, but much less toxic.	In humans, long-term inhalation may cause lung disease; skin, eye, throat irritation; dizziness; headache; nausea, vomiting, diarrhea; stomach cramps; insomnia; and inability to properly smell.
Arsenic	Toxic. Often associated with ores containing copper and zinc.	In humans, high doses lead to muscle spasms, nausea, vomiting, abdominal pain, diarrhea, death. Low dose over many years may result in skin, lung, or bladder cancer.
Beryllium	Toxic. Main hazard is inhalation of dust and its salts.	Human symptoms (weight loss, weakness, chest pain, cough, eye irritation) may be delayed from 5-10 years. Potential human carcinogen.
Cadmium	Highly toxic. Often found in ore bodies with silver and zinc.	Known human carcinogen. Has caused spinal-column damage in fish, and reproductive problems in ptarmigan.
Chromium	Metal: no hazards. Chromic acids and salts (e.g., chromate) are toxic.	Human symptoms include dermatitis; irritated eyes. Chromic acid and chromate are potential carcinogens; may cause liver, kidney damage; irritation of respiratory system; skin irritation.
Cobalt	Low toxicity for humans. Toxic to rainbow trout, carp, char and insect larvae.	In humans, may cause respiratory irritation; breathing difficulty; asthma and dermatitis.
Copper	Virtually non-toxic to humans. Toxic to fish, especially young fish. Often found in ore bodies that contain silver and zinc.	Lethal to aquatic life at varying concentrations. Neurological and behavioural (avoidance) effects are commonly associated with copper toxicity. In humans, may cause irritation to eyes and nose; dermatitis; in other animals: lung, liver, kidney damage; anemia.
Iron	Pure iron: non-toxic to humans. Toxic to mayflies, stoneflies and caddisflies.	Iron salts may cause irritation eyes, skin, mucous membrane; abdominal pain, diarrhea, vomiting; possible liver damage in humans.
Lead	Toxic to humans and fish. Found in most ore bodies with copper, silver and zinc.	Affects digestive, blood and nervous system. May lead to spinal deformities; kidney dysfunction and hyperactivity in both aquatic organisms and humans. Possible human carcinogen.
Manganese	Inhalation of excessive dust is toxic.	Affects nervous system. In humans, symptoms include insomnia, mental confusion; dry throat; cough; chest tightness; breathing difficulty; flu-like fever; low-back pain; vomiting; malaise; fatigue; kidney damage.

Levels of lead and arsenic in people living near mining areas have at times been found to be unusually high. Children, because of their lower body mass and potentially higher exposure (e.g., by playing outside and coming in contact with metals in the soil) often accumulate much higher concentrations of metals.

- In the 1970s, elevated levels of arsenic in snow, soil, water and vegetation samples within the city limits confirmed that not only mine workers by also residents of Yellowknife were being exposed to the potentially lethal chemical. The arsenic came from smelter emissions from the Giant Gold Mine. Tests of mine workers and children living in Yellowknife indicated that they had high levels of arsenic in their hair – which is a good indication of metals accumulating in the body. A study conducted in May of 1975 by Health and Welfare Canada showed that many health defects among Yellowknife citizens were commonly associated with arsenic exposure; and Yellowknife also had a higher cancer rate than Canada as a whole.[49]

Very low concentrations of metals may cause fish to avoid certain waters. This is an important issue for fish that migrate from fresh to salt water (*anadramous*), e.g., salmon. The avoidance of streams with low metal concentrations may result in the elimination of that species from the watershed.[50]

As mentioned above, metals will fall out of solution as acid mine drainage flows downstream, creating a slime that can coat streambeds. This coating, which can harden like cement, may affect streambed habitat for fish and aquatic organisms like benthic macroinvertebrates by fusing gravels together. Benthic macroinvertebrates are bottom-dwelling (*benthic*) animals without backbones (*invertebrates*) that are visible with the naked eye (*macro*). When the spaces between gravels are cemented, fish egg survival is threatened by lack of oxygen,[51] and macroinvertebrate habitat is lost.

Benthic macroinvertebrates and other aquatic organisms that dwell at the bottom of streams and lakes often have the highest concentration of these metals, because they

are in frequent contact with the metals that accumulate in sediments.

iii. Cyanide

Cyanide is the second-most serious mine contaminant.

Next to AMD, cyanide is the second-most serious mine contaminant. Cyanide is one of the most rapidly acting poisons known.[52] Some forms of cyanide are extremely toxic to organisms. As a result, contact between surface waters and cyanide must be avoided to protect water used for drinking, irrigation and watering of livestock, and to avoid adverse effects on fish, plants, wildlife and humans.

Cyanide has two main uses in mining.

- Cyanide has a natural attraction to gold, silver and other metals. It is increasingly being used to extract low-grade gold deposits using a heap leaching process (see pages 83-84). As the cyanide trickles through the crushed ore, the cyanide attaches to the tiny particles of gold, and these cyanide-gold units are collected. Later, the gold can be separated from the cyanide. This method is also used to extract silver.
- Cyanide is used in the milling and concentration of copper, lead, zinc, cobalt and molybdenum. It is added at certain stages in the milling process to separate target ore minerals from wastes, such as sulphides.

1. Cyanide Chemistry

The term cyanide refers to numerous compounds, both natural and human-made.[53] These compounds all have one atom of carbon (C) and one atom of nitrogen (N), which combine to form the chemical group CN.

Cyanide combines readily with most major metals to form *compounds* or *complexes* (see Box 1), which makes it useful in the extraction of metals from ores. Cyanide also tends to react with most other chemical elements, producing a wide range of toxic and non-toxic, cyanide-related compounds. Also, because cyanide contains carbon (which makes it an *organic* compound), it reacts

readily with other carbon-based matter, including living organisms.

Pure cyanide does not build up in the food chain like mercury and other metals. Sunlight, neutral pH environments and soil microorganisms cause rapid breakdown of cyanide into non-toxic constituents. But there is evidence that degradation is inhibited when there are insufficient microorganisms present to break it down (e.g., some desert climates), or in groundwater or under ice, where cyanide is not exposed to sunlight.[54]

While much of the cyanide present in mining-related waters breaks down into harmless compounds, significant concentrations of other potentially toxic cyanide breakdown compounds may last longer (*persist*) in the environment. These persistent compounds present the most risk to sensitive freshwater fish species. Examples of cyanide breakdown compounds include many metal-cyanide complexes, organic-cyanide complexes, cyanates, thiocyanates, cyanogen, cyanogen chloride, chloramines, together with ammonia, and nitrate.[55] See Table 10 for comments on some of these breakdown products.

Table 10. Forms of cyanide and cyanide-related compounds in mine waters[56]

Form	Comments
Free cyanide This includes the cyanide ion (CN^-), and hydrogen cyanide (HCN)	The cyanide ion is the predominant stable form of cyanide when pH is 9.0-9.5. As pH drops, more HCN is formed. Below pH 7.0, almost all dissolved cyanide is in the form HCN. All free cyanide forms are highly poisonous to humans and wildlife. Acute toxicity to various fish species ranges from about 20-640 $\mu g/L$,[57] while chronic toxic effects are reported in fish in the range of 5-20 $\mu g/L$. Free cyanide reacts within a few hours or days with almost any other chemical it contacts, producing a wide variety of new compounds (simple cyanide, cyanide complexes and cyanide-related compounds)
Simple cyanide compounds	NaCN is the most common form of simple cyanide at mine sites; it is used to leach gold from ores. Simple cyanide compounds readily dissolve in water, producing free cyanide (CN^-) and sodium (Na)
Metal-cyanide complexes. Weak complexes: e.g, $Zn(CN)_4^{-2}$, $Cd(CN)_3^{-1}$ Strong complexes: e.g, $Fe(CN)_6^{-4}$, $Au(CN)_2^{-1}$	When metal-cyanide complexes are released into the environment, they break down, releasing free cyanide and metals to the environment at various rates. Those that decompose rapidly are known as weak complexes. Those most resistant to decomposition are strong complexes. The stronger the complex, the stronger the acid required to breakdown the complex. Some of the strongest complexes, e.g., iron-cyanide complexes, do not break down even in the presence of strong acids. But they can break down and release free cyanide if exposed to various types of light (visible, ultraviolet).[58] These complexes are usually thought to be less toxic than free cyanide. But little is known about their chronic toxicity.
Organic-cyanide compounds	There is little published material on the toxicity of these compounds.
Cyanide related compounds	
Cyanate (NCO^-)	This is the main form of cyanide resulting from most cyanide decomposition processes used in the milling process at mine sites. Cyanates may last for significant periods of time before breaking down. Cyanate has been reported as toxic to trout at concentrations ranging from 13-82 mg/L.[59]
Thiocyanate (SCN^-)	Free cyanide reacts with forms of sulphur in mining effluents to produce thiocyanates. Thiocyanates are toxic to fish at concentrations ranging from 24-200 mg/L.[60] At low-level (7.3 mg/L), long-term exposures (124 days), reproduction in juvenile fathead minnows was affected.[61]
Ammonia (NH_3) and nitrate (NO_3^-)	The chemical breakdown of many of the above-mentioned cyanide and cyanide-related compounds often creates high concentrations of ammonia and nitrate. Ammonia a routinely encountered breakdown product during cyanide mineral processing. It is considered to be as toxic to fish as cyanide (toxic at concentrations between 0.083 – 4.6 mg/L). Nitrate toxicity is due primarily to its conversion to nitrite, which reacts in the body to create a compound called methemoglobin. Low levels of methemoglobin occur in normal individuals, with typical values usually ranging from 0.5 to 2.0%. Methemoglobin does not bind oxygen, causing a decrease in oxygen transport from lungs to tissues. Thus, concentrations above 10% may cause a bluish color to skin and lips, while values above 25% lead to weakness and a rapid pulse. Death may occur if methemoglobin values exceed 50-60%.[62]

2. Regulation of cyanide

As mentioned above, cyanide is present in mining-related waters in many forms. Most of the forms (e.g., cyanate, thiocyanate, metal-cyanide complexes) have no established water quality criteria, even though they are known to be potentially toxic. Also, regulators do not require monitoring for many of these cyanide-related compounds.[57]

Where mining is concerned, there are only three categories of cyanide that are routinely monitored. These are: 1) free cyanide, 2) cyanides that dissolve in a weak acid (*weak-acid-dissociable* or *WAD*); or 3) cyanides that dissolve in a strong acid (strong-acid-dissociable or SAD). SAD cyanide is often referred to as total cyanide.

1) **Free cyanide:** this method reports the sum of both the cyanide ion and hydrogen cyanide.

2) **WAD:** Reports free cyanide plus cyanide complexes that break down in a hot, mildly acid solution (about pH 4.5). This method fails to detect cyanates; thiocyanates; most cyanogens; cyanogens chloride; chloamines; more organo-chloride compounds; most gold, platinum and cobalt complexes and; most importantly, iron cyanide complexes.

3) **Total cyanide:** reports free cyanides, and most metal-cyanide complexes that break down in a hot, highly acid solution (pH less than 1.0). One would assume that monitoring for total cyanide would determine all of the various forms of cyanide, but this is not so. Total cyanide monitoring fails to detect cyanates and thiocyanates, two significant breakdown products found at mine sites; as well as many of the organic-cyanide complexes.

- In BC, at the Golden Bear cyanide heap leach mine, both WAD and SAD tests are done to determine cyanide concentrations. The SAD cyanide detects free cyanide, simple cyanides and complex metal cyanides (excluding cobalt and gold complexes). The weak-acid dissociable cyanide includes only free cyanide, simple cyanides and weak-acid dissociable metallocyanides such as zinc- and cadmium-cyanide complexes.

Neither method measures cyanate, thiocyanate, or cyanogen chloride.[58]

Because of the limitations of the regulatory monitoring requirements in BC and other jurisdictions, it is quite likely that some cyanide compounds (especially the cyanates and thiocyanates) might be present, but will remain undetected in mine waters. For example, mineral process sites that use the INCO cyanide destruction process often generate effluents that contain cyanate, thiocyanate,[59] but these compounds are not routinely tested for at mine sites.

Different jurisdictions have different maximum allowable levels of cyanide in drinking water. The European Union has one of the most stringent standards, with a maximum cyanide concentration of 0.05 mg total CN per litre (50 µg/L). The World Health Organization guideline value of 0.07 mg CN per litre (70 ug/L) of water is considered to be protective for both acute and long-term exposure in drinking water.[60]

In BC, the guidelines for cyanide in drinking water are 200 µg/L (SAD; includes thiocyanate).[61] For freshwater life, the criterium is a maximum of 10 µg/L (WAD only).

Impacts related to cyanide

1. Toxicity to Humans

In humans, cyanide can be readily absorbed through the skin, inhaled or swallowed. A person will die if they swallow one teaspoon of a liquid with 2% cyanide, or 50-200 mg of solid cyanide, which is about the size of a grain of rice.[62]

Death results because cyanide suffocates humans and other animals by blocking the transfer of oxygen across cell walls.

Sodium cyanide, the form most often used at mine sites, is also an extremely toxic and fast acting poison. It is

readily absorbed through the skin, and is an irritant of the skin, eyes and respiratory tract.

There have been very few documented human deaths caused by cyanide at mine sites.

2. Toxicity to fish

This section focuses on fish and not other wildlife because fish are much more sensitive to cyanide than birds and other terrestrial wildlife. Fish are killed by cyanide in concentrations in the microgram (µg) per litre range, while birds and mammal deaths occur when cyanide concentrations are in the milligram (mg) per litre range (i.e., 1000 times the concentrations that kill fish).[63]

Trout is one of the most sensitive fish species. Very small amounts of cyanide, 10 µg/L, can permanently affect a trout's ability to swim. Doses of 100 µg/L can cause death. Levels of 50 µg/L can prevent fish from reproducing. Aquatic microorganisms are even more sensitive.

Chronic exposure to cyanide may affect reproduction, and decrease the level of activity for many fish species.[64]

Unfortunately, there are great gaps in our understanding of cyanide toxicity to aquatic organisms. Little is known about the potential toxicity of metal-cyanide complexes, or what occurs once these complexes are ingested (e.g., how much free cyanide is released as the complexes decompose in the body). See Table 10 (above) for more toxicity information.

Factors affecting cyanide toxicity to freshwater fish:[65]

1. Cyanide concentration: toxicity increases with higher concentrations of cyanide.
2. Oxygen concentration: cyanide toxicity increases as dissolved oxygen in water drops below 100%.
3. Temperature: with each 12° C decrease in temperature, water containing cyanide becomes three times more toxic

4. pH: there is a slight decrease in toxicity when pH rises above 8.5.

5. Other factors: toxicity depends on the age and health of the fish, the amounts of water consumed, and the stress level of the animal.

3. A contentious chemical

Because of its extreme toxicity, the increased use of cyanide as a means of extracting gold has been viewed with caution by people living downstream of cyanide heap leach mines. And with good reason.

- Since 1982, the Montana Department of Environmental Quality has recorded six significant cyanide spills and leaks in Montana including a release of 50,000 gallons of cyanide solution in north-central Montana that contaminated a public drinking-water supply for the town of Zortman. There have been as many as 60 cyanide leaks since the early 1980s in Montana.

- In 1998, a truck carrying sodium cyanide to the Kumtor Gold Mine overturned into the Barskoon River, spilling a reported 1,762 kilograms of cyanide. According to Kyrgyz government and press reports, more than 4,500 people living near the spill area were evacuated, more than 500 people were hospitalized for cyanide-related illnesses, and two deaths were attributed to cyanide poisoning. In addition to human health impacts resulting from the spill, there were reported deaths of fish and cattle.[66]

- Between 1983 and 1992, at least 1,000 birds were killed when they drank cyanide-laden water from heap leach solution ponds at a mine in South Dakota. State wildlife officials reported that 47 species of birds were killed. The wildlife death toll increased when, in 1995, heap leach solution ponds overtopped after heavy rains. The overflow carried mine wastewater containing ammonia and cyanide into a tributary of Spearfish Creek, causing the death of more than 300 fish.[67]

4. Cyanide bans

- The community of Bergama, Turkey, was the first to win a legal ban on cyanide. In Turkey, some 700 villagers in the western town of Bergama filed a lawsuit against the environment deparment, asking for a halt to the operations of a Canadian-Australian gold mining firm called Eurogold, which was using cyanide leaching technology. In May of 1997, the highest Turkish administrative court overturned approval given by the Department of Environment for the proposed Eurogold project after a rally by 10,000 local people with 1,000 tractors occupied the mine site. The judgment was based on the Turkish Constitution and its guarantee of a healthy and intact environment. The court found that a cyanide-based mining technology was at odds with these constitutional rights.[68]

- In November 1998, in Montana, USA a state-wide initiative was passed that bans any new gold or silver mines that use cyanide leach mining technology.

- In August, 2000, the Czech Senate voted to ban the use of cyanide heap leach technology in mining.[69]

Some of the more progressive individuals and mining companies have begun to grapple with this issue. In its recent report on environmental performance, Canadian-based Placer Dome stated that: "government regulatory bodies and lobby groups in many parts of the world are working together towards banning cyanide in their jurisdictions. To prepare for that eventuality, Placer Dome's Technology Group has earmarked funds for research into: minimizing transport risk and cost by producing cyanide at the mine site, less expensive and more effective cyanide recovery and destruction technology, and alternatives to cyanide for leaching gold, which are environmentally friendly, give good recovery and are economically viable."[70]

iv. Sediment

Nearly all rivers and lakes have some solid matter that is suspended in their waters (known as *suspended sed-*

iments). The sediment is a by-product of the erosion process, which occurs when gravity, air, water and ice act upon exposed rock, causing it to fracture and break down.

The type and concentration of suspended sediment controls whether or not water is clear or cloudy. The lack of clarity or the degree of transparency of water caused by suspended substance is known as *turbidity*.[71]

Mining operations can greatly increase concentrations of suspended sediments in nearby rivers.

Mining operations can greatly increase concentrations of suspended sediments in nearby rivers and lakes because mining activities such as the removal of vegetation, blasting of overburden rock, and use of heavy machinery create ideal conditions for erosion. Wind and water pick up loose particles of soil and rock, carrying them into streams, rivers, lakes and reservoirs.

In undisturbed natural systems, concentrations of suspended sediments vary with the seasons. For example, spring rain, snowmelt and glacier-melt increase water flows and water levels, which tends to result in land erosion and sediment input into waterways. Large increases in stream flow may move streambed materials (*substrate*), and increase the amount of material in suspension. Accordingly, aquatic organisms have adapted to the natural variation in suspended sediments and turbidity; for example, during times of year when inputs of sediment are high, fish may move out of a particular stream.

The input of sediment to streams from mining activities may not, however, correspond to the natural cycles of sedimentation. As a result, sedimentation can cause significant changes to the aquatic environment and can disrupt aquatic life downstream of a mine site.

Impacts related to sedimentation and turbidity

There are numerous studies that summarize the effects of sediment and turbidity on fish.[72] The studies show that certain concentrations of sediment are lethal to fish. These concentrations typically range from the hundreds to the hundreds of thousands of mg/L of sediment.

Photo 6. Sedimentation

As mentioned above, the typical laboratory test for determining the lethality of a pollutant is the 96-hour LC50. The results of the 96-h LC50 test have limited value for predicting effects in the wild, and at best they are a rough indicator of the short-term effects of a contaminant.[73] Problems with the tests are they that the values do not indicate the effects of a more prolonged exposure to the contaminant, nor do they relate to the effects on fish habitat. Conditions in the laboratory cannot exactly replicate conditions experienced in the wild, e.g., with respect to sediment type, water velocity and potential abrasive and scouring effects, fluctuations in water chemistry, and feeding and food supplies. As a result, the 96-h LC50 results may underestimate the short-term lethal and sublethal effects in the wild.[74]

Sublethal concentrations of sediment are those that do not immediately kill organisms but jeopardize their survival and well-being. In a natural setting, the survival of fish depends on factors such as ability to find food, avoidance of predators, immune system health and ability to reproduce. For salmonids (including salmon and trout), sediment has the potential to affect all of these factors.

High concentrations of sediment can be harmful to fish and aquatic life.

There are a number of ways that high concentrations of sediment can be harmful to fish and aquatic life:[75]

- The finer particles become suspended in the water, which decreases the amount of light that can penetrate the water and alters the water temperature; these changes alone can threaten the survival of aquatic life.

- Fish swimming in water in which solids are suspended may suffocate, if there is enough sediment to clog their gills;

- Juvenile chinook salmon use clear streams to "seek relief" from high sediment concentrations in the Fraser River, which reduces their stress while seeking food and shelter. Some researchers have stated that suspended sediment concentrations could disrupt the feeding, growth and social behavior, and increase likelihood of disease in juvenile salmon.[76]

- Suspended sediments may prevent the successful development of fish eggs and larvae.

- Turbid waters may affect the natural movements and migrations of fish; and may affect the efficiency of methods for catching fish.

- The heavier particles entering streams and rivers settle out quickly, creating sediment, which can have disastrous effects on the aquatic life. For example, sedimentation can affect fish spawning by altering spawning habitat (gravels) or smothering eggs.

- Sedimentation can also smother aquatic vegetation and animals, and cover substrate that provides habitat for organisms at the base of the food chain. The reduction in abundance of these species may, in turn, affect fish that feed on these organisms.

- On April 15, 1999, police laid 13 charges against Royal Oak Mines Ltd., after a 16-month investigation into the dumping of earth into fish-bearing waters near Prince George, BC.[77] The investigation was conducted jointly by DFO and the Conservation Environment Officer Service of the BC Ministry of Environment, Lands and Parks. The charges related to the deposit of a deleterious substance (sediment) into fish-bearing waters and the destruction of fish habitat. The

offences were alleged to have occurred during construction of the Kemess mine site, between October, 1997, and May, 1998.[78] On January 16, 2001, the company pleaded guilty to one of the charges and was fined a total of $100,000 under sections 36(3) and 40(2) of the *Fisheries Act*.[79]

c. Minimizing Impacts to Waters

i. Environmental Planning

Proper planning before mining begins is critical in locating and designing a mine to prevent the discharge of contaminants into streams.

There are a number of steps the operator must take in the planning stages. The first is INFORMATION GATHERING.

The mine operator must have detailed information about:

- geochemistry (the chemical make-up of the rocks)
- the site's terrain, soils and vegetation
- climate
- surface and groundwater flows

Only after the mine operator has a detailed understanding of the site's characteristics can the mine plan be formulated.

It is important to always keep in mind that the greatest risks of water contamination will come from areas where rock contains high levels of acid-forming sulphides and low amounts of acid-neutralizing or buffering materials. Consequently, knowing the geochemical composition of the ore and waste rock is absolutely essential in mine planning. Before mining, a thorough system of rock sampling and testing to determine the acid generation potential of the full range of rock types encountered must occur.

Mines with the potential to create significant impacts to land and watercourses from AMD and metal leaching must provide detailed plans to the Ministry of Energy and Mines. These plans must outline the approaches the company will take to reduce contamination so that the environment is not significantly impacted (*mitigation* plans). Plans are required for all mine components that have a potential to create AMD.[80]

Areas with high water drainage may also have a high level of risk for water contamination. Thus, operators must incorporate knowledge of local climate and weather conditions, such as precipitation, snow pack and evaporation, into the mine plan.

- For example, waste impoundments must be designed not only to hold water that will be produced during normal mineral processing, but also water that may be introduced into the mine operation through normal and extreme precipitation, snowmelt and runoff events. Otherwise, drainage from large storms or seasonal snowmelt may cause impoundments to overflow their dams, spilling huge quantities of mining contaminants to surface and groundwater.

Mine plans should attempt to design and locate mine facilities such as waste rock dumps, tailings impoundments and leach heaps to minimize their contact with water, both during the mine life and after closure. Avoiding contact between water (streams, springs, seeps) and wastes will help prevent acid mine drainage, metal transport, sedimentation and pollution from process chemicals. The phrase "high and dry" is the rule of thumb for where to locate wastes on a mine site.

Contingency planning is essential. Mine waste materials behave in unpredictable ways; mills can experience upset conditions; pumps fail; pipes leak or break; premature shutdown of the mine may occur due to a downturn in metal prices; and floods and earthquakes are likely to occur in certain regions. Mine operators should have plans in place to deal with worst-case scenarios.

Mine operators should have plans in place to deal with worst-case scenarios.

These plans should not only outline potential actions, but should provide details on how different situations will be handled. For example, if sedimentation might be a problem, contingency plans should include information on where sediment ponds might be located, and how the sediment control structures will be engineered.

1. Limitations in the Planning Process

The ability to predict impacts and plan accordingly is only as good as the existing information and data.

- Sometimes there are no precipitation or snowpack data for the specific area where the mine will be located. The mining company must then use information from nearby climate stations to create predictions of what the water inputs will be to the site.
- The techniques for predicting AMD include tests that examine the balance between acid producing and acid neutralizing constituents of a waste (*static tests*), and tests that attempt to predict drainage quality over time (*kinetic tests*). The relative effectiveness, accuracy and reliability of the various predictive techniques is unclear.
- Ore bodies can be highly variable in their geology. If not enough samples are taken, the predictions of amounts of acid generating materials in ore and waste rock may not be accurate.

ii. Managing wastes to reduce the risk of water contamination

The primary goals of waste management should be to minimize waste generation, use the most environmentally safe methods, and use approaches that do not take great risks in the absence of sufficient information (i.e., they are *precautionary*).

The precautionary approach is absolutely essential, given the number of times structures have failed at mine sites, leading to contamination of waters. It is also important because of uncertainties and gaps in the data that are used to come up with mine designs, or to make

predictions of potential impacts. This will be discussed further on pages 160-162.

The following section mentions some general approaches for minimizing the risk of water contamination. Government regulators and other agencies have compiled more detailed, technical information in documents with titles such as "Best Management Practices." These documents give mining developers an idea of some of the better or more innovative technologies and approaches in mine design and construction, so that they can meet government standards and regulations.[81] The BC Ministry of Energy and Mines is coming out with Best Management Practices for aggregate mining in the fall of 2001.

Ore processing chemicals

Mill reagents should be selected on the basis of low toxicity and rapid breakdown into non-toxic products. Prior to discharge of ore processing waters (known as *effluent*), there are a number of different methods for removing potentially toxic chemicals and metals from the effluent, before it is discharged to the environment. Whatever method employed, the waters that leave the mill building should not contain toxic concentrations of any substance.

The Ministry of Environment, Lands and Parks issues effluent permits that set out for the mine operator the maximum concentrations of various substances allowed in the mill effluent. Sometimes, permits require the mine operator to conduct tests where aquatic organisms (usually young rainbow trout or water fleas) are placed in the effluent. If more than 50% of the organisms die, the effluent is considered too toxic to release. These types of tests are useful, because sometimes chemicals and metals can react to produce much more toxic effects than either substance would alone.

Fuels

Fuels should be stored in secure areas, to prevent movement of spilled substances from entering waterways. For examples, berms can be constructed around fuelling areas to contain any spills that occur.

The BC government has guidelines for the safe handling, transportation and storage of fuels.[82]

Photo 7. Fuel tanks kept in a bermed area to capture any spilled fuel

Tailings and waste rock

The most effective way of reducing the risk of water contamination from mining is to contain or isolate mining wastes from the environment. The benefit of doing this is two-fold. First, waste containment can prevent the migration of pollutants into the environment. Second, it can prevent the initial formation of AMD by limiting contact of sulphide minerals with water and oxygen.

A precautionary approach requires that additional measures be taken to capture mine waters should the primary means of waste containment fail. These built-in redundancies are not necessarily the most economic approach, but in the long-term they may very well save money and prevent environmental impacts.

Techniques for sound impoundment of tailings and mine water

Any mine waters or tailings that are impounded at the surface have the potential to be accidentally released and end up into streams and lakes. Tailings impoundments present a greater hazard because they typically store millions of tonnes of unstable, water-saturated sludge.

This material can pose a serious risk of contamination through leakage into groundwater or through massive structural failure of the dams. The risk of massive dam failures, however, has decreased in the past few decades, as knowledge of geotechnical engineering and soil mechanics has improved.

As mentioned earlier, sometimes waste material discharged as tailings can generate acid mine drainage. In the past, tailings areas were built out of materials that allowed water and air to flow through them (they were *permeable*). This allowed the acid mine drainage to seep into surrounding ground waters. Today, dams built to retain tailings can be constructed to minimize permeability through the use of bentonite clays, compacted tills or synthetic fabrics (e.g., *geomembranes*). This does not mean that seepages do not occur. The increased use of cyanide has made it apparent that incidents involving uncontrolled seepages are occurring, because cyanide is readily detectable in groundwater.[83]

Furthermore, even though we know how to design dams that should not fail, it does not guarantee that they will be constructed properly. In almost all cases, tailings impoundments and dams are constructed from materials found on site. These may not be the most ideal materials from an engineering standpoint.

> *"In regard to the construction of tailings dams, we are concerned that while their design may be adequate their construction may not be to specifications; construction is often performed by other than the designer."* Mines Inspector – New South Wales[84]

Most dam failures occur as a result of percolation through the dam wall, internal erosion, overtopping or flooding, and may be triggered by earthquakes or persistent heavy rain.[85] Water contamination can also occur via seepage through the impoundment and dam. Finally, wildlife may be attracted to salts that form on dry tailings, which can contain metals in toxic concentrations and endanger health of those animals.

Techniques to decrease the chances of water contamination at tailings and other impoundments include[86]:

- Location in an area that has a stable foundation
- Location in an area where surface drainage is minimal or can be diverted around the structure permanently
- Ample holding capacity to hold the maximum load of wastes generated,[87] plus added drainage from extreme rainfall and snowmelt
- Containment pond(s) below the structure to catch unanticipated spills from the main impoundment
- Proper lining to prevent groundwater contamination
- Strategically located monitoring wells, which should be placed around tailings impoundments to detect contamination of groundwater.
- Cut-off wells and recycle pumps to catch contaminants that do seep into groundwater
- State-of-the-art engineering and materials to ensure strength and stability of dams and dykes
- Reduction of toxic substances before tailings enter the impoundment
- Wildlife protection, including physical prevention of any wildlife access to cyanide solution ponds or tailings where the concentration of any substance exceeds water quality standards
- Capping or continually monitoring water levels at the tailings impoundment once mining ceases

Techniques for sound waste rock storage

Effective waste rock management techniques involve isolating the rock from natural elements and reclaiming the piles after mining ceases. Methods include:

- during active periods of waste disposal, the operator ensures that the waste dump is structurally intact (if the piles slump or erode, materials could end up being washed into water courses)

- the waste rock dump area is properly lined at its base, so contaminated waters cannot leak into the ground and contaminate aquifers
- diversion ditches are built around waste rock piles, and under-drains consisting of coarse, non-reactive (non-acid-generating) rock are used to avoid or minimize contact between water and wastes
- waste rock piles are situated in areas outside of primary water drainage (flowing water can leach out metals and lead to erosion and sedimentation)
- any natural water-flows in the area are permanently diverted away from the waste material
- when no more waste rock is being actively dumped, the materials are more completely isolated by methods such as capping

Notes on Liners

A secure, multiple lining system underneath waste rock piles, tailings impoundments, leach heaps, and solution ponds can greatly reduce the risk of contaminants migrating into surface and groundwater.[88]

The preferred liner system consists of two synthetic liners (most liners today are made of high-density polyethylene or HDPE, which is supposed to be resistant to stress and degradation by chemicals). These liners overlie a base of low-permeability soils, such as clay. Leak detection systems should also be installed to provide early warning that a liner has been punctured. The second liner, below the leak-detection system (and backed up with the underlining foundation of clay) acts as a final barrier to prevent contaminants that have leaked through the first liner from entering the groundwater.[89]

Operators must take special care in the installation and placement of liners. All liners are prone to leaking, especially along seams. Manufacturing flaws can damage the liners; rough handling before and during installation or improper storage can degrade liners;

exposure to heat and cold, rain, or ultraviolet radiation may reduce their effectiveness.[90]

Liners should never be installed in winter. If a liner is installed on frozen ground its foundation will be unstable. When millions of tonnes of ore (in the case of heap leaches) or waste rock are stacked on top of the liner, the weight of the rock will stretch and tear the liner. Wintertime construction of a heap leach liner contributed to the massive discharge of cyanide-laced water at the Summitville mine in Colorado.

Techniques for controlling sedimentation[91]

There are two primary ways to decrease the amount of sediment that reaches water courses:

1) minimize the amount of sediment that is generated (e.g., by minimizing land disturbance and controlling erosion), and

2) prevent sediment and sediment-laden water from entering water courses. Below are some examples of methods used to control erosion and sedimentation.

Erosion controls

Strawmatting and Mulches

Strawmatting is manufactured by embedding straw into a nylon or cotton mesh. This mat is rolled out over exposed soils, providing protection from rain, as well as a rooting medium for vegetation. The mats work best on smooth soil surfaces; if they are used on slopes that are too steep, the entire mat can slide downhill. These mats are often used in remote areas, where access for large equipment is limited.

Loose straw applied as a mulch (on top of seeded areas) will protect the soil by decreasing the impact of rain drops, and will allow the seeds to germinate instead of washing away.

Hydro-seeding

Seed is mixed with water, fibre mulch and fertilizer and sprayed onto an exposed soil surface. The fibre acts as a temporary protective cover for the soils until the vegetation establishes itself. Hydro-seeding is expensive, and is most effective where large areas need to be seeded and there is adequate access for the seeding equipment.

Sediment/Water controls

Divert clean waters

If water flows are diverted away from areas where loose soils and sediment exist, then the transport mechanism for the sediment, i.e., the water, will be cut off; and sedimentation will be minimized.

Gravel/sand-bag dams

These structures consist of gravel or sand-filled bags that are placed in ditches or diversion works to act as a dam. They can filter sediment, but their main role is to impound water for a length of time so that particles have a chance to settle out. The clear water flows over top of the dam. These structures are effective, extremely stable and require low maintenance.

Filter fences

Filter fences are constructed from synthetic fabric attached to stakes, or straw bales – anything that intercepts and temporarily slows down sediment-laden water. The idea is to trap the particles behind the fence, so that the water flowing out the other side is clear. They should only be used when flow rates are low, or in conjunction with other sediment controls. If runoff rates are too high, water will simply flow around the traps. These fences also have a high maintenance requirement; if they are not cleaned regularly the fabric will become clogged with sediment and the structure will begin to hold water and will fail.

Terraces

As water flows down a slope, terraces, which look like benches or steps, will slow down the flow. This allows more time for water to seep or infiltrate into the ground. Terraces are more effective if the flat benches are vegetated.

Seepage basins and sediment ponds

Seepage basins are large structures (up to 2 hectares) that collect runoff from large areas. The silt-laden water is captured and allowed to seep or infiltrate into the ground. Sediment ponds, which are also large structures, serve as areas for flows to collect and be held for a length of time, allowing the silt load to settle out. The clear water (or water low in sediment) is then allowed to flow out of the top of the pond. A series of sediment ponds, often referred to as polishing ponds, can be created, so that as the water flows from one pond to the next it loses some of its sediment load and increases in clarity.

Flocculants

Chemicals are sometimes used to help speed up the settling time and decrease the amount of sediment suspended in the water. These chemicals, which bind with silt and cause the mass of particles to settle out, are known as *flocculants*. Flocculants are used in more than a dozen settling ponds associated with coal mines in the East Kootenay. One problem is that the most common flocculant is toxic to fish; it causes suffocation by binding together their gills. While efforts are underway to find a less toxic settling aid, a more effective measure might be to reduce upstream inputs of the sediment.[92]

Techniques for preventing AMD

The effectiveness of the AMD prevention and source treatment methods is unknown.

> *"The effectiveness of the AMD prevention and source treatment methods is unknown."* – National Academy of Science Report

There are a number of strategies for preventing the impacts of AMD. These include: avoidance, underwater storage, blending and covers. While many of the

techniques have been successful under certain circumstances, the same methods employed at other sites have failed to prevent AMD.

Avoidance

If potentially acid generating (PAG) materials are not disturbed during the mining process, the risk of AMD is greatly reduced. Thus, the most effective mitigation strategy, and the first that should be considered, is avoidance through prediction and mine planning. For example, if test results show the presence of highly acid generating material in a particular zone, the company could choose to leave those areas intact – i.e., to not mine the acid generating ores.

Most companies, however, do not see avoidance of PAG materials as an option, especially when most or all of the economic metals may be associated with PAG materials (which is the case with many sulphide-bearing ore bodies).

If a company chooses to mine PAG materials, they will be required by government to come up with plans for preventing long-term impacts related to acid mine drainage.

Underwater storage

Acid-generating materials are often stored in water to prevent the contact with air that is necessary to start the process. This is accomplished by placing waste rock in a body of water, or by covering the top of a tailings pond with water once tailings deposition is completed. If PAG materials must be excavated or exposed, this is generally the most effective means of preventing AMD and reducing metal leaching.[93]

To remain effective, the water level must be closely controlled and monitored. If the water level drops and tailings are exposed to air, they will begin to oxidize (and will release acid). If the water levels become too high, they might overtop the dam, and the water would be released to the environment. Underwater storage, therefore, requires long-term maintenance.

Another consideration is that exposure to water may increase the amount of metals in solution. If the materials have already begun to generate acid before they are placed under water, they will have started to free up some of the metals bound in the rock or tailings. When placed in water, these easily accessible metals will enter the water. If enough metals are released, the water will have to be treated, or else it will become a long-term hazard. Thus, PAG materials must be flooded before AMD has progressed very far.

Blending of PAG and non-potentially acid generating (NPAG) materials

Blending refers to the deposition of PAG wastes with materials that have an excess of neutralization potential (i.e., NPAG materials). The objective in blending is to create a situation whereby any acid produced by the PAG materials is quickly neutralized by the NPAG materials. It is intended that the neutralization will occur before metals have been significantly leached out or before acidic drainage has migrated off of the waste site.

While blended waste rock dumps have been useful in preventing AMD at some coal mines, there has not been any evidence so far of success with hardrock mines such as gold and copper.[94]

Blending has a number of disadvantages that currently restrict its use. These include high costs; performance limitations; technical uncertainty; demanding information requirements; and extensive material and construction requirements.[95]

Case Study: Samatosum[96]

An example of a failed blended dump is Samatosum mine near Kamloops. The blended waste dump had been meticulously designed and constructed to prevent AMD. The waste dump alternated layers of PAG with layers of acid consuming materials. The environmental assessment study produced by the company included studies that predicted that method to be safe, and by all calculations the blended dump appeared to create a "walk-away" solution to the AMD problem. Conse-

quently, the company was not required to build an acid water treatment plant.

A study produced by the company in 1991, one year before the mine closed down, reported that, "The laboratory studies simulation, to date, has confirmed the effectiveness of the layering technique in controlling leachate pH in a laboratory environment."[97]

But something was wrong with the calculations. Four years after the mine shut down the waste dump went acid. What was thought to be a "walk-away" solution to AMD turned out to be a continuing AMD problem. A treatment plant was hastily constructed to deal with the increasing acidity of the waste dump seepages.

Covers

In the United States, the most widely used method for preventing acid generation involves capping and sealing acid-generating rock to prevent air and water from reaching the rock.[98] Also, covers have been used successfully to reduce water infiltration into already acidic waters with the objective of decreasing the amount of leaching, the volume of discharge and water treatment costs.[99]

In Canada, covers are not often used to prevent AMD. In BC, our humid conditions make it extremely difficult for covers to achieve the objective of preventing water infiltration; thus, it is unlikely that covers used in this region will serve their purpose of preventing acid formation and metal leaching.

Two areas of uncertainty that have prevented widespread use of covers and caps in Canada are: lack of data on long-term performance; and design measures to ensure the necessary degree of effectiveness.

Since few existing covers are more than 10 years old, further operational testing is required to determine the long-term design criteria, monitoring, maintenance and replacement requirements. For example, it is quite possible that covers will require perpetual maintenance and occasional replacement or "touch-ups" to ensure that erosion, animal burrows, or other activities do not

seriously affect the ability of the cover to reduce air and water infiltration.

Also, further testing is required to determine how best to design covers. In general, covers are expected to be most easy to construct and maintain on fine textured, level or gently sloping wastes. But this has not yet been proven.[100]

While capping is not used extensively in Canada to prevent AMD, it is a standard reclamation technique for waste rock piles and tailings impoundments. Capping a waste-rock or tailings pile can greatly reduce the contact of water and air reaching the wastes, thereby reducing the amount of metals or other potentially toxic substances that leach out. Covers also address another environmental and public safety problem created by abandoned mine sites: blowing dust. This is especially hazardous with piles composed of mill tailings and smelter slag byproducts, since such piles consist of very fine particles containing high concentrations of toxic heavy metals.

1. Limitations to Preventing Impacts

A National Academy of Science report released in 1999 concluded that there are many areas of uncertainty when it comes to predicting water quality or designing systems that will prevent pollution.

The Samatosum example showed how laboratory results failed to predict actual field conditions; and how state-of-the-art technology was not well enough understood to prevent AMD. Unfortunately, it is not an isolated example.

The Brenda Mine near Peachland, BC, is a good example of the maxim: expect the unexpected.[101]

- When the Brenda Mine was established it was not expected that molybdenum leaching from waste rock on the site would be a problem requiring retention of runoff water on site.

Table 11. Uncertainties in predicting and controlling pollution at mine sites

Potential source of pollution	Comment
Acid Mine Drainage	Predictions of long-term water quality related to AMD have a high degree of uncertainty. The prediction of both AMD and the leaching of mine waste and pit wall rock needs improving; like pit lake models, there has been little effort to compare predicted and actual concentrations The effectiveness of the AMD prevention and source treatment methods is unknown. Without reliable forecasts of long-term water quality, it is difficult to design effective mine waste management techniques to protect against future deterioration of water quality
Flow in waste rock dumps and impoundments	The flow of water through waste rock dumps and tailings impoundments is extremely variable, because of differing sizes and shapes of materials in every dump and impoundment. Current hydrologic models are incapable of reproducing the water flow patterns.
Hydrology	Water quantity affects water quality, and uncertainties in one area compound uncertainties in the other The modeling of water quantity and hydrologic processes contains uncertainties. In may not be known, for example, whether some pit lakes will have closed-basin or flow-through hydrologic features Site specific water balances, which in part were responsible for uncontrolled discharges from the mine at Summitville, are not sufficiently understood
Open Pit Lakes	It is currently not known how accurately pit lake models predict contaminant concentrations in pit lakes and surrounding groundwaters The viability of these lakes as long-term habitat and food sources for aquatic biota and wildlife has not been evaluated The long-term sublethal effects of cyanide and metals on aquatic biota and migratory birds has not been extensively studied

Predictions of long-term water quality related to AMD have a high degree of uncertainty.

Source: National Academy of Science, 1999. *Hardrock Mining on Federal Lands.*

- When the tailings pond was designed it was not expected that a temporary closure of the operations would threaten the stability of the tailings dam and require the discharge of a large amount of molybdenum-contaminated tailings water.
- When the pit was designed it was not expected that water would accumulate in the tailings pond faster than it evaporated.
- When the tailings water was pumped to the pit it was not expected that the pit would fill up in less than ten years.

All of these things came to pass.

The ability to predict conditions that will impact the effectiveness of pollution prevention techniques and, hence, affect water quality, is a serious issue; especially when communities rely on the water and the fish and wildlife that live in or use those waters.

iii. Treatment of AMD

In Canada, companies must treat AMD at all mine sites that they own, whether the mines are operating or closed.

Proven treatment methods exist to neutralize acidic waters and remove metals to a level that meets water quality criteria. Acid generation, however, may persist for hundreds or thousands of years following mine closure. Thus, these methods involve on-going expenditures and maintenance; none offer permanent, safe, "walk-away" solutions.

Active treatment

The most common method is active or continuous treatment. The contaminated water is pumped to a treatment plant, where it is combined with lime, limestone or some other alkaline substance. The acid is neutralized, and at a high pH many of the metals, such as copper and cadmium, will settle or precipitate out of solution. Further treatment to remove other metals or other toxic sub-

stances may be necessary before releasing water back into the environment.

There are a couple of major drawbacks to this method. First, the process generates huge volumes of waste (sludge), which is often high in heavy metals. This sludge has to then be disposed of in a safe manner. Second, it is expensive to construct and operate treatment plants. For example, it is estimated that an AMD (lime) treatment plant at the Britannia mine will cost $4.2 million to build and $780,000 per year to operate.[102]

Despite these drawbacks, active chemical treatment is the most common method of treating water contamination at both operating and closed mines in North America.[103]

Passive treatment

In addition to active treatment, passive treatment techniques are available. These techniques typically rely on the ability of plants and bacteria to trap or absorb metals. One such technique involves routing the contaminated effluent through areas stocked with aquatic plants, such as cattails. The attractiveness of this method is that it is relatively inexpensive, and much lower maintenance than lime treatment.

While the use of wetland treatment has been widespread in the coal industry, it has only been used in experimental trials at metal mines; thus, it is too early to know the method's usefulness in treating water contamination from open pit or underground metal mines.

Some of the potential drawbacks to using wetlands as a treatment method at metal mines include:[104]

- Wetlands may trap so many metals that they may create new toxic wastes sites
- Upkeep of wetlands is often difficult in dry areas
- Wetland plants that accumulate toxic metals could pose a health threat to foraging animals

Collection and treatment of AMD should be seen as an absolute last resort. The operation of treatment plants for very long periods of time is clearly not desirable – our technologies, although improving, are not good enough to guarantee that engineered structures will not fail; and the long-term maintenance and upkeep of the treatment plants places a burden on future generations. So prevention of AMD and water pollution is still the only way to guarantee the purity of our water resources.

1. Limitations to Treatment

As mentioned above, the major limitation to existing, proven treatment methods is that they involve ongoing expenditures and maintenance: none offers permanent, safe, "walk away" solutions.

Equity Silver Mine Case Study[105]

At the Equity Silver Mine near Houston, BC, the containment system for AMD is elaborate and requires constant monitoring. Tailings from the old mill, which contain cyanide, are submerged in a 109 ha constructed pond, to prevent them from generating AMD. The water level in the tailings pond must be precisely controlled: if it drops too far, the tailings will be exposed to air and will begin to generate acid. Conversely, if water levels become too high they could breach the tailings dam, releasing contaminated water to the environment.

Drainage from the waste rock dumps is collected in ditches and pumped to the AMD treatment plant. In the plant, the AMD is combined with lime, which neutralizes the acidity, and is discharged to settling ponds. The metals settle out in a sludge, which is then pumped to the main open-pit. At the present time the pit water, which is still relatively low in metals, is released to the environment.

To date, impacts on the environment have been minimal. To maintain this good environmental record, however, requires the perpetual operation of the treatment system. A list of potentially catastrophic complications include:

- Major wash-outs of the mine access road, bridges, or rail lines, which would prevent the twice-weekly required delivery of lime for the treatment plant. This means that the road has to be maintained for as long as the treatment plant is in operation, which could be for 100,000 years.
- Extremely large storms or snowmelt could overload the treatment system or cause a breach of the tailings impoundment.
- Storms could severely damage the power lines to the mine site. This would mean that it would be impossible (given the fact that there are limited back-up diesel generators) for the remaining pumps to handle large flows.

Notes

[1] Environmental Mining Council of BC. 1998. *Acid Mine Drainage: mining and water pollution issues in BC*. Victoria, BC.

[2] US Environmental Protection Agency. 1995. *Human Health and Environmental Damages From Mining and Mineral Processing Wastes.* Technical Background Document. (Office of Solid Waste, U.S. Environmental Protection Agency). The table is based on analysis of 66 cases of damages resulting from mining. It is not a statistically representative sample, but the cases do provide convincing evidence that wastes from mining and mineral processing have caused significant human health and environmental damages.

[3] For example, open pits, as they are developed, often intercept groundwater flows. When this occurs, this water must be pumped out of the pit to keep working surfaces dry. It is not uncommon for open pit mines to pump millions of litres of water per day. This water may

be discharged to land, streams or other water bodies, if the quality is high enough; or pumped to the tailings impoundment if the quality is poor. Rarely is it pumped back into the same aquifer from which it was removed. As a result, other users who were using that groundwater for irrigation or drinking water may suffer from a decrease in available supply.

[4] R.E. Krauss. 1993. "Pollution prevention in mining: Homestake Mining Company's McLaughlin Mine, A Case Study." *in* Anderson, K.A. and Purcell, S.K. (eds.) *Proceedings from the International Conference on Pollution Prevention in Mining and Mineral Processing, Snowmass Village, Colorado (August 24-27, 1993)*. pp. 108-115.

[5] Companies are required by provincial law (Spill Reporting Regulation, *Waste Management Act*) to immediately report spills of hazardous materials. Every region in the province has an emergency response officer, who is responsible for determining the severity of the spill and required clean-up measures. To find out more information about spills, contact the Enforcement and Emergencies Program of MELP (Phone: 250-387-2182).

[6] Information from Dangerous Goods Incident reports. BC Ministry of Environment, Skeena Region.

[7] Information from Dangerous Goods Incident reports. BC Ministry of Environment, Skeena Region.

[8] "Labrador miners accused of littering," *Globe & Mail*, 12/19/95, p. B6.

[9] Environment Canada. Oil, Water and Chocolate Mousse. http://www2.ec.gc.ca/chocolate/en/wildfish_e.htm

[10] Bohn, G. "Mine's seepage poses threat to river," *Vancouver Sun*. 02/12/88. p. B1.

[11] All information from Mininstry of Environment, Lands and Parks (Skeena Region) Dangerous Goods Incident reports.

[12] Hawley, J.R. 1977. *The use, characteristics and toxicity of mine-mill reagents in the province of Ontario*. Pollution Control Branch, Ontario Ministry of the Environment, Toronto. Other Sources: National Institute for Occupa-

tional Safety and Health. Documentation For Imme diately Dangerous To Life or Health Concentrations (IDLHs, AS OF 3/1/95) http://www.cdc.gov/niosh/idlh/intridl4.html; Canadian National Pollutant Release Inventory 1999 (Environment Canada http://www.ec.gc.ca/pdb/npri/).

[13] Marshall, I.B. 1982. *Mining, Land Use and the Environment*. Volume 1. A Canadian overview. Land Use in Canada Series No.22. (Ottawa: Environment Canada, Lands Directorate).

[14] Chapter 11 *in The State of Canada's Environment.* 1991. *(*Ottawa: Government of Canada), p.8.

[15] Saywell, T. "Royal Oak fined for Back Bay pollution," *Yellowknifer*. 03/05/1992. p. A3.

[16] DaRosa, C. and Lyon, J.S. 1997. *Golden Dreams, Poisoned Streams*. (Mineral Policy Center, Washington, DC). p. 82.

[17] Groundwater is water found underground within the free space of materials like sands, gravels or sandstones.

[18] Steffen Robertson and Kirsten Canada Inc. March, 2000. *Hydrogeological and hydrological evaluations for development of remediation options for Mount Washington*, Courtenay, BC. Final Report prepared for Environment Canada. p. 4-11.

[19] Steffen Robertson and Kirsten Canada Inc. March, 2000. *Hydrogeological and hydrological evaluations for development of remediation options for Mount Washington*, Courtenay, BC. Final Report prepared for Environment Canada. p. 4-11.

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Chapter 6
Mining and Land

6. Land

The most severe impact from mining, for both water and air, is contamination of the resource. For land, however, the greatest impacts are related to soil and vegetation disturbance.

Land Disturbance

Land disturbance occurs during all phases of mining.

Land disturbance occurs during all phases of mining from exploration through to abandonment. The majority of disturbance takes place during the development phase, when the mine site is being constructed. As mining proceeds, disturbance continues as the area covered by waste materials grows.

The quantities of materials deliberately moved at the earth's surface through mining and quarrying greatly exceed those moved by natural processes such as water and wind erosion. Only the most violent extreme volcanic eruptions shift greater quantities of materials.[1]

The scars, pits and piles resulting from mining are in many cases permanent effects. The magnitude of these effects is directly related to the size of the operation.

a. Major Sources of Disturbance

i. Stripping of overburden

The first task in mining is to remove whatever covers a mineral deposit (the *overburden*). Also, vegetation and soil are deliberately stripped away to clear areas for mine buildings, roads and power line corridors. Further stripping of overburden takes place when the mine goes into production, for example, during the sinking of the mine shafts and excavation of open pits.

ii. Disturbance from open pits and wastes

Open pits

From the table below, it is clear that there is a great deal of variation in amount of disturbance at open pit mines. But in all cases, the land disturbed by open pit mines far exceeds the land disturbed by the underground operations. For example, the area disturbed at the Kemess open pit mine is 20 times the area disturbed by the underground Snip operation.

To provide some perspective, the area disturbed by the Highland Valley copper mine (109.3 km^2) is almost as large as the area of the City of Vancouver (114 km^2).

Table 12. A comparison of land disturbance at open pit and underground mines in BC

	Total Area Disturbed		Waste Rock		Tailings		Roads		Pit Area	
Mine Name	**hectare**	**km^2**	**hectare**	**km^2**	**hectare**	**km^2**	**hectare**	**km^2**	**hectare**	**km^2**
Highland Valley Open Pit Valley operation Lornex[a] operation	6226 4700	62.3 47.0	2011	20.1	2171 4700	21.7 47.0	263	2.6	878	8.8
Kemess Open Pit	2673	26.7	116	1.1	243	2.4	185	1.9	179	1.8
Huckleberry Open Pit	470	4.7	8.5	0.09	8.5	0.09	28.2	0.3	25.2	0.3
Eskay Creek Underground	22.2	0.2	0.6	0.006	0	0	7.9	0.08	0	0
Snip Underground	110.9	1.1	7.8	0.08	24.2	0.24	15.5	0.15	9	0.09

Sources: [a] Canadian Mining Journal's *1999 Mining Sourcebook*. p. 115. All other data from the Ministry of Energy and Mines (database on Area Disturbed and Reclaimed For Metal Mines In British Columbia as of Dec. 31, 1998).

Open pits are growing

In 1982, a report released by the Canadian government stated that the largest area of mine disturbance at an open pit metal mine in Canada was 1688 hectares (ha), while the average disturbance related to open pit mines was 180 ha.[2] From the above table, it is evident that open pits have increased in size since 1982. The growth is most likely a reflection of the fact that technology has changed in 18 years. The development of larger-scale extraction methods and machinery, combined with processing techniques that allow easier extraction of lower-grade ores, have made this mode of mining more economically attractive.

Photo 8. Aerial photo of Highland Valley open pit mine

Photo 9. Aerial photo of Myra Falls underground mine

The quantity of waste material produced by mining is enormous. Mining generates much more waste than product.

- *Approximately 2 1/2 tonnes of waste (2500 kilograms or 5500 pounds) are generated to produce enough gold for one wedding band.*[3]

There are two terms that are important in understanding how much waste will be created at a mine: the stripping ratio, and the ore grade.

Stripping ratio is the tonnage of waste material removed to allow the mining of one tonne (one thousand kilograms) of ore. For underground mines, the ratio can be 1:1. In open pit mining it varies, generally, from 6:1 to 40:1 (i.e., 40 tonnes of waste rock must be moved to access one tonne of ore).

Grade of ore is the amount of valuable mineral in each tonne of ore. The grade determines how much waste is generated during milling. Four centuries ago, copper ores that were mined worldwide had a grade of 8 percent by weight; today, most copper ores average less than 1 percent copper. A grade of 1% means that for every tonne of ore, ten kilograms will be copper and 990 kilograms will be waste.

Open pit mines almost always have much lower grade ores than underground mines. For example, Huckleberry ores are 0.419% Cu (open pit mine); Myra Falls ores are 1.8% Cu (underground mine).[4]

It is more expensive to mine using underground techniques, and so, the ore deposits must be of a fairly high grade to make the venture affordable. The reason that open pit operations can exploit such low-grade deposits is because the picks and shovels historically used in mining have been replaced by powerful machines that can gather more than 40 tonnes of material in one scoop and in five minutes can load a 200-tonne capacity truck. By moving waste rock and ore more quickly and efficiently than ever before, it is now possible to mine extremely low-grade ores and still make a profit.

Waste rock dumps

As shown in the table above, the area covered by waste rock dumps associated with underground mines can be quite small relative to open pit operations. One reason is that ore is of a higher grade, so less waste rock is stripped away. Also, the wastes generated in underground operations often are put back into shafts, tunnels, and adits (this is called "backfilling). Backfilling serves a dual purpose of reducing surface wastes and providing structural support underground.

Open-pit mines produce about fifty times more solid waste than underground mines.

In general, open-pit mines produce about fifty times more solid waste than underground mines.[5] The Canadian Mining Journal annual review (1981), reported that waste rock represented 60% of all material extracted at 18 Canadian open-pit mines. In the same survey, of the 49 underground mines responding, one third reported no waste rock lifted to the surface, whereas the remainder reported that only six percent of all the material extracted was waste rock.

Photo 10. Waste rock dumps at Highland Valley copper mine

Tailings impoundments

Tailings ponds or impoundments can cover extremely large areas, sometimes spanning the entire width of a river valley.

In the old days, tailings were dumped onto land or directly into streams. Flowing water would wash the wastes downstream, making room for more tailings to be dumped. This practice contaminated water and stream sediments, clogged irrigation channels, killed organisms directly, or destroyed the habitat of fish and other aquatic organisms.

Today, mines in North America are not permitted to dump tailings into rivers or the ocean. In rare cases, tailings have been dumped into Canadian lakes, e.g., Eskay Creek. But this practice is highly controversial because of the lack of long-term studies on the potential for metals leaching from the wastes. The US Environmental Protection Agency currently prohibits discharge of tailings into US waters.[6]

As a result, tailings must be impounded on the surface. Many tailings facilities hold millions of tonnes of semi-liquid wastes. They range in size from small ponds, to huge impoundments that cover areas 50 square kilometres.

Photo 11. Tailings impoundment filling a river valley

iii. Roads

Some of the most significant direct and indirect impacts of mining result from the construction of exploration and mining roads. Not only do they physically disturb the soil and vegetation, but they also lead to a host of other impacts, which are discussed in greater detail below. Depending on the size of the roads and the characteristics of the area where they are being built, impacts from roads can be minimal or they can completely transform an area, e.g., by paving the way for further industrial development.

Impacts Related to Disturbance

Land disturbance caused by mining can affect wildlife and vegetation in a number of ways. Also, mining can cause dramatic changes to landscapes through erosion; downward shifting or sinking (*subsidence*) of the land; or the creation of permanent scars such as open pits.[7] And the impacts to land can extend far beyond the perimeter of the mine site.

Impacts to land can extend far beyond the perimeter of the mine site.

1. Impacts on wildlife

Many mines in BC are located in remote mountainous terrain that provides habitat to a variety of fish and wildlife species. As shown in the table above, mining operations can require a great deal of land ranging upwards to open-pit mines that cover 25-100 km^2. The creation of an industrial operation on the land can easily displace wildlife, forcing animals to abandon the area or use it only as a migration route.

The major impact on wildlife comes from the construction of roads into previously unroaded areas.

> *"Over the last few decades, studies in a variety of terrestrial and aquatic ecosystems have demonstrated that many of the most pervasive threats to biological diversity – habitat destruction and fragmentation, edge effects, exotic species invasion, pollution and overhunting – are aggravated by roads . . . In short, nothing is worse for sensitive wildlife than roads."*[8]

Nothing is worse for sensitive wildlife than roads.

Roads alter wildlife habitat; act as barriers to wildlife movement; cause changes in animal behaviour, such as out-migration; increase mortality from roadkill, hunting and illegal poaching; and, as mentioned in an earlier section, contribute to the degradation of water quality and loss of fish habitat.

Habitat loss and fragmentation

- All mine sites and access roads occupy areas that were previously wildlife habitat.[9] In many cases, the elimination of small areas of habitat is not a serious matter, but in other cases, it can be extremely detrimental to wildlife.
- When roads and mine sites slice through formerly unbroken habitat areas, they can affect the ability of animals to hunt, find cover or den. An ongoing study in B.C. has found wolverine den sites exclusively in roadless drainages.[10]
- Mine sites and roads divide wildlife habitat into fragments. This can lead to disruption of animal calving/rearing grounds, important forage areas, and animal migration corridors. Some species have traditional patterns, which, if interrupted, can lead to

permanent abandonment of their range. The move may lead to a permanent reduction of the population size, or perhaps the elimination of that particular group of animals. This has been particularly well documented in the case of mountain sheep.[11]

- Many roads and trails follow valley floors and floodplains of watercourses, because the soil conditions and level terrain make construction in these locations relatively easy and inexpensive. These valleys are productive ecosystems and many are key winter ranges for moose, caribou, many furbearers and small game species.

- South-facing slopes are also preferred for road construction, because of their relative lack of permafrost. Such slopes are often winter ranges for sheep or goats because these areas usually have less severe snow conditions than other slopes, hence creating more optimal habitat due to superior thermal regime and availability of vegetation. Many of these winter ranges are associated with mineral licks, which constitute another critical habitat feature – and their destruction should be prevented.

Barrier to movement

Wildlife often have an avoidance response to vehicles and other forms of human activity, e.g., noise created by heavy machinery. Although some species become increasingly tolerant to some human activities, this does not always occur.

Studies have shown that lynx generally will not cross openings greater than 30 metres,[12] and bobcats avoid roads and habitat within 100 metres of roadsides.[13]

- When the Omineca mine road was built in northern BC in the late 1970s, slash barriers along the road led BC fish and wildlife branch officers to dub it a 'moose trap'. There was also concern that the piled up slash was interfering with migration of caribou herds "as effectively as a barbed wire fence." BC Wildlife Federation spokesperson Les Story cautioned, "when you break up a migration corridor for a herd of caribou, you're signing its death warrant."[14]

Increased wildlife mortality

In high-density wildlife areas, roads can result in high numbers of vehicle wildlife collisions, and direct mortality from collisions can devastate populations, especially when they are few in number or isolated geographically.[15] Roads also create an obvious source of mortality from trapping, hunting or poaching due to easy motorized entry into previously inaccessible areas.

- At the Kemess mine, the presence of 300-500 construction and mine workers during mine development posed a threat to the vulnerable bull trout populations in nearby streams. Even though there was a NO ANGLING/HUNTING rule for all mine employees, contractors and visitors in the Environmental Assessment Project Approval Certificate, incidents of fishing were "rampant."[16]

Underground openings pose a hazard to human and wildlife if not properly fenced off during operations or permanently sealed off when the mine closes.

2. Impacts on vegetation

Roads leading into mine sites also impact vegetation through the introduction of non-indigenous (*exotic*) plants and animals; increased predation and parasitism on forest interior species; and high road densities may threaten timber productivity through erosion and soil nutrient losses.

3. Erosion

In an undisturbed ecosystem, trees and vegetation help to regulate the flow of water within the environment. The plants, themselves, act as temporary storage areas for water, and they help to soften the impact of rain as it falls to the ground. Furthermore, the roots and organisms associated with roots form cavities and air pockets in the soil so that when it rains the water is absorbed into the earth.

When trees and vegetation are removed, two major changes take place: erosion increases, and runoff increases.

1) Increased erosion: without the vegetative covering, topsoil can be easily washed away.

2) Increased runoff: without the absorptive capacity of the vegetation, the amount of precipitation hitting the earth often exceeds the absorptive capacity of the soil. This leads to an overflow of the system – more water remains on top of the soil, and gravity takes over, carrying the water and soil downhill, where it eventually is absorbed by the soil or runs off into a stream.

The impacts of erosion can be problematic at a mine site. Water flowing through waste rock and earthen piles can also lead to erosion and destabilization slopes, causing landslides and mudslides. Slides cause vegetation and soil damage, and can threaten water quality and worker safety.

The construction of roads can increase erosion by:

The construction of roads can increase erosion.

- disrupting groundwater flows due to compaction of the roadbed;
- concentrating water in culverts and channels. If improperly designed these can burst and cause flooding and erosion; and
- increasing runoff and sediment transport due to the compacted, impervious nature of the road surface; or as a result of poorly designed and constructed roads.

All of these events increase erosion and result in increased sedimentation and turbidity of the receiving waters. As mentioned in Chapter 5, pages 142-145, sediment in water can kill fish and aquatic organisms.

In addition to sediment being a water pollutant, it can also have an impact on the land. If there is a heavy sediment load to a stream, the stream channel may begin to fill in. This can increase the chances of flooding since the same amount of water is flowing through a smaller channel. If the frequency of floods increases, the vegeta-

tion along the riverbanks may die off, which, in turn, may lead to increased erosion of stream banks.

4. Subsidence and openings to underground

Sooner or later, most underground mines produce sinkholes or other forms of subsidence that are noticeable at the surface. Occasionally, surface cracks or *fissures* may develop.[17] These effects are greatest for underground mining of shallow, bedded deposits and least for deep, massive, hard-rock mines.

- At the Cominco Sullivan Mine located near Kimberly, BC, land subsidence is one of the many problems that the company has to deal with. The removal of supporting pillars in the mine has resulted in subsidence, i.e., the collapse of surface land above the underground mine shafts. Surface cave-ins, up to 120 m in diameter and 45 m in depth, some of which open to the underground, have meant that parts of the site have had to be fenced-off for decades, and will continue to be fenced indefinitely. Reclamation of these areas will not be possible until the land stabilizes, at some point in the future. Subsidence is expected to affect 105 hectares of Cominco's land that has the physical capability for moderate yield forests.[18]

5. Cumulative impacts

There is a perception among some industry and government agencies that mining impacts are confined to a small area.[19] While it is true that some mine sites do not occupy large areas, a mine's sphere of influence can be far-reaching; the 'footprint' of a mine is more than what is clearly visible. The infrastructure required to service a mine can significantly increase the range of land disturbance and impacts.

As the following quote illustrates, the mine site is at the centre of a complex web of energy, water, processing and transportation infrastructure.

> What harm is a ten acre mine in a park of 500 000 acres?

> *"Let me tell you about a 10 acre mine in one provincial park. This requires a hydro-electric power development (or power poles into the park), a tailings disposal site, a mining mill site, mill effluent disposal sites, many roads, a camp, barge shipping and tugs on a major lake, loading-out works, then a highway through the park (along water grades) all for just a starter. That 10 acre hole influences 100,000 acres of the choicest part of the park."*[20]
>
> – Bob Ahrens, former parks director for Strathcona Park

The disturbance caused by one mine, or one road into a mine, can have devastating impacts on a regional scale.[21] When a road is built into a previously unroaded area, it increases the likelihood of further development in the area. There is a tendency for wilderness roads and trails to be extended beyond their original destination by increments. For example, during exploration, trails are often built laterally from an initial access route. While a network of trails may be a benefit for mineral exploration purposes, wildlife populations in the area become susceptible to overharvesting, and the effects upon the landscape escalate in proportion to the amount of area covered.[22]

If there are a number of mining operations in a watershed, the disturbance caused by those operations, in addition to any other activities such as agriculture or logging, can significantly alter the landscape. Similarly, the contaminants entering a stream from a single mining operation may not have a significant impact on aquatic life, but if several operations are dumping metals or chemicals into the same stream there may detrimental effects. Consequently, it is important to evaluate the potential impacts of a mining operation in the context of the developments that presently exist or may occur in the future.

b. Minimization of Impacts to Land

If land disturbance, and its effects on wildlife and vegetation, is a primary concern, there are some things to consider:

- If there is an option, albeit more expensive, of using underground mining methods, this is obviously a much less intrusive method.
- There are likely to be cases where the land, and the life that the land supports, are far more valuable to a community than the minerals and metals that lie beneath the surface (and any economic spin-offs that a mining development might offer).

To avoid long-term problems of unsightliness, erosion and sedimentation, reclamation of disturbed land areas and tailings disposal sites should be initiated far in advance of mine closure. In BC, laws requires that exploration sites be reclaimed after exploration ceases. Reclamation ideally involves a long-term land-use plan established before the mining operation is carried out.

i. Planning for Closure and Reclamation

Site reclamation should be happening while the mine is operating.

When creating mining and waste handling plans, closure and reclamation should be in the forefront of a developer's mind. Ideally, some site reclamation should be happening while the mine is operating.

Proper mine planning can minimize greatly the amount of waste that is deposited on the surface, and can decrease the potential for contamination from wastes after the mine is closed. For example, the concepts mentioned in Chapter 5, pages 148-159 (Managing Wastes to Reduce the Risk of Water Contamination) can make reclamation much easier and less expensive than if wastes are not carefully managed during the mining process.

The ideas proposed in reclamation plans should be carefully examined for feasibility – bearing in mind that the effectiveness of different techniques is influenced by site-specific topography, soils and climate. Techniques for remediating land surfaces disturbed by mining usually include regrading, recontouring, and revegetation.

Planning to minimize road impacts

Reclamation of roads is generally much easier than the reclamation of areas disturbed by mining operations.

The ease of reclamation activities will depend, to a large part, on how well the road was designed and constructed to begin with.

The primary goals during road building should include:[23]

- minimizing the area that will be cleared or stripped through careful planning
- minimizing the disturbance to native vegetation and soils when disturbance cannot be avoided
- reducing or preventing problems of erosion by revegetating areas disturbed during road construction

Revegetation of a disturbed area may occur naturally. If seeding and fertilization are necessary, consideration should be given to the timing of the operation so that the probability of seedling survival is high.

Roads can be designed to drain water as quickly as possible in a way that minimizes erosion. Erosion control filter fabrics can be used on sections on roads where erosion is a potential problem. Structures can be constructed to divert water away from disturbed areas. Sediment filter fences, however, need to be continually maintained to ensure that they remain effective. Straw bales, which are sometimes used to catch sediment, can create their own pollution by producing a natural acid (*tannic acid*), so their use should be carefully monitored. Settling ponds or "catchment" basins can capture sediment runoff before it reaches surface water.

Photo 12. Sediment filter fences not working

Waste Rock and Tailings Impoundments

Tailings and waste rock dumps can be reclaimed by capping them with clay, covering the cap with topsoil and re-establishing vegetation. Proper shaping and revegetation of waste impoundments is important. Waste rock and tailings piles should be regraded and contoured into gentle slopes, because steep-sided waste piles are particularly vulnerable to erosion.

Unfortunately, topsoil can be difficult to come by in areas of thin soils. Therefore, efforts must be made to conserve and protect any topsoil removed during the mining process so that it can later be used to revegetate the site.

The land should be re-seeded with native species of grasses, shrubs and trees. Because native species are better adapted than imported species to a local climate and soil conditions, they will establish themselves more effectively on reclaimed land.[24]

Establishing a covering of plants on mined land can be challenging; mine wastes often lack nutrients necessary for plant growth, or they are toxic to plants because of their high acidity and metals concentration; lack of nutrients. Thus, efforts to revegetate tailings can be expensive and often unsuccessful in severe climate conditions sometimes experienced in mountainous and northern environments. The cost of stabilizing tailings impoundments to prevent wind and water erosion and

spread of tailings can be as high as $410,000/ha, or an average of $200,000/ha.[25]

Reclamation of potentially acid generating (PAG) materials

The following are some suggestions to decrease the chances that potentially acid-generating materials will create long-term water quality problems:

1) segregate from other wastes while mining is occurring;

2) isolate from air and water;

3) create dump slopes and tailings impoundment banks that are at a 3:1 angle or less;

4) incorporate lime into dumps and tailings to help neutralize reactive sulphides;

5) cover the entire surface of the dump and tailings areas with a neutral rock cap that does not contain acid generating material. The rock cap acts as a barrier between the reactive sulphides and the top soil covering. The cap, therefore, must be of a sufficient depth of at least a metre to prevent oxidation;

6) add sufficient topsoil to create a medium to grow vegetation. Species that are native to the area and/or have the ability to stabilize top soil (keep it from eroding) and absorb moisture should be planted.

Open pits and underground workings

Pits are generally left "as is." For most of the metal mines in BC, there is no requirement to reclaim pits where the walls are sheer rock. There is no requirement to attempt to return the open pit to its pre-mining contour or topography, e.g., by backfilling the non-acid generating wastes, covering them with topsoil and revegetating the backfilled materials. As a result, recontouring of pits is rarely done, because no mining company wants to invest in moving waste materials; especially at the end of the mine life, when no more income in being generated from the mine.

In-pit disposal of waste rock and tailings should be considered when the waste materials are non-acid generating. This will decrease the land surface disturbed by waste rock piles, and will perhaps provide a vegetated surface and more aesthetically pleasing shape to the pit.

The backfilling of underground mines is a fairly common practice, and a good one, since it tends to reduce subsidence effects.

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Chapter 7
Environmental Regulation of Mining Activity and Reclamation

7. Environmental Regulation of Mining Activity and Reclamation

As discussed in chapter 3, the province has little discretion to refuse to allow mineral exploration and development. The province does however, regulate the manner in which mineral exploration and development are carried out. Location and staking of claims is subject to limited regulation, while construction and operation of mines is more closely regulated.

As discussed in the previous chapter, the use of land during mine exploration and development may be quite extensive, and could cause environmental damage. The *Mines Act* and the Health, Safety and Reclamation Code for Mines in British Columbia (the "Mines Code") are the main pieces of legislation that regulate mineral exploration and development.

Other legislation requires permits for discharges of contaminants or harmful substances and regulates activities such as the construction of mines.[1] Environmental assessment legislation requires an examination of the effects of mine projects before they are approved.

a. The Mines Act and the Health, Safety and Reclamation Code

Section 10 of the *Mines Act* requires a miner (including owners of Crown-granted mineral claims) to obtain a permit from the chief inspector prior to commencing any mechanical disturbance of the ground, excavation, exploratory drilling, processing or waste disposal. As part of the application, the mining company must file with the district inspector a plan outlining the details of the proposed work and a program for the protection and reclamation of the land and watercourses affected by the mine. The Ministry of Energy and Mines consultation policy requires consultation with First Nations in this permit process, and, therefore, this stage offers an opportunity to influence the mine development and

Section 10 of the Mines Act *requires a permit prior to commencing any mechanical disturbance of the ground, excavation, exploratory drilling, processing or waste disposal.*

protection and reclamation requirements (see Chapter 8).

Some of the things the miner must outline in the plan include:[2]

Plan requirements.

- a map showing the location of the mine property;
- a plan showing topographic contours, claims, leases, licenses, lakes, streams, buildings, roads, and the locations of all proposed mining undertakings and related facilities;
- descriptions, design data and details of the geology and ore reserves, surface mining, roadways, material handling, overburden and waste rock dumps, stockpiles, processing plant and facilities, buildings, tailings transportation and impoundment, and water systems and storage facilities;
- methods to be followed in constructing haulage roads;
- a traffic control plan;
- detailed maps of present and proposed underground workings; and
- a plan of surface installations in relation to the proposed or actual mine openings.

Also required in the plan for approval of mineral exploration, placer mining, sand and gravel pits and quarries, is:

- a map,
- airphoto or
- airphoto overlay showing proposed work and reclamation, and for underground work:
- an Application for Approval of Underground Exploration Work, and
- a detailed map of the present and proposed underground workings and surface installations.

Plan requirements for hardrock mines.

For proposed coal and hardrock mines, major expansions or modifications of existing producing mines, large pilot projects and bulk samples, and, if required by the chief inspector, for hardrock and placer mineral exploration, placer mines, and sand and gravel pits, the plan must include[3]:

- a map or airphoto showing the location and extent of the mine, and the location of lakes, streams, and inhabited places in the vicinity of the mine;
- particulars of the nature and present uses of the land to be used, with particular reference to[4]:

Particulars of the nature and present uses of the land.

- land ownership, including surface and mineral rights, licensed users including guides, outfitters, trappers,
- climate,
- geology and description of the deposit,
- surface water and groundwater, including drainage, water quality, licensed water rights, hydrology and fisheries,
- groundwater, including water quality and hydrology,
- vegetation,
- wildlife, and
- land capability and present uses, such as agriculture, forestry and recreation;

Land capability and present uses.

- particulars of the nature of the mine and the extent of the area to be occupied by the mine, including:
    - description of the mine and processing plant,
    - development schedule,
    - waste disposal, including tailings, waste rock, and overburden,
    - prediction of acid generation,
    - stockpiling of surface soil materials,
    - protection of watercourses, including prediction of effluent quality for all disturbances,

- drainage control, monitoring and maintenance,
- surface development and areas disturbed to date, projected over the next five years and projected over the life of the mine, and
- source and use of any water required in the operation;

Program for the protection and reclamation of the land and watercourses.

- a program for the protection and reclamation of the land and watercourses during the construction and operational phases of the mining operation, with particular reference to environmental monitoring and surveillance, and a detailed reclamation program for the next 5 years;
- a conceptual final reclamation plan for the closure or abandonment of the mine; and
- an estimate of the total costs of outstanding reclamation obligations over the planned life of the mine, including costs of long term monitoring and abatement.

The company must prepare and submit for acceptance to the chief inspector, a plan for dumps, roads or ramps to be constructed as part of a dumping operation, and must ensure that construction is in accordance with the plan.

First Nations may be members of Regional Mine Development Review Committees.

An overseeing advisory committee and regional advisory committees review applications for mine approvals and reclamation permits, and make recommendations to the chief inspector or district inspector.[5] Regional advisory committees are called Regional Mine Development Review Committees ("RMDRCs"). They are inter-governmental, and include representatives of both federal and provincial agencies. Only sensitive exploration projects are referred to local RMDRCs. First Nations may be invited to be members in RMDRCs for projects that could potentially affect their rights. If a First Nation is aware of a potential mine development in their territory and have not been invited to participate in the RMDRC, they may with to ensure that their nation is represented.

As discussed in the case study in Appendix A, the Tahltan First Nation benefit from participating in the B.C. Northwest Mine Development Review Committee, a process that allows them to act proactively rather than reactively. They formed the Tahltan Advisory Group on Mining ("TAG") to address mining issues and ensure that the Tahltan leadership and community are fully informed about mining developments.

Participation in an RMDRC.

First Nations are entitled to be consulted separately, and participation in an RMDRC should not be a substitute for separate consultation if necessary. Further, participation in an RMDRC can provide the First Nation with useful viewpoints and information, and allow them to find out if other agencies (e.g., DFO or the provincial Ministry of Environment) have concerns about the proposed development or agree with their concerns.

Participating in the permit process.

Participating in the permit process can be useful, because section 10(3) of the *Mines Act* allows the chief inspector to issue a permit on conditions the chief inspector considers necessary, which can include security for mine reclamation (including a requirement for yearly deposits), environmental protection, and mitigation of damage to watercourses affected by the mine.[6] If the mining company fails to carry out the reclamation program, or fails to comply with the terms of the permit, the chief inspector can cancel the permit and order the company to stop the mining operation. If necessary, the chief inspector can require review of the permits once a year and make changes to the conditions of the permit at any time with or without an application.

If the mining company fails to carry out the reclamation program, or fails to comply with the terms of the permit, the chief inspector can cancel the permit and order the company to stop the mining operation.

The Kemess South case study (see Appendix A) demonstrates the danger of not requiring companies to give adequate security. If adequate security is not required, the company may lack financial resources to carry out reclamation, protection and mitigation requirements.[7]

If adequate security is not required, the company may lack financial resources to carry out reclamation, protection and mitigation requirements.

If a mine is proposed in a First Nation's territory, the First Nation can seek to ensure that the plan is adequate and that sufficient conditions are included in the permit in order to protect important values and resources, and that sufficient security is required if potential damage to watercourses exists. Your Nation may want to hire a

consultant familiar with mining plans to review the plan with them. Once the mine is in operation or under construction, the First Nation can notify the chief inspector of mines if they suspect the company is not complying with the permit or carrying out the remediation program.

The company must maintain working plans at the mine site.

The company must maintain working plans at the mine site and update these plans every three months. Periodic reviews of the plans may reveal changes, resulting in potential implications for land and water.[8] Working plans include a surface plan showing the claims, licenses or leases on which mining is being carried out, and all lakes, watercourses, naturally unstable ground, main roads, railways, power transmission lines, shaft openings, adits, surface workings, dumps, dams, tailings ponds and their overflow channels, and topographic contours. For underground mines, a separate underground plan for each level must show all workings, including shafts, tunnels, diamond drill holes over 7m long, dams, bulkheads, electrical substations, explosives storage, shop areas, and permanent seals and stoppings.

Part 9 of the Mines Code seeks to:

- ensure the stability of major dams, dumps, fills, and piles of rock or overburden;
- ensure the security of major waste deposits and major impoundments or reservoirs at mine sites, and;
- includes provisions for controlling surface runoff and infiltration into the ground.

Tailings, impoundments, dams, waste dumps and deposits.

A mining company must obtain a permit to construct a major impoundment, dam, or waste dump, and may not commence work on a major waste dump, dam, or impoundment without the chief inspector's written acceptance. All major waste emplacements and major impoundments must comply with specifications established by the chief inspector. Permission of the district inspector is required before operating a tailings impoundment or major water-controlling dam. Prior to the abandonment of any impoundment, dam, or waste

dump, the chief inspector must be satisfied as to the long-term stability of exposed slopes.

Reclamation standards.

The Mines Code prescribes reclamation standards as well. The Code, while setting out standards, does allow for leeway in carrying out many reclamation activities, at the discretion of the chief inspector of mines. Reclamation generally must be carried out to "a standard acceptable to the inspector". Some of the reclamation requirements are as follows:

a) The company must reclaim the land surface to an acceptable use that considers previous and potential use.

The company must reclaim areas to a level of productivity equal to that existing prior to mining unless it is impractical to do so.

b) The company must reclaim areas to a level of productivity equal to that existing prior to mining unless it is impractical to do so.

c) The company must leave land and watercourses in a stable condition.

d) The company must re-vegetate land to a self-sustaining state using appropriate plant species. Surface soil material removed for mining is saved for use in reclamation programs unless this objective can be otherwise achieved.

e) Prior to abandoning the mine, the company must remove all machinery, equipment and building structures, cover and revegetate concrete foundations, and dispose of scrap material.

The company must reclaim waste dumps.

f) The company must reclaim waste dumps to ensure:

- long-term stability, erosion control, and water quality, and
- achievement of land use and productivity objectives.

The company must reclaim watercourses.

g) The company must reclaim watercourses to:

- ensure maintenance of long-term water quality,
- restoration of drainage to original watercourses or new ones which will sustain themselves without maintenance, and

- achievement of use and productivity objectives that are no less than existed prior to mining unless the chief inspector is satisfied that achieving that level of use and productivity is impractical.

h) The company must reclaim pit walls. Pit walls constructed in overburden are reclaimed in the same manner as waste dumps. Pit walls constructed in rock or steeply sloping footwalls need not be revegetated. Pit wall seepage may require treatment to ensure acceptable water quality. Where the pit is free from water, and safely accessible, vegetation is established. Where the pit floor will impound water, provision is made to create a body of water where use and productivity objectives are achieved.

The company must reclaim all tailings ponds and impoundment structures.

i) The company must reclaim all tailings ponds and impoundment structures to the approved land use. A permanent spillway must be installed prior to final abandonment of the tailings dam. Dry tailings are covered with soil to decrease windblown wastes from contaminating the surrounding area.

Unless maintenance of permanent access is required, the company must reclaim all roads.

j) Unless maintenance of permanent access is required, the company must reclaim all roads.[9]

k) The company must monitor vegetation for metal uptake, and where harmful metal levels are found, reclamation procedures must ensure that levels are safe for plant and animal life.

l) The company must dispose of toxic chemicals that cannot be returned to the manufacturer.

Potential acid generating material.

m) The company must place all potential acid generating material in a manner which minimizes production and release of acid mine drainage to a level that assures protection of environmental quality.

The chief inspector can specify monitoring programs.

The chief inspector can specify monitoring programs that the company must undertake to demonstrate that reclamation objectives including land use, productivity, water quality and stability of structures are being achieved. First Nations may be able to convince the chief inspector to require their involvement in such programs. Also,

First Nations could seek to ensure that reclamation objectives affecting First Nations use of the lands, water or wildlife and fish in their territory are met, and to ensure adequate monitoring.[10]

At least 30 days before commencing exploration work for which a permit under the *Mines Act* is required, the miner must apply for a permit. The chief inspector of mines has the discretion to require an application to be published in local newspapers. Any person affected or interested in the application has 30 days from the last day of publication to view the application and make written representations to the chief inspector.

Surface work on the property may not commence without approval of the district inspector. Before a mining company can undertake underground exploration work, the company must obtain the approval of the district inspector. If it is likely that mechanical disturbance during exploration will expose acid material, the company must undertake acid generation tests. If the results show that acid generation can occur, all potential acid-generating material must be placed in a manner which minimizes production and release of acid mine drainage to a level that assures protection of environmental quality.

All potential acid-generating material must be placed in a manner which minimizes production and release of acid mine drainage.

The *Mines Act* does not provide a process for appealing permit decisions or orders made by the chief inspector, in contrast to, for example, the *Waste Management Act*, which allows appeals to the Environmental Appeal Board. Permit decisions can be challenged by commencing judicial review proceedings in court.

Under the *Mines Act*, if an abandoned or closed mine poses a danger to people or property, or is a source of pollution of lands or watercourses, an inspector can enter the mine and order that work be done to remove or alleviate the danger or remedy the pollution. The owner of the mine will be responsible for reimbursing the government for the cost. If a First Nation suspects that an abandoned or closed mine is causing damage to their territory or people, they can advise the inspector.

If an abandoned or closed mine poses a danger or is a source of pollution, an inspector can enter the mine and order that work be done.

Failure to comply with the *Mines Act* or the Mines Code is an offence punishable by fine or imprisonment.

i. Application of the Mines Act and the Health, Safety and Reclamation Code to Aggregates[11]

Report of the Aggregate Advisory Panel.

Gravel pits and quarries subject to the *Mines Act* are subject to the *Health, Safety and Reclamation Code for Mines in B.C.* ("Mines Code"). No written description of the current *Mines Act* permitting process for aggregate operations is readily available. The recently released report of the Aggregate Advisory Panel noted that many stakeholders felt excluded from *Mines Act* permitting process and were concerned about inadequate public notice, the lack of opportunities to review technical information and the lack of an avenue to publicly discuss proposed mines.[12]

Note that the Aggregate Advisory Panel heard from many stakeholders who thought that the MEM does not adequately enforce the *Mines Act* and related permits. In speculating about the reasons for this perception, the panel noted:

> "limited resources that Ministry of Energy and Mines can designate to aggregate operations at any one particular time, the discretionary nature of enforcement, the fact that inspectors' orders are not published, the Ministry's preference to make orders and negotiate solutions rather than take court action, and the lack of authority under the *Mines Act* to issue monetary penalties."[13]

The more detailed requirements for a mine plan specified in section 10.1.2 of the Mines Code will not apply to a gravel mine unless specified by chief inspector.

Part 12 of the Mines Code deals with sand and gravel mines.

Part 12 of the Mines Code deals specifically with sand and gravel mines. This brief part specifies the applicability of the Mines Code to intermittently operated gravel pits, the requirement for occupational health and safety committees and provisions for visual instead of audible alarms on mobile equipment.

Unlike coal and hardrock mineral mine proposals, applications for aggregate operations are not required to be referred to a Regional Mine Development Review Committee. Many aggregate operations proceed through MEM's conventional referral process.

Not required to be referred to a Regional Mine Development Review Committee.

Commercial aggregate operations within the Agricultural or Forest Land Reserves require prior approval of the Land Reserve Commission under the *Soil Conservation Act* or the *Forest Land Reserve Act*. The applicant must demonstrate that the proposal will result in equivalent or enhanced site productivity upon completion.

b. The Waste Management Act

The *Waste Management Act* requires miners to obtain permits or approvals for discharging waste or pollution. The Minister designates regional waste managers, who are responsible for issuing permits allowing a mining company to introduce waste into the environment. When issuing a permit, the manager can:

Permits or approvals are required for discharging waste or pollution.

- impose requirements to repair, alter, improve or add works, or to construct new works;
- require the mining company to give security;
- require the mining company to carry out monitoring;
- require the mining company to conduct studies; and
- specify procedures or requirements regarding the handling, treatment, transportation, discharge or storage of waste.

Approvals are temporary (up to 15 months), and can be subject to the same types of requirements as permits.

A First Nation can appeal a decision to issue a permit or approval to the Environmental Appeal Board. To do so, they must commence the appeal within 30 days after notice of the decision.

The decision to issue a permit or approval can be appealed to the Environmental Appeal Board.

The *Waste Management Act* requires mine owners to provide a site profile to a district inspector when applying for a permit or revisions to conditions of an existing

Site profile.

permit under s. 10 of the *Mines Act*, and when giving notice of intention to stop work before abandonment. The approving officer or district inspector assesses the site profile and may forward it to a manager to determine if a site investigation is required. If the manager suspects that the site may be contaminated or contains substances that may cause or threaten to cause adverse effects on human health or the environment, the manager can then order the mine owner to undertake a site investigation and submit a report to the manager. After reviewing the report, the manager determines whether the site is contaminated.

Determining whether a site is contaminated.

A manager can issue a remediation order with respect to a contaminated site. The order can require the mining company to:

A manager can issue a remediation order.

- undertake remediation;
- contribute, in cash or kind, towards another person who has reasonably incurred costs of remediation; and
- provide security.

A manager can also order a company to:

- abate pollution;
- acquire, construct or carry out works or measures necessary to prevent, control, abate or stop the pollution; and
- carry out remediation in accordance with any criteria.

The Minister can declare that it is necessary for protection of human health or the environment for government to undertake remediation at a contaminated site that is not being adequately remediated, or at a high risk orphan site.[14] The Minister can then carry out remediation and recover the costs from the miner.

Government can undertake remediation at a contaminated site that is not being adequately remediated and recover the costs from the miner.

An officer (designated by the director of waste management, or a conservation officer under the *Environmental Management Act*) can enter a mine or mine property to investigate any process, work or activity that:

- produces or is capable of producing waste;

- causes or may cause pollution; or
- is used to store, handle, treat, destroy or dispose of waste.

Suspension or cancellation of an approval or permit.

The Minister or a manager can suspend or cancel a permit or approval if the permit holder fails to:

- complete construction of works specified in the permit;
- comply with terms of the permit or approval;
- comply with an order issued under the *Waste Management Act*; or
- comply with any requirements of the *Waste Management Act*.

Suspension or cancellation of an approval or permit effectively shuts down the mine.

c. The Environmental Management Act

The Minister can declare that a work, undertaking or resource use has a detrimental impact, and can make an interim order.

This Act gives the Minister of Environment, Lands and Parks broad powers to declare that an existing or proposed work, undertaking or resource use has, or potentially has, a detrimental environmental impact. The Minister can then make an interim order for up to a fifteen-day period:

(a) restricting, modifying or prohibiting the operation of the work or undertaking, or the use of the resource, or

(b) generally requiring the person to do anything that the Minister requires to be done with respect to the work or undertaking, or the use of the resource.

The provincial cabinet may, whether or not an interim order has been made or has expired, make an order either permanently or for a specified period:

(a) restricting, modifying or prohibiting the operation of the work or undertaking, or the use of the product or resource, or

(b) generally requiring the person to do anything that the provincial cabinet requires to be done with respect to the work or undertaking, or the use of the product or resource.

We are not aware of any examples of this Act being used, but it is worth keeping in mind in the event that a First Nation suspects a mining activity is damaging their territory.

d. The Water Act[15]

As noted in Chapter 5, large quantities of water can be consumed during mineral production. The *Water Act* requires miners to obtain a license to do any of the following:

- divert and use a quantity of water;
- store water;
- construct, maintain or operate works necessary for diversion, storage, carriage, distribution and use of water; or
- alter a stream or channel.

A free miner may divert water for prospecting purposes without first obtaining a permit.

A free miner may divert water for prospecting purposes without first obtaining a permit if the water is unrecorded (i.e., the right to the use of the diverted water is not held under a license).

A licensee, applicant or "riparian owner" may file an objection to issuance of a license.

A licensee, applicant or "riparian owner" may file an objection to issuance of a license. A riparian owner is an owner of lands adjacent to, or beside, a body of water. Although the *Water Act* abolished riparian rights in British Columbia, provincial legislation cannot extinguish aboriginal or reserve rights. Arguably, therefore, a First Nation whose reserve is adjacent to the affected body of water should qualify as a riparian owner, and a First Nation with an unrecognized (by the Province) aboriginal title is also, arguably, a riparian owner, although the government bureaucrat (the comptroller or regional water manager) may decide otherwise. Even if no objections are filed, the comptroller or water manager may

refuse the application or part of it, require additional plans or information, require security, or issue a conditional license. Even if a person does not fall within the list of persons who can officially file an objection, they can still, therefore, object by writing to the comptroller or water manager responsible for granting or refusing the application.

The comptroller or water manager may refuse the application or part of it, require additional plans or information, require security, or issue a conditional license.

i. Notice and Appeal Process for Parties Affected by the Granting of a License[16]

For any application for a water license, a notice must be given to various interested parties as set out in the Act. Interested parties may include other license holders, potential applicants, or landowners whose land or property is situated along the same watercourse. Additionally, other interested parties who may be affected by the application include federal and provincial government agencies (such as the Ministry of Fisheries), and local or municipal governments. Any of these parties who feel that their rights may be prejudiced by the granting of the water license may file objections.

Whether or not the objection warrants a hearing is then determined by the Comptroller of Water Rights, who is authorized to deal with the issue under the Act. If the license is issued over the objections of any affected parties, there are further appeal processes available. An appeal can be taken to the B.C. Environmental Appeal Board, providing it is completed within 30 days after the decision to grant the water license was made. Note that members of the general public do not have rights to object to the granting of water licenses. Only parties who are either license holders, riparian land owners (owners whose property is adjacent to or beside the waterway), or applicants for licenses, are permitted to file objections before the Environmental Appeal Board because the granting of the license may affect or prejudice their rights.

Whether or not the objection warrants a hearing is determined by the Comptroller of Water Rights.

ii. How First Nations Can Object to Water License Grants[17]

If First Nations lands are located adjacent to, or beside waterways, under this provision of the *Water Act*, they would be included as an "interested party," whose rights may be affected by potential water license grants. The First Nation should provide written notice to the Comptroller of Water Rights or Regional Water Managers, indicating that you are "riparian land owners" and therefore have a right to be notified when any applications for water licenses are made that may prejudice your interests. If you object to the granting of any potential license, then you have the right to file an objection with the Comptroller of Water Rights. If the license is granted against First Nation objections, they can appeal the decision before the B.C. Environmental Appeal Board. But the appeal must be made within 30 days after the decision to grant the license is issued.

Decisions to grant licenses can be appealed to the Environmental Appeal Board.

e. The Fisheries Act

As discussed in Chapter 5, mining activity can have serious impacts on fish and fish habitat. The *Fisheries Act*, which is federal legislation, contains provisions that First Nations may invoke to protect fish and fish habitat from negative impacts caused by mining.

The Act prohibits the destruction of fish except as authorized.

Section 32 of the Act prohibits the destruction of fish by any means other than fishing except as authorized by the Minister or the regulations made under this Act.

The Act protects fish habitat.

Several provisions of the *Fisheries Act* seek to protect fish habitat. The *Act* prohibits anyone from carrying on any work or undertaking that results in the harmful alteration, disruption or destruction of fish habitat, unless authorized by the Minister of Fisheries or under regulations made under the *Fisheries Act*.[18] The *Act* also prohibits anyone from depositing or permitting the deposit of a deleterious substance[19] of any type in water frequented by fish or in any place under any conditions where the substance or any other deleterious substance that results from the deposit may enter any water frequented by fish. A person does not contravene this prohibition, however, if regulations (under the *Fisheries Act*

or another Act) authorize the deposit. Such authorizations typically specify the waste, pollutant or deleterious substance, the quantity under which the release is allowed, and conditions under which the discharge is permitted.[20]

Some release of waste or pollutants is permitted.

The Minister of Fisheries determines whether an existing or proposed work or undertaking results or is likely to result in alteration, disruption or destruction of fish habitat that constitutes or would constitute an offence under the Act, and what measures, if any, would prevent that result or mitigate the effects. The Minister also determines whether there is or is likely to be a deposit of a deleterious substance by reason of the work or undertaking that constitutes or would constitute an offence and what measures, if any, would prevent that deposit or mitigate its effects. If the Minister forms the opinion that an offence is being or is likely to be committed, the Minister may:

The Minister determines whether an offense is being committed and can require modifications or restrict the operation.

- require modifications or additions to the work or undertaking or modifications to any plans, specifications, procedures or schedules, or
- restrict the operation of the work or undertaking.

With cabinet approval, the Minister can close the work or undertaking.

A breach of prohibitions under the *Fisheries Act* is an offence and a person convicted of a first offence may be required to pay a fine up to $1,000,000. For subsequent offences, the court may impose a fine of up to $1,000,000, up to 3 years in jail, or both. Regulations under the *Fisheries Act* actually contains an incentive to lay a charge against persons or companies for committing an offence under the Act. If the provincial government or an individual lays the charge, half of any penalty imposed upon conviction is paid to the provincial government or individual. These sections have been used, and people have recovered half the penalty levied.[21]

If the provincial government or an individual lays the charge, half of any penalty imposed upon conviction is paid to the provincial government or individual.

The Metal Mine Liquid Effluent Regulations ("MMLER") were made under the authority of the *Fisheries Act*. These regulations apply to all new mines, expanded mines and reopened mines, except for gold mines. MMLER

The Metal Mine Liquid Effluent Regulations.

prescribes the following substances as "deleterious substances" for the purpose of the *Fisheries Act*:

- arsenic
- copper
- lead
- nickel
- zinc
- total suspended matter (non-filterable residue that results from the operation of a mine, that is contained in liquid effluent from the mine); and
- radium 226

MMLER authorizes the deposit of the above substances if the effluent does not exceed prescribed concentrations, or if the deposit is into a tailings impoundment area designated by the Minister of Fisheries and Oceans.

Failure to enforce existing regulations when the effect is to jeopardize fisheries relied upon by First Nations, may be a breach of the government's fiduciary responsibilities.

Unfortunately, though the MMLER has been in effect for almost 25 years, no charges have been laid against any company for violating the MMLER, although, according to MiningWatch Canada, as many as one in four active mines are out of compliance with the regulations.[22] This failure to enforce existing regulations when the effect is to jeopardize fisheries relied upon by First Nations, may be a breach of the government's fiduciary responsibilities.

If a substance is not listed in the MMLER and a First Nation knows or suspects that the substance is harmful to fish and being deposited into fisheries waters, the First Nation can ask the Minister to require the company to cease depositing the substance and/or obtain authorization for the deposit. If the company in question applies for authorization, the First Nation may wish to see any reports, and may wish to hire their own expert to conduct a study to determine whether the deposit is harmful to fish or fish habitat.

MMLERs are under review.

The MMLERs have been under review for some time, and the federal government has proposed changes.[23] Those changes include the addition of cyanide, used in

gold mining, and a requirement for an environmental effects monitoring (EEM) program at mine sites.

The changes proposed during the last session of parliament did not include the addition of mercury and cadmium.[24] A mine would therefore still be in compliance with the MMLERs although its wastewater, waste rock and tailings contain toxins such as cadmium and mercury, which are known to be a problem at many mine sites.

The amendments proposed during the last session also included a test for "acute lethality". The test would involve placing fish into mine effluent and monitoring how many die. If more than half the fish die, the effluent will not pass the MMLER requirements. Only rainbow trout are used in these tests, despite the fact that other species may be native to the waters into which the effluent is deposited or spilled.[25]

The MMLER does not include a legal tool to require a site-specific regulation to be developed and applied to a mine site where the EEM determines that the operation is damaging the environment.

f. Local Government Regulation of Aggregate Mines[26]

Unlike hardrock mines, aggregate operations are normally located close to where the material produced will be used, typically, close to urban centres. Because of this, local governments will often play an important role in decisions regarding aggregate operation sitings.

Municipalities can regulate or prohibit aggregate extraction.

The *Local Government Act* empowers municipalities to regulate or prohibit extraction of aggregate under a soil removal and deposit by-law. Soil removal and deposit bylaws prohibiting aggregate extraction must be approved by the Minster of Municipal Affairs with the concurrence of the Minister of Energy and Mines. As aggregate extraction is not considered to be a use of the land, it cannot be regulated under land-use zoning by-laws – soil removal and deposit by-laws are the only direct means for local governments to regulate the location of aggregate pits. They may be able to regu-

late associated activities, such as aggregate processing, through zoning bylaws, however. When issuing permits under the *Mines Act*, MEM may consider zoning requirements, but is not bound by them.

g. Environmental Impact Assessment

The purpose of environmental impact assessment legislation is to provide a process for assessing the environmental effects of a project before the project begins. A common complaint of the EA process from First Nations is that, in practice, the EA process never stops mines from operating, it merely ensures that minimum environmental standards are met.[27] Both a provincial and a federal environmental assessment process exist, and sometimes both processes will apply to the same project. (See, for example, the South Kemess Copper/Gold Mining Project case study, which highlights the need for adequate coordination between the provincial and federal governments.)

i. The Federal Environmental Assessment Process

Under the *Canadian Environmental Assessment Act* ("CEAA") the environmental, social and cultural effects of projects are assessed. CEAA applies if the federal government is the project proponent, must issue permits or approve or authorize a mine development. For example, a mining undertaking requires authorization under the *Fisheries Act* if it will result in the harmful alteration, disruption or destruction of fish habitat. Also, if the development is on federal lands or funded with federal assistance, CEAA will apply. Regulations list the kinds of projects that require assessment, as well as the level of assessment, such as whether the assessment will be comprehensive, or simply a "screening".

Regulations list the kinds of projects that require assessment.

CEAA has different levels of assessment for different types of projects. Most projects will go through only a screening. Large projects having greater impacts usually require a comprehensive study. Only a very large mine will trigger a comprehensive study (e.g., produc-

Only a very large mine will trigger a comprehensive study.

tion of 3,000 tonnes/day from a metal mine). Whether the project goes through a screening or comprehensive study, the process is a self-assessment. That is, the project proponent (the mining company) is responsible for completing the assessment. Therefore, the likelihood is low that the assessment will conclude that the project should not go ahead because of its environmental impacts.

The project proponent (the mining company) is responsible for completing the assessment.

In some instances, a project can be referred to a panel who will make a recommendation to the responsible authority (the official who is responsible for giving approval under the applicable legislation, say, for example the *Fisheries Act*). If, after completing a screening report or comprehensive study:

In some instances, a project can be referred to a panel.

- uncertainty remains whether the project is likely to cause significant adverse environmental effects, or
- the project is likely to cause significant adverse impacts but it may nonetheless be justified, or
- public concern warrants a reference to a mediator or review panel, the Minister will refer the project to a mediator or review panel.[28] Participant funding is available for participation in review panel assessments and mediations.

Participant funding is available for participation in review panel assessments and mediations.

The Canadian Environmental Assessment Agency administers the *Act*, and their website, www.ceaa.gc.ca, contains information on environmental assessments and opportunities to participate, training and guidance materials, and an index of all CEAA assessments.

ii. Provincial Environmental Assessment[29]

Overview

The government of British Columbia has a fiduciary responsibility to ensure that aboriginal rights and title and treaty rights are not unjustifiably infringed. In addition to this common law duty, the *British Columbia Environmental Assessment Act* specifically provides for First Nations participation in the review process. First Nations have the right to provide input into the process

First Nations have the right to provide input into the process and to sit on the Project Committee if they choose to do so.

and to sit on the Project Committee if they choose to do so. The proponent is also required to prepare a separate plan for consultations with First Nations.

First Nations play a critical role in the review process. Depending on their rights and the steps they have taken to establish these rights, this role may go so far as to require their consent before a project proceeds. At a minimum, however, the BC Supreme Court has held that consultation with First Nations must be meaningful and must at least consider solutions concerning the disputes arising in the environmental review process.

The British Columbia Environmental Assessment Act

The *British Columbia Environmental Assessment Act* (BCEAA) became law in British Columbia in 1995, replacing a number of different environmental assessment processes, and consolidating them under one comprehensive process.[30] The BCEAA was supposed to be a new and better environmental assessment process that would balance the needs of industry, government, First Nations, and other community interests. The purposes[31] of the Act are to:

The purposes of the Act *include sustainability, integrated assessment, prevention/mitigation of adverse effects, providing an open and accountable process, and First Nations and public participation.*

(a) promote sustainability by protecting the environment and fostering a sound economy and social well-being,

(b) provide for the thorough, timely and integrated assessment of the environmental, economic, social, cultural, heritage and health effects of reviewable projects,

(c) prevent or mitigate adverse effects of reviewable projects,

(d) provide an open, accountable and neutrally administered process for the assessment

  (i) of reviewable projects, and

  (ii) of activities that pertain to the environment or to land use and that are referred to the board in accordance with the terms of reference mentioned in section 51(1)(c), and

(e) provide for participation, in an assessment under this Act, by the public, proponents, First Nations, municipalities and regional districts, the government and its agencies, the government of Canada and its agencies and British Columbia's neighbouring jurisdictions.

The BC Supreme Court recently considered the purpose of the BCEAA and how it relates to issues raised by First Nations that become pushed to the side during the environmental assessment process.

In the case *Taku River Tlingit First Nation et al.* v. *Ringstad et al* (the "Tulsequah Chief Mine decision"), the Taku River Tlingit First Nation (the "Tlingits") challenged an environmental assessment of a proposed mine in their traditional territory because the assessment process and final recommendation never dealt with the issues the Tlingits brought to the table. The Tlingits argued that the purpose of the BCEAA had to be seen in the light of the broad public purposes that underlie environmental protection and assessment. The Tlingits further argued that all matters bearing on the sustainability of the Tlingits' land-based way of life must be addressed in the environmental review.

Decisions under BCEAA must be consistent with its purposes, including the sustainability of aboriginal communities.

The judge agreed with the Tlingits and said that the real question in evaluating whether an environmental assessment has met the requirements of BC law, is whether the Minister's decision satisfied the statutory purposes of the BCEAA, including the purpose of promoting development which is sustainable for British Columbia's communities, including aboriginal communities.

BCEAA has a number of opportunities for First Nations involvement, both as First Nations representatives and as members of the public. The *Act* also specifically requires proponents to set out from the beginning their plans for consultation with affected First Nations.[32]

Which Proposals Require an Environmental Assessment?

BCEAA is "threshold based", which means that only proposed developments, (referred to in the *Act* as "proj-

Only proposed developments of a certain size or greater will require an environmental assessment before they can be approved.

ects" or "reviewable projects") of a certain size or greater will require an environmental assessment before they can be approved. The projects which require an environmental assessment are set out in the *Environmental Assessment Reviewable Projects Regulation.* Part 2 of this regulation deals with Mine Projects, dividing them into six categories including: coal mines, mineral mines, sand and gravel operations, placer mines, construction stone and industrial mineral quarries, and off-shore mines. Each category has its own section that describes what threshold, or minimum size operation will require an environmental assessment. These thresholds may change from time to time. For example, under s. 20, construction of a new mining facility is reviewable only if "the facility has, or when the construction phase is completed will have, a production capacity of 75 000 tonnes or more of mineral ore per year." Until recently the threshold was 25 000 tonnes of ore per year. The threshold for sand and gravel operations is 500 000 tonnes or more of sand and/or gravel per year, or 1 000 000 tonnes over four years.

If a proposal does not require an environmental assessment, can you get one anyway?

The Minister can require an environmental assessment of a project which does not meet the minimum threshold requirements.

The Act also gives the "Responsible Minister," who, in the case of mining projects, is the Minister of Mines, the power to require an environmental assessment of a project which does not meet the minimum threshold requirements set out in the *Reviewable Projects Regulation*[33]. Unfortunately, under the *Act*, requiring the Minister to use this power is not possible. Possibly, in certain situations, the government's fiduciary responsibility to First Nations may require some form of impact assessment to evaluate impacts of a proposed mining activity on the First Nation. In this case, following the full BCEAA process may not be necessary.

The environmental assessment process is coordinated and facilitated by the environmental assessment office.

If An Environmental Assessment Is Required Or Will Be Conducted For A Specific Proposal, What Is The Process?[34]

Application for a Project Approval Certificate

The environmental assessment process is coordinated and facilitated by the environmental assessment office

(EA Office), located in Victoria (www.eao.gov.bc.ca).[35] The environmental assessment process begins when the individual or corporation (referred to in the process as the "proponent") wishing to develop the project applies to the executive director of the EA Office for a project approval certificate.

Application requirements.

An application under BCEAA must include a description of, among other things, the purpose of the project, existing environmental, social and other conditions, the potential impacts of the project, proposed measures for mitigating adverse effects, and *plans for consultation with First Nations* and the public.

The only two court cases that evaluated the requirements of the BCEAA have both concerned mines, both were brought by First Nations, and both raised the issue of consultation. In the Huckleberry Mine decision (*Cheslatta*) [36] the Court held that consultation is a requirement of the Act. The Tulsequah Chief Mine decision went farther to state that consultation must not only occur, but also be meaningful and "at least consider solutions concerning the disputes arising in the environmental review process".

Establishing the Project Committee

The Project Committee's job is to participate in the environmental assessment of the proposal and formulate a recommendation to the government.

When the EA Office receives an application for an environmental assessment, they are required to establish a Project Committee. The Project Committee's job is to participate in the environmental assessment of the proposal and formulate a recommendation to the government about whether the project should be allowed to proceed, and if so, how the project should be developed. The people who make up the Project Committee are set out in the Act. Representatives of any First Nation, whose traditional territory includes the site of the project or is in the vicinity of the project, must be invited to sit on the Project Committee.[37] The Executive Director of the EA office decides how many representatives of each First Nation sit on the Project Committee. The Act does not specify what "in the vicinity" of the project site means.

Representatives of any First Nation, whose traditional territory includes the site of the project or is in the vicinity of the project, must be invited to sit on the Project Committee.

The other members of the Project Committee include:

- the government of British Columbia;
- the government of Canada;
- any municipality or regional district in the vicinity of the project or in which the project is located;
- any of British Columbia's neighbouring jurisdictions in the vicinity of the project.

The Project Committee does not include representatives of different stakeholder groups within the community such as local business groups or industry, community associations or environmental organizations.

Project Committee may determine its own process.

The Project Committee may determine its own process, such as how it will meet and when, but it is required by the Act to do several things:

- provide the executive director of the EA Office and the government advice, analysis and recommendations about whether the project should go ahead;
- analyze and advise the executive director of the EA Office on the potential effects of the project, prevention or mitigation of those effects, comments received about the project from the public or from a public advisory committee, if established.

With respect to process, the judge in the Tulsequah Chief Mine decision said that the BCEAA process is flexible, but must be consistent. She found that an abrupt change in the time given to review and comment on the final recommendation of the Project Committee was unfair, and unlawful.

Project Report Specifications and Project Report: What is Considered in an Environmental Assessment?

Only certain environmental assessments will require a full project report.

Only certain environmental assessments will require a full project report. BCEAA allows the government to approve the project and issue a Project Approval Certificate after reviewing the project application, recommendation of the Project Committee and any comments from the public. If a project is determined to be of sufficient environmental significance, a Project Report is

ordered. If a project report is required, the first step is to draft "project report specifications".

Project Report Specifications.

The Project Report Specifications are a list of the questions that the project report must answer, or information that must be gathered in the report. This stage presents an excellent opportunity for First Nations to have their issues addressed because the BCEAA states that the Project Report must meet the requirements of the Project Report Specifications (see "Some Pointers for Participation in Environmental Assessments" below).[38] Failure to answer the questions set out in the Project Report Specifications could be grounds for a legal challenge.

BCEAA's objective of promoting sustainability might not be achievable prior to development of a regional land-use plan or the conclusion of a treaty.

Any issue can be raised for consideration in an environmental assessment, so long as it somehow relates to the purposes of the *Act*. Of particular importance to First Nations is the fact that the court has recently held that treaty issues can be considered in the BCEAA process. Until recently, the BC government has consistently stated that the environmental review was not the process to deal with these matters and that they could not consider treaty issues. In an important statement in the *TRTFN* v. *Redfern* decision, the judge held that it was not wrong to say that the BCEAA's objective of promoting sustainability might not be achievable prior to development of a regional land-use plan or the conclusion of a treaty with the Tlingits. The Ministers were not required to conclude a treaty or land use plan first, but they were required to take some measures.

Public Hearing

If, after completion of the Project Report, the Minister of the Environment and the Minister of Mines consider that major issues are not resolved, they can require a public hearing. This forum allows the public, the proponent and expert witnesses to present submissions and briefs. Assessing how useful a public hearing might be for raising and addressing First Nations issues is difficult because, to date, no projects, mining or otherwise, have been referred for a public hearing under BCEAA.

Opportunities for Input Outside the Project Committee

Public review and comment periods.

The *Act* envisions various opportunities for public comment and advice that could be useful opportunities for First Nations not included in the Project Committee to raise their issues and concerns. Public review and comment periods are found at the following steps in the BCEAA process[39]:

- the public can review and comment on the application submitted to the EA Office by the proponent;
- the public can make comments and suggestions during the preparations of the project report specifications, regarding what kinds of questions should be answered in the project report,
- the public can review and comment on the project report; and
- the public can comment and make suggestions during the preparation of the terms of reference for a public hearing.

Specific time lines for all public comment periods are set out in the *Environmental Assessment Prescribed Time Limits Regulation.*

"Public Advisory Committee".

In addition to these mandatory opportunities to participate in the BCEAA process, the Executive Director of the EA Office can choose to establish a "Public Advisory Committee" to advise and make recommendations to the Project Committee on matters of public concern. These committees can be made up of anyone whom the EA Office chooses. Conceivably, a group of First Nations representatives not directly involved in the Project Committee could use this process to make presentations to the Project Committee about First Nations issues.

Final Recommendation of the Project Committee

At the end of the BCEAA process, the Project Committee must make a recommendation to government about whether and how to approve the project. No statutory requirement exists that all members of the Project Committee agree as to the recommendations forwarded to

the Ministers. However, in the Tulsequah Chief Mine decision, the judge was clear that opportunities must be given to all Committee members, including First Nations, to express, in a meaningful way, their views.

Opportunities must be given to all Committee members to express their views.

The Project Committee recommendation can be very specific, and include among other things, guidelines for protocol with First Nations, for monitoring and follow up programs to evaluate environmental impacts as they unfold, and for additional fieldwork to be done during the construction and operation of the project.

The government is not required to accept the recommendation of the Project Committee. In the Tulsequah Chief Mine decision, the judge said that the government must make their decision based on an awareness and consideration of the positions and submissions of all the members of the Project Committee and not just the majority. Additionally, the court has held that governments' final decisions must be reasonable. This means a court will review the decision only to see if it is based on sound reliable evidence and ensure that the reasoning leading up to the decision is logical and consistent. The court will not otherwise substitute its view for that of the provincial decision-maker.

The government is not required to accept the recommendation of the Project Committee.

Governments' final decisions must be reasonable.

iii. Some Pointers for Participation in Environmental Assessments[40]

First Nations whose traditional territory includes the site of the proposed project must be invited to sit on the Project Review Committee. It is advisable to take this opportunity, because in subsequent permitting and approval processes, while First Nations are entitled to be consulted, provincial policy may limit the level of consultation.[41] At the environmental assessment stage, First Nation's participation is provided for in the BCEAA. In the subsequent regulatory stages, a First Nation's constitutional right to be consulted may or may not be met by the permitting agencies or the individual government administrators responsible for issuing licenses and permits.

Reasons to participate in an environmental assessment.

The other reason for participating at the environmental approval stage is that First Nations want to be fully involved in the strategic questions about the project's overall environmental acceptability. The big issues will all be decided by the time the project gets to the regulatory stage, and a First Nation will have missed excellent opportunities to influence whether and how the project ought to be approved. If your Nation waits until the regulatory stage to participate, you will be involved only in "fine-tuning" the conditions for the project to proceed, and it will be too late to address any major concerns a First Nation might have about the project.

If First Nations help determine the rules, they will be better able to influence how the Project Committee does it work, and to add transparency and accountability.

The Act allows the Project Committee to determine its own procedures for conducting the review of a project. First Nations should take part in this process; otherwise the Environmental Assessment Office will determine the procedures. A First Nation can develop a list of operating rules for, or with, the committee, and seek their adoption of those rules. The Taku River Tlingit have done this for the reconsideration of the Tulsequah Mine approval and the committee adopted all their proposed rules. If First Nations help determine the rules, they will be better able to influence how the Project Committee does it work, and to add transparency and accountability to what the committee eventually recommends to the Minister.

Careful use of consultants.

The careful use of consultants can greatly add to the value of First Nations' participation in the project review. Use consultants strategically. For example, when first joining a Project Committee, consider hiring a technical advisor who has broad experience in environmental impact assessment and mining. That generalist should be able to review ***all*** the technical material submitted as part of the project application (including the project description) and identify the potential problem areas with the project (e.g., acid mine drainage) that need specialized expertise to review. A First Nation may hire several consultants for very focused, brief reviews of particular aspects of the proposed project, but in the end, the "generalist" technical advisor will be able to piece together their assessments and present a comprehensive

and accurate picture of the mining project's potential impacts to First Nation lands, people and interests.

One of the early but critical activities of the Project Committee is to develop a set of information requirements (called the "Project Report Specifications") for the proponent to prepare its environmental report. This is where a First Nation should identify ***all*** the important questions for the First Nation that need to be answered in the subsequent environmental review.

"Project Report Specifications".

A First Nation can use consultants to help formulate information requirements for the project report. Determining the scope of the assessment and what the company is required to evaluate is critical to ensure that the assessment fully considers the potential ecological, social, cultural and economic impacts. The Project Committee director (assigned by the Environmental Assessment Office) will take the input from all the Project Committee members and compile the Project Report Specifications. Carefully review the Draft Project Report Specifications to ensure that your Nation's information requirements have been incorporated accurately and fully into the Project Report Specifications.

Determining the scope of the assessment and what the company is required to evaluate is critical to ensure that the assessment fully considers the potential ecological, social, cultural and economic impacts.

Ensure the specifications require an assessment of alternative ways of doing the project where appropriate. Otherwise, the project proponent is not required to undertake as comprehensive an assessment as your Nation may require. Be on the lookout for wording changes between the draft Project Report Specifications and the final Project Report Specifications that are issued to the proponent. For example, in the Tulsequah Mine assessment, the Taku River Tlingit First Nation discovered that while they had stipulated that "the proponent *must* conduct an analysis" of community impacts concerning Atlin, the Specifications read that "the TRTFN *supports* an analysis". Some requirements were entirely deleted. Make sure that the final specifications are entirely satisfactory to your Nation before they are issued to the proponent. Don't assume that someone else will do the job properly.

Ensure the specifications require an assessment of alternative ways of doing the project where appropriate.

When participating in meetings, during which technical or scientific matters will be discussed, consider bring-

When participating in meetings, during which technical or scientific matters will be discussed, consider bringing a consultant.

ing a consultant.[42] For example, if attending a meeting to review wildlife material, bring a wildlife ecologist. However, don't send any technical advisor to a meeting without your Nation's Project Committee member. Having the official member present at all times should ensure that the advisor does not misconstrue your Nation's position, and reports back to the community and political leadership about the Project Committee meetings, and ensures that the scientist's perspective is consistent with the views and values of your Nation.

Keep in mind the purposes of the BCEAA. A project should be recommended for approval only if it meets those purposes.

First Nations can be effective in forcing the Project Committee to evaluate the project on the basis of sustainability.

One of the purposes of the BCEAA is to promote sustainability, which should mean that only sustainable projects are approved. First Nations can be effective in forcing the Project Committee to evaluate the project on the basis of sustainability. This in turn requires a mutual understanding of the definition of sustainability. By participating in the assessment, a First Nation can ensure an assessment of the implications of the proposed project on both their community's and their culture's sustainability. An assessment of the project's sustainability should include consideration of the ecological, social, cultural and economic effects in the short and long term.

Maintaining a strategic, "big picture" perspective in the environmental review process can help ensure a thorough and integrated assessment.

Another purpose of the Act is to "provide for the thorough, timely and integrated assessment of the environmental, economic, social, cultural, heritage and health effects" of projects. A common problem is that government agency representatives on the Project Committee come to the table with their narrowly focused regulatory perspectives and no proper understanding of the objectives of environmental assessment, or how this differs from regulatory permitting. Maintaining a strategic, "big picture" perspective in the environmental review process can help offset this problem. Government committee members have a tendency to allow important, strategic issues to slide to the regulatory stage for resolution (for example, when a Special Use Permit under the *Forest Act* is applied for).

At the regulatory stage, once the Ministers give environmental approval, a First Nation has virtually no possibility of influencing the decisions made regarding permitting conditions. Also, very little flexibility exists, because the project has already received approval – the regulatory stage is often limited to "fine-tuning".

Insist on addressing every impact within the environmental assessment.

Insist on addressing *every* impact within the environmental assessment itself so that a committee recommendation is made to the Ministers at the end of the process, after everyone has learned how all the significant impacts will be managed both during and after the project. Also, because government representatives have a regulatory bias, they will almost certainly come to the table to discuss *how* the project should proceed, thus skipping over a very important part of a true environmental assessment – the issue of *whether* the project should proceed at all on environmental grounds.

Make sure, in the project report specifications, that the project proponent is required to gather adequate baseline data.

The third purpose of the Act is to prevent or mitigate adverse effects. Make sure, in the project report specifications, that the project proponent is required to gather adequate baseline data.[43] Without this basis, making any reliable prediction of impacts or proposing effective mitigation or prevention is not possible. Neither will it be possible to design and implement a reliable monitoring program that will prove useful in detecting impacts of future projects or managing the project in question. Because collecting adequate environmental data usually means a number of surveys over at least a two-year period (and sometimes more), proponents will resist investing in such studies at a late date since it would cause a delay in the project.

The fourth purpose of the Act is to provide an open, accountable and neutrally administered process.

First Nations representatives should:

Take complete notes.

1. Take complete notes at every meeting, whether formal or informal, and during every phone call with government, the proponent, or other members of the Project Committee.

Create a paper trail.

2. Create a paper trail by following up on meetings and phone calls with a memo or letter to the other par-

ticipants summarizing what was discussed, decided and agreed to.

3. Ask the other participants to respond if their understanding of the meeting is different. If they do not respond, assume they agree, and if they later take a different position, you will be in a position to demonstrate that they had an opportunity to comment on your view of the meeting and did not take it. If you are required to appear in court at some later point, your view of the meeting has a better chance of prevailing.

Instruct consultants to take notes and follow up on meetings.

4. If consultants are hired who have discussions with industry, government, or committee members, instruct them to take complete notes and to follow up on meetings and conversations by providing both you and the other participants with a memo or letter.

5. If making an oral presentation, prepare a written version in advance, for the record.

6. If a document or letter presents a different version of the issues as you saw them (e.g., if you reach consensus with the Project Committee or a subcommittee on an issue, and then a report identifies your nation as the only entity taking that view), demand an explanation for the change.

In instances of disagreements with other committee members, put your view in writing.

7. In instances of disagreements with other committee members, put your view in writing to reduce the likelihood that a member might say that the Project Committee reached a consensus on the issue.

8. As a Project Committee member, make sure the proponent is meeting the Project Report Specifications, and not just doing a rush job in order to get the mine approved quickly.

Be as detailed as possible in your comments.

9. Be as detailed as possible in your comments, including comments on what you expect the assessment to include, and on what you regard as deficiencies in the Project Report Specifications or the Project Report.

Review all terms of reference for experts hired to do portions of the assessment.

10. Review all terms of reference for experts hired to do portions of the assessment. Hire consultants to do

peer reviews if you are not confident in a study completed by a consultant hired by the proponent. Make sure that if you disagree with a report or with the terms of reference for a report, you make it clear either in the report, or at least in writing to the proponent, the author of the report and the Environmental Assessment Office.

When the proponent submits the Project Report:

1. Carefully review the project report as submitted by the proponent, to make sure that sufficient information is provided to meet the Specifications. If not, create a written list of deficiencies for the Project Committee's review. Do not accept a report for review if the report is so deficient that forming an opinion on the project and its potential impacts is impossible.

Create a written list of deficiencies.

2. Ensure all necessary assessments are done, and that alternatives are assessed.

3. When the proponent resubmits the Project Report, make sure all deficiencies have been resolved. If the report still does not meet the Specifications, reject it again.

4. If the committee decides to accept the report despite the deficiencies, make sure a written record exists of your view that the Report did not meet the Specifications, and that a full assessment was therefore not possible.

5. Hire experts to review the technical components. If concerned that an assessment was not done properly, consider hiring an independent expert to provide a critique of the company's work and/or do an independent assessment.

Hire experts to review the technical components.

6. If the proponent failed to identify viable alternatives, and you believe some alternatives should have been assessed, state this opinion in the report to the Minister.

When the recommendations report is being prepared:

Get involved as one of the writers of the report.

1. Avoid having the EAO write the recommendations report. When the review is complete, get involved as one of the writers of the report. To do this, establish a sub-committee of the main committee to be responsible for writing the report as part of the procedures for the Project Committee when the review first begins.

Before writing the report, make sure the review is properly completed.

2. But before writing the report, make sure the review is properly completed and that the Project Committee has dealt with all the important issues. In the Tulsequah Mine review, for example, an assessment of land use impacts to the Tlingits was never discussed by the Project Committee before the EAO Recommendations Report was circulated for approval.

3. Submit your own recommendations report to the Ministers if you do not agree with the rest of the Project Committee and their findings in the final report.

Finally, First Nations should:

Review the Project Approval Certificate (PAC).

4. Ask to review the Project Approval Certificate (PAC) and the Reasons for Decision before they are issued, with a view to making sure that any necessary conditions or requirements are included.

5. Make sure all necessary commitments are included. No explicit, formal, or legal connection exists between the recommendations report and the Project Approval Certificate. While the Ministers (Environment and Mines) responsible for making the decision may not want the Project Committee to interfere at this point, First Nations have constitutionally protected rights which supersede the environmental assessment process and the legislation.

We are not aware of any projects where the Ministers have given First Nations the opportunity to review the PAC. However, the Ministers may be more likely to submit the PAC for their review if a First Nation asks to review it, not as a Project Committee member, but as a First Nation with aboriginal rights and/or title to the area where the project will be located. The PAC will contain only provisions for the proponent. If the recom-

mendations report laid out numerous recommendations for government to make the project work properly, the Ministers are unlikely to put requirements for government in the PAC. Examples of types of recommendations for government are access control, such as closing roads after the mine is closed, and a commitment to enforce wildlife regulations.

In some instances, mining companies have failed to comply with the terms and conditions of the PAC or permits such as *Mines Act* permits.[44] BCEAA allows the province to stop construction and operation of a mine until the company complies with the conditions of a PAC. First Nations may be able to encourage the province to monitor and enforce PAC and permit requirements or conditions where First Nations' interests are impacted, because failure to monitor and enforce may be a breach of the province's fiduciary obligations.

BCEAA allows the province to stop construction and operation of a mine until the company complies with the conditions of a PAC.

Legislation:

Environmental Assessment Act, R.S.B.C. 1996.

Environmental Assessment Reviewable Projects Regulation, B.C. Reg. 276/95.

Environmental Assessment Prescribed Time Limits Regulation, B.C. Reg. 278/95.

Canadian Environmental Assessment Act, S.C. 1992, c. 37.

Environmental Management Act, RSBC, 1996, c. 118.

Fisheries Act, R.S. 1985, c. F-14.

Fisherys (General) Regulations, SOR/93-53.

Health, Safety and Reclamation Code, 1997.

Metal Mine Liquid Effluent Regulations, C.R.C., c. 819.

Mines Act, R.S.B.C. 1996, c.293.

Waste Management Act, RSBC 1996, c. 482.

Water Act, RSBC 1996, c.483.

Cases:

Cheslatta Carrier Nation v. *British Columbia* (1998), 53 B.C.L.R. (3d) 1 (S.C.).

Taku River Tlingit First Nation et al v. *Ringsted et al*, 2000 BCSC 1001.

References

C. Chambers and M. Winfield, *Mining's Many Faces – Environmental Mining Law and Policy in Canada* (Toronto: The Canadian Institute for Environmental Law and Policy, 2000), available at www.cielap.org.

Notes

[1] This chapter does not discuss all applicable legislation such as, for example, the *Navigable Water Protection Act*, and the *Highway Act*.

[2] Mines Code, s. 6.1.3

[3] Mines Code, s. 10.1.2

[4] While aboriginal peoples' interests are not specifically mentioned, they are at least arguably included in "land ownership", and should be included in "land capability and present uses".

[5] The Chief Inspector appoints all other inspectors from within the staff of the Ministry of Energy and Mines.

[6] Ministry policy is to include environmental conditions in permits, and to require security for reclamation. Exceptions may include sites in the Agricultural Land Reserve, where the Land Commission holds security, and sites operated by local governments.

[7] For another example of a situation where the government failed to get adequate security from a mining company, see the "Little Salmon Carmacks First Nation and B.Y.G. Mt. Nansen Gold Mine" case study in "Between a Rock and a Hard Place", which is included in Appendix A to these materials.

[8] Mine plans often change after approval of the mine project. This can result in a mine project that is substantially different from the one that was subject to review during an environmental assessment. For example, see "Lessons from the Environmental Assessment process of the South Kemess Copper/Gold Mining Project", which is included in Appendix A to these materials.

[9] Roads can have major impacts on wildlife, by opening up previously secluded areas to non-aboriginal hunters.

[10] Inadequate monitoring has been a problem at many mines. Without adequate monitoring, First Nations cannot know whether companies operating in their territories are complying with permit conditions or requirements imposed by the legislation. See, for example, "Lessons from the Environmental Assessment process of the South Kemess Copper/Gold Mining Project", reproduced in Appendix A to these materials.

The Little Salmon Carmacks First Nation carries out its own monitoring by encouraging hunters to provide samples from animals harvested near the tailings pond, and submitting bison blood samples to the Yukon Government for analysis. See "Little Salmon Carmacks First Nation and B.Y.G. Mt. Nansen Gold Mine" in "Between a Rock and a Hard Place", reproduced in Appendix A to these materials.

Similarly, Makivik Corporation, rather than rely solely on the company's monitoring, has conducted its own studies on water quality. See "Makivik Corporation and Falconbridge's Raglan Mine" in "Between a Rock and a Hard Place."

[11] This section was written by Greg Simmons.

[12] *Managing Aggregate, Cornerstone of the Economy*, March 2001. This report can be viewed at www.em.gov.bc.ca/Mining/AggregateReview.

[13] Ibid., p.27.

[14] An "orphan site" is a contaminated site for which a responsible person cannot be found or is not willing or financially able to carry out remediation in a time frame specified by a manager, or a contaminated site of which a government body has become the owner subsequent to the failure of the former owner to comply with a requirement to carry out remediation at the site. The manager determines whether an orphan site is high risk.

[15] For a more detailed discussion of the *Water Act*, see EAGLE's workshop materials entitled "Water and First Nations", forthcoming.

[16] Reproduced from EAGLE's "Water and First Nations" workshop material, written by Mai Rempel.

[17] Reproduced from EAGLE's "Water and First Nations" workshop materials.

[18] *Fisheries Act*, s. 35.

[19] Defined as:

> (a) any substance that, if added to any water, 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 or to the use by man of fish that frequent that water, or
>
> (b) any water that contains a substance in such quantity or concentration, or that has been so treated, processed or changed, by heat or other means, from a natural state that it would, if added to any other water, 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 likely to be rendered deleterious to fish or fish habitat or to the use by man of fish that frequent that water.

[20] *Fisheries Act*, s. 36.

[21] For example, in a private prosecution brought by a local resident, an Ontario Court, in September, 2000, convicted the City of Hamilton of violating the *Fisheries Act*. The city was fined $300,000 and $150,000 was awarded to the citizen who commenced the private prosecution. See ss. 61 and 62 of the Fishery (General) Regulations.

[22] MiningWatch Canada News Release, May 25, 2000, "Federal Timidity on Tough Regulations to Limit Mine Pollution Places Communities, Environment at Risk". The Auditor-General of Canada's *Report to Parliament for the Fiscal Year Ended 31 March 1990* notes that following delegation of enforcement responsibility to the provinces, compliance rates in 1988 were 48%, compared with 88% in 1982. Almost half of the mines that failed to comply with the MMLERs exceeded effluent standards

by 200 percent. See "Lessons from the Environmental Assessment Process of the South Kemess/Copper Gold Mining Project".

[23] Proposed changes are expected to be released (in the Gazette) in late spring or early summer of 2001.

[24] MiningWatch Canada News Release, May 25, 2000, "Federal Timidity on Tough Regulations to Limit Mine Pollution Places Communities, Environment at Risk".

[25] MiningWatch Canada News Release, May 25, 2000, "Federal Timidity on Tough Regulations to Limit Mine Pollution Places Communities, Environment at Risk".

[26] This section was written by Greg Simmons.

[27] Mining Watch B.C. "Between a Rock and Hard Place: Aboriginal Communities and Mining" Sept. 1999, p. 3.

[28] The Innu found that effective participation in panel hearings was important because community participation made clear to the panel that the people understood the project and its potential impacts. This in turn gave credibility to the peoples' experts and concerns. In both the federal and provincial environmental assessment processes, panels make recommendations regarding whether and under what conditions, projects should be approved. The recommendations are not binding on the government decision-makers. For example, the federal and Newfoundland governments approved the Voisey's Bay project despite the panel's recommendation that the project move ahead to permitting only after the conclusion of land rights negotiations and Impact and Benefits Agreements with the Innu and Inuit. See "The Innu Nation and Inco's Voisey's Bay Nickel Mine/Mill", in "Between a Rock and a Hard Place" (MiningWatch Canada, 1999), which is included in Appendix A to these materials.

[29] The section was written by Margot Venton, of Sierra Legal Defence Fund.

[30] Mines in BC used to be assessed under the BC *Mine Development Assessment Act* S.B.C. 1990, c. 55.

[31] BCEAA section 2.

[32] BCEAA section 7(2)(k).

[33] BCEAA, section 4.

[34] An outline of this process is included as Appendix B to these materials.

[35] The EAO has an Aboriginal Advisory Committee that deals with assessment procedures for proposed mines. See the "Tahltan First Nation, The Mining Industry, and Environmental Assessment" in "Between a Rock and a Hard Place", included in Appendix A.

[36] (1998), 53 B.C.L.R. (3d) 1 (S.C.)

[37] BCEAA, section 9(2)(d).

[38] BCEAA, section 24.

[39] BCEAA, section 16.

[40] This section was written by Cheryl Sharvit and Tony Pearse, a consultant with extensive experience with mining issues, who assisted the Taku River Tlingit First Nation in their participation in the environmental assessment for Redfern's Tulsequah Chief Mine.

[41] **At present, the province generally takes the position that it has only has a legal or constitutional obligation to consult with First Nations where the right in question has been proved.**

[42] The Innu Nation suggests that hiring good experts for panel reviews is important for getting good recommendations. They pooled resources with other groups and engaged in fundraising in order to hire good experts. See "The Innu Nation and Inco's Voisey's Bay Nickel Mine/Mill" in "Between a Rock and Hard Place", included in Appendix A to these materials.

[43] Inadequate baseline information has been a problem in several assessments of mining projects in First Nations' territories. See, for example, "Lessons from the Environmental Assessment of the South Kemess Copper/Gold Mining Project" and the Huckleberry Mine case study, which are included in Appendix A to these materials.

[44] See for example the "Huckleberry" case study.

Chapter 8
Addressing Mine Developments in Your Territory

8. Addressing Mine Developments in Your Territory

This chapter discusses some of the processes that First Nations participate in to protect their interests when mine developments are proposed in their territories. Options include entering into Impact and Benefit Agreements or other agreements with mining companies, entering into agreements such as Interim Measures Agreements with government, developing consultation or approval processes for companies to follow, and participating in existing consultation and referral processes.

a. Impact and Benefit Agreements

Impact and Benefit Agreements (IBAs) are an increasingly common means by which aboriginal peoples seek to address mining impacts and set the ground rules for their relationship with mining companies.

Mining can have both positive and negative impacts on aboriginal peoples and communities. Impact and Benefit Agreements (IBAs) are an increasingly common means by which aboriginal peoples seek to address these impacts and set the ground rules for their relationship with mining companies. While we are not aware of any existing IBAs in British Columbia at the time of writing, one commentator notes that "IBAs are emerging as the primary means of establishing a formal relationship between the project developer and local people."[1]

Government can require mining companies to enter into IBAs as a condition of obtaining project approval,[2] and land claims agreements may require IBAs.[3] Where IBAs are not required by law or policy, companies may seek to negotiate IBAs voluntarily in order to establish a positive relationship with their neighbours and secure the support of aboriginal peoples for the project. The parties to IBAs are typically the mining company and First Nations, but they may involve government, and may also involve local non-aboriginal communities. While most IBAs are negotiated with respect to proposed mining developments, they can be entered into

to address exploration activities in a First Nation's territory.[4]

IBAs typically deal with a variety of topics.

Because mining developments can have positive impacts, such as economic benefits, on aboriginal communities, and can also have negative social, environmental and economic costs, IBAs typically deal with a variety of topics, including:

- employment and training;
- economic development, contracting and business opportunities;
- financial provisions and equity participation;
- social, cultural and community support;
- environmental protection;
- protecting cultural resources and values, subsistence economic activities and traditional lifestyles; and
- monitoring social, environmental and cultural impacts of the mining project.

The preamble can be used to interpret the agreement.

IBAs typically begin with a preamble that outlines general principles and objectives of the parties. For example, statements of common objectives could include a statement that the parties wish to minimize negative impacts and ensure that, after completion of the project, the land will not be diminished in its ability to support aboriginal peoples' current uses such as hunting, trapping and fishing. These types of provisions can also be put in a "Purpose" section at the beginning of the body of the agreement. The preamble can be used to interpret the agreement, and some agreements specify that the preamble forms part of the agreement or should be referred to as an aid to interpretation of the IBA.[5]

Environmental protection provisions in an IBA are in addition to any requirements under legislation or conditions attached to permits and authorizations.

Environmental protection provisions in an IBA are in addition to any requirements under legislation or conditions attached to permits and authorizations. Steve Kennett has identified the following kinds of environmental protection commitments that IBAs can place on mining companies:

- Identify alternative methods and locations for carrying out components of the project that may cause significant environmental impacts (e.g., alternative locations for tailing ponds, effective treatment methods for mill effluent) and assess the net advantages and disadvantages to the natural environment of such alternatives after proposed mitigation measures are applied;

An IBA can require the company to identify alternative methods and locations.

- Refrain from using (or permitting subcontractors to use) specified materials, chemicals or products (e.g., PCBs) in any phase of the project;
- Notify the aboriginal party if the mining company or any subcontractor intends to use any materials, chemicals or products the use of which is restricted by regulation or reasonably known to be under consideration for such restriction by the relevant federal, provincial or territorial governments;
- Provide the aboriginal party, prior to the construction and operation phases of the project, with:
    - an inventory of all products and materials (e.g., fuels, chemicals) to be used on or in connection with the project that may, if released into the natural environment, impair the quality of the environment;
    - plans for the use, storage and handling of the above-mentioned products and materials to ensure the prevention of spills, leaks or abnormal discharges; and
    - contingency plans detailing the responsibilities of project personnel, as well as the equipment and materials to be used, in the event of a spill, leak or abnormal discharge;

Requirements related to harmful products and materials.

- Obtain prior consent of the aboriginal party before it or any subcontractor applies herbicides or pesticides in connection with the project;
- Consult with and consider the views of the aboriginal party regarding environmental mitigation or remedial work in general and specific activities or components of the project that are likely to have nega-

Environmental mitigation or remedial work.

tive environmental impacts (e.g., route selection for and construction of access roads, power lines, etc.);

- Undertake specified mitigation measures in relation to anticipated impacts;

Ongoing information requirements.

- Provide information to the aboriginal party on a regular basis regarding specified project impacts and provide such other information as may reasonably be requested by the aboriginal party in relation to project impacts;

- Ensure that the aboriginal party receives the same data as the regulatory authorities in the event of an environmental mishap or other incident that would legally require a report of the facts to those authorities;

Monitoring program.

- Establish a monitoring program in order to evaluate the accuracy of impact predictions, identify unanticipated impacts, assess the efficacy of impact mitigation measures and determine the significance of impacts after mitigation;

- Provide the aboriginal party with reasonable access, upon giving prior notice, to monitoring locations on project lands for the purpose of taking measurements and samples in order to ensure compliance with the environmental protection provisions of the agreement and any regulatory requirements pertaining to the project;

Mitigation measures for unanticipated impacts.

- Undertake such additional mitigation measures as may be required to satisfactorily address impacts that were unanticipated at the time that the IBA was signed and impacts that are materially greater in significance than was originally predicted;

Baseline environmental studies.

- Conduct or follow up on baseline environmental studies and communicate the results of these studies to the aboriginal party; and

- Continue monitoring and mitigation measures as specified in the agreement in the event of a temporary interruption of the mining project.[6]

IBAs can establish joint or independent advisory or monitoring committees.[7] They can also include:

- information requirements for applications and permits;
- consultation requirements for applications for approvals;
- preconditions to project authorizations such as contingency plans; and
- conditions to be attached to project authorizations.[8]

IBAs can deal with specific concerns, such as wildlife, as well. These provisions may relate to the project itself or to the issue of employees of the mining company hunting and fishing.[9] An IBA can include an undertaking by the mining company to limit or prohibit (to the extent legally permissible) access by non-aboriginal employees to aboriginal lands.[10] IBAs can also include provisions aimed at protecting cultural and archaeological resources, and areas of particular cultural significance.[11]

Wildlife areas of particular cultural significance.

An IBA can impose abandonment and reclamation requirements on the company, including a requirement that the company provide security for the cost of reclamation before commencing operation of the mine.[12]

Abandonment, reclamation and security requirements.

Some IBAs include a provision preventing the aboriginal party:

- from opposing the project or objecting to the issuance of approvals, licenses and permits,
- from taking legal action to prevent or delay the authorization of the project, or
- from seeking to subject the project to an environmental assessment.[13]

In such a case, the IBA should be reviewed very carefully before signing, to ensure that it provides strong protection for First Nations' interests. Some IBAs include a clause that protects the rights of the aboriginal parties to take action with respect to environmental harm.[14]

Some IBAs include a clause that protects the rights of the aboriginal parties to take action with respect to environmental harm.

IBAs are complex agreements. It is advisable for First Nations to hire negotiators familiar with IBAs and/or

Complex agreements.

mining projects to ensure that the agreement is in the First Nation's interest:

> The socio-economic position of aboriginal people, in combination with a lack of political, organizational, legal and financial resources, may place them in a disadvantageous bargaining position when compared with the mining companies and governments who may also be at the table. Satisfactory results from the aboriginal perspective likely require that aboriginal people have not only a certain amount of leverage to back their initial bargaining position but also the capacity – within their organizations or through access to expert advice – to undertake complex IBA negotiations and to ensure that these agreements are implemented effectively.[15]

First Nations' leverge in negotiations may be affected by government's position.

First Nations' leverage in these negotiations depends in part on the government's position on aboriginal rights and on the state of the law, because companies may refuse to go further than government or courts require them to in providing benefits to First Nations and minimizing impacts of mining projects.[16] In British Columbia, the government has demonstrated a strong reluctance to acknowledge aboriginal rights, especially aboriginal title.

If an environmental assessment of the project has already occurred, you may want to hire a consultant to conduct a review of the assessment before agreeing to an IBA, because the environmental assessment may form the basis for environmental provisions in the agreement.

Enforceability.

Another important issue regarding IBAs is their enforceability. The language contained in IBAs is often qualified. For example, commitments to hire aboriginal people may be phrased in terms of making 'best efforts' to reach target numbers. Failure to meet the target may not be a breach of the IBA that entitles the First Nation to a legal remedy in the courts.[17] A clause in the IBA stating that it is a binding contract may go some way towards addressing the enforceability issue, but will not transform 'best efforts' commitments into binding obligations.[18]

References:

Steven A. Kennett, *A Guide to Impact and Benefits Agreements* (Calgary: Canadian Institute of Resources Law, 1999).

Janet M. Keeping, *Local Benefits from Mineral Development: The Law Applicable in the Northwest Territories* (Calgary: Canadian Institute of Resources Law, 1999).

b. Interim Measures and Treaty-Related Measures

IMAs and TRMs are linked to the B.C. Treaty Commission process.

First Nations who are engaged in the British Columbia Treaty Commission process may be able to:

- protect particular tracts of lands from mineral development,
- impose conditions on mining developments,
- participate in land and resource use planning and management, and/or
- obtain funding to build capacity to participate in mining developments or alternative economic land uses (e.g., tourism) in their territories by entering into Interim Measures Agreements ("IMAs") with respect to those lands.

Temporary arrangements that can be formalized when a treaty takes effect.

The lands in question must be identified as lands that may be included in the treaty settlement. IMAs are usually entered into with provincial ministries (e.g., the Ministry of Energy and Mines). IMAs are temporary arrangements that can be formalized when a treaty takes effect.

An example of a recently negotiated IMA is that between B.C. and the Sliammon First Nation (December 2000). This IMA provides funding for a tourism marketing study and strategy as well as a tourism-training program for Sliammon members. Sliammon First Nation has developed a vision of their future, and has identified the tourism industry as a key component of their economic future.

Gitanyow (November 2000) entered into a IMA which will provide funding for the Gitanyow wildlife stewardship project, to train Gitanyow members to administer a hunter designation program and collect information about the Gitanyow harvest. Gitanyow members will work as wildlife stewards, and will observe and monitor hunting activities in the area. The Gitnayow will not have enforcement powers, however, and will refer any concerns to the provincial wildlife branch.

Recently, the Province announced that IMAs are a priority for the government, in its efforts to expedite the treaty negotiation process. "Treaty-Related Measures" ("TRMs") have been introduced as a type of interim measure intended to address First Nations concerns about land and resource development in their territories while treaty negotiations are underway. TRMs can include:[19]

- studies to generate information that will expedite treaty negotiations;
- protection of lands and land acquisition for treaty settlement;[20]
- participation of aboriginal peoples in land, resource and park planning and management; and
- economic and cultural opportunities

Canada and British Columbia share the costs of TRMs.

The primary difference between TRMs and IMAs is that Canada and British Columbia share the costs of TRMs.

More TRMs than IMAs have been entered into recently. Some examples of recent TRMs include:[21]

- Kaska Dena (December 2000) will receive funding to increase their participation in the forest sector. A forest resource council will be established, and will have equal representation from the Ministry of Forests and the Kaska Dena. This council will facilitate consultations, make recommendations to district managers and seek to resolve outstanding issues through a dispute resolution mechanism. The Kaska Dena will also receive funding for a land-use study to identify lands critical to the Kaska Dena for treaty settlement as well as lands for resource development and economic

opportunities. They will also receive funding for a study to assess the feasibility of an outfitting joint venture.

- Lheidli T'enneh First Nation (December 2000) entered into a TRM that provides the Nation with funding to participate in establishing a wildlife advisory committee for the Northern Interior Region.
- Sliammon First Nation will receive funding for:
    - the Okeover round table to identify water quality issues;
    - the Theodosia River adaptive water management planning process;
    - self-government capacity development (including training in land management);
    - a commercial recreation opportunities study; and
    - a shellfish aquaculture study.
- Tsawwassen First Nation (July 2000) will receive funding to conduct a Cultural Heritage Resources Study to identify culturally important sites within the Statement of Intent area.
- Tsay Key Dene First Nation (December 2000) entered into a TRM agreement to provide support for Tsay Keh to participate in environmental restoration work on the Kemess power line corridor.

IMAs and TRMs are generally only entered into with First Nations who are at Stage 4 of the Treaty Process.

c. Memoranda of Understanding and other Agreements

Agreements with companies and government.

Some First Nations have succeeded in gaining some control over mineral developments in their territories by entering into various forms of agreement with companies and government.

In 1997, the Innu Nation, the Labrador Inuit Association, and the provincial and federal governments entered into a Memorandum of Understanding (MOU) with respect

to the Voisey's Bay Nickel Mine.[22] The MOU expanded the definition of "environment" beyond the definition in the *Canadian Environmental Assessment Act*. The company therefore had to consider "the social, economic, recreational, cultural, spiritual and aesthetic conditions and factors that influence the life of humans and communities", though the Act's definition of "environment" was narrower. Through the MOU, the Innu were able to take control of social and economic studies, and the Innu and Inuit appointed panel members.

The Voisey's Bay Nickel Mine MOU.

In 1996, BHP Diamonds Inc. proposed to develop Canada's first diamond mine, in the Lac De Gras area of the Northwest Territories.[23] The environmental assessment panel made some recommendations that were outside the scope of the standard licences, permits and land lease. Most of these recommendations related to monitoring, reporting and review of environmental management plans. Participants in the mine approval process were also of the view that the legal regime was deficient and that an agreement for environmental protection was necessary. In response to the environmental assessment panel report, the federal government required "satisfactory progress" on negotiations of an environmental agreement between government and BHP, and on negotiation of IBAs.

The BHP Environmental Agreement.

BHP, the federal government, and the government of the Northwest Territories subsequently entered into an Environmental Agreement to address the concerns and deficiencies that came to light during the environmental assessment process, and to provide for aboriginal involvement in the regulatory process. The parties to the Environmental Agreement were BHP, the federal government and the government of the Northwest Territories. Affected aboriginal peoples entered into IBAs with BHP, and also signed the Implementation Protocol to affirm their agreement with the Environmental Agreement. Environmental groups did not participate in the Environmental Agreement negotiations, but were involved as advisors to the aboriginal groups.

The BHP Implementation Protocol.

The Implementation Protocol established an Independent Environmental Monitoring Agency, and also

provided that any changes to the Environmental Agreement would be made only after consultation with the aboriginal groups with a view to achieving consensus. The Protocol also requires written reasons for any changes not agreed to by the aboriginal people.

Through this process, the aboriginal groups were able to influence environmental requirements that went beyond those provided for in the legislation. Some of the features of the agreement include:

Features of the agreement.

- sanctions for non-compliance, including a draw-down on BHP's security deposit and provisions allowing suspension or termination of land leases
- establishment of an Independent Environmental Monitoring Agency[24] to monitor the regulatory process, implementation of the agreement, compliance of BHP and government with obligations

Establishment of an Independent Environmental Monitoring Agency.

- annual reporting requirements regarding compliance with the agreement and permits and authorizations, monitoring programs, studies and research, operational activities and actions to address impacts and compliance problems

Annual reporting requirements.

- a requirement for environmental impact reports

Environmental impact reports.

- a requirement on BHP to prepare environmental management plans (including environmental monitoring programs)
- a requirement for BHP to undertake compliance and effects monitoring programs

Compliance and effects monitoring.

- provisions for ongoing environmental compliance (eg., waste disposal, hazardous chemicals)
- security deposit obligations to cover reclamation and guarantee compliance with obligations under the agreement, an irrevocable guarantee from BHP's parent company, and provision for review of the adequacy of the deposit.

Security deposit obligations.

d. First Nations' Guidelines and Consultation Processes

First Nations can develop guidelines for companies operating in their territories.

In some instances, First Nations have developed guidelines for companies operating in their territories to follow. The Innu, for example, have developed "Mineral Exploration in Nitassinan: A Matter of Resepect: Innu Nation Guidelines for the Mining Industry" (available on the Innu Nation's website: www.innu.ca).[25] The Innu Nation have been able to enforce the guidelines because they have demonstrated their willingness to take legal action and engage in protests to protect their rights and lands and bring public attention and support to their concerns, and also because their participation in the environmental assessment led the panel to recommend that the Voisey's Bay project be allowed to go ahead only after conclusion of a land claims agreement and IBA.[26]

e. The Ministry of Energy and Mines Consultation Guidelines

These guidelines and the forms referred to in the guidelines are included as Appendix C to these materials, and are also available on the Ministry website: www.em.gov.bc.ca. This section provides a summary along with some commentary.[27]

Restricted to Mines Act *and Mining Code approval.*

These guidelines are intended to guide Ministry of Energy and Mines staff in implementing the province's consultation guidelines and policies. They are restricted to *Mines Act* and Mining Code approvals. The issue of consultation with aboriginal peoples when issuing mineral tenures is discussed briefly in an appendix. That appendix states that consultation with First Nations prior to location of claims is impossible, because the first consultation between the miner or claim locator and provincial staff is when a claim is recorded. Further, it states the following:

> "Advice received from the Ministry of Attorney General is that the issuance of title does not, in itself, constitute a potential infringement of aboriginal rights and title."

No consultation on tenures.

Despite *Delgamuukw*, then, (see Chapters 1 and 2), the province maintains that issuing a property interest in

minerals to a third party when the province issuing the interest may not have the full property in the minerals to give away, is legal. Not only does the province not own what it is selling or giving away where aboriginal title has not been surrendered or extinguished, but also, as seen in Chapter 3, if minerals are found under the staked ground, their development is almost always inevitable. The courts may, therefore, eventually consider that the province's position is wrong. In the meantime, aboriginal peoples will need to be creative and diligent in protecting their interests prior to the *Mines Act* permitting stage of mineral development, or challenge the government's position and actions in court.

No consultation on leases.

The guidelines take a similar approach to mineral leases, which, as discussed previously, are a very secure form of mineral tenure giving extensive and exclusive rights to mining companies. Because a lease must be issued to a recorded holder, no discretion is possible, and so no consultation with aboriginal peoples. While this lack of consultation may be unconstitutional, only cabinet, and not Ministry of Mines staff, can change the legislation and/or policy to allow consultation and discretion to refuse to issue a lease. The province, however, will most likely proceed to issue leases without consultation until the *MTA* is challenged by aboriginal peoples in court as unconstitutional.

The guidelines note that issuance of *Land Act* licenses and leases is discretionary and so may be subject to consultation with aboriginal peoples.[28]

Separate guidelines are in place for each of:

- exploration,
- mine development and expansion that does not trigger an assessment under the *Environmental Assessment Act*,
- mine development and expansion that triggers an environmental assessment, and,
- reclamation.

i. Exploration

"Pre-consultation" stage (Step 1).

The guidelines contemplate consultation regarding exploration only when the mining company must obtain a *Mines Act* permit to undertake the exploration (see Chapter 7). At the "pre-consultation" stage (Step 1), ministry staff are directed to identify First Nations who may be affected by the proposed exploration. After identifying potentially affected First Nations, staff complete a "Consultation Assessment Form" to determine whether consultation is required.

Staff complete a "Consultation Assessment Form" to determine whether consultation is required.

The nature of the proposed exploration activity.

Mines staff will consider the nature of the proposed exploration activity, and the nature of the land. The following characteristics of the proposed activity will likely result in a decision that consultation is not required:

- minor permit amendments
- exploration activities where prior or current involvement with First Nations is documented
- exploration activities that have already been the subject of consultation
- exploration on previously disturbed sites
- drilling using existing roads and drill pads
- helicopter activity and temporary camps in support of the above activities
- reclamation activity
- induced polarization surveys.

New exploration requiring a *Mines Act* permit, and permit amendments with significant changes will normally require consultation.

Consultation where lands have already been subject to disturbance.

The fact that lands have been disturbed or damaged already does not mean that further damage will not amount to an infringement of aboriginal rights and title protected by s. 35 of the *Constitution Act, 1982*. First Nations communities may therefore consider insisting on consultation where lands have already been subject to disturbance but have not been damaged to the extent that the people can no longer exercise rights on those

lands, or where the lands can recover if no further disturbance occurs.

Types of land.

If the exploration is proposed for the following types of land, then, in accordance with the guidelines, no consultation with First Nations is likely to occur:

Situations normally not requiring consultation.

- Archaeological or Traditional Use Studies (TUS) have already been completed and areas of aboriginal interests which have been identified in such studies are not affected;
- Private land, within a municipality or city boundary or within urbanized areas where the level of development on adjoining properties precludes the maintenance of aboriginal interests on the subject property;
- Previously developed in a manner that precludes maintenance of aboriginal interests on the subject property; or

Situations normally requiring consultation.

- Not known to have aboriginal use or interests, based on significant efforts to obtain information on aboriginal use.

Consultation will normally be required if the land:

- is near or in a known traditional use or archaeological site area;
- is within or close to a reserve or aboriginal settlement area;
- contains known aboriginal interests as indicated from past consultation and/or research of the area;
- has been subject to little or no past disturbance, or has been continuously held by the Crown.

Inaccurate or incomplete studies cannot be relied on without further consultation.

If an existing TUS and/or archaeological study of the affected area is inaccurate or incomplete, your Nation can consider putting the ministry on notice that these studies cannot be relied on without further consultation with the First Nation. First Nations may also wish to explain to mining officials that exploration activities can affect their interests even if they are not in or near a "traditional use site" or reserve or settlement area. Effects on water some distance upstream, for example,

Focus on sites ignores the interrelationships that exist in ecosystems.

can have serious consequences for downstream fisheries and fishing rights. A focus on sites ignores the interrelationships that exist in ecosystems.

In considering whether consultation is necessary, staff are instructed to consider the following in addition to the above:

- treaties,
- interim measures agreements,
- consultation protocol agreements,
- emergency situations, and
- public safety.

If staff determine consultation is not required, they must document the reason and conclude a "Consultation Assessment Form." Your First Nation may wish to review the reasons and the form if you are not consulted regarding exploration activities that, in your Nation's view, required consultation.

Review the reasons and the form if you are not consulted.

Step 2 "Basic Consultation".

Step 2 of the Guidelines is "Basic Consultation". At this stage, staff are instructed to "endeavor to address concerns" identified by First Nations. They are also instructed, consistent with the provincial policy of denying the existence of rights until proven in court, to "only refer to POTENTIAL rights/title." Staff will forward to affected First Nations a referral letter seeking input regarding potential impacts on aboriginal interests, along with a copy of the Notice of Work and Reclamation and a First Nations Consultation Comments Form. First Nations are given about 30 days to respond.

Staff will forward a referral letter along with a copy of the Notice of Work and Reclamation.

The Consultation Comments Form.

The Consultation Comments Form asks whether the area of proposed activities is near or in a "site of aboriginal importance", and if so, requests a description of the nature of the site. It also asks whether the area is within traditional use areas, and asks for a description of any such uses. Obviously a First Nation may have more to say than to simply answer these two questions in the one-page form provided. No reason exists to keep a First Nation from submitting additional comments and concerns.

"Consultation Status Sheet".

At this point the ministry staff person will initiate a "Consultation Status Sheet" to record the consultation process. Included in this log will be all phone calls, meetings and letters. A First Nation may wish to keep their own "consultation log".

Circumstances under which the application will be cleared.

Mines Branch Staff will assess a First Nation's input and then decide whether to issue the permit as is, accommodate the First Nation's concerns by making minor amendments or attaching terms and conditions to the permit, or move to Enhanced Consultation (Step 3). The application will be "cleared" if:

- First Nations advise they have no interests or concerns;
- First Nations concerns may be addressed with a minor amendment or in permit terms and conditions; or
- available information indicates the absence of potential rights/title.

Enhanced Consultation (Step 3).

If staff decide that the aboriginal issues have been dealt with, then they are supposed to notify the First Nation in writing, explaining how the issues were considered and how concerns were addressed. They will then complete the Consultation Status Sheet. If the application cannot be cleared, staff are instructed to proceed to Enhanced Consultation (Step 3).

Directed at assessing the probability of potential aboriginal rights and title, whether the activity will infringe those rights and whether any infringement can be justified.

Enhanced Consultation is directed at assessing the probability of potential aboriginal rights and title, whether the activity will infringe those rights and whether any infringement can be justified. If a First Nation refuses to provide information regarding their rights or title, staff will do their own research and come to a conclusion without the First Nation's involvement. If meetings take place, staff are instructed to keep minutes, including date, location, attendees, issues raised and by whom, decisions made and by whom, commitments made and by whom, action items with time frames and the person accountable for action. Notes of all formal and informal discussions and meetings are recorded on the Consultation Status Sheet. First Nations representatives may wish to do the same.

If staff determine that an infringement of potential rights or title is not likely, then no further consultation is required, except to notify the First Nation and provide reasons for clearing the application. If the "probable existence" of an aboriginal right or title is indicated, they will assess the impact of the proposed activity, and complete an "Infringement of Assessment of Potential Rights/Title Form." If they determine that the proposed activity would significantly impact the practice of potential rights, staff refer the issue to the Aboriginal Relations Branch and the Chief Inspector of Mines for an assessment of justification of the infringement or accommodation of aboriginal interests.

"Infringement of Assessment of Potential Rights/Title Form."

At this stage, the decision whether to clear the application is made at the senior management level. The review is conducted by the Chief Inspector of Mines in consultation with the Aboriginal Relations Branch, the Ministry of Aboriginal Affairs and the Attorney General's office. A decision will be made to:

- clear the application and notify the First Nation of the decision and rationale;
- not clear the application and notify the First Nation of the decision and rationale; or
- attempt to accommodate the aboriginal interests or negotiate a solution.

ii. Mine Development or Modifications to Existing Mines for Production not Meeting EAA Thresholds

As under the exploration guidelines, Step 1 directs staff to identify potentially affected First Nations. They do not, however, make a decision whether to consult. Consultation must take place prior to permitting a mine or mine expansion. Staff will consider whether any reviews undertaken by another agency (e.g., Forests) were adequate in terms of the assessment of First Nations' interests. Staff may rely on the findings of the other agency, so a First Nation may wish to review the other

Consultation must take place prior to permitting a mine or mine expansion.

agency's assessment and notify Energy and Mines of any deficiencies.

While ministry officials may use information provided by First Nations participation in Regional Mine Development Review Committees, the guidelines note that such participation "may not meet the requirements for satisfactory consultation". Arguably, participation in these committees can never satisfy the obligation of the decision-maker to consult separately with potentially affected First Nations, but if participation in an RMDRC satisfies First Nation concerns, no further consultation is needed.

Step 2 – Initial Steps in Consultation.

The consultation process then moves to Step 2 – Initial Steps in Consultation. A Consultation Status Sheet is initiated, and a referral letter is sent to the First Nation or community, along with the Notice of Work and Reclamation, Mine Plan and Reclamation Program and a copy of the First Nations Comments Form. As we noted above, if this form is not sufficient, there is no reason why First Nations cannot add to it. Again, staff are instructed only to refer to potential rights/title. First Nations may wish to hire consultants at this point to assist with their review.

First Nations may wish to hire consultants at this point.

Staff are instructed to provide First Nations with an opportunity to consult directly with the Ministry, apart from participation on a RMDC.

Staff are instructed to try to address First Nations' concerns and provide First Nations with enough information to allow them to understand the effect the project will have on land and potential aboriginal interests. Staff are also instructed to provide First Nations with an opportunity to consult directly with the Ministry of Energy and Mines, apart from participation on a Regional Mine Development Review Committee.

Staff are to take note of "indicators of aboriginal interests provided which may form the basis for claims of rights/title."

The First Nation's response will be reviewed by ministry staff to identify the First Nation's concerns and obtain information on aboriginal interests for the assessment of potential rights or title. If a concern is not within the ministry's mandate, they will advise the First Nation of the appropriate contacts. Staff are to take note of "indicators of aboriginal interests provided which may form the basis for claims of rights/title."

At Step 3, Enhanced Consultation, staff assess whether potential for rights/ title is present, and if so, how the proposed activity will impact those rights.

At Step 3, Enhanced Consultation, staff assess whether potential for rights/title is present, and if so, how the proposed activity will impact those rights. As we noted above under Exploration, staff will do their own research and rely on it if the First Nation refuses to participate or offer proof of their rights or title. Staff will keep notes of all formal and informal discussions. If meetings take place, staff are instructed to keep minutes, including date, location, attendees, issues raised and by whom, decisions made and by whom, commitments made and by whom, action items with time frames and person accountable for action. First Nations may wish to do the same.

If staff determine that no potential exists for rights or title, or that there is no impact on potential rights or title, they will notify the First Nation of the reasons why no further consultation is required, and advise the First Nation how they can provide input into the public notification and review process. The guidelines note that "if the probable existence of potential rights/title is indicated, it is almost certain the proposed activity would infringe potential rights/title." At this stage, staff may attempt to resolve the issues by amending the application, adding or amending terms and conditions, or through facilitating accommodation of First Nations' concerns by the applicant.

The guidelines note that "if the probable existence of potential rights/title is indicated, it is almost certain the proposed activity would infringe potential rights/title."

If resolution is not achieved, the matter is taken over by the Chief Inspector of Mines, in consultation with the regional office, the Aboriginal Relations Branch, the Ministry of Aboriginal Affairs and the Attorney General's office. The Chief Inspector will assess justification, and the Aboriginal Affairs Branch may obtain a legal opinion. The First Nation may wish to obtain its own legal opinion at this point. A decision will then be made to clear the application, not clear the application, attempt to accommodate the aboriginal interests, or negotiate a solution. The First Nation must be notified of any decision and the rationale.

The First Nation must be notified of any decision and the rationale.

iii. Mine Development or Modifications to Existing Mines Meeting the Threshold of the Environmental Assessment Process

Energy and Mines staff may rely on the EAO's findings

If Energy and Mines staff are of the opinion that the Environmental Assessment Office (EAO) assessed the potential for rights and title, and adequately consulted with the relevant First Nations, then staff may rely on the EAO's findings. If such consultation is insufficient, the process for mine developments or modifications falling below the environmental assessment threshold will apply. A First Nation may wish to advise Energy and Mines staff if the EAO did not adequately consult with them.

iv. Reclamation

The guidelines require consultation regarding reclamation only if the activities in question were originally permitted without sufficient consultation.

The Notice of Work and Reclamation is provided to First Nations during the exploration and/or mine development application stage. The guidelines require consultation regarding reclamation only if the activities in question were originally permitted without sufficient consultation. In that case, the permitting official must review the proposed reclamation plan and determine if it is likely to infringe on aboriginal rights or title. If available information is inadequate to make this assessment, then the official must consult with the First Nation. The guidelines acknowledge that participation by a First Nation in a Regional Mine Development Review Committee cannot be regarded as fulfilling the Ministry's obligation to consult regarding the potential for infringement on aboriginal rights and title, and instructs the District Inspector to meet separately with representatives of First Nations.

f. British Columbia Assets and Land Corporation's Aboriginal Interest Assessment Procedures (AIAP)

The AIAP[29] guides BCAL staff when considering tenures or sales that may affect First Nations' interests.

Aboriginal Interest Assessment Report.

This process governs consultation with First Nations with respect to gravel (aggregate) mining. The procedures include a flowchart for quick reference. As staff proceed through the AIAP, they record each step in an Aboriginal Interest Assessment Report, which mirrors this flowchart. The AIAP notes that one of the purposes of the report is to facilitate legal review of land use decisions. First Nations may find it useful to compile their own reports that mirror the flowchart and process as well, to facilitate a legal review of decisions from the First Nation's perspective.

If an environmental assessment has been carried out BCAL staff will determine whether further assessment or consultation is necessary.

If an environmental assessment has been carried out for a proposed gravel mine project, BCAL staff will review the assessment and consultation with First Nations to determine whether further assessment or consultation is necessary. If the consultation, or the assessment by the EAO of potential aboriginal rights and title, was inadequate, the First Nation may wish to advise BCAL of deficiencies and request that they further consult with them.

The AIAP is divided into two main phases. The purpose of Phase 1 is to determine whether there is potential for aboriginal rights and title, and therefore a need to consult. The purpose of Phase 2 is to determine whether there is potential for infringement, and if so, whether such infringement is justifiable, and to attempt to negotiate a resolution.

Phase 1

Phase 1 of the process is aimed at determining whether a *prima facie* (on its face) case exists for potential infringement of aboriginal rights or title.

When BCAL receives an application for a license or lease, the AIAP directs the Land Officer (LO) to first consider the nature of the proposed disposition in order to determine whether any referrals to First Nations are necessary.

A referral may not be required in certain circumstances.

In the following circumstances a referral may not be required:

- tenure renewal with no changes, unless aboriginal rights are known to exist[30];
- minor tenure modifications;
- short-term tenure that does not involve a substantial change to the land; and
- proposals covering small amounts of land, especially inaccessible land (e.g., mountaintop) or where the land overlaps with an existing tenure.

If BCAL staff decide from the outset that, because of the nature of the proposed lease or license, no potential exists to affect aboriginal rights or title, then staff can proceed to clear the license or lease without a referral.

If the LO decides that a referral may be necessary, the LO or Project Manager identifies First Nations with a potential interest in the land. The AIAP states that the majority of newly proposed leases and licenses will be referred to First Nations.

The majority of newly proposed leases and licenses will be referred to First Nations.

If First Nations with potential interests in the area are identified, referral letters are sent out (usually by both fax and mail). Appendix 3 of the AIAP includes a sample referral letter. Along with the referral letter, BCAL will send the First Nation maps and information regarding the size and location of the property, and the terms of the proposed license or lease. The referral letter will request that the First Nation provide specific information regarding the potential existence of aboriginal rights and title on the property and how those rights may be impacted by the proposed lease or license. The letter asks for information that indicates that members of the Nation continue to carry out aboriginal customs, practices or traditions on the specific property, or that the Nation has a unique connection with the land due to, for example, the continuing existence of archaeological sites.

The referral letter will request that the First Nation provide specific information regarding the potential existence of aboriginal rights and title on the property and how those rights may be impacted by the proposed lease or license.

Initially, the First Nation will be given a 45-day period within which to reply, but the time may be extended at their request if the Nation requires more time to consult with elders or carry out research. If the First Nation

If the First Nation does not respond, BCAL staff will make an assessment of the First Nation's interests without their input.

does not respond, BCAL staff will make an assessment of the First Nation's interests without their input.

While waiting for First Nations' responses to referrals, the LO or Project Manager assesses the nature of the land subject to the proposed lease or license, and considers the following factors:

The LO or Project Manager assesses the nature of the land subject to the proposed lease or license.

- proximity to an existing aboriginal community;
- known continuing aboriginal use (not just traditional use) or interests (based on efforts to obtain information on aboriginal use);
- proximity to known traditional or archaeological sites where archaeological or traditional use studies have been conducted;
- existing or previous development that precludes maintenance of aboriginal interests on the land in question;
- location of the land within a municipal/city boundary or within urbanized areas where the level of development on adjoining properties precludes the maintenance of aboriginal interests on the lands proposed for the lease or license;
- relative economic or intrinsic (e.g., spiritual) land value.

BCAL staff then consider referral responses along with the above to determine if the potential for aboriginal rights or title exists. The AIAP directs staff as follows with respect to evidence:

Statements by First Nations which assert aboriginal title over the land must be accompanied by evidence.

> "Statements by First Nations which assert aboriginal title over the land, or which indicate they are at the treaty table to discuss that land, or which indicate that they have an unspecified attachment to the land, do not constitute a factual basis for potential aboriginal rights or title. The potential for aboriginal rights or title is based on what is characterized as *prima facie* evidence, e.g. where there is oral or archival information relating to use and occupation of the land."

If First Nations do not respond, or do not provide a complete response, BCAL will make a determination as to whether potential rights exist based on all collected information. BCAL staff may ask for further comments.

Factors weighed to determine if potential exists for aboriginal rights or title.

The following factors are weighed to determine if potential exists for aboriginal rights or title:

- the nature of the proposed license, lease or land use,
- the nature of the land,
- historical and ethnographical information on interested First Nations,
- site inspection, and
- referral responses.

Indicators against the potential for aboriginal title.

The following are considered to be indicators against the potential for aboriginal title:

- land alienated to or occupied by third parties in the past (length of occupation and use are considered);
- land alienated on long-term lease to third parties in the past;
- land subject to existing treaty (e.g., Treaty 8, Douglas treaties);
- land already developed;
- land distant from reserves and areas with known aboriginal interests;
- land within an urban area, or surrounded by development; and
- no indication that an aboriginal people has maintained a substantial connection or bond with the land since 1846 (e.g. no aboriginal activity in the area for an extended period).

BCAL staff will not make an internal decision that aboriginal title no longer exists with respect to an area of land.

In most cases, BCAL staff will not make an internal decision that aboriginal title no longer exists with respect to an area of land, particularly if a First Nation has asserted aboriginal title to the land. Staff will likely share their conclusion with the First Nation and allow the First Nation to respond with specific information demonstrating a continued connection to the land.

Indicators for the potential for aboriginal title.

The following are indicators for the potential for aboriginal title:

- title to the land continuously held in the name of the Crown;
- indicators of aboriginal interests in the land (e.g., near or adjacent to a reserve or formal village or settlement; in area of traditional use; containing significant archaeological sites; used for aboriginal activities; notice from a First Nation asserting interests/aboriginal title; subject to a registered specific claim); and
- undeveloped land close to known aboriginal use areas such as fishing, hunting, trapping, gathering or cultural sites.

If BCAL staff conclude that no or very low potential exists for aboriginal rights or title, they will clear (i.e., issue) the license or lease, and send a notification letter to any First Nations who responded to referrals or indicated that they wish to be notified about the outcome.

If staff conclude that the evidence indicates a moderate to high potential for aboriginal rights or title, they will assess the factual basis for the potential for aboriginal rights or title. The Project Manager or Senior Land Officer will decide either to clear the disposition or obtain more detailed information to further assess the factual basis for aboriginal rights and title.

Staff assess the factual basis to determine whether the potential for rights or title is significant.

Staff assess the factual basis to determine whether the potential for rights or title is significant. They will make this assessment based on responses received from First Nations, the completed Aboriginal Assessment Interest Report, a legal review of *prima facie* ("on the face of it") evidence, referral to the Archaeology Branch if there are indicators of the existence of archaeological sites within or near the land, and any studies that staff decide to commission (e.g., archaeological overview assessments, archaeological impact assessments, heritage resource overview, traditional use studies).[31] The person or company seeking the license or lease will usually pay for any studies.

Staff may rely on studies completed by other agencies.

Staff may rely on studies completed by other agencies such as the Ministry of Forests. If studies are commissioned, the First Nation may wish to review the Terms of Reference, which the Aboriginal Relations Land Officer

will sign. If First Nations have not responded to referrals or have provided incomplete responses, staff will send a 30-day notice letter seeking further information. As in the initial assessment, staff will make a decision based on all collected information, even if First Nations do not respond or do not respond completely.

Staff may send a 30-day notice letter seeking further information.

If the Project Manager or Land Officer determines that the potential is not significant, they recommend that the Regional Manager clear the lease or license, and the Regional Manger will then issue the lease or license. If the analysis leads staff to conclude that the potential for aboriginal rights or title is significant, they will proceed to Phase 2 of the AIAP.

If the analysis leads staff to conclude that the potential for aboriginal rights or title is significant, they will proceed to Phase 2 of the AIAP.

Phase 2

In Phase 2 of the AIAP, staff make a final determination regarding the potential for aboriginal rights or title, whether the potential for infringement is significant, and, if so, they seek to mitigate and/or negotiate a resolution with the impacted First Nation(s).

In Phase 2, BCAL staff initiate direct consultation (i.e., face-to-face meetings and discussions) with affected First Nations in an attempt to resolve concerns. The Manager, Aboriginal Relations may request legal counsel at this point. Therefore, First Nations may find this an appropriate stage in the process to obtain legal counsel. Modifications to the proposal, or changes to the lease or license may be approved as a result of this direct consultation.

BCAL staff initiate direct consultation in an attempt to resolve concerns.

If direct consultation results in concerns being addressed, BCAL staff will clear the lease or license, and send a notification letter to the First Nation advising of the decision to proceed, responding to any specific interests raised by the First Nation and providing the reasons for the decision to issue the lease or license.

If concerns remain, staff will either consult regarding the potential for infringement, or disallow the proposed license or lease. BCAL staff must obtain and follow legal advice if they consult regarding potential infringement of potential rights or title. BCAL staff and legal counsel will consider the following:

If concerns remain, staff will either consult regarding the potential for infringement, or disallow the proposed license or lease.

- comments from First Nations;
- independent review by regional staff;
- the nature of the disposition and the land, considering:
    - whether the First Nation (not individual members of the nation) is or has been involved in the activity or project, for example as a joint venture
    - whether the lease or license is pursuant to a plan that has been consulted upon
    - whether the activity involves a substantial change to the land
    - whether the land can be easily reclaimed
- whether the proposed land use is seasonal (e.g. winter activity that does not conflict with First Nation summer activity on the land); and
- if there is potential for aboriginal title, whether aboriginal activities on the land will be interfered with, whether the activity will change or damage the nature of the land, whether a non-renewable resource is being extracted, and whether the disposition to a third party is long-term.

The AIAP considers that infringement of aboriginal rights may include an activity or exclusive tenure that prevents coexistence of aboriginal activities.

If potential for infringement is indicated, BCAL staff are directed to consider justification issues or disallow the proposed lease or license.

If the above assessment leads staff, on the advice of legal counsel, to conclude that no potential for infringement is indicated, they will clear the disposition and send the First Nation a notification letter that advises of the decision and reasons for issuing the license or lease. If potential for infringement is indicated, BCAL staff are directed to consider justification issues or disallow the proposed lease or license.

Factors with respect to justification.

The AIAP directs staff to consider the following factors with respect to justification, and provides some examples:

- extent of infringement (e.g., development with no chance of reclaiming the land to its natural state v. development of renewable resources; infringement of potential title over a village site v. infringement of potential title arising on hunting grounds);
- extent of consultation and effort to minimize infringement; and
- emergency situations and public safety.

If the potential infringement is not justifiable, the disposition cannot be cleared unless negotiations resolve concerns and the First Nation agrees to the disposition.

If the potential infringement is not justifiable, the disposition cannot be cleared unless negotiations resolve concerns and the First Nation agrees to the disposition. If the potential infringement is justifiable, staff will attempt to negotiate in order to accommodate the First Nations' interests and mitigate the infringement.[32] These decisions are made on the basis of legal advice from the Ministry of the Attorney General.

If the potential infringement is justifiable, a letter with reasons is sent to the First Nations.

If no agreement is reached with the First Nation, and the potential for infringement is not justifiable, the license or lease must be disallowed. If the potential is justifiable, then the license or lease can be cleared, and a letter stating the reasons for closing consultation and issuing the license or lease is sent to the First Nation. Those reasons should explain why BCAL has determined that any infringement is justifiable. If no resolution is possible because the First Nation refused to negotiate, then BCAL staff may clear the disposition and send a letter to the First Nation advising of the decision and reasons for the decision. If the concerns are resolved through negotiations, the proposed license or lease can be cleared.

Notes

[1] Steven A. Kennett, *A Guide to Impact and Benefits Agreements* (Calgary: Canadian Institute of Resources Law, 1999) at 1.

[2] This requirement may be found in legislation, or may be a matter of government policy. Sometimes governments will require IBAs for a specific project, as was the

case with the Ekati diamond mine in the Northwest Territories.

[3] An example is the Nunavut Land Claims Agreement, Article 26.

[4] At the exploration stage, however, the mining company does not yet know whether any deposits being explored are commercially viable, and so the potential for obtaining extensive commitments or payments is limited.

[5] Steven A. Kennett, *A Guide to Impact and Benefits Agreements* (Calgary: Canadian Institute of Resources Law, 1999) at 39-40.

[6] Kennett, at 91-92.

[7] Kennett, at 93.

[8] Kennett, at 93.

[9] Kennett, at 93.

[10] Kennett, at 79.

[11] Kennett, at 96.

[12] Kennett, at 94-95.

[13] Kennett, at 45.

[14] Kennett, at 90.

[15] Kennett, at 18.

[16] Kennett, at 30.

[17] Kennett, at 25.

[18] Kennett, at 25. In the context of employment, the company may resist including a binding provision specifying a certain number or percentage of aboriginal employees because such targets may prove unattainable despite the efforts of the parties.

[19] A backgrounder on TRMs is found at ww.aaf.gov.bc.ca/news-releases/2000/TRMbackgrounder.htm.

[20] However, where a TRM includes acquisition of land in anticipation of a treaty settlement, jurisdiction over

the land will not change until the effective date of the treaty.

[21] Based on summaries and news releases available on the Ministry of Aboriginal Affairs website: www.aaf.gov.bc.ca.

[22] See the case study included in "Between a Rock and a Hard Place: Aboriginal Communities and Mining", which is reproduced in Appendix A to these materials.

[23] The Canadian Institute of Resources Law's Independent Review of the BHP Diamond Mine Process, Submitted to the Mineral Resources Directorate, Department of Indian Affairs and Northern Development, 30 June 1997, provides a comprehensive review of the approval process for this mine.

[24] The agency is composed of four people appointed by the aboriginal groups and three appointed jointly by Canada, the Northwest Territories, and BHP. The agency is funded primarily by BHP, and the remainder is funded by the federal and territorial governments.

[25] See the case study included in "Between a Rock and a Hard Place", which is found in Appendix A.

[26] These recommendations were not followed and are the subject of litigation.

[27] These guidelines are meant to supplement the province's "Consultation Guidelines, September 1998" and the "Crown Land Activities and Aboriginal Relations Policy Framework". See EAGLE's workshop materials "The Nature and Scope of the Crown's Fiduciary and Constitutional Obligations to Consult with Aboriginal Peoples".

[28] The British Columbia Assets and Lands "Aboriginal Interest Assessment Procedures" are discussed in the next section.

[29] The AIAP is included as Appendix D to these materials, and is available at http://www.bc-land-assets.com.

[30] First Nations may wish to advise BCAL of aboriginal rights to lands subject to existing licenses or leases, so that those rights are considered before a renewal.

[31] Appendix 7 of the AIAP provides a description of each of these types of studies.

[32] The Province considers compensation to be the exclusive responsibility of the federal government.

Appendix A
Case Studies

The case studies in this Appendix were reproduced with permission of
Mining Watch Canada and the Enviornmental Mining Council of British Columbia

Appendix B
Outline of the British Columbia Environmental Assessment Process

Appendix B:
Outline of the BC Environmental Assessment Process

The environmental assessment process in British Columbia is as follows:

1) The proponent of a reviewable project submits an application for a project approval certificate. The application identifies the proponent and the individual responsible for answering questions respecting the application. The application also provides a preliminary overview of the project, including a description of:

   a) the purpose and major components of the project;

   b) existing information pertaining to environmental, economic, social, cultural, heritage and health characteristics and conditions in the vicinity of the project;

   c) onsite and offsite facilities of, or associated with, the project;

   d) the construction plan and a timetable for completion;

   e) any new or expanded public works or undertakings that will be required;

   f) potential environmental, economic, social, cultural, heritage and health effects of the project;

   g) measures proposed to prevent or mitigate adverse effects;

   h) plans pertaining to land use and related resource issues in the area of the project that are authorized under legislation;

   i) public information distribution activities and consultation activities carried out by the proponent, a summary of public response and the issues identified;

   j) any program of public information distribution or consultation proposed by the proponent during the next stages of project planning and review;

   k) information distribution activities and consultation activities undertaken by the proponent with a First Nation and a summary of the First Nation's response and the issues identified; and

l) any program of information distribution or consultation proposed by the proponent with a First Nation during the next stages of project planning and review.

2) Upon receiving an application for a project approval certificate, the Executive Director of the Environmental Assessment Office (EAO) has seven days to either accept the project for review or notify the proponent of deficiencies. The EAO assists the Minister of Environment, Lands and Parks in administering the Environmental Assessment Act. The EAO maintains a project registry, which is intended to provide public access to records relating to environmental assessments.

3) The Executive Director establishes a project committee (the executive director is the chair of the project committee unless he or she delegates that responsibility to another individual from the EAO). The Executive Director must invite each of the following to nominate a representative or representatives (the number is determined by the Executive Director) for the project committee:

- the government of British Columbia
- the government of Canada
- any municipality or regional district in the vicinity of the project or in which the project is located
- any First Nation whose traditional territory includes the site of the project or is in the vicinity of the project
- any of British Columbia's neighbouring jurisdictions in the vicinity of the project.

4) Within seven days of receiving an application, the executive director must give notice to the public inviting comments about potential effects of the project, notify First Nations whose traditional territory includes the site of the project or is in the vicinity of the project of that step in the review process, and invite comments about potential effects of the project.

5) Within 45 days after receiving copies of an application, the Executive Director makes an assessment, in consultation with the project committee, of the adequacy of any measures which the proponent has taken, or proposed, relating to distribution of information about the project. The assessment may specify further necessary measures, including consultation with First Nations.

6) The Executive Director must give the public between 30 and 75 days to comment on the application, and then must advise the proponent of any comments received and give the proponent an opportunity to respond to the comments.

7) Within 40 days of expiry of the comment period, the executive director must either refer the application to the Minister of Environment, Lands and Parks and the minister responsible for the reviewable project for a decision, or, order that a project report be prepared and that the project undergo further review. In making this decision, the executive director must take into account any comments received, and the recommendation of the project committee. The Executive Director can only refer the application to the ministers for a decision if he or she, in consultation with the project committee:

   a) ascertains that any specified further measures for distributing information about the project have been carried out;

   b) considers that the application identifies and adequately describes the potential effects of the projects; and

   c) examines whether or not, in the opinion of the project committee, the application sets out practical means of preventing or reducing to an acceptable level all significant adverse effects of the project.

   The Executive Director must provide the ministers with the project committee's recommendations and reasons regarding whether a project approval certificate should be issued, and its recommendations regarding whether a project report should be prepared and the project made subject to further review. An order that a project report be prepared and that the project undergo further review must be accompanied by the project committee's recommendations and reasons relevant to further review.

8) If the application is referred to the ministers for a decision, the ministers must consider the application and any recommendations of the project committee, and, within thirty days, either: a) issue a project approval certificate and attach any conditions the ministers consider necessary; b) refuse to issue the project approval certificate; or c) order that a project report be prepared and that the project undergo further review. The ministers must give written reasons for their decision.

9) If either the Executive Director or the ministers order a project report and further review, the executive director has 20 days to prepare draft project report specifications that identify any information, analysis, plans and other records that the executive director, on the recommendation of the project committee, considers relevant to an effective assessment of potential effects. The proponent will be required to include that information with the report. The project report specifications may identify any matter considered relevant, including:

   a) the rationale for the project;

b) the site selection procedure for the project, the reason why the site was chosen and a description of alternative sites considered;

c) the existing environmental, economic, social, cultural, heritage and health characteristics and conditions that may be affected by the project;

d) the potential for direct and indirect effects of the project;

e) alternatives to the methods of construction, operation, modification, dismantling or abandonment proposed in the application, and the potential effects of those alternatives;

f) potential impacts on the exercise of aboriginal rights;

g) health issues;

h) the potential for accidents;

i) information relevant to assessing the probable cumulative effects of the project;

j) plans showing how the proponent intends to carry out: public consultation; consultation with First Nations; measures to prevent or mitigate adverse effects of the project; monitoring; evaluation of the adequacy of any measures proposed to prevent or mitigate adverse effects of the project.

10) Within seven days of preparation of draft project report specifications, the Executive Director must give notice to the public and invite comments about potential effects of the project. The executive director must give the public between 15 and 30 days to comment on draft project report specifications. The Executive Director also must notify First Nations whose traditional territory includes the site of the project or is in the vicinity of the project that draft specifications have been prepared, and invite comments about potential effects of the project. The Executive Director must advise the proponent of any comments received and give the proponent an opportunity to respond to the comments.

11) The Executive Director has 20 days from expiry of the public comment and review period to prepare final report specifications and request the proponent to prepare the project report in accordance with those specifications.

12) Within 25 days of receiving the project report, the Executive Director must accept the project for review if it meets the final project report specifications, or withhold that acceptance if it does not meet the specifications.

13) If accepted for review, the proponent must provide the number of copies specified by the executive director. Within seven days of receiving those copies, the Executive Director must give notice to the public inviting comments about potential effects of the project, and must notify First Nations whose traditional territory includes the site of the project or is in the vicinity of the project that the report has been accepted, and invite comments about potential effects of the project.

14) Within 45 days after receiving copies of a project report, the Executive Director must make an assessment, in consultation with the project committee, of the adequacy of any measures which the proponent has taken or proposed relating to distribution of information about the project. The assessment may specify further necessary measures, including consultation with First Nations.

15) The Executive Director must provide the public between 45 and 60 days to comment on the project report, advise the proponent of any comments received and give the proponent an opportunity to respond to the comments. The Executive Director has 70 days from the end of the public comment period to refer the application to the ministers for a decision. In making the referral, the Executive Director must take into account the application, the project report and any comments. The Executive Director cannot refer the project to the ministers unless any specified further measures relating to distribution of information have been carried out.

16) The ministers have 45 days to make a decision to issue the certificate, refuse the certificate, or refer the application to the Environmental Assessment Board ("Board") for a public hearing. They must consider the application and project committee recommendations, and give written reasons for their decision. The Board includes regular members and temporary members who have relevant expertise or special knowledge for a particular hearing. The *Act* does not require First Nations representatives to be on the Board.

17) Within 30 days after a referral to the Board, the ministers must specify draft terms of reference for the public hearing. The draft terms of reference may include a requirement that the board inquire into, and recommend whether, any approvals in relation to the application should be given.

18) Within seven days after preparing draft terms of reference, the Executive Director must notify the public and invite comments about the draft terms and potential effects of the project. The Executive Director must also notify First Nations whose traditional territory includes the site of the project or is in the vicinity of the project that the draft terms of reference have been prepared, and invite comments on those draft terms and potential effects of the project.

19) The Executive Director must provide the public between 30 and 60 days to comment on draft terms of reference, advise the proponent of any comments received and give the proponent an opportunity to respond to the comments. The minister then has 30 days to prepare final terms of reference.

20) The Board must conduct public hearings into applications for project approvals in accordance with the terms of reference.

21) On conclusion of a public hearing, the Board must submit a written report to the provincial cabinet that includes the Board's recommendation regarding whether to issue or refuse to issue the certificate. If the board recommends that the certificate be issued, it may recommend conditions, including conditions related to preventing or mitigating adverse effects, monitoring the effects of the project, and evaluating the adequacy of the measures to prevent or mitigate the adverse effects of the project.

22) After receiving the Board's report, the Cabinet has 45 days to decide whether to issue or refuse the project approval certificate. It is important to note that while the ministers and cabinet must consider recommendations of a project committee or board, and comments from the public and First Nations, they are not bound by them. The decision of whether to allow a project to proceed is discretionary, and the *Act* does not constrain that decision. In contrast, under the *Canadian Environmental Assessment Act*, if a project is likely to cause significant adverse environmental effects that cannot be justified in the circumstances, the responsible authority must not permit the project to proceed. The decision maker, as in British Columbia, exercises a great deal of discretion, but there are some criteria that guide decision-making. Decision makers are arguably more accountable under the Canadian Act than under British Columbia's *Act*.

    At any time between acceptance of an application for a project approval certificate and submission of the project report, the proponent may request that applications under other legislation such as the *Mines Act* be considered at the same time as the application for a project approval certificate. The authority under the other legislation has 30 days to issue the approval, refuse the approval with reasons, or specify a date on which the proponent can expect a decision.

Appendix C
Ministry of Energy and Mines Consultation Guidelines

Appendix D

British Columbia Assets and Lands Corporation Aboriginal Interest Assessment Procedures