

Mine
Reclamation
Planning in the
Canadian North

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and
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Chapter One

Reclamation Planning

1.0 Introduction

In the Canadian North little attention has been given to long-term reclamation and restoration of mine exploration and development sites. Degradation of the northern environment is a result of this neglect. As public environmental awareness increases along with participatory opportunities, it is increasingly important that the credibility of reclamation practices be proven and reliable. This pertains not only to the policies and actions of reclamation practice, but also to the way in which we perceive reclamation.

Mining is an interim use of the land, however the impacts associated with this use often result in permanent landscape changes. Questions persist about the true potential and extent of mine reclamation; is reclamation a method of mine closure that minimizes environmental degradation, or is it an opportunity to enhance and develop the disturbed land base towards an ecologically productive state? Reclamation is an important aspect of the public vision of the mining industry. Ziemkiewicz (1987) has noted that the intensity of reclamation activity is directly related to the public desire to produce alternative land uses from extremely disturbed landscapes.

Reclamation is an integral component of the life-cycle of a mine. Present day mining is dependent upon reclamation to maintain the integrity of the landscape and lifestyles disturbed by this land use. Open pit mining requires comprehensive reclamation strategies to be integrated with ore extraction and the handling of large volumes of waste rock, and as a result, reclamation strategies are often an important component of the materials balance in the development of the mine. Ideally, reclamation practices operate in conjunction with mine development and are staged throughout the life of a mine. This reduces final closure costs and the handling of large amounts of material in the final stages of operation.

Traditional reclamation practices of mineral extraction occur at the final stages of mine development: reclamation is the “end” mine, and is usually directed at stabilizing slopes and reseeding the impacted area. Very little research has been conducted on alternative methods of reclamation with respect to

different visions of the mine site and different approaches to the concept of reclamation itself. Exploring new approaches in reclamation may offer mining developments the opportunity to integrate disturbed landscapes into the community or ecosystem of which the mine is but just one element. Increased opportunities in impact mitigation and the enhancement of affected social and ecological communities is possible through a process of reclamation planning based within the principles of environmental impact assessment. Reclamation may be the only aspect of mineral extraction that can contribute to sustainability.

There is a need to examine how reclamation presently fits into the regulatory framework of mine development and to determine the feasibility of defining landscapes and community goals prior to ore removal and processing. An analysis of the present state of reclamation processes in both Canada and the United States will provide an informative basis as to the “state of the art” in reclamation on a global scale. Examination of the concept of “progressive reclamation” reveals the need and importance of rethinking present reclamation practices and shifting the concept to include social and ecological components to the final landscape.

The purpose of this report is to investigate existing reclamation practices and develop an alternative concept of progressive reclamation for the Canadian North. The objectives of this report are:

- To review and assess selected reclamation practices and processes and identify the strengths and weaknesses embodied in the current concept of mine reclamation;
- To describe emerging concepts in progressive reclamation and examine evolving principles in the planning and practice of reclamation;
- To link the concept of reclamation to the concepts of healthy communities, sustainability in mining, and the environment; and
- To identify the changes necessary in current day policy, regulation, land use planning, and mining development to facilitate the implementation of new concepts in reclamation into mineral development.

The report consists of four parts. Part One provides a definition of reclamation and an overview of reclamation policy and legislation in the Northwest Territories and selected jurisdictions of Canada and the United States. The purpose of this section is to identify the “state of the art” in reclamation as it is

presently embodied in recent policy and legislation. Part Two reports on the emerging trends associated with mining and reclamation and examines the recent literature that defines a different framework for reclamation practices. Part Three presents five case studies in the practice of current day reclamation at mines in British Columbia and the Northwest Territories. This section describes the approach adopted by mining companies in mine site reclamation from both a program and project perspective. Part Four of the report develops a conceptual framework with respect to reclamation planning. Issues such as sustainability and mining, environmental impact assessment, scales of reclamation, and reclamation practice are discussed in the context of the latest literature in these areas. This section of the report culminates in an alternative approach to progressive reclamation in mining and provides recommendations describing the key elements to implement this approach in the Canadian North.

1.1 Defining Reclamation

In Canada, the free entry system defined the early process of establishing an operating mine, and lacked concepts in reclaiming the lands disturbed by resource extraction (Barton, 1993). The concept of reclamation planning in Canada was not realized legally until the late 1960s (Marshall, 1982). Since that time, reclamation and the perception of mining has changed considerably. These changes provide an indication of the direction in which mining and reclamation is heading. The following section shall examine *what* is meant by reclamation in a Canadian context and identify emerging themes that may well have to be addressed in the development of future reclamation policies in Canada.

What is meant by reclamation? Three categories that define various levels of reclamation can be identified: restoration, reclamation and rehabilitation. *Restoration* implies restoring affected landscapes to the conditions that existed prior to the disturbance in question. This would include recreating original topography and re-establishing the previous land use or land condition, as well as groundwater patterns and plant and animal communities. *Reclamation* denotes an approximation of pre-disturbance conditions with an emphasis on the re-establishment of native species. Reclamation generally includes any treatment that is not restoration. That is, where pre-mining conditions need not be restored, but rather where a different condition is established that is appropriate to surrounding land uses and conditions. *Rehabilitation* refers to the return of a disturbed site to a stable and permanent use or condition that is directed by a pre-mine plan. The use or condition must not contribute to environmental deterioration and be consistent with surrounding aesthetic values (Marshall, 1982; McLellan, 1983;

Doll, 1988). Thus, there is a sliding gradient with respect to establishing the initial ecosystem and landscape. Restoration requires duplicating the former site conditions, reclamation attempts to approximate pre-disturbed conditions, and rehabilitation allows alternative landscape opportunities.

Doll (1988) has argued in favour of the concept of rehabilitation as described above. He has concluded that while restoration and reclamation aim to return disturbed landscapes to pre-mined conditions and use, that this is not only extremely difficult, but it limits the opportunities for alternative land uses that may be more socially acceptable and ecologically sound. That is, the disturbed site should not be thought of as a discrete unit, but rather in the context of the entire ecosystem of which it is a part; where the land resource is preserved and opportunities for enhancement identified. Opportunities for improved uses of disturbed landscapes, such as agriculture or identified species habitat, can be realized by applying rehabilitation methods. Munshower and Clark (1988) elaborate on this concept and supplements Doll's interpretation by placing rehabilitation within a broader concept of reclamation. He states:

Reclamation includes all aspects of the environment; it is not restricted to soils and vegetation. Although the disturbed area cannot be returned to its exact pre-mining condition, it can be rehabilitated. It can be returned to a useful function in the ecosystem of which it is a part. In all cases however, the most economical means of attaining reclamation goals is to develop a suitable reclamation plan prior to the actual land disturbance (p. 20).

Thus, rehabilitation consists of a progression of activities based upon a plan, or plans, with the goals of reclamation in mind. In the Canadian context, rehabilitation has been the widely accepted option (Marshall, 1982). Rehabilitation is based within the concept of reclamation in that site stability and a degree of ecological integrity are inherent in both definitions. As Marshall states "...most statutes and regulation in Canada use the term 'reclamation', but define the conditions required under it as though it were, in fact, rehabilitation" (p. 62). This is apparent in the jurisdictions reviewed in this report where, as part of permitting and licensing processes, reclamation plans are a requirement of project approval.

Reclamation is a two tiered activity that involves first, a planning process, and second, a scientific process implemented in the field at the sites of disturbance. The standard approach to reclamation planning is best exemplified by Marshall's (1982) overview of the mining process. The phasing of a mine consists of three steps: pre-production, production, and post-production (Figure 1.0).

Reclamation is planned in the pre-production stages and subsequently implemented after mining has occurred. The reclamation plan and implementation are developed from base-line data collected prior to mining, typically as a requirement of the approvals process. The impacts associated with the mining process are described in what Marshall termed “The Shadow Effect” (Figure 1.1). Impacts are viewed as site and off-site effects resulting from mine development and operation that interact with, and affect the environment.

The emphasis of this approach is primarily upon containment of pollutants and irritants (noise and dust) to the site of disturbance. What is lacking is the broader view of mining disturbances and the significant role reclamation could adopt in their mitigation. This refers to the role of reclamation planning as a tool to enhance disturbed landscapes to higher, more productive uses in both ecological and social settings.

1.2 Reclamation Legislation and Guidelines in the NWT

Mining is a fundamental aspect of the recent history and current day economies of the Northwest Territories. With the onset of the Klondike gold rush one hundred years ago, vast areas of the northern territories were changed forever. Mining in the Northwest Territories has become one of the area’s major land uses relating not only to the mine sites themselves, but also to the construction of access roads and air strips, exploration sites and the establishment of both permanent and temporary mining communities in this large region.

The early mining legislation of the northern territories were derived from regulations made under the *Dominion Lands Act* when Rupert’s Land was transferred to the Dominion of Canada to become the Northwest Territories in 1870. Two years later in 1872 the *Dominion Lands Act* was

Figure 1.0
Marshall's Mine Development and Reclamation

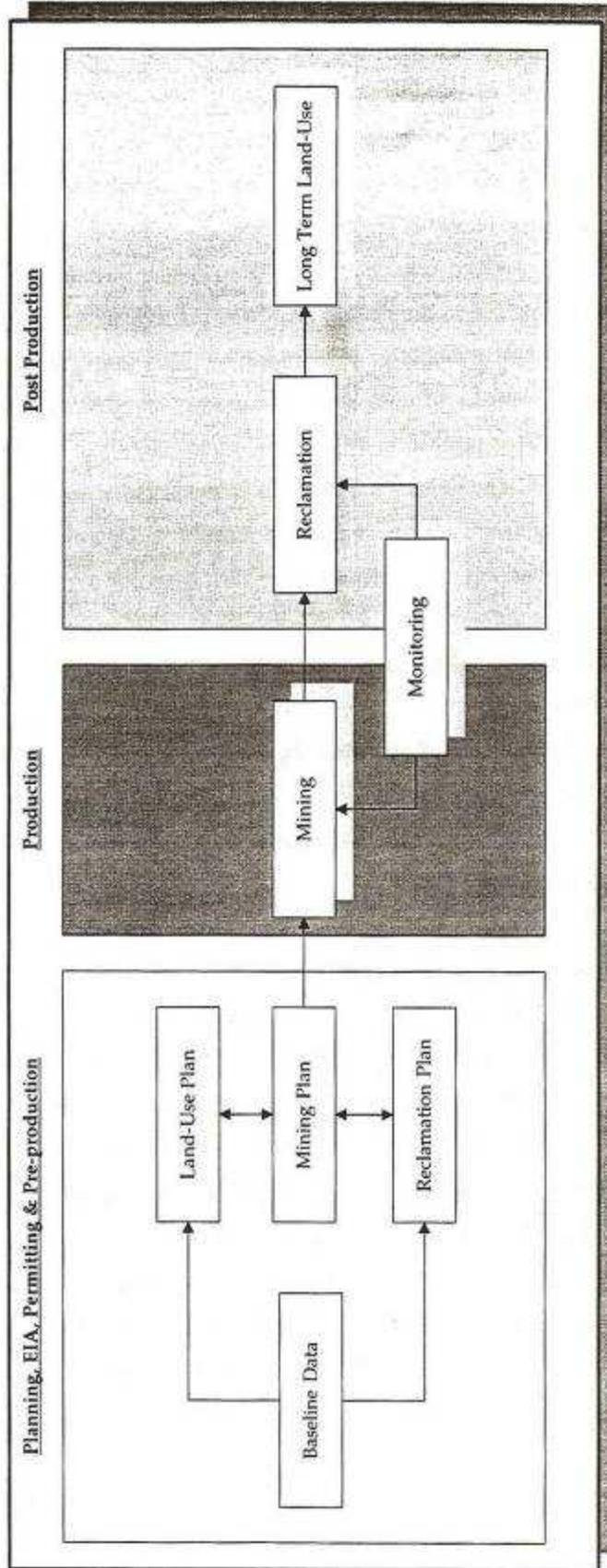
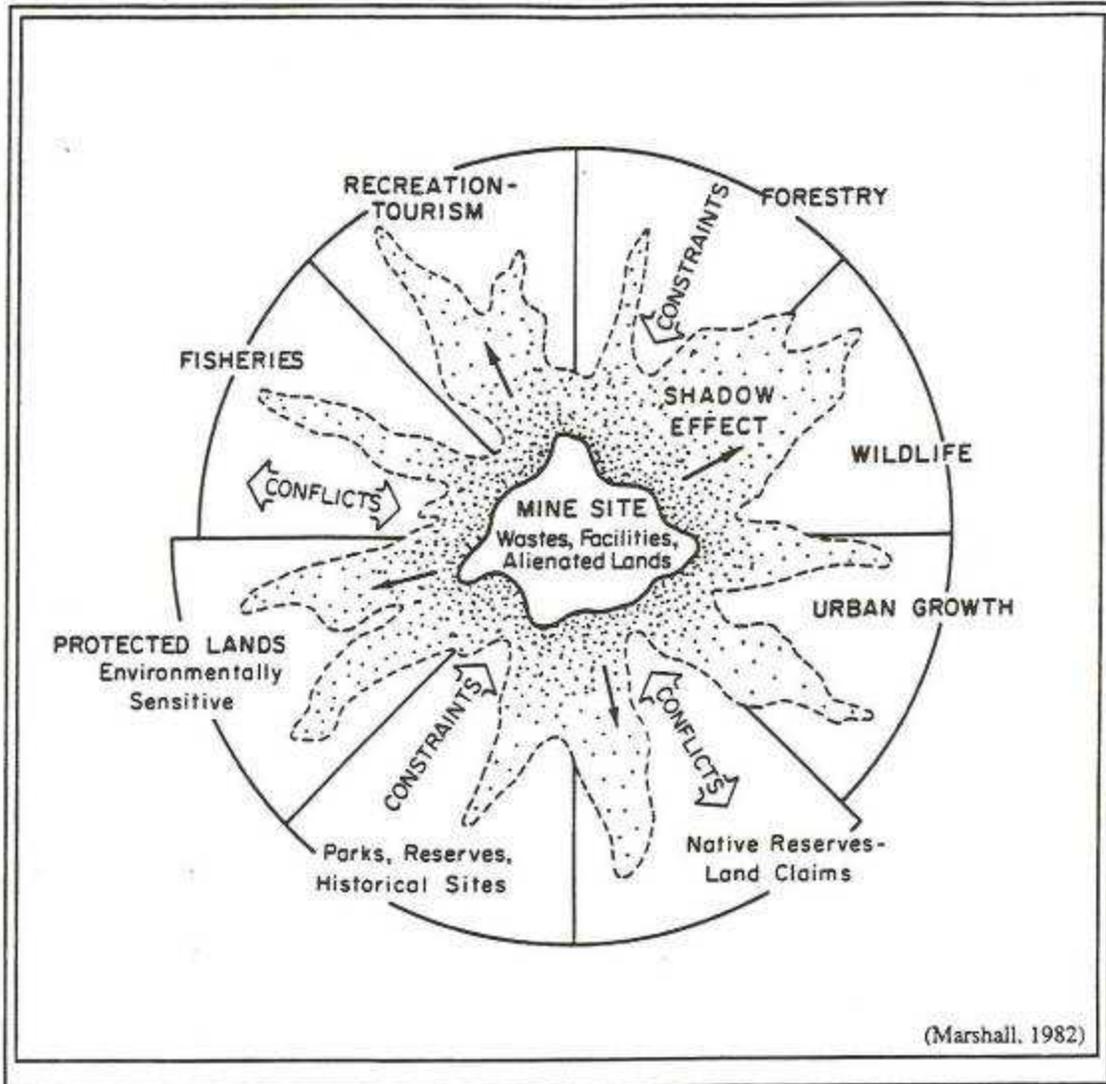


Figure 1.1
The Shadow Effect



enacted (Barton, 1993). The founding principles of mining law in the territories was based upon the free entry system granting rights to enter upon lands in search of Crown minerals, stake claims, apply for a land lease, and to produce mineral resources. Since 1910 mining law has developed in an incremental manner as technology, land use issues, environmentalism, and aboriginal land claims have affected public policy development in mining throughout the Twentieth Century.

While a number of bodies of legislation deal with mining and land use in the Northwest Territories, there is no single piece of legislation that directly addresses the reclamation of mine sites and surrounding impacted areas. Where reclamation is required within the Northwest and Yukon Territories, it is found within guidelines prepared by Federal agencies involved in the regulation of the mining industry. The standing of these guidelines is derived from discretionary powers embodied in the statutes and regulations overseeing land leasing and water use. Generally, reclamation requirements are imposed as a condition of a lease and/or a permit and enforced through reference to the guidelines associated with the regulations (Marshall, 1982; DIAND, 1992).

The Northwest Territories administers reclamation planning under the *Territorial Lands Act (TLA)* and the *Northwest Territories Waters Act (NWA)*. The TLA is administered by DIAND, who shares administration of NWA in the Northwest Territories with the Northwest Territories Water Board. In 1993, the *Northern Inland Waters Regulations* were revoked and replaced by the *Northwest Territories Water Regulations*.

The TLA controls and manages all territorial lands through the use of land use permits (Section 8) and the establishment of land management zones (Section 23 [g]). Mining rights may be granted under Section 12 of the Act which also provide for the use of regulations to protect the holders of surface rights:

The Governor in Council may make regulations for the leasing of mining rights in, under or on territorial lands and the payment of royalties therefore, but such regulations shall provide for the protection of and compensation to the holders of surface rights.

In addition, regulations respecting the protection, control and use of the surface of territorial lands may also be made under Section 23(j). Together, these sections permit for the imposition of reclamation through regulations as a condition of obtaining a land lease for mining.

Two sets of land based regulations administer this act: the *Territorial Land Use Regulations* (TLUR) and the *Territorial Lands Regulations* (TLR) (DIAND, 1992). The leases issued under the TLR regulations may contain conditions of lease pertaining to the reclamation of a mine site and its land based components.

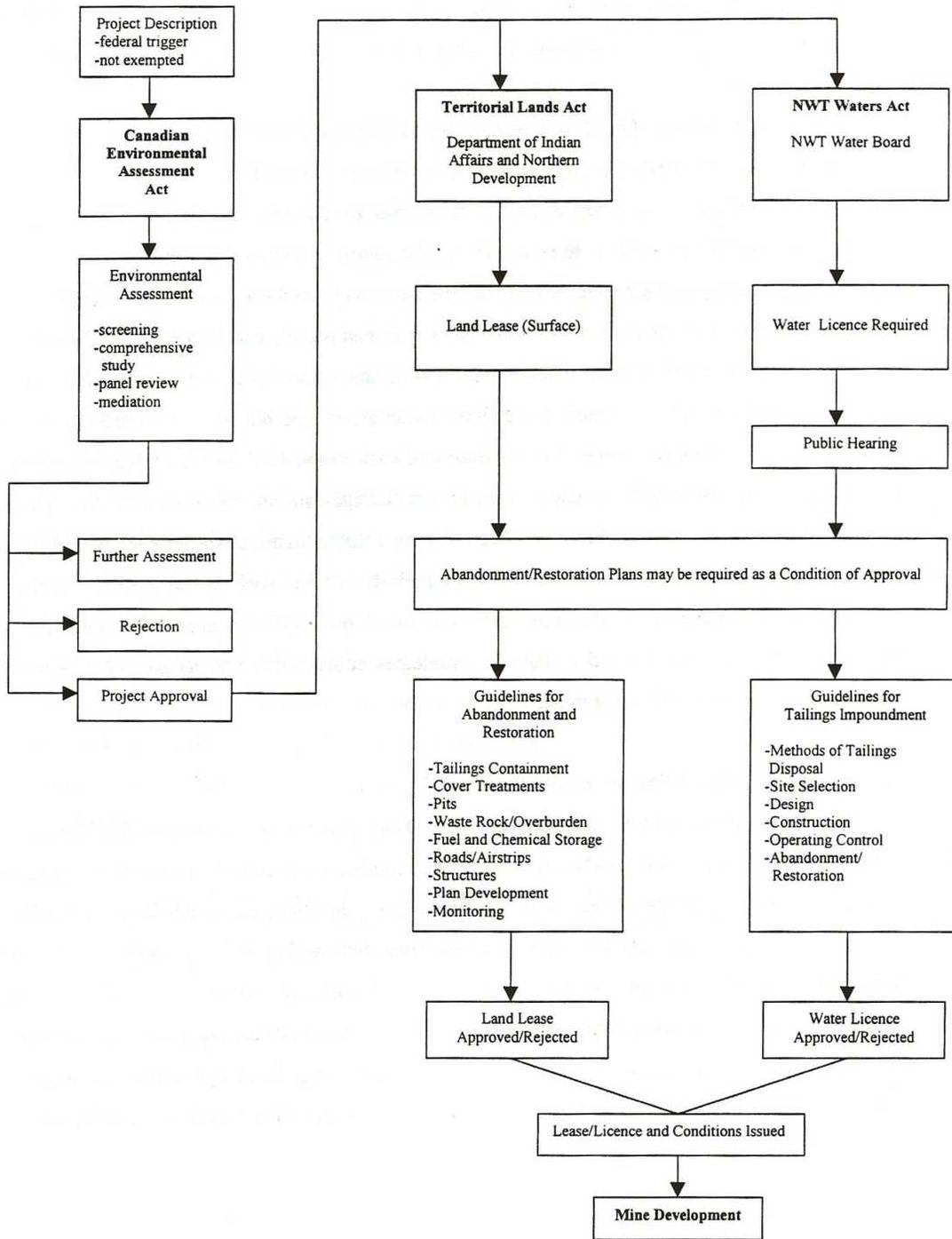
Under the regulations of the NWA reclamation is again addressed as a condition of licensing. A water licence is required by a mine proponent where water is used directly, water is crossed by roads or other infrastructure, flood control or diversions are planned, or where flow or storage of water is planned. Where waste is to be deposited, the applicant would also require a water license. Reclamation requirements are triggered through the need to obtain these two permits/licences.

The present state of the regulatory regime has segregated reclamation into two separate entities: land based and water based issues (Figure 1.2). One characteristic of this structure is duplication where issues such as erosion, runoff and sedimentation are related but must be addressed in both licensing and permitting processes. The separation of such interrelated and dependent components also increases the opportunity for gaps where impact linkages are not easily identifiable. This is particularly true in the north where it has been observed that climatic characteristics contribute to latent impacts that may not be observed for long periods of time, such as the leaching of acidic compounds from land-based wastes into water systems. A more efficient approach would address both land based and water based reclamation strategies concurrently and as part of a series of related plans over the lifetime of a mine.

1.2.1 Reclamation Guidelines in the North

In an effort to standardize licensing and permitting reclamation conditions, the Northwest Territories Water Board and DIAND have published guidelines addressing some of the primary issues affecting the practice of reclamation in the North. In 1987, the *Guidelines for Tailings Impoundment in the Northwest Territories* was published, followed by the *1990 Guidelines for the Abandonment and Restoration Planning for Mines in the Northwest Territories*. The first of these documents serves to provide information on the “site investigation, design, construction, operation and abandonment of a technically safe and environmentally sound tailings facility” (NWTWB, 1987). The protection of inland water resources from mine tailings contamination is at the heart of

Figure 1.2 Mine Licensing and Permit Approvals in the Northwest Territories



these guidelines. The technical design of facilities to minimize any identified potentially significant impacts to water resources is the emphasis of these guidelines.

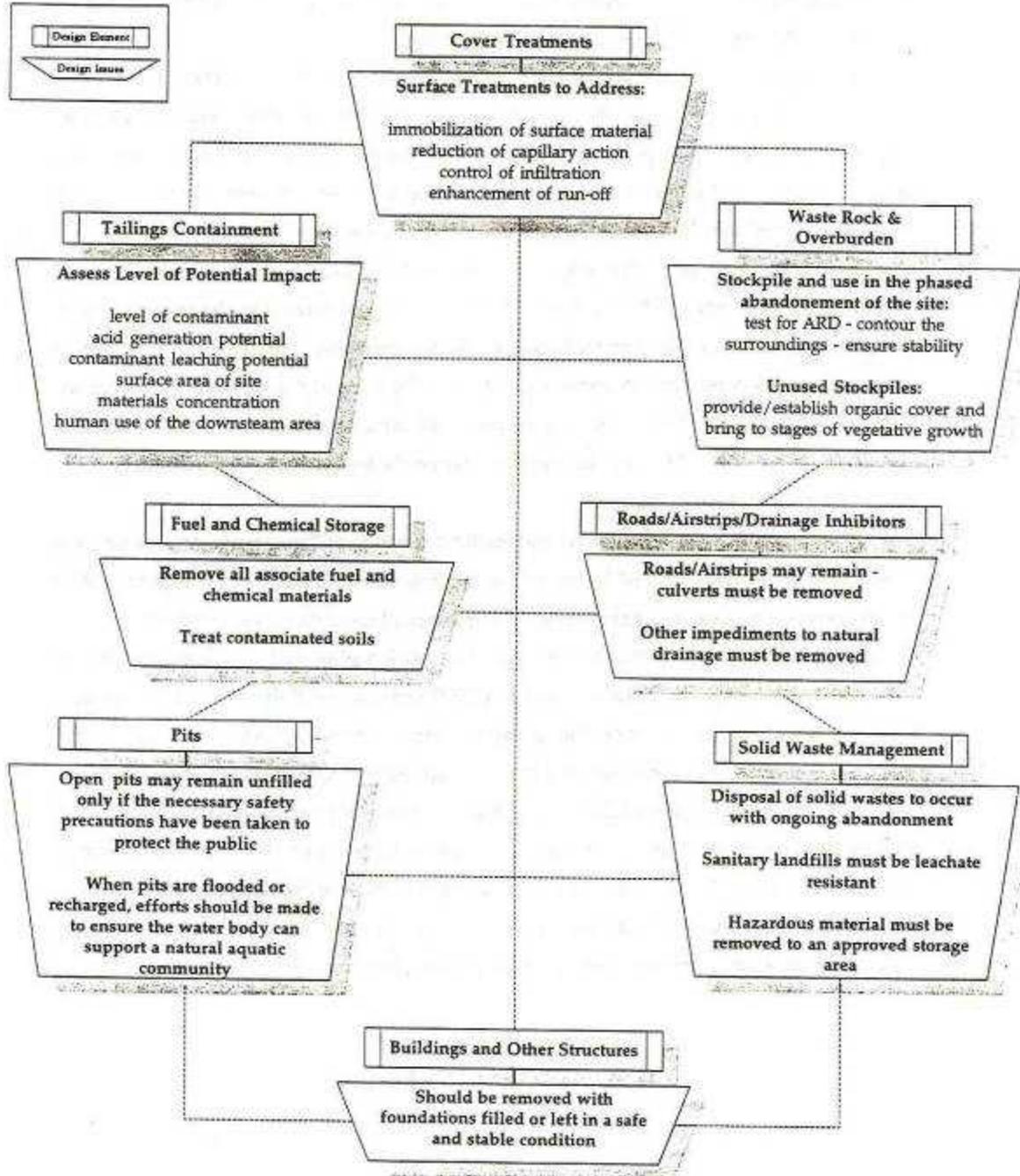
The guidelines require that as a part of licensing, a mine plan, monitoring plan, a contingency plan and an abandonment plan be submitted. The abandonment plan guidelines focus on addressing erosion and revegetation issues to ensure that the physical integrity of the site is maintained upon final abandonment of the site. These guidelines represent some of the early attempts to address mine site reclamation in the Northwest Territories.

The Guidelines for the Abandonment and Restoration for Mines in the Northwest Territories (1990) represent an attempt by the NWTWB and DIAND to consolidate the requirements of abandonment and restoration plans pertaining to mining operations. Prior to this, concerns were expressed by proponents as to the contents and detail of the required plans. In the past, an *ad hoc* approach led to a great deal of variation in plans that were submitted to the review agencies (NWTWB, 1990). The 1990 guidelines present a format for the preparation of abandonment and restoration plans by mine proponents.

The guidelines state as a goal of restoration: the prevention of “progressive degradation...and natural recovery of areas affected by mining” (p. 1). Figure 1.3 summarizes the design elements and requirements that are to be addressed in the preparation of restoration plans in the NWT

The guidelines encourage the development of restoration plans that are integrated with the extraction and processing of materials. The NWTWB hopes to instill flexibility in the licensing process in order to revise restoration plans as more information becomes available over the life of a mine. This includes the submission of information respecting reclamation at various phases of operations. The initial phase requires an expressed commitment to reclamation on behalf of the proponent. In the interim phase the proponent’s reclamation efforts are to focus on baseline studies and the preparation of detailed restoration plans. In the final phase of operation the submission of a plan detailing the location of restoration activities, a schedule for completion and a monitoring program for the restored site is required at least three years prior to closure.

Figure 1.3
Northwest Territories
Restoration Planning Design Elements and Issues



1.2.2 Northern Water Resources Studies

The Northern Water Resources Studies presented an updated approach to reclamation in the north in 1992. The purpose of the report was to provide an aid to reclamation planning in the north. The report compartmentalizes mine sites into their various units and identifies objectives of reclamation based on the physical and chemical stability of the site, and land use considerations.

For the first time in the north, the report introduces the concept of “Design for Closure”. This concept has two objectives:

...that mine components meet reclamation objectives, and that reclamation activities be incorporated into the design and...conducted during operation of the mine components rather than delay until closure (DIAND 1992, p. 6).

The report outlines a process for designing for closure that consists of seven steps. The basis of the design consists of a closure plan that should be developed prior to the development of the mine. However, such a plan needs to be open for revision and adjustment to account for changing variables over the course of a mine operation. The report recommends seven steps in a design process for developing a closure plan:

- Evaluate and describe the pre-development environment;
- Describe the facilities and components that will comprise the mine site in terms of their physical and chemical characteristics;
- Describe the proposed reclamation measures to be implemented both progressively and post closure;
- Implement an impact assessment based upon the proposal and reclamation measures proposed. If site objectives may not be met alternative reclamation measures should be examined. If impacts prove to be unacceptable then alternative mine development may be considered;
- Establish monitoring and maintenance requirements;
- Prepare construction and phased development schedule with associated costs; and
- Outline how reclamation will be financially assured.

The report details reclamation techniques to address the primary components of physical and chemical stability and land use. Physical and chemical stability emphasize minimizing and

containing contaminants at mine site, while land use considerations address contouring and revegetation measures for disturbance areas. While the findings of this report have not yet been adopted into guidelines or policy in the Northwest Territories, it proposes a significant change in the approach to mining in the north by addressing the closure of a mining operation in conjunction with development plans.

1.2.3 Consultation Document: Mine Reclamation in the Northwest Territories

In February 1997, DIAND released a consultation document respecting mine reclamation in the Northwest Territories. This paper has been circulated to stakeholder groups in preparation for the final publication of the Mine Reclamation Policy. One of the primary reasons for the development of this policy was a significant increase in claims staking in the Northwest Territories and the likelihood of several new mine development applications. In an attempt to increase certainty in the region and confirm the Federal government's commitment to sustainable development, the draft policy aims to adopt a more comprehensive approach to mine reclamation planning in the North.

One of the key components of the draft policy is the harmonization of reclamation plans between the land and water based regulatory regimes. As discussed, the existing licensing and lease structure requires reclamation guidelines be followed for both the land-based aspects of project development under the *Territorial Lands Act*, and for the water-based elements under the *Northwest Territories Waters Act*. The new policy proposes to integrate approvals under a combined reclamation plan that addresses both land and water issues surrounding mine development.

The new requirements that may be imposed on mining companies include:

- the submission of a mine reclamation plan and the approval of that plan prior to production;
- the updating of reclamation plans as mine development and reclamation practices change from the approved plan;
- the submission of an annual report detailing the progress of reclamation;
- the inclusion of progressive reclamation as development and production proceed throughout the life of the mine; and
- the provision of financial assurances to the Crown that will ensure site reclamation is conducted at the expense of the mining company.

In addition, the new policy will hold mining companies liable to the site until a written acknowledgement from the Minister is signed confirming that the approved reclamation plans and conditions have been met by the operator. This policy component is important in that it holds mining companies to post closure monitoring of a site as long as is required and will force companies to address potential long-term impacts from the site such as acid mine drainage. The policy will serve to increase the liability of future mining companies operating in the North.

The details of the mine reclamation plans are similar to those required under the existing guidelines but include more detailed requirements respecting reclamation budgets for each year of the mine life, contingency reclamation measures in the event of temporary closure, and a plan for post-closure monitoring. In general, the new policy will influence the consideration of reclamation planning at the front-end of licensing and, upon approval, on yearly basis throughout the life of the mine to post closure scenarios.

While the draft policy associates itself as one component in the co-management initiative of natural resources in the Northwest Territories there is no evidence of this in the document. Stakeholder consultation on the content of the policy is ongoing, however there are no avenues for co-management within the reclamation policy respecting contributions to end-land use objectives, linkages between mining operations in proximity to one another (cumulative effects), and participation/consultation in plan development. In its present state, the draft policy maintains the status-quo in project approvals providing strong lines of communication between proponent and regulator but very little communication, or proactive involvement, for other stakeholder groups.

1.3 The Practice of Reclamation in Canada

How is reclamation practiced in Canada today? An overview of current legislation and guidelines provides an assessment of how reclamation is being applied in different jurisdictions. The most recent legislation with respect to mining and reclamation in other Canadian jurisdictions is found within the provinces of Manitoba, Alberta and British Columbia. A discussion of the legislation in these provinces provides insight as to how reclamation is considered and incorporated into the mining regulatory regime in these provinces.

Manitoba

The *Mines and Minerals Act* (1991) of Manitoba requires the approval of a mineral lease in order to establish a mining operation. Section 111(2) requires the approval of a closure plan and security for rehabilitation prior to the commencement of mining. Part 14 of the Act exclusively addresses progressive rehabilitation, which it defines as: “rehabilitation of the [mine] site that is carried out in the course of the operation...” (p. 109).

Mine proponents in Manitoba are required to incorporate the concept of progressive rehabilitation into their closure plans and ensure that it occurs whether or not an operation discontinues or is closed. In addition, the filing of yearly rehabilitation reports is required that document the rehabilitation work undertaken to date at the mine site and account for any changes such works pose for the approved closure plan. As works proceed the closure plan security may be returned in installments if the required rehabilitation objectives have been achieved. These securities are disbursed from a Mine Rehabilitation Fund established by the province to ensure the availability of monies for such purposes or in the event of abandonment.

From a legislative perspective, the *Mines and Minerals Act* presents an updated approach to the concept of reclamation. The province has incorporated the concept of progressive reclamation (rehabilitation) directly into the Act, and requires the staged/phased restoration of the mine site through incentive systems that allow for the return of rehabilitation securities as the mine site is progressively restored. In addition, the submission of yearly reports allows for flexibility and change in the mining initiative, while at the same time ensuring that progressive rehabilitation is taking place over the life of the operation. In general, the Manitoba legislation brings reclamation of lands impacted by mining closer to the “front end” of the licensing process where it is an integral component of licensing that is evaluated, adjusted, and implemented throughout operations.

Alberta

In 1993, the Province of Alberta proclaimed the *Environmental Protection and Enhancement Act* (EPEA)(1992). This Act amalgamates a number of pieces of environmental legislation in Alberta including the *Land Surface Conservation and Reclamation Act* (1973). One purpose of the EPEA was to bring together many pieces of legislation under one act in order to streamline and improve the certificate and permitting processes for a variety of projects in their construction, operation and

reclamation. The Act not only incorporates permit and certificate approvals, it also contains provisions and direction for environmental impact assessment in relation to any proposals (public and private) submitted under the Act.

With respect to mining and reclamation, proponents are required to provide reclamation plans along with development plans for mine operation proposals. A reclamation certificate is required by the proponent before any surrender of the surface lease for the project is binding. Therefore, before closure is approved by the province, it is the onus of the operator to demonstrate that reclamation has proceeded as prescribed in the reclamation plan. If the province is satisfied that no further environmental protection is required, the certificate may be issued and the operator released from the lands. As under the *Land Surface and Conservation and Reclamation Act (1973)*, all new developments and reclamation requirements are handled through the Conservation and Reclamation Council (previously known as the Land Conservation and Reclamation Council).

In addition, the practice of reclamation is driven by the Conservation and Reclamation Code of Practice. The Code stresses the following goals and objectives:

- The return of a disturbed site to a land capability equivalent to the pre-disturbed capability. This capability is to be sustainable under normal management conditions of the land;
- Reclamation standards are driven by the pre-disturbed land inventories of soil, landscape and vegetation conditions;
- Potential impacts to soils, landscape and vegetation are also to be derived from pre-disturbance land inventories;
- Operations should be conducted in a manner that conserves the conditions of soils, landscape, and vegetation to reduce impacts on the site and improve the success of reclamation;
- Potential impacts are to be assessed prior to construction;
- Native vegetation should be protected with the goal of rapid re-establishment of vegetation compatible with adjacent lands in mind;
- Monitoring must be undertaken in relation to all activities associated with the project and conducted prior to the granting of a reclamation certificate; and
- Reclamation practices must be conducted on as much of the disturbed land area as

possible (Shergill, 1995).

Environmental Impact Assessment (EIA) is playing an increasing role across Canada and, including Alberta, is becoming an additional step to the approval of a mining operation. The undertaking of an EIA can increase the time and money in the approval process, as well as the public scrutiny under which a proposal is judged. Section 42 of the EPEA provides for the further assessment of a proposal at the discretion of the Director where the preparation of an environmental impact assessment report may be required. Reports prepared under the EIA process are required to address the mitigation of negative impacts upon the environmental, social, economic and the cultural environments of the impacted area. Considerations in impact determination and mitigation are to include cumulative, regional, temporal and spatial scales. Thus, where an EIA is required, the scale at which reclamation is addressed becomes inclusive of more considerations whereas the reclamation code is more technical in focus. In essence, EIA broadens the scope of the approval process.

British Columbia

In conjunction with the recent approval of Bill 79, the *Environmental Assessment Act* (1995) (EAA), the *Mines Act* (1989) provides for some the most extensive and comprehensive reclamation requirements in Canada. The *Mines Act* allows for the review of two types of application: exploration and small mines, and major mines (based on tonnage produced). Major mine applications require the submission of a detailed mine plan and reclamation program. The reclamation program information requirements are set out under Section 10.6.1 of the Code. These standards are required as a condition of permit approval, however more stipulations for reclamation may be added as site specific conditions may necessitate.

Initial permit approval requires the submission of two reclamation plans supplemented yearly by reclamation reports as a condition of approval. The first plan is a detailed “Five Year Reclamation Plan” that includes information on the implementation of the five year plan in tabular and mapped formats as well as any background research. Typical plans include information on vegetation development, soil conditions, land use objectives, natural plant succession and species establishment. A second plan referred to as a “Conceptual Final Reclamation Plan” is also submitted for permit approval. This plan is to provide information on the closure and abandonment of the mining operation and addresses the

following issues:

- End land use objectives - closure configurations, wildlife targets;
- Productivity and capability targets - how reclamation success will be evaluated;
- Long term stability - physical/chemical for all structures and discharges;
- Treatment of structures and equipment - what will remain or be removed;
- Waste dump reclamation - configuration, management, soil treatment and revegetation;
- Tailing reclamation - impoundment configuration, management, revegetation;
- Pit and underground reclamation - flooding, water quality, discharge and geo-technical stability;
- Watercourse reclamation - post mine site water management;
- Sealing of underground workings - geo-technical stability requirements;
- Road reclamation - revegetation and decommissioning;
- Trace elements in soils and vegetation - a program to assess trace elements;
- Disposal of toxic chemicals; and
Operational and post closure monitoring - geo-technical, ARD, trace elements, revegetation and sedimentation.

As part of the reclamation program the proponent must also address soil salvage, stockpiling and replacement, environmental monitoring and replacement, erosion control, and sediment retention. These may be on separate plans or incorporated into the reclamation plans described above. Finally, proponents must prepare their own cost estimates for all phases of mine development and closure. These estimates then form the basis of the timing and size of the securities required as a condition of permit.

The *Environmental Assessment Act* (1995) in British Columbia establishes thresholds against which all mining proposals must be evaluated. If a proposal for development or expansion of a site exceeds or meets a threshold (tonnage and area targets), it is required to undergo a review under this

Act and receive a Project Approval Certificate prior to the issuance of a *Mines Act* permit. The review process consists of three stages: application, project report, and board hearing (if necessary). Reclamation is an issue given significant attention throughout the EIA process in British Columbia. At the application stage the proponent is required to provide a reclamation feasibility assessment that identifies potential impacts and the capability to mitigate such impacts through design and construction of the mine, environmental protection, and reclamation. In addition, at the project report stage the proponent must include all information as is required under the *Mines Act* for inclusion in the report review.

In 1969, British Columbia became one of the first jurisdictions to enact mine reclamation legislation in Canada. Since that time, the legislation has changed significantly in response to social changes. This is evident in the licensing and environmental assessment review processes, where the practice of reclamation is a forefront issue intertwined, and addressed concurrently, with operational feasibility of the mine proposals themselves. These requirements are embodied in the legislation, laying out a rigorous process for permit and project approval in an attempt to ensure the long term environmental integrity of lands impacted by the mining industry. Also since 1976, the Technical Research Committee on Reclamation (TRCR) has provided a forum for the circulation and discussion of reclamation research ongoing across North America. This committee maintains communication between government, industry, and academia with respect to the practice of reclamation.

1.4 Reclamation in the United States: Federal and State Initiatives

The approach to reclamation in the United States is significantly different from that of Canada. Federal laws in the U.S. require reclamation of surface mined lands for uranium mines only. There are no specific federal provisions for reclamation or environmental protection of hardrock open pit or surface mined lands. State governments may pass their own legislation respecting hard rock mined land reclamation. However, in the absence of such federal laws it is sometimes necessary for a combination of other state and federal laws to provide for such environmental protection measures as reclamation. In this context, two tiers of legislation at the Federal and Washington State levels of government are discussed as well as specific state legislation on reclamation in Arizona, and Colorado.

Federal and State Legislation

The 1872 *Mining Act* of the federal government is still valid in the U.S. This Act does not require reclamation, but simply describes the procedure for locating, filing, patenting and holding a mining claim. In Washington State the *Public Lands Act* (rev. 1987) requires the proponent to obtain a mining lease from the Department of Natural Resources. The 1987 amendment requires reclamation of disturbed lands upon termination of a mining lease. State mining regulations require that the reclamation plan be submitted as a condition of lease approval. Since mining activity is considered to be a disturbance to the environment, the proponent is also required to submit an Environmental Impact Statement (E.I.S.) under both the *National Environmental Policy Act* (NEPA)(1969) and the *State Environmental Policy Act* (SEPA)(1969). Approvals issued under the SEPA are linked to other pieces of legislation which establish specific environmental standards on elements such as water pollution, clean air and hazardous substances. The approved permits contain all the standards and requirements to meet government levels as required in legislation such as the *Clean Air Act* (1977), *The Federal Water Pollution, Prevention and Control Act* (1987) and the *Hazardous Substance Tax Act* (1987). Operations and closure plans must maintain the site conditions as specified in the permit which are based upon a milieu of federal and state legislation.

In some U.S. states, the nature of federal and state legislation with respect to reclamation is less direct in the case of hardrock mining. It relies on a complex assemblage of regulations from other acts to set the standards for the operation and reclamation of mine lands. However, the regulations and contents of the legislation are sufficiently detailed to set very specific levels of expectation with respect to reclamation and operating standards for mines. Some of these standards have come under criticism for their stringency and impracticality. Approximate original contour requirements have been considered inhibiting in terms of reclaiming to a higher use as well as achieving environmental enhancement (Doll, 1988). Other U.S. States such as Arizona and Colorado have approved legislation specifically for mined land reclamation.

Arizona

Under the *Geothermal Resources Act*, Title 27, Chapter 5: Mineral, Oil and Gas; Mined Land Reclamation, the State of Arizona allows for the adoption of rules addressing reclamation of surface disturbances at exploration operations and mining units. The key elements of this legislation include the

use of reclamation plans and schedules, mining units, soil conservation, financial assurances (securities) and specific requirements for exploration activities.

Reclamation plans and financial assurances are required for any surface disturbance (exploration or mining unit) that is greater than five acres. Reclamation plans are divided into multiple mining units with proposed reclamation measures for each unit that are designed to meet specific post-mining land use objectives. Thus, end land use objectives drive reclamation planning at the exploration or mine development and closure stages. The information that is to be included in the reclamation plan includes descriptive documentation and/or schedules that identify the expected disturbances associated with each mine unit, the final topography of impacted areas, roads associated with the operation, and, fish and wildlife habitat disturbances. The development of reclamation measures to address the identified disturbances should, at minimum, include information on:

- Restricting public access to pits, shafts and other hazardous areas;
- Erosion control and stability of remaining features;
- Revegetation, conservation and monitoring of revegetated areas;
- Habitat encouragement and the association of such habitats to adjacent lands;
- The timing of disturbances and the beginning and completion of reclamation; and
- The cost to conduct each stage/measure of reclamation.

In addition, the Act requires the conservation of soils on all unit sites where revegetation is to take place unless it is proven to be impractical to do so. This includes the separation of topsoil and organics from overburden, stockpiling, and spreading when required to enhance opportunities in the re-establishment of vegetation.

The Act also incorporates specific requirements for any exploration activities or disturbances that are not associated with post-exploration operations. A second reclamation plan is required for exploration disturbances that addresses the reclamation of roads, drill holes, drill pads, pits, trenches, and areas that have been cleared to conduct exploration. Reclamation plans are to account for the restoration of drainage patterns, revegetation, access, the capping of holes, re-contouring, erosion control, the backfilling of pits, de-compaction of soils, and adjacent land use compatibility.

Two final elements of the Act that are significant include substantial change allowances and variances. Substantial change allowances permit for revision of reclamation plans where an operator finds it necessary to adjust these plans to account for changes in ore bodies, materials handling and other uncertainties that were not evident at the time of approvals. Variances are conditional orders that

allow operators to vary from specified reclamation requirements as contained in the act or in previously approved plans. Variances account for *innovative reclamation* where research or other limitations (site characteristics) indicate that the requirements of the Act or plans may limit the best possible reclamation measures. These two aspects of the Arizona Statute account for uncertainty in mining, flexibility in reclamation planning, and factors associated with the duration of operations such as new technology development, or temporary shutdown due to market forces.

Finally, public involvement in mined land reclamation as required by the Act is limited to comments in response to the public disclosure of information with respect to the mining application. This information includes the proposed post-mining land use(s) and a general description of the proposed reclamation measures. Thus, public participation in reclamation and mining assumes a role of respondent in relation to the *a priori* development of mine plans and programs (A.R.S. : 901-991).

Colorado

Reclamation in Colorado is addressed by the *Colorado Mined Land Reclamation Act* (CMLRA)(1996). The significant elements of this Act include a policy declaration within the legislation, information exchange and research, and the preparation of reclamation plans.

The CMLRA includes a legislative declaration which defines the policy directive for mining and reclamation in Colorado. The policy establishes the context of reclamation within the scope of mining approvals and the public interest. The Act states:

It is declared to be the policy of this state...to foster and encourage the development of an economically sound and stable mining and minerals industry and to encourage the orderly development of the state s natural resources, while requiring those persons involved in mining operations to reclaim land affected by such operations so that the affected land may be put to a use beneficial to the people of this state (C.R.S. 34-32-102).

This policy is realized through the development of a mined land regulatory program designed to balance the cost of reclamation practices with the environmental benefits derived from its success. One of the main features of this program is the establishment of a Mined Land Reclamation Board. This board serves to initiate and encourage studies and programs relating to the development of less destructive methods of mining, better methods of reclamation, effective reclaimed land use and the

coordination of information derived from these studies with other agencies associated with environmental, recreational and rehabilitation concerns. Research, information exchange, and coordination adopt a key role in reclamation in Colorado State.

The CMLRA requires the development of reclamation plans as part of permit approval. These plans are to be updated each year to document the extent of current disturbances, reclamation accomplished during the preceding year, anticipated new disturbances, and the reclamation program for the upcoming year. Reclamation plans consist of three main components: the general requirements, land use requirements, and the phasing strategy.

The general requirements of reclamation plans are comprised of ten reclamation measures:

- Grading to achieve final topography to meet post-mining land use objectives;
- The impoundment of water through earth dam construction;
- The handling of acid generating waste to protect drainage systems from pollution;
- The disposal of refuse for aesthetic purposes and pollution prevention;
- The establishment of self sustaining vegetation with an emphasis on native species;
- The separation topsoil from other spoils for use in reclamation;
- The minimization of disturbances on surface and ground water systems;
- The protection of areas outside the project from slides or other damage;
- The stabilization of all surface areas affected by operations; and
- The conformity of end land use objectives with local jurisdictional plans.
-

The Act also includes reclamation requirements for specifically identified land uses. Operators are required to state which of the affected areas will be reclaimed to a particular land use. These include forestry, crop, horticulture, homesite, recreational, industrial and associated wildlife habitat uses. For each of these uses, an number of reclamation requirements must be met to the satisfaction of the reclamation board such as species selection, appropriate liability insurance, slope attainment and planting conditions. In general, these requirements are determined by the board on a case by case basis, as minimum requirements to achieve a suitable land capability for targeted end land uses.

The third component of the reclamation plan is that of the phasing strategy. The Act requires that reclamation be conducted concurrently to mining as is practical, and preferably in five year phases. In addition, upon completion of operations each phase of final reclamation is to be completed with five years of one another. These strategies are to be incorporated in the reclamation documents and plans as part of permit approval.

1.5 The Present State of Reclamation: Summary and Analysis

The preceding discussion illustrates a number of current concepts that are inherent in legislation and guidelines that oversee mined land reclamation in North America. While no one jurisdiction possesses all elements, most employ a combination of tools and techniques to regulate and implement reclamation. Figure 1.4 summarizes these efforts by common approval requirements, reclamation plan/program components and concepts, and reclamation criteria/requirements.

When compared with what was considered the “state of the art” (Marshall, 1982) in the early eighties, it is evident that a number of general evolutionary events have occurred in reclamation. These are depicted in Figure 1.5. First, the EIA process expands the inputs that are considered in plan development and project approvals. These inputs now include long-range forecasting of impacts, broader boundaries and increased cultural and ecological considerations. Second, plans are expected to be more comprehensive and integrated with one another. The mine site is now broken into its various components, impacts and disturbances are assessed, and reclamation measures proposed that would minimize or mitigate these impacts. In addition, research is considered an integral component in the preparation of these plans and their alteration throughout the life of the mine. Third, in the production stages reclamation is a concurrent activity with ore removal and production and supported by yearly reporting and forecasts for future production, and

Figure 1.4
Elements of Reclamation

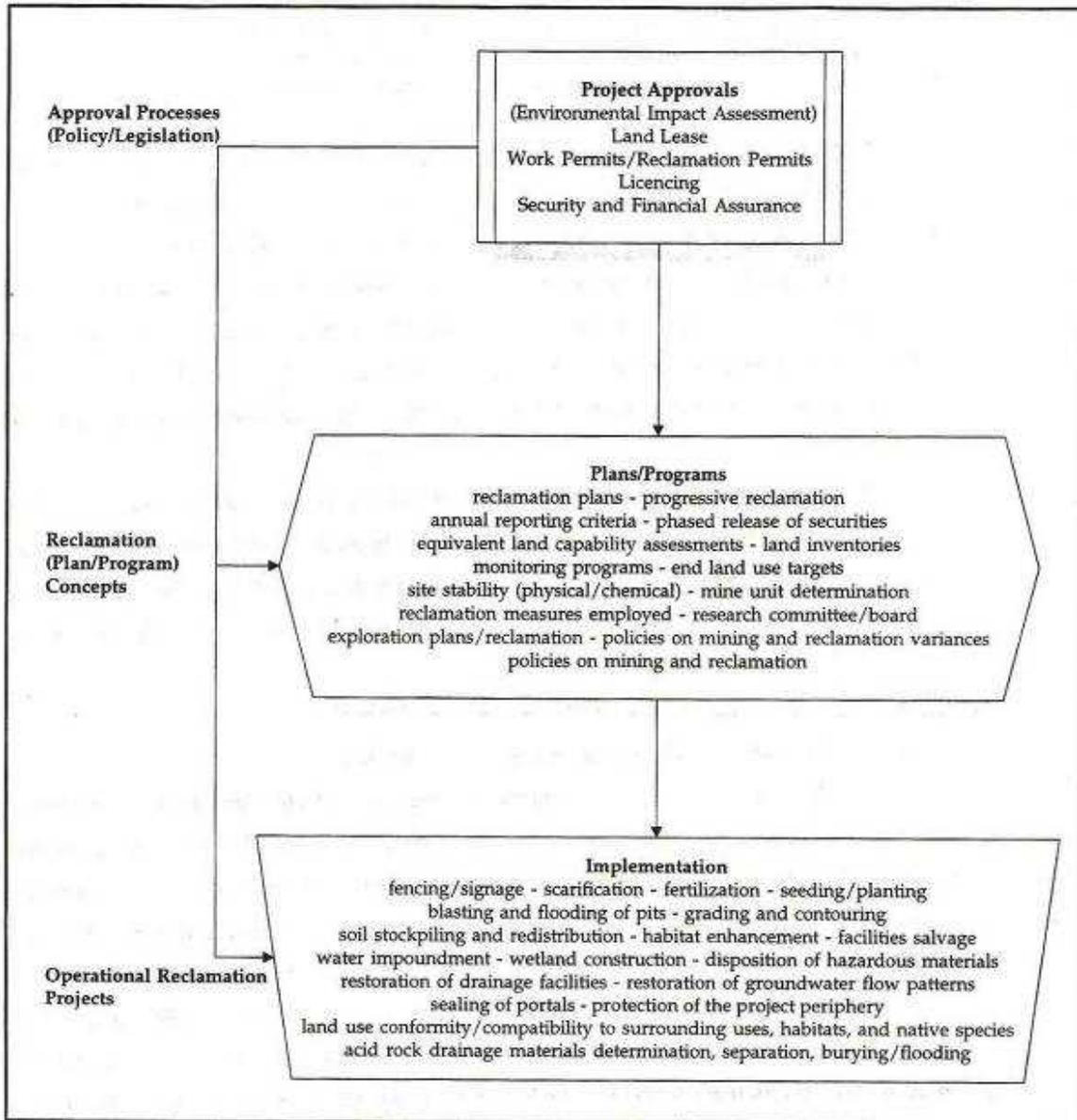
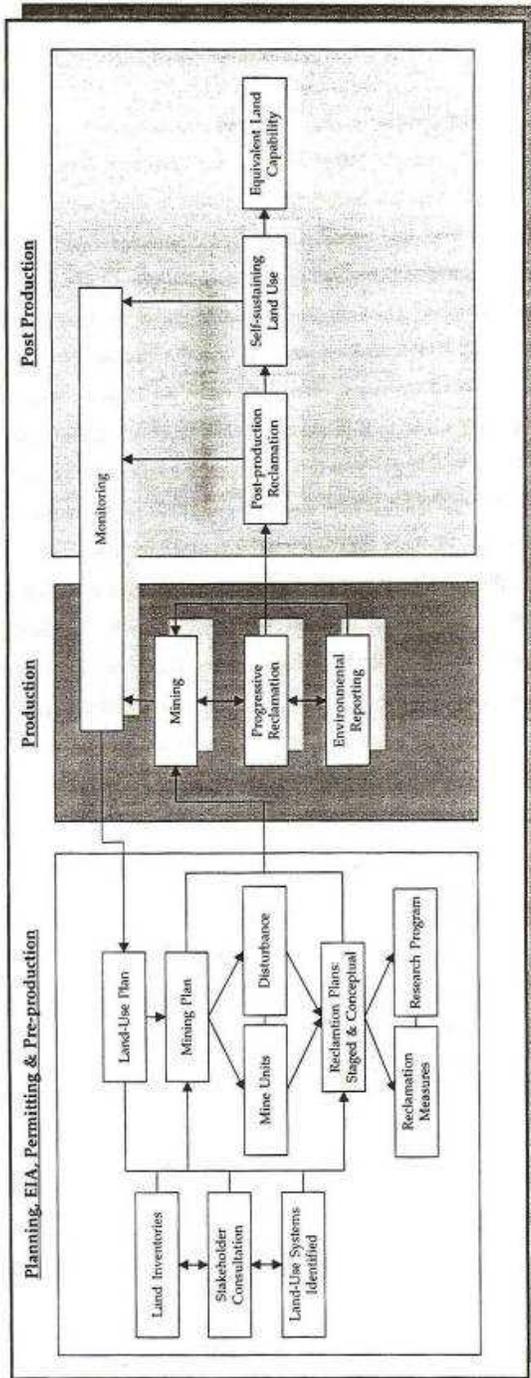


Figure 1.5
State of the Art (1998) Mine Reclamation



reclamation related activities. Reclamation is no longer considered effective only in the post-production stages. In post-production reclamation continues until a self sustaining land use is established that will re-generate to an equivalent land capability prior to that of mining.

While the legislation review revealed that these steps are not required in all jurisdictions and that approaches to mine regulation vary (guidelines/legislation), their depiction in a complete framework produces an indication as to where reclamation and mining are heading in the 1990s. The present “state of the art” may be considered somewhat idealistic and more reflective of what is being requested of the mining industry rather than what is occurring at ground level. This is particularly evident upon a review of the recent literature on reclamation and environmental management, and a comparison of mine site reclamation case studies.

Chapter Two

Alternative Directions in Reclamation

2.0 Reclamation Challenges and Opportunities in the North

The previous discussion brings to light many of the challenges the environment of the Canadian North presents to healthy mineral development. The primary challenges include the unique natural and social environmental setting of the Northwest Territories coupled with the values of the Native peoples and their direct dependence upon the natural environment of the North. Cold region ecosystems are generally low in species diversity and primary productivity and comprised of short food chains associated with simple predator prey relationships. The result is an environment that is more susceptible to the negative impacts associated with change in the environment. The cultural and environmental sensitivity of the North implies the need to address reclamation in a different context from that of its traditional role. This includes broadening the role of reclamation as a means to introduce different values into the decision process to promote the enhancement of disturbed landscapes and lifestyles. The dramatic increase in mining activity emphasizes the need to closely examine the role of reclamation in this respect. Present day impact mitigation and reclamation initiatives, while important and necessary, are strictly site oriented and driven by reclamation regulations. An expansion of the roles of the affected stakeholders is required to build upon existing methods in reclamation and increase the knowledge of the environments in which the mining industry operates. The ultimate challenge will be to effectively translate a new approach to reclamation into legislation and guidelines that addresses these issues.

2.1 Environmental Impact Assessment and Mining

Environmental impact assessment (EIA) has become an element of the environmental decision making framework and is becoming an inherent factor in the approval of mining operations. Typical EIA legislation consists of "triggers", or limits, that initiate the EIA process. In the case of mine proposals it is common for these limits to be related to either tonnage extracted, the project land area, or most often both. It is evident that for a mine proposal to forego the EIA process that such a

proposal would be very small. For example, in British Columbia any mineral mine that will produce mineral ore of more than, or equal to, 25,000 tonnes per year is subject to the review process. Any modification to an existing mine entailing more than, or equal to, 25 hectares is also subject to review (EAA, Bill 29). At the federal level, comprehensive study is required for the proposed construction, decommissioning or abandonment of a gold mine for example, with an ore production capacity of 600 tonnes per day (219,000 t/yr.) (CEAA, Bill C-13).

Environmental assessment is a process that is initiated where the potential impacts of a project are deemed to require assessment and review prior to project approval. When a project has been successful in the EIA process it is deemed ready for the permitting stage. This sequence has often been criticized for its redundancy as many consider the EIA process to be more rigorous than that of permitting. Nevertheless, the EIA process significantly affects reclamation planning and practice for mine project approvals.

In addition to permitting and licensing requirements, the initiation of an EIA broadens the scope of consideration in project review and formalizes the evaluative criteria against which a project is considered. This is exemplified in Alberta's EPHA (1992) where environmental assessment reports are to contain:

...a description of the potential positive and negative environmental, social, economic and cultural impacts of the proposed activity, including cumulative, regional, temporal and spatial considerations (Sec 47(d), EHPA, 1992).

Thus, where significant impacts and concerns are anticipated, it is necessary to address a multitude of dimensions in project development.

The inclusion of the EIA process in mine project approvals brings with it the input and participation of more stakeholder groups. This may include the establishment of project committees, public advisory committees, consultation with the public and First Nations, and other levels of government. Some projects may also be classified as "reviewable" under the *Canadian Environmental Assessment Act*. This can produce a two tiered environmental assessment; one at the federal level, and a second at the provincial level. At the present time the Canadian government is investigating how to harmonize the provincial and federal levels of environment assessment to avoid duplication and improve efficiency in the assessment process (NRC, 1995a).

Although EIA may have advanced the state of the art in reclamation, it does possess some shortfalls of its own. Impact assessment has been criticized for its narrow scope and inability to move beyond the technocratic in information acquisition (Westman, 1985; Smith, 1993; Burdge et al., 1995; Webler et al., 1995; Meredith, 1995). Moreover, Smith (1993) identifies the focus of impact statements as the main cause of this process' deficiencies. Project specific impact statements alone provide a “ narrow focus, [inhibiting] the ability of impact assessment to address such issues as risk, uncertainty and cumulative effects” (p. 95). Meredith (1995), supports the concept that impact assessment is a culturally specific activity and that rather than simply dealing with ecosystems, impact assessment must address socio-ecosystems to encompass social and ecological perspectives of our environment. Impacts generated on the environment must address the culture in which these impacts occur. This approach is supported in the environmental planning and environmental assessment literature. A social learning perspective is preferred in the form of public participation as an autonomous political practice (Friedman, 1987; Smith 1993; Edelstein and Kleese, 1994).

Support for social learning as a key to the success of impact assessment is recognized for four reasons. First, meaningful public participation in the process enhances the competence of the final decision through the use of local knowledge and the public examination of expert knowledge. Second, legitimacy is established in a process where affected parties can state their case and have equal opportunities to influence the outcome. Third, social learning in the form of public participation is connected with democratic processes in decision making. Finally, involvement in a learning experience can foster stewardship ideals for the community in which people participate (Webler et al., 1995).

Given the increasing use of environmental impact assessment in mine proposals, it is apparent that the main impact on reclamation may come in the form of increased participation in reclamation planning initiatives. As such, reclamation is more than the practice of technical expertise; it may also be a planning process that involves collaborative decision making with aims to maximize the use and environmental integrity of disturbed land resources.

2.2 Emerging Themes in Reclamation

Reclamation has most often been identified as an iterative activity taking place both on paper, in the preparation of plans and permit approvals; and in the field through a scientific process of research, evaluation and application, in an effort to implement approved plans (Sweigard, 1990). At the heart of

both of these processes is a series of similar goals and objectives. Sengupta (1993) indicates that the modern goals of reclamation include:

- The establishment of permanently stable landscapes that are aesthetically and environmentally compatible with the surrounding undisturbed landscape;
- The establishment of a post-mining land use that contributes effectively to the productive capacity and stability of the greater ecosystem;
- The reshaping of the land to a topography that contributes to the stability and productive capacity of the entire area and not necessarily pre-mining contours; and
- To achieve a state of reclamation that is suited for as many alternative uses as is practicably feasible.

With respect to the planning and research processes mentioned above that define reclamation, these goals are expressed at the policy level in a variety of forms. From a planning process the specific goals of reclamation are typically expressed in either statutes/regulations or in government guidelines. In the research process the goals of reclamation are expressed in the form of design standards or performance standards which are to be realized to meet for example, certain permit or licence requirements. The processes are related in that at the planning level specific targets, or goals, are stated that drive the practice of reclamation in the field. However, the practice of reclamation is limited across a number of sites due to the site specific nature of mine developments and the unique variables inherent in each, such as changes in the ore bodies, climate, and environmental sensitivity in general. As such, both processes must be extremely adaptable to different development proposals, and flexible enough throughout the duration of mining to ensure that end land use objectives are not compromised. The different approaches in each process pose significant ramifications for the success of reclamation over both the short and long-term.

2.2.1 The Planning Process

A distinction may be made between Canada and the U.S. in their respective approaches to regulating mining and meeting the goals of reclamation. Smyth and Dearden (1996) have examined the regulatory requirements of western North American mountainous jurisdictions to identify similarities and differences, and the associated implications from a reclamation and environmental management

perspective. They describe a scale of regulatory process between Canada and the U.S. where the U.S. is at one end, with a legislative and rigorously enforced system of reclamation, while in Canada reliance is placed on guidelines. In this context the authors examine three concerns that relate to the attainment of reclamation goals and improved environmental management: interaction, flexibility and information acquisition.

Interaction:

Individuals affected directly or indirectly by mining should have input in the development of regulations. The authors identify "conduits for information flow" between government, industry and universities. This would reduce regulatory abuse by incorporating a strong participatory component in the process. The benefits of a model of negotiated regulations are identified as an increased aesthetic component in reclamation and a more effective development and understanding of reclamation research and technology. This approach is similar to the changes called for in environmental impact assessment aimed at broadening the inputs of the process.

Flexibility:

Reclamation considerations for mines are accepted to be site specific in nature. That is, what may be suitable for one reclamation program in one area, may not be suitable for a similar mine in another. In fact, it is also possible that different reclamation practices are required across one mine site alone. For example, this is the case for the Highland Valley Copper Mine in British Columbia, where the size of the mining operations necessitates reclamation planning over five different bio-geoclimatic zones (Jones, 1996). Therefore it is vital that any regulatory process accommodate the variation that is inherent in reclamation practice. This can be facilitated through built-in flexibility in elements such as performance standards, variances to plans and yearly review of reclamation progress. These should be broad enough in scope to permit the best possible application of reclamation techniques over a wide range of disturbance scenarios.

Information Acquisition:

Smyth and Dearden (1996) describe reclamation as being an art and a science that can be realized and improved through innovation. The key to continued innovation is through the establishment and

maintenance of information flows. This means providing a mechanism through which reclamation research can reach the regulators as well as other reclamation practitioners. Such an approach requires the involvement of government, industry and academia. The sharing and input of information between these three bodies on a continual basis will contribute to improved reclamation and provide increasing options in environmental enhancement. Organizations such as the Technical Research Committee on Reclamation in British Columbia and the Reclamation Research Technical Advisory Committee in Alberta, fulfil such a role.

In summary, Smyth and Dearden (1996) conclude that reclamation theory and practice must develop further and may do so if more attention is applied to interaction, flexibility and information acquisition. In this manner the conceptual aspects of reclamation can be explored further, expanding the practice from a tool of environmental protection to one that nurtures ecosystem integrity. In the planning process of reclamation it is important that modern day frameworks provide for such a direction and strike a balance between those aspects of reclamation that are legislated and those that are provided for in general guidelines.

2.2.2 The Research Process

In practicing reclamation, scientific research assumes a significant role in defining what may or may not be applied to a disturbed landscape. The parameters for such research are often established in the design standards and/or the performance standards established in a particular jurisdiction. These criteria and standards are nested in the legislation and regulations that direct reclamation and can have serious ramifications on the scientific process in reclamation research.

Design standards are defined in reclamation procedures that may be detailed in the regulations. This may include elements such as soil type/quantity, topographic configuration and plant species. The United States goes so far as to require approximate original contour (AOC) configuration for surface coal mining operations. This standard has been criticized for its logistical and financial impracticality and for its limiting consideration of alternative uses or landscapes for disturbed sites.

Performance standards relate a level of expected performance on a reclaimed project without specifying the steps of procedure. They allow for flexibility, experimentation and discovery in reclamation practice.

Doll (1988) has concluded that both approaches are lacking in some ways:

Experience and research in reclamation have clearly shown that design standards...are not conducive to the best quality to most cost-effective reclamation...[and that] performance standards are difficult to regulate...[and can] increase the possibility of reclamation failure if the pre-mine reclamation plan is not adequate (p. 50).

Design and performance standards are key aspects within the reclamation planning process. They affect current day practices, but also have implications for scientific discovery. Inadequate standards have the potential to endanger the mine site in the short-term, and inhibit the conceptual advancement of reclamation theory and practice in the long-term. There is a need to integrate the best characteristics of both concepts so that reclamation is effective but not static.

Doll (1988) has argued for an approach to reclamation that is developed through the performance standards concept, but where the practice follows site specific design criteria on a project by project basis. The method or process by which such an approach may be realized involves three steps. The first is the assembly of data describing pre-mine conditions, which may be acquired primarily through inventories. This information is then used to establish the level of post-mine productivity potential. The next step is the development of site-specific design standards to meet the potential performance levels derived in the previous step. Finally, these standards are incorporated into a reclamation program and monitored over the course of the program to evaluate success. This approach maximizes reclamation practice by allowing for the use of research and the development of new techniques as required, fostering more comprehensive post-mine land use planning, simplifying regulations, and allowing for broader inputs into developing and evaluating a reclamation plan.

2.2.3 Summary

Some emerging themes in modern reclamation can then be identified. First, ecosystems are now the focus of management rather than preventive management alone; the mine site is viewed as one element in the mosaic of complex ecosystems and that modern technology presents us with opportunities to integrate the disturbed landscape into ecosystems rather than simply minimize degradation. Second, broader inputs are necessary to realize enhancement potential. Smyth and Dearden (1996) suggest more social inputs while Doll (1988) emphasizes data collection through inventory. Collectively broader inputs of a socio-ecological nature are required to truly enhance disturbed environments. Third,

flexibility is vital both in the regulatory regime and within the techniques practiced at the mine site. Flexibility allows for the development of reclamation practice as the art and science it is becoming. Fourth, information will affect positive change in the regulatory approaches to reclamation planning as well as the techniques of reclamation practice exercised in the field. While Smyth and Dearden (1996) emphasize the establishment of conduits for information flow between government, industry and academia, Doll (1988) stresses frameworks that allow for the conduction of reclamation research.

With these themes in mind, it is becoming clear that reclamation consists of two interrelated and dependent facets: reclamation planning and reclamation practice. Reclamation planning refers to the process through which reclamation occurs, while reclamation practice refers to the techniques and experimentation taking place in the field, at ground level. Emerging themes in reclamation directly affect both planning and practice and the development of new approaches to reclamation must account for this distinction. In Canada, a number of initiatives are underway that relate to each of these emerging themes in reclamation.

2.3 Canadian Initiatives in Mining and Reclamation: Changing Agendas

Traditional problems in the mining industry are being overshadowed. A more open approvals process, environmental assessment, and an increasingly scrutinizing public have shifted the emphasis of the mining challenge from *how* a reserve will be developed to *whether* it will be developed at all (Summers and Lewko, 1995). In conjunction with a diversifying economy the leverage of the mining industry at the policy level has declined as a result of these factors. In order to be competitive on the world stage it is now necessary for the mining industry to be concerned with social responsibility as well as resource exploitation (Felske, 1992). Doggett (1992) has suggested that :

For long-term survival and prosperity, a mineral policy framework must be established that adapts to the systematic changes occurring in society without diminishing the important contributions made by the industry (p. 95).

It is necessary that a mineral policy framework pay attention to the public policy environment. Despite the fact that the mining industry represented 14.6 percent of Canada's total export earnings and \$11.7 billion to Canada's trade surplus in 1994, a number of variables are placing the industry in jeopardy (NRC, 1995b). These need to be addressed by industry and government together.

Environmental, First Nations and industrial interests are now competing for land resources and as a result, stress on land and conflict between groups has increased. A situation exists where values other than economic worth are part of the decision making process. It has been noted:

.. many people believe that while natural resources and wilderness areas belong to the public, the benefits of resource development such as mining accrue only to the select few...If the land remains undeveloped, it is available to everyone (McAllistar, 1992, p. 34).

Reclamation has a vital role to play in addressing these changing agendas. Ecological enhancement is a means by which the mining industry and government can express their social responsibility. In response to the emerging volatility in the mining industry the Canadian government has undertaken a number of initiatives the goal of which is to provide policy directions that will improve the investment climate for mineral capital in Canada (NRC, 1995b). Initiatives such as the Canadian Council of Ministers of the Environment, Building a More Innovative Economy, and the Whitehorse Mining Initiative all have the potential to impact mining. With respect to reclamation, the most relevant endeavour has been the Whitehorse Mining Initiative.

2.3.1 The Whitehorse Mining Initiative

The Whitehorse Mining Initiative (WMI) was a multi-stakeholder consultation process designed to produce a new strategic vision for mining in Canada. Representatives included the mining industry, senior government, labour unions, Aboriginal peoples and the environmental community. The objective of the WMI was to:

...move toward a socially, economically and environmentally sustainable and prosperous mineral industry, underpinned by political and community consensus (Mining Association of Canada, 1994 p.132).

A leadership council oversaw four negotiating groups that included the environment, land access, finance and taxation, and workplace, workforce/community. The WMI Leadership Council Accord was signed in September 1994 and represents the most comprehensive government initiative with respect to mining and reclamation in Canada.

The Environment working group of the WMI deals with mine reclamation in two parts. The first

addresses the reclamation of current and future mines, while the second part focuses on abandoned mine sites. With respect to current and future mines, the WMI placed a great deal of emphasis on establishing an appropriate fiscal regime to facilitate good reclamation practice. The proposed regime supported the principles of complete reclamation in a progressive fashion where possible. Interestingly, one of the large steps of the WMI was to have the mining industry accept the responsibility of addressing environmental disturbances caused by its activities. In this spirit, reclamation is deemed necessary to protect the environment and public health, and minimize environment degradation. The working group derived seven major recommendations for current and future mines as summarized in Table 2.0. Although the recommendations remain broad in their intention, specific needs for current and future mine reclamation practice are clearly articulated.

Table 2.0
WMI Current and Future Mine Reclamation Recommendations

<i>Issues</i>	<i>Recommendation</i>
Financing	Reclamation funding options need to be provided to proponents through mechanisms acceptable to regulatory authorities.
Phasing of Securities	Payments should be subject to a negotiation process between the proponent and authorities on a project by project basis.
New Mines	Securities must be able to cover reclamation liability actually incurred to that point in the life of a mine.
Operating Mines	Special consideration should be placed on those mines where no reclamation plan exists as to identifying securities and their phasing.
Reclamation Funds	Reclamation funds should flow through to the subject company and taxed as regular income. The fund should be sheltered from current taxation.
Post Mine Maintenance	Proponents should be released from liability when compliance with the reclamation plan is demonstrated and when financial and risk assurance is posted.
Reclamation Planning	A multi sector public liaison committee should have input on the nature and extent of reclamation required. This process must be timely and cost effective.

The recommendations consist of two primary foci:

1. the funding of reclamation through financial securities - who pays what, and when, - with the final release of liability, and
2. a multi-sector public input as to the nature and extent of reclamation.

With respect to “old” mine sites very little consensus was achieved. The issue centred around how old abandoned or orphaned sites would be dealt with in terms of liability and funding. From an environmental perspective, joint and several liability was favoured where liability is assigned to delinquent permit holders and payment made by those operators. Those parties to which liability has been assigned may make issue in the courts if they desire. Industry rejected this proposal as a “deep pockets” approach of unfair allocation of responsibility. They felt:

...governments licensed and permitted these past operations, developed the statutes and recommendations that applied to them, and benefited economically from their operations, they should also share in the responsibility for reclaiming old sites produced (Mining Association of Canada, 1994 p. 94).

As a result of this rift, only four recommendations were produced by the group (Table 2.1).

With respect to mine reclamation, the WMI has placed an emphasis on financial bonding and accountability in reclamation practice. One of the most significant recommendations is the establishment of a liaison committee consisting of the public and multi-sector interests who will define the parameters of the reclamation plan. This represents a break from traditional reclamation planning that was conducted primarily “in-house” by the proponents and in conjunction with approval agencies. In response to changing agendas in the mining industry, the WMI supports the involvement of stakeholders in the reclamation process, and in a sense, places the public on the agenda with mining companies and government. A move towards a more socially responsible and responsive approach to mine approvals and ecological enhancement in the mining sector is underway.

This concept is elaborated upon by the Land Access and Information Group (LAIG) addressing new approaches in mining, land use planning, and decision making processes. Three key concepts

Table 2.1
WMI Old Mine Site Reclamation Recommendations

<i>Issues</i>	<i>Recommendation</i>
Liability	Efforts should continue in developing a method for identifying responsible parties and assigning liability for reclamation of old mine sites. These methods should address the concerns of stakeholders.
Orphaned Mines	A fund generated from government consolidated revenue, taxes on industry, and taxes on the consumer, should be used to pay for the clean up of "orphaned" mine sites.
Abandoned Mines	Government should encourage the exploration of old sites through a regulatory framework which explicitly limits a prospector's or company's environmental liability to the clean up of environmental disturbances.
Public Image	Those in a position to assist voluntarily in the financing of the clean-up of an orphaned mine site should be encouraged to do so since much could be gained for industry as a whole by such activity.

were the focus of this aspect of the WMI: mineral information inventories/mineral resource assessment, participatory ability and opportunity, and ecosystem based planning. The first concept of "inventories and assessment" is directed at the underlying resource potential. This aspect is the focus of information gathering and understanding in making land use decisions. The second concept of participation relates to public involvement in land use decisions (including reclamation planning) in a balanced fashion. Participation should contribute to the process rather than inhibit its progress. The final concept of ecosystems based planning proposes a decision making process founded upon environmental units such as watersheds, rather than project specific and surrounding land use units. The overall goal comprised of these elements is to maintain the integrity, quality and health of ecosystems (Mining Association of Canada, 1994).

The ramifications for reclamation as a result of the WMI may be significant, or inconsequential, depending upon how well the recommendations are followed by government and industry. The use of mineral inventories and assessment in conjunction with other resource and natural feature inventories will assist immensely in defining end land use or condition options. In conjunction with increased participation by stakeholders, it is evident that the WMI perceives reclamation as an opportunity to achieve a more socially or ecologically beneficial use for disturbed landscapes. The greatest impact on reclamation planning will come from the introduction of ecosystem-based land use planning. The incorporation of environmental units into the decision making process with regard to mining applications will expand the scale at which reclamation planning occurs. In considering the extent of mining disturbances on ecosystems, it follows that reclamation will have to address broader temporal and spatial issues such as the "shadow effect" as referenced by Marshall (1982). The current day focus of the shadow effect attempts to account for synergistic and cumulative effects of mine development upon the integrity of ecosystems, entire watersheds, and the lifestyles of the people in the vicinity of development. This concept of the shadow effect is expanded further in Chapter Four.

The WMI presents industry, government and the public with significant challenges with respect to reclamation. The concept of reclamation needs to be re-evaluated and redefined in order to meet evolving public policy.

2.4 Emerging Themes in Reclamation: Summary

A distinction may be made between what is presently the "state of the art" in reclamation today and

the emerging directions of this concept that are leading to tomorrow. The “state of the art” reveals that reclamation in the 1990s from a regulatory and procedural standpoint may be defined by four characteristics:

- Progressive reclamation has become the standard regulatory approach to mine closure where reclamation is expected to be considered at the front-end of the licensing/permitting process;
- Legislation and policy have built-in incentives that release portions of reclamation securities as portions of the impacted area are reclaimed according to the plans and conditions;
- Reclamation practices and progress are documented on plans submitted with the proposal that include staged plans, final reclamation plans, and yearly progress reports over the lifetime of the mine;
- Environmental assessment is emerging as the decision making process with respect to how impacts are determined, mitigated and monitored;
- Emerging themes in reclamation and mining reveal a progression from what may be termed the “present day concepts” listed above. Six inter-related central themes may be identified that have the potential to impact how reclamation is perceived and practiced in the future;
- The goals of reclamation have expanded from preventive management to one of ecosystems enhancement and ecosystem planning;
- It is accepted that broader inputs are now required to truly realize the potential of reclamation. This includes inputs from industry, government, academia, the public and traditional cultures;
- Flexibility needs to become entrenched in processes or policy affecting reclamation to account for the site specific nature of proposals and the findings of ongoing research.

- Information flow is essential to augment both flexibility and inputs into reclamation planning. Information flow should occur between stakeholders and participants, as well as among the scientific community. This will ensure a developing knowledge of varying resource values and the circulation of improved technologies in the practice of reclamation;
- Social responsibility is the fifth emerging theme. The mining industry is slowly beginning to accept this position and is becoming more receptive to new initiative in reclamation; and
- Sixth and finally, the environmental assessment process is moving away from a strictly scientific/technical exercise to one of inter-disciplinary and multi-sector characteristics. This will allow for the consideration of reclamation practice at the varying scales as required in some of the most recent pieces of legislation.

An analysis of mine site case studies with a focus on reclamation programs and practices will provide insight into reclamation planning at new and developing mines in Canada.

Chapter Three

Case Studies in Mine Development and Reclamation

3.0 Introduction

Four case studies illustrate the state of the present practice of reclamation at the project level. Two mine proposals are reviewed to examine how progressive reclamation is factored into the approvals processes. The Mount Polley project was the last mine application to be filed prior to the enactment of the British Columbia *Environmental Assessment Act* (1995) and recently received an approval permit. The BHP Northwest Territories Diamonds Project was the first diamond mine in the Northwest Territories to be reviewed by a panel under the *Environmental Assessment and Review Process* (EARP). This project has also recently been approved with production scheduled for October 1998.

Two operating mines are reviewed to obtain an understanding of mine reclamation in practice. Bullmoose Coal Mine and Highland Valley Copper Mine are in operation in British Columbia. Bullmoose has been producing since 1983 and Highland Valley Copper is a large scale copper mine handling massive volumes of waste rock. The case studies are important because they place reclamation in the context of large developing mines and provide insight as to how reclamation is approached on an operational level.

Mount Polley Mine, British Columbia

The Mount Polley mine will be an open pit copper and gold mine located near Williams Lake in the Cariboo region of British Columbia. Mine activities will disturb 556 hectares of land. This includes three pits, two dump sites, tailings storage, the plant/mill site, roadways, settling ponds and overburden stockpiles. Powerline disturbances remain to be determined. The Environmental Baseline Report (Hallam Knight Piesold, 1995) states that all of the disturbed areas will be reclaimed to the original capability once mining has ceased. The life-span of the entire operation is anticipated to be thirteen years with peak production averaging 105,000 tonnes per day.

The documentation on reclamation consists of a reclamation and closure plan that divides the mine

site into reclamation units with land use goals and reclamation strategies for each unit. The significant elements of the reclamation and closure plan for the mine development include: reclamation/land use objectives, post mining landforms, reclamation units, reclamation strategy, reclamation methodology, and the reclamation research program.

Northwest Territories Diamonds Project, Northwest Territories

The Northwest Territories Diamond Project is developing a diamond mine in the Lac de Gras area of the Northwest Territories. The mine project consists of five kimberlite pipes four of which are located within a few kilometres of one another north of Lac de Gras, while a fifth is 29 kilometres south east and adjacent to the lake. The mining method is to begin with open pit procedures at all pipes and continue with underground mining at two of the pipe locations. The estimated life of the mine is twenty-five years with an annual waste rock production value of 35 to 40 million tonnes. The operation will produce disturbances directly associated with extraction and production consisting of waste rock dumps, road construction to access and transport materials, a centralized processing plant, a tailings impoundment, an airstrip, work camp, power plant and associated facilities. The proposal has undergone an environmental assessment and in 1996 the Report of the Environmental Assessment Panel was released (see CEAA 1996). This report recommended the approval of the diamond mine with conditions. The approach to reclamation and methods that will be employed in the Northwest Territories Diamonds Project divides the mine site into reclamation units and defines the reclamation criteria for each unit.

Bullmoose Mine, British Columbia

Bullmoose Operating Corporation mines coal 87 kilometres south of Chetwynd and 40 kilometres west of Tumbler Ridge in British Columbia. Mining operations are situated in higher elevations between 1300 and 1800 metres, while the plant is in a valley at 1100 metres. Coal production began at the site in 1983 and as a requirement of licensing the Annual Report on operations documents the reclamation program undertaken on a yearly basis.

Highland Valley Copper, British Columbia

Highland Valley Copper is one of the largest base metal mining complexes in North America. The

mine is located in the southern interior of British Columbia, approximately 80 km southeast of Kamloops and encompasses a disturbance area of 5,900 hectares. The mine produces approximately 370 million pounds of copper and 4 million pounds of molybdenum annually. Reclamation planning at the mine site may be divided into two related, but distinct categories. The first is Highland Valley Copper's use of a land management program known as Reclamation Scheduler. This program is used to track mine related disturbances and modifications made thereof on an annual, five year, mine life, and decommissioning basis. The second key element to reclamation at Highland Valley Copper is an intense research/application program designed to provide quantitative measures of reclamation success of specific treatments and trials, and to identify and implement techniques to improve reclamation at the mine site. Together, these two programs are intended to progressively reclaim the mine site to a state of self-sustainability and to protect water quality in the area over the life of the mine and post closure.

3.1 Reclamation Land Use and Landform Objectives

Mount Polly: The primary objective of the reclamation plan is to return all mine-disturbed areas to an equivalent level of capability to that which existed prior to mining on an average property basis. This is to be achieved by preserving water quality, stabilizing engineered structures (dumps, tailings and pits), the removal of roads and equipment, integration of the disturbed lands into the landscape and the establishment of self-sustaining vegetative cover. A description of the anticipated landforms upon full reclamation indicates that the most significant landform changes will be in areas of open pits, waste rock dumps and the tailings area. The reclamation of the mill area, road corridor and powerline corridor will produce the least significant change from pre-mining conditions.

Northwest Territories Diamonds Project: Three reclamation goals are identified for the diamond mine project: the provision of stable physical land forms, the re-establishment of productive use of the land, and the protection of water resources of the project area. The objectives of these goals aim to provide post-mining habitats, allow for continued use of the natural and cultural resources of the area by Aboriginal peoples, and protection of the quantity and quality of water in the project area.

The lands reclaimed from the mining disturbance propose to return the areas to wilderness uses such as a migration route for caribou, grazing, and denning areas for other wildlife species. The land use

approach for reclamation includes the division of impacted areas into reclamation landscape units each with a specific reclamation strategy. It is believed that a mosaic of reclaimed areas in terms of landscape and vegetation patterns will support a variety of land uses and meet the prescribed reclamation objectives.

Bullmoose Mine: The primary activity during operations is the grading, seeding and planting of disturbed areas where tested applications have been proven. The Bullmoose rehabilitation plan states as its two main objectives; 1) the re-establishment of wildlife habitats within the mine site, and 2) the reduction of erosion and pollution prevention, and the stabilization of soils through vegetation and water management. These efforts are consistent with existing legislative and regulatory requirements in reclamation which emphasize site stability, public safety and pollution prevention.

Highland Valley Copper Mine: The land use objectives of the reclamation program at this mine include developing a self-sustaining vegetation cover using a combination of agricultural and native species to achieve specific land use objectives for disturbed areas. The program aims to achieve a productivity on the reclaimed land equal to what existed prior to development on an average property basis, and to ensure that water quality in the mined area conforms to government guidelines set by the British Columbia Ministry of Environment Lands and Parks.

Mine plan reclamation information is collected to assess the tonnage of suitable overburden that is available for reclamation purposes and the number of truck hours it will require to transport from the pit areas to the reclamation sites. This is an important element of reclamation planning at Highland Valley Copper since the size of the truck fleet is fixed and it is imperative to know how much time will be available for the trucks to contribute to the reclamation effort. It also links reclamation activities directly to the rate of ore removal and the immediate availability of soils and overburden stocks.

3.2 Reclamation Units and Scheduling

Mount Polly: The reclamation approach divides the mine site into six reclamation units based upon the type of material and the potential reclamation strategies to be applied in each unit. These units are defined according to disturbance categories: the mill facilities, open pit walls, open pit ramps and

benches, waste rock areas, the tailings area, access roads and the powerline corridor. For each unit a proposed land use objective has been developed and the reclamation measures that will be undertaken to meet these objectives expressed.

The mill and plant area unit will be cleared of hazardous materials, while all building and facilities are to be removed and salvaged. Foundations will be cleared and efforts to re-establish vegetative growth will be undertaken. Open pit units are to be fenced and signed with warnings. In addition, pit benches and edges will be re-sloped where possible and seeded if required to improve aspect. The remainder of the open pits will be flooded through groundwater flow and the redirection of precipitation and runoff. It is estimated that it will take 160 years to fill the pits in this manner. Waste rock units will be re-sloped to 2:1 and seeded and planted to prevent erosion and to enhance wildlife habitat opportunities. The tailings area unit will be reclaimed to wetland and forested through soil enhancement and drainage manipulation. The embankments and dams will be graded, seeded and planted, again to prevent erosion and increase habitat in the area. Access roads will have their cutbanks re-sloped and natural drainage pathways re-established through the removal of culverts and re-contouring of these areas. The powerline right-of-way, if no longer required in the area, will have the facilities dismantled and salvaged, while the corridors will be left to natural regeneration with some seeding and planting in more heavily disturbed areas.

The reclamation strategy provides the time frame at which reclamation objectives are expected to be realized. These are derived primarily from identified ore reserves and anticipated production rates. Three phases of reclamation comprise the Mount Polley plan beginning immediately after construction. Stabilization and erosion/sedimentation prevention are priorities early on throughout the first year of operations. Phase two continues until the open pits are fully developed, in this case twelve years. This phase emphasizes revegetation, and a research programs to test new techniques in reclamation. In addition, a moving five year plan will be kept to document the yearly reclamation initiatives and serve as a reporting device to the regulatory agencies. The final phase of the strategy focuses on closure and decommissioning of the mine. Reclamation at this phase is anticipated to continue several years after operations cease and includes monitoring until it is safe to de-commission the mill, the tailings impoundment and the waste dumps.

Northwest Territories Diamonds Project: The use of reclamation units serves to provide a framework

on which specific reclamation strategies may be built. Each unit is discussed in terms of final surface configuration (grading), substrate development (soil construction), and vegetation patterns.

Exploration units include camps, underground portals, waste rock areas and water control facilities. It is proposed that structures will be cleared and removed, portals sealed, obtrusive landforms contoured to the surrounding topography, and the restoration of natural drainage patterns. Revegetation will take place in areas of high erosion susceptibility, otherwise natural recolonization is encouraged.

The mine operations unit includes water control, the tailings pond, waste dumps, the plant site, roads, and pits. A number of diversion channels, dams, drainage facilities and sedimentation ponds are part of the diamond mine project. These elements are to remain after mining operations have been concluded, and will serve as riparian habitat, esker complexes or wetland areas. The waste dumps will be sloped to 2:1 and revegetated. Re-contouring will also be undertaken to provide additional microhabitats for wildlife and plant species. The plant site consists of the mill, camp, airstrip, power facilities and associated infrastructure. All surface structures will be removed as well as sewage facilities and fuel storage areas. Foundations will be capped with waste rock and re-contouring of these areas will attempt to restore natural drainage patterns. The airstrip is to remain to serve as an emergency strip for aircraft in the area. Some of the roads will be re-contoured and revegetated to blend with the surrounding landscape, while others will remain behind to serve as travel corridors and relief areas for caribou. Larger roads between sites will remain as simulated eskers for habitat provision. All culverts will be removed and re-contouring conducted to establish the appropriate drainage patterns around the remaining roadways. The open pit areas of the mine will be flooded through direct precipitation, runoff and groundwater seepage. The total time to fill all of the established pits will be 212 years. The earliest flooding will be completed at one of the pits within six years of post extraction. Safety measures around the pits include the use of waste rock to construct windrows around danger areas. The completion of these reclamation measures in each unit of the mine operation is believed to be sufficient to meet reclamation and land use goals stated in the Environmental Impact Statement.

The scheduling of reclamation is identified for four elements of mine life. The initial reclamation program will address disturbances associated with exploration and development of the mine. The operational program consists of reclamation activities associated with mine operations such as capping and topdressing of waste dumps, and the reclamation of tailing pond cells. In the decommissioning and closure stages, reclamation will involve facilities removal and the establishment of stable land forms. The

fourth stage of scheduling accounts for temporary closure of the mine. In this instance the stability of areas affected by the operation is the main concern. Progressive removal, construction and reclamation of many of the mine components will minimize the risks in the event of a temporary closure of the mine site.

Highland Valley Copper Mine: Reclamation Scheduler is a computer program utilized by Highland Valley Copper since 1993. The program receives data inputs from mine site development activities and coordinates mine reclamation planning across the entire site over the course of operations. Prior to 1993 reclamation was driven by the development of yearly reclamation plans and coordinated with a simple spreadsheet program (Lotus 123). Yearly reclamation plans prioritized areas for reclamation and then developed specific projects for each location (scarification, fertilizing, seeding). Equipment requirements, labour needs and projected reclamation yields (hectares) are then determined and organized on the spreadsheet program. The advantage of Reclamation Scheduler is that much of this information can now be entered and reclamation plans, schedules, and budgets derived on a yearly, 5 year, mine life, and decommissioning basis. This new approach employed at Highland Valley Copper consists of information inputs, costs determination, mine plan reclamation development, and the production of work forecasts and summary reports for the annual reclamation report.

The Highland Valley Copper mine site is extremely large and requires a sophisticated approach in planning reclamation. The site is divided into five work zones consisting of the Highmont, Lornex, Valley and Bethlehem pit areas, and the Highland Tailings Pond. Each zone is divided into work locations associated with plant sites, pits, waste dumps, tailings areas, and other infrastructure such as roads and power rights-of-way. For the purposes of reclamation, 20 disturbance types have been identified that may occur across the mine site and are classified according to the reclamation techniques necessary to return the land back to a productive state. Disturbance categories include groupings of flat disturbances, disturbances with slopes greater than 10%, tailings ponds, pit walls, and areas where no reclamation preparation is necessary (flooded areas). Reclamation techniques that may be applied to each disturbance category may include scarification, leveling and capping with rock or overburden, resloping, rounding, and seeding.

For each work zone and sub-locations, reclamation planners assign a disturbance class which will then dictate the reclamation techniques to be applied at each specific location across the mine site.

From here the reclamation planner determines the resources required to complete these tasks in terms of the equipment hours required, the tonnage of overburden or capping material necessary, and the hectares of disturbance to be reclaimed.

Reclamation Scheduler is able to generate two primary forms of output. The first is the work location output. This file is an update of the ground inventory as it relates to the information entered at the beginning of the process. In other words it represents the progress of groundwork that has taken place over the year at each work location in each work zone. The second form of output is the summary report. The summary report contains all relevant data for reclamation activities during the planning year. This includes the financial cost of the period, hectares reclaimed on flats and slopes over five years to the given year, equipment required and the expected versus actual reclamation costs over the year.

The use of this tool in reclamation at the Highland Valley Copper mine site serves to control and target areas for reclamation preparation and revegetation and to monitor the costs, equipment usage, material uses, ground prepared and ground vegetated. In addition the spatial information with respect to where work has taken place directs future reclamation planning efforts in the years following.

The collection of the information required to run Reclamation Scheduler enables the mining company to plan reclamation anywhere on the site and have an immediate determination of the financial costs, labour required, and the equipment necessary to meet their planning objectives. It is also updated as areas are reclaimed enabling the forecast of future reclamation efforts, changes to previously reclaimed areas, and a current picture of the status of reclamation at the mine.

3.3 Reclamation Vegetation

Mount Polly: Vegetation initiatives at Mount Polly include site preparation, soil salvage, growth media, and species selection.

Northwest Territories Diamonds Project: Substrate development is an important component of the Diamonds Project revegetation program. Substrate development emphasizes the production of healthy soils or substrate to foster healthy vegetative growth on disturbed areas. This development program includes the undertaking of a soil inventory to identify potential soil salvage areas, salvaging, and the

application of soils to disturbed areas targeted for revegetation. Vegetative reclamation focuses on how to develop the required building block to facilitate successional stages in plant growth on disturbed sites. As such, reclamation vegetation is strongly connected to the reclamation research program that will identify which species are appropriate to meet this goal. The vegetation of a site in practice will begin with the establishment of pioneering species consisting of various seed mixtures through a variety of methods (hydroseeding, broadcast seeding, drill seeding and air seeding). Permanent cover is dependent upon naturally invading species which will be monitored for success.

Bullmoose Mine: The focus of the rehabilitation program has been on research, seed mixture development, planting and habitat development. The 1995 program consisted primarily of the recontouring, soil coverage, seeding, and fertilizing of waste rock areas. In addition, tree and shrub planting was undertaken in exposed areas of suitable slope. Habitat development was conducted with the placement of large rocks at the base of mined rock piles. Prepared sediment ponds were treated with the addition of cat tails, bulrushes and sedges, and the tailings dam was seeded and planted with deciduous cuttings where it had reached levels of high water. Ongoing monitoring is conducted on-site to identify potential hazards and track air and water quality.

Highland Valley Copper Mine: The vegetation reclamation program at Highland Valley Copper is thoroughly integrated into the reclamation research program. This program emphasizes species selection and operational techniques used throughout the mine site to learn more about the site specific requirements of reclamation practices at sites of disturbance. The program consists of a number of land and water related projects and the monitoring of reclaimed sites to determine productivity, assess species composition, foliar nutrients, metal concentrations, tree and shrub survival and growth, and the aquatic productivity of lakes and ponds. Additional studies conducted by Highland Valley Copper include recontouring requirements to reclaim waste rock sites, identifying suitable overburden materials for capping mine wastes, the inoculation of grass species with nitrogen-fixing bacteria, and the development of a passive wetland system to remove metals from discharge water (Jones, 1996).

3.4 Reclamation Research

Mount Polly: The research program serves as a device to develop the methods, materials and protocols to achieve the land use and reclamation objectives for each unit. This includes extensive inventories of soils, vegetation, wildlife, habitat, metals uptake and acid-base accounting. The emphasis of the research program is to establish growth on the disturbed sites.

Northwest Territories Diamonds Project: The research program is an ongoing effort throughout mine operations to assist in meeting the goals of reclamation in the most efficient and effective manner. Research will be conducted in test plots investigating seed mixes and plant growth materials, shrub transplants, habitat potential and slope stability and erosion control.

Highland Valley Copper Mine: Reclamation research is deemed to be the foundation of successful reclamation planning and practice at this mine development. The program is divided into two components. The first is an assessment and monitoring program designed as on-going efforts and the evaluation of these practices to determine their success. The second component is the predictive studies research program. This program seeks to address specific areas of concern and to provide data that can be useful in facilitating future reclamation planning and decommissioning. A sample of the many projects undertaken and ongoing at this mine development are described below.

Trojan Pond Fishery Project: This project focuses on the establishment of fish species in Trojan Pond, the former tailings impoundment area for the mill operation that closed in 1985. An experimental stocking program was established to determine the potential of this pond to support a fishery and to examine the metal uptake of the fish in the pond. This project is a joint effort between the mining company and the British Columbia Ministry of Environment, Lands and Parks. In 1991 the pond was stocked with 1,500 Kamloops rainbow fry and stocking has continued through to 1996. Sampling of the trout began in 1993 and the results have been extremely positive. Fish growth has been above average and for the metals assayed, Trojan fish contain less than the average for uncontaminated British Columbia Lakes (Jones, 1996).

In 1995, the project was expanded to the construction of a spawning channel to allow mature fish to spawn and eliminate reabsorption of fish eggs in fish isolated to a singular water body. The spawning channel has also proven to be successful with 136 using the channel in 1995, and over 150 in 1996.

Cattle Grazing Experiment: This experiment began in 1992 to assess the impact of elevated molybdenum forage on beef cattle. The project was a partnership between Highland Valley Copper, Agriculture and Foods Canada, and the British Columbia Cattleman's Association. Grazing was permitted by a sample of beef cattle throughout the summer of 1994 on 55 hectares of revegetated Bethlehem Main tailings. The cattle were then also fed tailings grown hay. This project is ongoing and the results have not been published to date.

Passive Wetland System Experiment: This project is designed to determine the feasibility of using natural processes to reduce metal concentrations in discharge waters. It is believed that a low maintenance treatment option may be available to reduce metal concentration by utilizing aquatic plants and sulphate reducing bacteria in a wetland setting. A closed wetland system was constructed with controlled inflow and outflow to determine the limitations of a wetland system. This project involves the use of a 49,000 litre steel tank modified to simulate a pond, the addition of a coarse granular substrate (gravel), sulphide reducing bacteria, and producing anoxic conditions (free-floating aquatic plants - Duckweed). Results as of 1995 indicate that the system is effectively reducing molybdenum concentrations based upon inflow and outflow comparisons. Future experiments hope to determine the quantity of mine water that can be treated effectively using this system (Jones, 1996).

Other monitoring and assessment, and predictive studies being undertaken at the Highland Valley Cooper Mine include:

- **Productivity Sampling:** the measurement of biomass to assess the performance of reclaimed sites.
- **Species Composition Sampling:** to provide a measure of species diversity based on measures of percent cover, number of species, and relative abundance. This information contributes to the refinement of seed mixtures for reclamation to achieve self-sustainability at reclaimed sites.
- **Foliar Nutrient Assessment:** to provide information respecting the requirements of maintenance fertilizer applications and to determine the stability of sites where fertilizer applications have been discontinued.
- **Metal Uptake Assessment:** the study of metals (molybdenum, copper and sulphur) in

foliage to determine the forage suitability of reclaimed sites. This is also part of the cattle grazing experiment.

- **Growth Performance of Native Trees and Shrubs:** to provide performance rates of species with respect to growth characteristics and site characteristics to determine which species flourish best and under what site specific conditions. This includes species sampled, material(s) in which they were planted, slope and aspect.
- **Aquatic Monitoring of Mine Lakes and Ponds:** to understand growing conditions at these sites and the influence of mine drainage on natural ponds on the property. One of the key aspects of this monitoring process was to determine the potential of the ponds to perform biological removal of metals from mine drainage.
- **Site Preparation and Resloping Requirements for Waste Rock:** to assess the relationship between specific site conditions (slope and aspect) and its effect on establishing vegetative cover.
- **Evaluation of Reclamation Suitable Overburden Material:** to understand the usefulness of the substantial volume of overburden materials released with pit development. Overburden materials present an opportunity as a capping surface over waste rock to establish the growing conditions necessary to reclaim the waste dumps.

3.5 Overview of Current Reclamation Practices

It is evident from the case study overview that a number of generalizations may be made with respect to mine planning and operation and the role of reclamation. Common to all sites is that progressive reclamation is now the accepted practice. With respect to reclamation plans the use of mine units and reclamation measures to address disturbances is the favoured approach in long term reclamation planning. The scope of the issues confronted in the mine plans were also common, and could be described as being limited to traditional practices in reclamation, namely:

- the emphasis of reclamation as a site specific activity stressing the testing of vegetative coverage on various surface disturbances;
- the re-contouring of areas to a planned and stable topography;
- public safety/hazard issues; and
- habitat regeneration.

Absent from the reclamation plans and programs are efforts relating to the wider systems that surround the disturbed areas and how reclamation relates to traditional land uses prior to development, or opportunities for the future. With the exception of the Northwest Territories Diamonds Project, no plans mention how reclamation will enhance the final landscapes versus simply mitigating impacts, or how cultural connections to the area will be re-established. Reclamation plans and programs are still too narrowly focussed. Reclamation strategies include no initiatives beyond project boundaries.

Highland Valley Copper has begun a reclamation research program to return the site to a self-sustaining natural state. The size of this mining operation and the numerous reclamation activities that are being undertaken require an effective land management system to coordinate, monitor, and plan reclamation initiatives throughout the life of the mine. The use of Reclamation Scheduler as a land management data base for reclamation enables Highland Valley Copper to methodically manage all aspects of this mine development for reclamation activities in the short and long term. This approach is also integrated with a budgetary component enabling the immediate assessment of financial, labour and equipment resources to undertake many of the tasks scheduled for implementing their reclamation plan. This reclamation effort represents an extremely sequential, focused, and research intensive type of program.

The case studies illustrate that the primary emphasis of reclamation in the United States and Canada is site stability and the re-establishment of ground cover. The scope of mine reclamation tends to focus on site remediation within the context of the scientific paradigm consisting of test plots and experimental sites. While this is an essential element in the process, alone, it is inadequate. Missing is the broader aspect of mine reclamation and its role in the community; including the transfer of the site from the mining company to the previous or future owners.

Due to the character of the case studies and the early stages of mining of each site, the final closure and reclamation conditions of the mines is presently undetermined. With a progressive approach to reclamation the final landscape form should soon follow the mine closure. However, not all mines practice progressive reclamation. Recent work by McKenna and Dawson (1997) indicates that the closure plans for mines and the performance goals for the final landscape are often poorly defined. In a site review of 57 mines in Canada and the United States the authors found that closure plans (taking on average 9-18 months to develop) were often out of date once excavation of the mine site had progressed. They noted that performance goals for the end land use were often poorly identified and that performance criteria for the reclaimed landscape were rarely defined and followed with post-closure monitoring activities.

A second important aspect to the assessment done by McKenna and Dawson (1997) deals with the liability associated with mine closure. They note in their survey that in many of the case studies the mine company is unwilling to hand back the site to the original owner for fear of liability with respect to maintaining the site. Given the potential liability of a mine site, owners tend to retain the sites indefinitely in order to avoid potential law suits. In the end, this “liability trap” prevents the transfer of land ownership and a final reclaimed landscape. The authors note (p. 16),

... there is a “certification barrier” (neither mines nor regulators are attempting to certify land) and a “transfer barrier” (the mines don’t want to give up the land and the original owner - usually the crown – doesn’t want the land back). Until these two barriers can be overcome by all levels of government working with the mines, the notion of “temporary use of the land” is not being fulfilled as intended.

Thus, the custodianship of the final landscape is held in limbo as a result of the lack of a defined end-use landscape and the responsibility for accepting the long term maintenance of the site. Present reclamation regulation and practices tend to fail in identifying a final land use, defining landscape performance criteria, and in determining of custodian responsibilities.

Chapter Four

A Conceptual Framework for Mine Reclamation

4.0 Strategic Visions

It is important to possess a vision of the way a mine site should look after the ores have been taken, the facilities removed, and the land re-sculpted. A vision of a preferred landscape has to be described followed by a set of sequential reclamation activities, structured to take place as each phase of mineral development unfolds. Reclamation should not be the final set of on-site actions; rather a progressive sequence of many activities beginning, and integrated, with the earliest stages of exploration and development planning. Reclamation is not an afterthought; it is a front-end issue that to be successful must start at the beginning and continue until the vision becomes a reality. However, this vision must also be tempered by the inherent uncertainty associated with mining operations. The nature of deposit geology can be unexpected over the life of a mine and as a result, changes in mine development and the materials available for stabilization and reclamation of disturbances may take place. Therefore, a vision for reclamation must recognize the dynamic nature of mining.

The cultivation of such a vision and how it is integrated and applied in the activities of exploration and mine site planning represent two of the greatest challenges in reclamation planning today. In addition, the emerging directions of reclamation as described in Chapter Two present reclamation planners with a complex agenda in order to meet these directives. Reclamation must incorporate concepts such as integrated resource management, ecosystems, environmental assessment and sustainability. Only in this manner can reclamation address land stress and disturbance as an opportunity; and the lands impacted by mining as the resource through which this opportunity is realized.

This change in reclamation is proposed through the development of Regional Reclamation Plans (RRPs) in areas of existing and potential mine development. A Regional Rehabilitation Plan is a doctrine prepared collaboratively by the stakeholders of an area in which resource extraction potential exists.

The development of an RRP may take place in an upper tier regional planning process or triggered by an application for large-scale development as with the requirements of the environmental impact assessment process. The contents of an RRP may be based upon identified and validated valued environment components: those aspects of the environment for which there is professional and public concern. In this manner the RRP establishes “the guideposts” of development and the goals and objectives of reclamation in the event of environmental disturbance. Once an RRP is prepared and adopted it assumes the role of a strategic document into which future mining, or other large-scale developments such as a pipeline, must feed into and direct their reclamation practices. In essence, an RRP captures the broader issues of the “shadow effect” related to large scale development, in particular mining, and works inward from a collaborative vision of the broader landscape system to the sites of disturbance and impact.

4.1 The Basis for Regional Rehabilitation Planning

Two main concepts are essential in Regional Rehabilitation Planning: an ecosystems approach and the employment of integrated resource management principles in the decision making process.

Integrated Resources Management

Integrated resources management incorporates social values and preferences as an information resource in the decision making process. It aims to directly involve people in issues identification, data analysis and alternatives selection at various levels of the process (Armour, 1990). Public action and participation is considered to be a key element in attaining sustainability in the mining industry and therefore must play a role in the development of a description of the post mine landscape. Bringing stakeholders into the decision making process builds upon the activity of turning “knowledge-to-action”, to one that promotes “knowledge-to-consensus-to-action” (Friedman, 1987). It is a means to identify valued environmental components in a region and requires a decision framework that incorporates stakeholder participation in defining and building a Regional Rehabilitation Plan.

With the incorporation of additional values and stakeholders into the decision making process, it is imperative that this process be culturally relative, that is, where a number of cultures are involved in, or affected by, a management decision, it is imperative that environmental change be considered within more than one frame of meaning. For example, Edelstein and Kleese (1994) have noted that impact

assessment can be a tool of cultural homogenization, where values that stray from the dominant paradigm (western values/culture), are absorbed and moulded within a rational process rather than seen as an alternative that may lead to entirely different results. In the case of mining, this may mean that while the impacts and mitigation surrounding mining operations may be acceptable or even desirable for one culture, they may be far from sufficient, or even tolerable to another. This scenario is particularly true in the Canadian North where western regulatory structures need to facilitate land use and development among a number of varying cultures.

Attempts to incorporate what is often called Traditional Ecological Knowledge into the decision process can use forms of collaborative decision making (Cortner and Moote, 1994; McLain and Lee, 1996) aimed at striking a balance between utility and environmental interests. Collaborative decision making is a method of integrated resources management designed to allow for a wider range of stakeholders to play a role in policy development and implementation. It is evident that such an approach to decision making is not temporary and may have application over a broad spectrum of environmental issues. As Cortner and Moote (1994) note:

A growing interest in public involvement...indicates professional recognition of the legitimacy of the claims that various groups are making on natural resources and the need to involve these voices in decision making (p. 169).

This is particularly relevant in Canada as indicated by the Whitehorse Mining Initiative (WMI). The WMI has recommended the use of multi-sector public liaison committees in determining the nature and extent of reclamation required for mining projects (WMI, 1994). In the context of regional rehabilitation planning, the challenge is how to incorporate these interests into the development of a reclamation plan and/or program. The use of Regional Rehabilitation Plans will serve to express these values and interests in a meaningful way and contribute to the practice of reclamation in the field.

An Ecosystem Approach

An ecosystem approach in environmental management involves considerations that emphasize natural boundaries defined by integrated biotic, abiotic, social and cultural systems of the environment. In this context, an ecosystem perspective in mine reclamation affects the scales at which we perceive and implement reclamation planning in terms of time and space. In 1982, Marshall alluded to this as the

shadow affect, where the various stages of mining possess the potential to alter ecosystem properties at local regional and global scales over varying periods of time. However, Marshall was specifically addressing pollutants generated on site and deposited at a distance from the operation by air pollution (sulfur, mercury, arsenic,), water pollution (acid rock drainage, sediment run-off) and noise pollution (blasting, trucking). While these aspects of the shadow effect are important, they are incomplete. More information on transitory impacts are needed as they relate to landscape systems such as wildlife ranges, community values and perceptions of the land, and how mining affects such elements.

An ecosystem approach introduces new considerations into the shadow effects of mining such as cultural scales, the need to identify the impacts of mining and the measures that will be used to mitigate these impacts on varying cultures. Human and environment relations are culturally specific and can vary from one region to another forming relationships that have been termed socio-ecosystems (Meredith, 1995). This is particularly relevant in the north where the documentation of Traditional Knowledge needs to be incorporated into the decision process of mining to account for and sensitize impacts affecting traditional institutions such as hunting grounds, trapping lines and the beliefs and identity of Aboriginal peoples (Keith, 1996). The use of RRP's is a means to express these concerns.

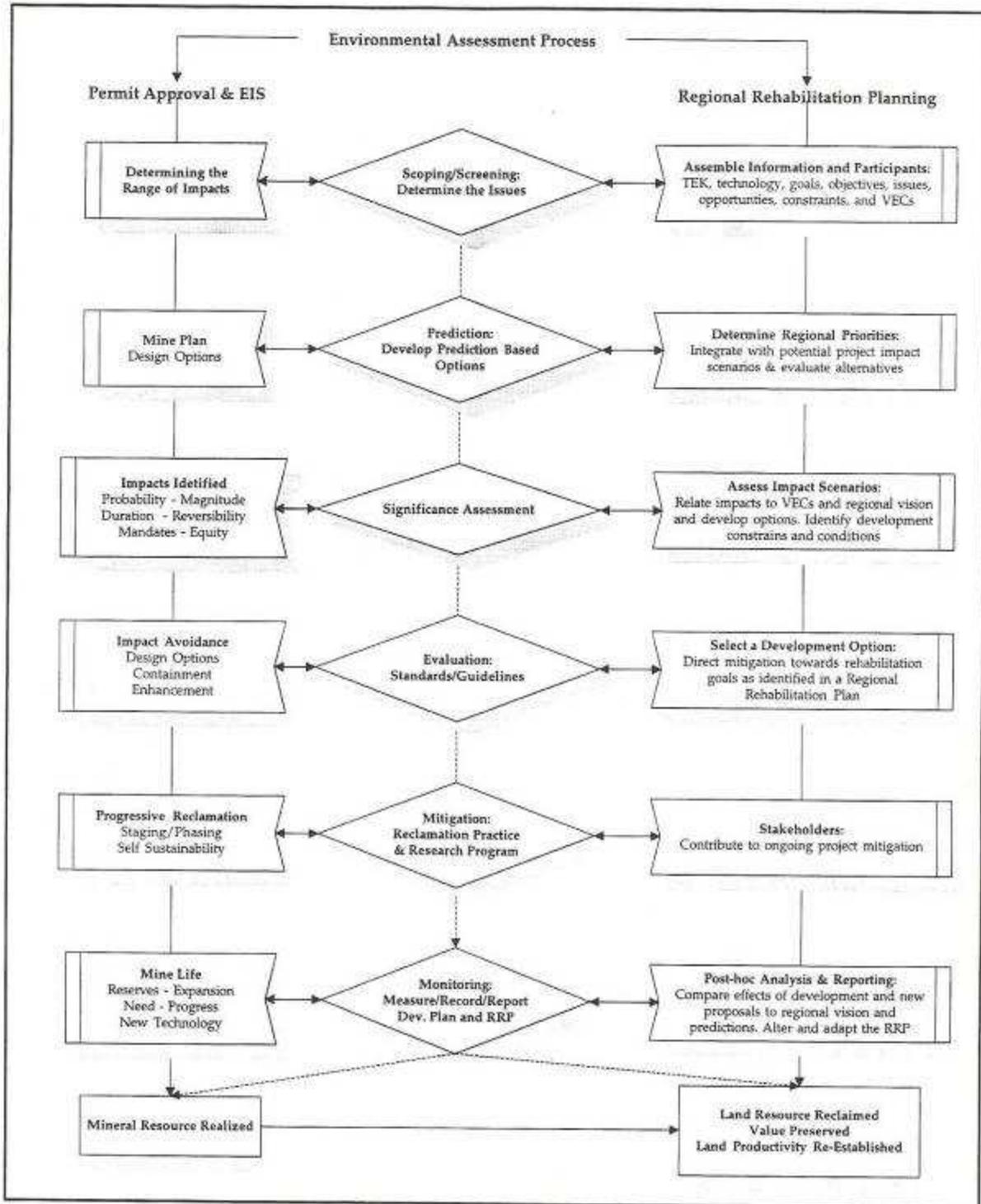
An ecosystem approach in regional rehabilitation planning will require the assessment of potential impacts at greater scales than traditionally incorporated in mine proposals. This will include: 1) the integration of mine site planning with a strategic vision of a region or watershed as developed and presented by relevant stakeholders; 2) the assessment of varying resource values and the potential threat mining operations may pose to these ethics; and, 3) the measures that will be taken, on and off the mine site, to minimize impacts and work towards the betterment of the region or watershed as a whole (Wyant et al., 1995). The greatest concerns in adopting such a method in reclamation may lie in that, as the scale of consideration increases (from the site specific to the watershed or bio-regional levels) stakeholders increase, and the complexity of the parameters to be considered in the decision process. As a result, it becomes more difficult to integrate all elements equally into a reclamation plan or program. In general, opportunities for inequity rise significantly with the application of an ecosystems approach (Armitage, 1995). Therefore, what is essential in any reclamation decision framework is the acquisition and coordination of information and its integration into a decision framework that can evaluate the issues at a manageable scale. The key is to highlight the linkages and relationships among sources of information. Methods of information acquisition, coordination and understanding are readily available

amongst the principles of environmental impact assessment. The application of these principles in reclamation planning in both a formal and informal manner, may provide the tools necessary to incorporate integrated resources management and an ecosystems approach to reclamation in mine development.

4.2 Regional Rehabilitation Planning

The preparation of a Regional Rehabilitation Plan can be achieved through the application of environmental impact assessment elements within the planning and approvals process. These elements form the basic building blocks of environmental assessment and are comprised of actions such as screening, scoping, impact prediction, and monitoring. Figure 4.0 illustrates the conceptual relationship of environmental assessment and a Regional Rehabilitation Plan. The application of environmental impact assessment principles in regional rehabilitation planning permits for the assembly of necessary information and provides for the inputs required in the decision process to maintain the biotic, abiotic and social/cultural environments of lands impacted by mining. The use of this technique expands upon the concept of reclamation from a measure of mitigation to a process that is designed to establish goals in environmental enhancement and coordinate activities towards this goal. This process may be conducted in a formal sense (where triggered by legislation), or informally, as a procedure undertaken by an upper tier planning authority in the anticipation of resource development.

Figure 4.0
Conceptual Framework for Reclamation Planning



A Regional Rehabilitation Plan will contribute to the preparation of reclamation plans and programs by development proponents. Procedurally, this concept may be expressed as one that develops reclamation as a process that runs congruently to the development and application of the mine site and is consistent with an approved Regional Rehabilitation Plan. A Regional Rehabilitation Plan will provide the opportunity to further bring reclamation to the forefront of the approval process. Within the licensing and impact assessment processes, reclamation could adopt a much larger role. Procedurally, the development of a Regional Rehabilitation Plan could consist of three steps that incorporate procedures in impact assessment and are applied within the mine approval process or an upper tier planning process.

4.2.1 Building a Regional Rehabilitation plan

As a means to regulatory approval, reclamation and the development and implementation of a Regional Rehabilitation Plan should consist of three connected steps. At each step a combination of EIA methods are invoked to contribute to the development of this plan through the identification of issues pertinent to mine development, the associated impacts, and valued environmental components.

Step One: Stakeholder Groups and Data Assembly.

This step involves the assembly of the relevant interests to participate in preparing a Regional Rehabilitation Plan. This may be accomplished through a scoping and screening exercise.

Scoping and Screening:

Scoping is the preliminary step in reclamation planning. At this stage the necessary information and participants are assembled. This includes the documentation of baseline data consisting of Traditional Knowledge, biophysical, socioeconomic, cultural and any other specific inventories that may be required in relation to the proposal. The identification of environmentally sensitive areas or areas of natural, scientific or cultural interest would be an essential component of the scoping stage. It should also establish who the participants will be in the preparation of the Regional Rehabilitation Plan. The primary goals and objectives of the reclamation plan should be expressed describing a vision of the post mining landscape as derived by the various stakeholders.

A screening exercise should be conducted to identify the central issues and problems that may arise

in relation to the mine plan proposal and the attainment of reclamation objectives. The purpose of this exercise would be to identify linkages and gaps in information among participants and the information required to prepare a Regional Rehabilitation Plan. It is imperative that this stage address issues of cultural relativity and incorporate it into the decision process. Screening should also achieve a manageable data base and determine all relevant stakeholders who will, or should, take place in the project. In summary, the information and representation assembled through this exercise should be sufficient to provide information with respect to “what is” and “what ought to be” from both the scientific and cultural perspectives of the area(s) to be impacted by the mining operation. In addition, it will be necessary to determine how the Regional Rehabilitation Plan will “fit” with other planning processes in the study area and how such processes may be linked to assist in the development of an RRP.

Step Two: Preparing a Regional Rehabilitation Plan.

Step Two builds upon the information developed in the first step for the purpose of developing a vision of the lands impacted by mining at various stages of the mining life cycle. This should include a final concept plan for the area, phased concept plans at various stages of mine life (5 years) and a statement of a strategic vision for the region/bio-region that will be reclaimed from the impacts mining operation. In effect, the product of this step represents a policy statement and commitment on behalf of the participants to achieve a set of described reclamation goals and objectives which together should provide for the overall enhancement of the area(s) impacted by the mining operation. This may be achieved through the procedures of prediction of impacts, significance assessment, and evaluation.

Prediction of Impacts:

Prediction is an ongoing exercise over the course of a projects operation. It begins with addressing how to integrate the strategic reclamation vision with the identified project impacts. Prediction serves to inject flexibility and adaptiveness in plan development and implementation. As part of this exercise, alternatives to reclamation objectives should be considered to account for uncertainty over the course of mine operations and/or the development of new technology in reclamation. This may be represented by concept plans consisting of broad goals and objectives, but clear enough to direct reclamation practice for the different mine development proposals. Prediction of different potential development scenarios serves to develop options in plan development and allow for the selection of alternatives by the various

participatory groups.

In some cases it may be impossible to predict the development of the mine and the resulting impacts. However, the exercise of predicting potential impacts and the resulting development scenarios provides a method to address changes needed for the uncertainty that sometimes comes with developing ore bodies.

Significance Assessment:

The options derived from predicting the impacts of different mine development scenarios require an attachment of significance. This refers to attaching a level of significance to each option developed in the previous step. In terms of reclamation, significance would relate to which reclamation option would have the greatest impact on the stated goals or vision of the area impacted by mining if, or if not, it were implemented. This includes how the reclamation plan selected would affect cumulative effects, the duration of impacts, risk, the stability and resilience of environmental components, and the magnitude of impacts (Smith, 1993). In other words, which plan best addresses the potential impacts from mining while promoting a direction for reclamation towards the pre-stated vision.

Evaluation:

This step involves determining what option derived from the prediction and significance assessment exercises is the most feasible within the context of the reclamation goals, and the objectives of the mine operation itself. Feasibility is typically determined through the expressed standards or guidelines, however it must also be determined through available technology and the willingness for stakeholder to make trade-offs between differing values of the impacted area. Here, is where both the analytical and qualitative aspects of the impact assessment process are integrated. While the impacts associated with a mining operation must be quantified and described in terms of their probability, magnitude, reversibility, legalities/mandates, and social equity, the selection of an alternative reclamation plan will be value based and should be made within the context of what is scientifically realistic at the time and within the goals and objectives of a strategic vision for reclamation.

At this stage, the necessary information has been assembled, evaluated and integrated into the development of a reclamation concept plan for the disturbed landscape. This plan should represent the product of stakeholder consensus and reflect a systems approach (phases/evaluation/revision/

reporting/participants) for plan implementation. The next stage in the process describes how the reclamation concept will be implemented.

Step Three: Plan Implementation and the Practice of Reclamation

Step Three should describe how the reclamation plan will be implemented over the duration of the mine operation. This includes detailed information on mitigation measures at various scales of consideration and a commitment to report and consult on the progress of reclamation practices on a regular basis (one to two years). This step would develop structured reclamation plans and programs similar to those reviewed in the case study, but within the scope of the Regional Rehabilitation Plan. This may be achieved through the implementation of mitigation and monitoring plans and programs.

Mitigation:

The mitigation stage describes, in detail, the practice of reclamation. This would extensively detail by topic each area of mitigation (cultural linkages, air quality, water quality, aspect, transportation...), the efforts that will be exercised to mitigate the identified impacts, and work towards the goals of the reclamation plan. Mitigation measures should be described at the various scales of potential impact as revealed in the previous steps of plan development. This includes mitigation on-site, off-site, and at a regional level. This should also include the timing for mitigation measures to proceed at these various scales. In addition, this part of the statement would describe the intended reclamation research program. This should include the goals and anticipated results of this program, experiments proposed, their location, how and when they will be conducted, and how the research results will be disseminated.

Monitoring:

Monitoring is an ongoing activity. In the context of reclamation, monitoring should involve the measurement and recording of reclamation procedures and research and a comparison of these results with the stated strategic vision and goals for the mine site upon closure. These results should be discussed among the stakeholders in a consultation process and altered or adjusted as required to meet the goals of the strategic concept reclamation plan. These results could be collected and analyzed yearly as a means to follow mining and reclamation activity from “cradle to grave”.

The use of a Regional Rehabilitation Plan through these three steps expresses a strategic vision for

land reclamation, and a detailed reclamation program, designed to implement this vision. Such a decision framework can contribute to re-attaining the environmental vitality that is often threatened by mining. Land reclamation can be considered congruently in the licensing and approval of a mining proposal providing a balance in development and ensuring a commitment to reclamation by various groups of interests. This process incorporates the elements of integrated resource management in policy and plan development and adopts a systems approach in the development of these products. The final result of such a process realizes the opportunity that can be found in disturbed land resources that may otherwise be lost for decades after mining has ceased.

The use of this approach could go a long way to promoting sustainability in mineral resources management. Sustainability has become one of the central issues in public policy development. Very little attention has been directed to non-renewable resources such as the products of the mining industry (NRC, 1995a). Increasingly however, it is becoming impossible to avoid addressing the concept of sustainability and the extraction of mineral resources. Environmental issues such as acid mine drainage, sedimentation of watercourses and terrestrial habitat degradation have brought to light some of the important issues that need to be addressed at a policy level if sustainability and mining can co-exist. The expression of these concerns and action directed by consensus will aid in meeting the goals of sustainability. Reclamation planning should make use of this approach in an effort to reduce the long-term stress that mining places on the environment. Formally or informally, the employment of these steps in the approvals process and in the development of a Regional Rehabilitation Plan could assist in achieving the broader based objectives of the mining industry and public policy environment.

4.3 Conclusions

Regional Rehabilitation Planning presents an alternative concept of reclamation with the aim of defining landscape and community goals prior to the removal of ore, and within the broader context of sustainable development principals. The following is a summary of the major findings and key points of the report.

- **Reclamation planning and practice in the Northwest Territories is presently deficient.** The existing guidelines and requirements of the permitting and licensing process in the Northwest Territories have traditionally segregated mine reclamation into its land based and water based

components. This has created duplication in some instances, and created gaps in others where the latent impacts of mine development have been overlooked and the cumulative impacts of mining unassessed.

- The draft Mine Reclamation Policy in circulation by the Department of Indian and Northern Development brings the issue of reclamation in the North into the spotlight by virtue of identifying reclamation as an important issue in mineral development in the Northwest Territories. **While the draft policy propounds the co-management of natural resources and stakeholder participation in its preamble, it is not reflected in the policy itself.** The policy in its present state maintains the communicative status quo between government and industry and does not provide avenues for alternative contributions in the development of reclamation initiatives surrounding mineral development proposals.
- **The dramatic increase in mineral claims and exploration emphasizes the need for the development of a comprehensive approach to reclamation.** This approach should address the overall land resource, its inherent value to the local environments, and the mineral resource as but one element of the many values in a landscape. The present status of standard modern reclamation practices in Canada include comprehensive mine site development and reclamation plans that sub-divide the site into units, disturbances associated with development, and prescribed mitigation and reclamation efforts for each of these units. Extensive research programs are usually involved in reclamation practices to improve the success of applications in the field and to attain self-sustaining vegetative cover after development. This approach is determined by a site experimentation approach and generally follows a scientific analysis of the mine site to determine its final slope stability and revegetation capacity. Reclamation rarely goes beyond the area of the affected mine site.
- Presently, mine legislation, policy, and guidelines focus on the site specific nature of reclamation and its role in stabilizing, containing, and revegetating the mine site. **Reclamation should be perceived and embodied in the regulatory structure in a broader sense, expanding its contribution to community development, ecosystems enhancement and watershed management.** What is

missing is a certification process by which the final landscape can be adopted by future owners. The certification by government, industry, and the community of a reclaimed mine site provides a transfer of the site and avoids the liability traps that many mines are facing today.

- Emerging themes in reclamation indicate two tiers of consideration; a planning process for reclamation involving *how* plans are produced and what issues are included in this process, and a research process involving field practices to implement the reclamation plan and attain pre-stated goals and objectives. **The focus of these themes is to move reclamation beyond its use as a preventive tool in resource management to one of environmental enhancement inclusive of socio-ecological criteria, flexibility in implementation, and the effective dissemination of research results.** The mining industry must become more concerned with social responsibility as well as resource exploitation.
- Environmental Impact Assessment is becoming an important step in the approval process of large northern developments. **Regulators and the community should use this process as a means to broaden the scope of issues incorporated into mine development and the implementation of reclamation plans.** EIA has the potential to allow for interdisciplinary and multi-sector input in decision making for reclamation planning.

4.4 Recommendations

In order to implement alternative reclamation concepts a new policy approach is required that can be integrated into existing regulatory frameworks. A new approach to mining and reclamation in the Northwest Territories requires:

1. **The Whitehorse Mining Initiative be implemented through a continuing commitment made by government and industry to improve reclamation practice by:**

- a multi-stakeholder task force should define the nature and extent of reclamation policy and standards required. Site-specific reclamation requirements must involve local communities and monitoring bodies including co-management boards and special agencies (e.g. BHP Independent Environmental Monitoring Agency);

- reformed security integrated into the life of the mine and the progressive reclamation of the surrounding area, covering full reclamation costs;
- proponents should be released by the regulatory authority when they have fully complied with the reclamation plan;
- systematic research, evaluation and documentation of reclamation 'best practice' in the north supported by industry and government (i.e. DIAND, NWTWB, Fisheries and Oceans and Environment Canada) for application to future mine development to continually improve reclamation. This might be best managed by a multi-stakeholder group through targeted use of resource revenues.

2. That new federal legislation be introduced for the Northwest Territories that embraces the principles established in this document and through the targeted task force mentioned above.

Specific steps are as follows:

- **Stakeholder** involvement be required for all mine reclamation plans.
- Define the process and steps to create a **Regional Rehabilitation Plan** (RRP) in those areas subject to mining. The RRP should be a product of government, industry and the communities affected by mining. Where development proposals trigger an environmental assessment, the RRP should be generated concurrently with other development plans within the procedures of the environmental assessment. Strong public participation role is essential in developing the RRP. The role of a Regional Rehabilitation Plan should be viewed as a living document that may be subject to revision over the life of a mine development. As circumstances change, for example in the ore body, or as a result of additional development approvals, the RRP may need to change. The RRP should serve as the “guide posts” to reclamation and direct mineral resource extraction towards a desired end-state that represents the regional vision for the impacted area. The RRP should be based on identified socio-economic, biological, and physical valued environmental components. Once these have been stated, the RRP should direct research and project initiatives at and beyond

the mine, identify and establish partnerships between communities, government and industry, detail financial assurance measures, prescribe a monitoring, reporting and revision process, and establish a means of feedback and communication with respect to ongoing activities related to the mine and/or other related projects.

- Provide a **landscape certification** process to release industry from liability constraints in the final reclamation stages of a mine site. This should be done as part of the RRP and have the full participation of government and the community in the definition of what is acceptable as a final landscape.

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