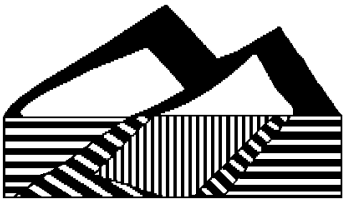
Evaluating Mining and its Effects on Sustainability:
the case of the Tulsequah Chief Mine

Final Report

Report prepared for the



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July 28, 2001

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Acknowledgements

I would like to thank Dr. Jack Ruitenbeek and Dr. Salah El Serafy for comments on earlier versions of this report. They are both respected economists with broad backgrounds and a wealth of experience and knowledge in mining and sustainability issues. Malcolm Taggart provided helpful comments on this report, drawing on his experience with mining issues in Northern Canada and issues related to abandonment and closure. Dr. Bob Gibson went beyond the call of duty in sharing the latest developments in the ongoing evolution of environmental assessment practice and theory.

Thanks to Alan Young of the Environmental Mining Council of British Columbia for his ongoing support of research into the requirements to reconcile mining with sustainable development.

As author, I take full responsibility for any remaining errors or omissions in this report.

Peer review commentaries and curriculum vitae

Note: This report underwent a peer review process. The commentaries of the reviewers, and their qualifications, precede the report.

Peer Reviewers:

Dr. H. Jack Ruitenbeek
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12 April 2001

Alan Young, Executive Director
Environmental Mining Council of BC
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Dear Mr. Young,

RE: Review of manuscript and draft final report by T. Green entitled "Ensuring the sustainability of the Taku River Tlinget and the lands on which they depend" [Tulsequah Chief Mine – Sustainability Assessment]

I was requested to review and comment on work being conducted by Mr. Tom Green relating to a sustainability assessment of the Tulsequah Chief Mine (TCM). My involvement consisted of commenting on initial outlines (January), reviewing in detail drafts of arguments relating to sustainability (February/March), and review of a draft final report (March/April).

My reviews were undertaken to ensure that the report captured current thinking regarding the issue of sustainability, that it was complete in its treatment of issues that might affect mining, and that it accurately interpreted the literature in a context that was relevant to sustainability assessment within British Columbia in general and with respect to the Tulsequah Chief Mine in particular. My own experience in this area consists of twenty years as professional advisor to governments, businesses, and international organizations relating to sustainability and environmental economics within renewable and non-renewable resource sectors.

I am satisfied that Mr. Green has captured and resolved all of the issues and concerns that I have raised with him over the course of the past months. I believe that the most recent product of his efforts (the draft final report prepared at the end of March 2001) makes a worthwhile contribution to the discussion of sustainability assessment of mining in British Columbia. It provides a comprehensive representation of sustainability issues and presents an analytical framework that is consistent with current international thinking in this area. It also proffers an analysis of the TCM that, given available information, represents a fair assessment of the project's sustainability. In brief, I endorse the report and its major findings.

In particular, I also believe that the report gives all parties much food for thought on a number of hitherto neglected issues within the context of sustainability assessment in British Columbia. The report's path-breaking treatment of "need", "adaptive management", and "complexity", for example, should give all stakeholders a solid grounding in these issues. This grounding will, one hopes, lead to further productive thinking in this area.

Yours sincerely,

H. Jack Ruitenbeek, Ph.D.

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CITIZENSHIP

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EDUCATION

Ph.D. (Development & Environmental Economics) 1990, London School of Economics, London, U.K.
M.A. (Natural Resource Economics) 1984, University of Calgary, Canada
B.A. (Distinction-Economics) 1980, University of Calgary, Canada
B.Sc. (Distinction-Astrophysics) 1979, University of Calgary, Canada

Fluent in English. Working/reading proficiency in French and Dutch. Reading proficiency in Indonesian, Spanish, Portuguese.

AFFILIATIONS

Founding member of Canadian Chapter of International Society for Ecological Economics. Reviewer for following professional journals: Ecological Economics (U.S.A.); Environmental Development Economics (U.K.); Environmental and Resource Economics (Netherlands). Sustaining Member of International Society for Reef Studies.

COUNTRIES OF WORK EXPERIENCE

North America: Canada, United States
Africa: Botswana, Cameroon, Ghana, Guinea-Bissau, Kenya, Madagascar, Moçambique, Nigeria, São Tomé and Principe, Uganda, Zambia, Zimbabwe
Asia: Cambodia, China, India, Indonesia, Malaysia, Maldives, Papua New Guinea, Philippines, Singapore, Sri Lanka, Thailand, Vietnam
Latin America and Caribbean: Barbados, Bolivia, Brazil, Chile, Curaçao, Guyana, Jamaica, Mexico, Peru, Trinidad and Tobago, Venezuela, and all OECS States (Anguilla, Antigua and Barbuda, British Virgin Islands, Dominica, Grenada, Montserrat, St. Kitts and Nevis, St. Lucia and St. Vincent and the Grenadines)

BACKGROUND

1981-Present President
H.J. Ruitenbeek Resource Consulting Limited

Performed contract studies as a private consultant to the resource industry and to governments and regulatory agencies. Areas of study included renewable resource development (fisheries, tourism, agriculture, forestry, wildlife), development economics (West Africa, Southeast Asia, India, Latin America & Caribbean), energy policy and development (oilsands, electricity, natural gas), logistical systems (transportation systems, communications, trade) and environmental policy. Consultant to Asian Development Bank, IUCN, IFC, World Bank & UN regarding environmental economics policies, to CIDA, CEARC & CEAC regarding environmental economics policies, economic instruments and indicator design. As a staff consultant to the World Bank, he managed a five year World Bank Research Committee funded project relating to marine system valuation, and a four year project related to the use of market based instruments in environmental management.

1995-Present Scientific Advisor
EEPSEA/IDRC, Singapore

As part of an international panel, responsible for evaluating and monitoring projects relating to environmental economics valuation being funded by the Environmental Economics Program for South East Asia. To date, this has required involvement in some capacity in over 100 projects in a peer review capacity, or in judging proposals and research (including Sri Lanka, Cambodia, Vietnam, Indonesia, Malaysia, Nepal, China, Philippines, and Papua New Guinea.) In addition, he was responsible for designing and

implementing a methodology to assess the damages of haze from the 1997 fires in Indonesia (such damages assessed at US$5 billion), and to make appropriate policy recommendations relating to fiscal and land-use reforms.

1993-2000 — Adjunct Professor, Department of Geography, University of Victoria

Research conducted in the field of ecological economics, as Research Associate to the Centre for Sustainable Regional Development. Projects have focused on indicator design.

1987-1989 — Consultant, World Wildlife Fund/EEC - UK

Assisted the Korup National Park Project, Cameroon, providing economic analyses of park management alternatives regarding development of a buffer zone and resettlement of villages. Advised on economic development strategy for Oban National Park and an associated rural development plan in Nigeria.

1982-1987 — Sessional Instructor, University of Calgary

Instructor of undergraduate courses in natural resource economics, intermediate micro-economics and introductory business economics.

1985-1988 — Research Associate, CERI Energy Research Ltd. (division of Canadian Energy Research Institute)

Managed and conducted economic contract research projects in energy research areas.

1980-1981 — Senior Consultant, AERA Economic Consultants

Performed studies as a private consultant to the natural resource industry and to governments and regulatory agencies in remote community policy design.

EXPERT WITNESS

Expert testimony has been provided to the following authorities: Alberta Energy Resources Conservation Board, Ontario Energy Board, National Energy Board, British Columbia Utilities Commission, and the Government of Canada House of Commons Standing Committee on the Environment.

CURRENT RESEARCH

Dr. Ruitenbeek's current personal research deals with complex systems analysis and the potential role of economic modeling using complex systems frameworks based on work of the BACH group at the University of Michigan. The applied aspects of this work extend into implications for coastal zone management decision-making and for adaptive co-management policies. A recent publication by CIFOR (May 2001) entitled "The Invisible Wand", co-authored with Cynthia Cartier, proposes a framework for incorporating complex systems attributes into policy design and addresses the potential role for adaptive management within bio-economic systems.

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From: *Salah El Serafy, D.Phil.(oxon)*

July 25, 2001

Mr Alan Young,
Executive Director,
Environmental Mining Council of BC,
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Fax 1-250 384 2620

Dear Mr Young:

Draft final Report by Tom Green
'Mining and Sustainability: The Case of the Tulsequah Chief Mine'

Tom Green has been seeking my advice on his work for a number of years, and I have been quite impressed by his conscientiousness in addressing the tasks to which he addresses himself, his wide reading in environmental/ecological economics, and his versatility in applying theoretical approaches to empirical investigations. In regard to the Taku River Tlinget project he communicated to me for comment a number of drafts of the report in question, and I find his handling of this assignment to be no exception to the high standards he set himself.

Mr Green has produced a most readable document that captures the relevant aspects of this project in a manner that fully meets the guidance provided by the courts. Placing his analysis in terms of the specific context of British Columbia without neglecting the worldwide framework shows a firmness of approach and a useful focus that I have found illuminating. I was particularly impressed by the attention given in the report to the likely deleterious impact of the prospective road (which is a component of the project under review) – thus bringing in experience which has sadly been noted in other countries where such roads have opened up access to previously unspoilt areas. The analysis the report provides of the implications of the proposed mine for the sustainability of the Taku River Tlingit First Nation is thorough and instructive. Altogether, the emphasis placed throughout the report on sustainability is quite exemplary.

All in all I think this is an admirable piece of work, and I am writing to let you know my view of it.

Yours sincerely,

Salah El Serafy,
Formerly Senior Advisor,
Environment Department,
The World Bank, Washington DC

Salah El Serafy

Curriculum Vitae

University Education:

1) B. Com. Hons. University of Alexandria 1947
2) B. Sc.(Econ.) Hons. University of London 1952
3) D. Phil. (Economics) University of Oxford 1957

Professional Experience

University of Alexandria: 1958 - 1962. Lecturer and Associate Professor. Teaching at undergraduate and graduate levels, and conducting and supervising research.

Harvard University: 1962-1964. Fulbright post-doctoral Fellow, 1962-64: Research Fellow, Department of Economics, 1962-63; and Research Fellow, Center for Middle Eastern Studies, 1963 64. Research and Teaching, combined with a lecturing program on development at various United States universities.

The Economist Intelligence Unit Ltd., London. 1964-1972. Senior Research Consultant; Project Manager; Project Director. Widely varied assignments, as senior economist in charge. Tasks included country economic analysis, commodity research, macroeconomic studies, economic forecasting and project appraisal with extensive field work in Africa, Asia, and Europe. Work covered macroeconomic projections of South Korea and Pakistan to guide long-term port development (studies used later as basis for loans from the World Bank); senior economist on a major sugar rationalization study (with Tate & Lyle and Bookers) for Java, Indonesia; team Leader of a United Nations study for the Vardar Axios river basin development (Yugoslavia and Greece). Economic advisor (on a two-year secondment to the United Nations) to the Kingdom of Libya. Team leader of various studies including: the Compatibility of the United Kingdom's Macro-Economic Policies in the 1960s at the time of using IMF resources; an econometric study of future world demand and supply of tourism services; international economic integration; hydraulic dam projects; projections of financial market variables. Most of these studies were confidential to the clients who commissioned them.

The World Bank, Washington DC: 1972-1992. Senior Economist, Economic Advisor, and Senior Advisor. World Bank experience covered Regional and Central Departments as Senior Country Economist; Senior Evaluation Officer in the Operations Evaluation Department; Senior Economist, Country Policy Department; Economic Advisor on the Economic Advisory Staff of the Senior Vice President Operations; and Senior Advisor, the Environment Department. Tasks included country macroeconomic analysis and policy formulation, structural adjustment operations, integrating environmental issues in country policies and drafting Operational Directives to guide implementation of Bank policies by Bank economists. Represented the World Bank at various international fora to explain Bank economic policies to OECD (Paris), FAO and World Food Program (Rome), and the European Community(Brussels) among others.

Consultancies and Related Activities: 1992 -
1992 consultant to World Bank Environment Department;1993-4 consultant to World Bank Operations Evaluation Department as leader of the World Bank's Team for the evaluation of the Global Environment Facility (Pilot Phase) with collaborating teams from UNEP and UNDP: final report published by the three agencies in 1994. Consultant to World Bank Europe, Middle East and North Africa Department, 1995 to make a presentation to the Omani cabinet on the depletability of Petroleum in an attempt to influence fiscal restraint. 1995 consultant to the World Bank Development Economics Vice-Presidency on "Macroeconomic Policy and the Environment: Greening the National Accounts". Various lecturing assignments 1995 - 1999: at Cairo and Alexandria Universities, University of Maryland, USAID, US Environment Protection Agency, IMF and the World Bank. 2001 began membership of an international Working Group on Economic Instruments for Environmental Policy under the aegis of

UNEP and UNCTAD. Peer-reviewing academic papers prior to publication for a number of development journals. Currently writing a book on macroeconomics and green accounting.

Other Involvements:

Among numerous assignments and tasks, chaired Joint World Bank-UNEP workshops in 1980s for reforming the United Nations System of National Accounts. Nominated by UNEP twice in the 1980s to serve on panels on the economics of the Montreal Protocol on Substances that Deplete the Ozone Layer. Member of UNEP's National Accounts Expert Group. Advisor to FAO on Forestry Green Accounting.

Member of the Editorial Boards of the Journal of *Ecological Economics* (until1999), and *Journal of Environmental Taxation and Accounting*. Life member of the Royal Economic Society.

Selected Publications

Will the Third World Ever Take off? **1972**. Chapter 4, pp. 69-98 in *Key Issues in Applied Economics 1947 1997.*

The Oil Price Revolution of 1973-1974. **1979**. *The Journal of Energy and Development*, vol. 4, no. 2, pp.273 290.

Absorptive Capacity, the Demand for Revenue and the Supply of Petroleum. **1981.** *The Journal of Energy and Development,* volume 7, number 1, pp. 73-88.

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The Proper Calculation of Income from Depletable Natural Resources. **1989**. Chapter 3, pp.10-18 in Y. J. Ahmad, S. El Serafy and E. Lutz, (editors) *Environmental Accounting for Sustainable Development*, A UNEP-World Bank Symposium. The World Bank, Washington D.C.

The Environment as Capital. **1991**. Chapter 12, pp. 168-175 in Robert Costanza (editor), *Ecological Economics, the Science and Management of Sustainability.* Columbia University Press, New York.

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Oil and the Economies of Oil Exporting Countries. **1995**. Chapter 12, pp. 127-138 in Siamack Shojai (editor), *The New Global Oil Market, Understanding Energy Issues in the World Economy.* Praeger, Westport, Connecticut and London.

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In Defence of Weak Sustainability. **1996**. *Environmental Values*, pp. 75-81, volume 5.

Green Accounting and Economic Policy. **1997.** *Ecological Economics*, volume 21, pp. 217-229.

Contabilidade verde e política econômica, ch.12, pp.193-214. **1997.** Clóvis Cavalcanti (org.), *Meio ambiente, desenvolvimento sustentável e políticas públicas*, Sao Paulo: Cortez: Recife: Fundaçao Joaquim Nabusco.

The Urgent Need to Internalize CO_2 Emission Costs (jointly with Robert Goodland). **1998**. *Ecological Economics*, volume 27, pp.79-90.

Depletion of Australia's Non-Renewable Natural Resources - A Comment on Common and Sanyal. **1999**. *Ecological Economics*, volume 30, pp.357-363.

Natural Resource Accounting. **1999**. Chapter 77 (pp. 1191-1206) in Jeroen C.J.M. van den Bergh (editor), *Handbook of Environmental and Resource Economics*. Edward Elgar: Cheltenham, UK and Northampton, Mass., USA.

Green Accounting and Macroeconomic Policy. **2000**. Chapter 7 (pp. 71-93) in Clóvis Cavalcanti (editor)*, The Environment, Sustainable Development and Public Policies: Building Sustainability in Brazil*. Edward Elgar: Cheltenham, UK and Northampton, Mass., USA.

Steering by the Right Compass: Proper Measurements for Sound Macro-economic Management. Forthcoming, **2001**. Chapter in a book edited by Ekko van Ierland, Edward Elgar.

Natural Resource Availability. (**2002**?) Entry in forthcoming UNESCO's *Encyclopedia of Life Support Systems*.

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Executive summary

This report develops a model for assessing the compatibility of proposed mines with the requirements of sustainability. The model is then applied to the Tulsequah Chief Mine reopening project proposed by Redcorp Ventures Ltd.[1]

This copper/gold/lead/silver/zinc mine was in production from 1951 – 1957 before it was abandoned due to low mineral prices. The mine is located on the Tulsequah River, 12 miles upstream from its confluence with the Taku River, and immediately upstream from the Alaska/BC border. The 18,000 km^2 Taku River Watershed is still pristine and unroaded, and contains exceptional wildlife values. It is also part of the traditional territory of the Taku River Tlingit First Nation (TRTFN). The Tlingit have historically harvested from the Taku River drainage, and continue to do so to this day.

Key environmental concerns associated with the mine include:

- the need for a 160 km access road from Atlin, BC to the mine site;
- the potential for Acid Mine Drainage, and;
- the implications of the mine and road on the sustainability of TRTFN environmental interests, economy and culture.

The proposed mine reopening was reviewed under BC's *Environmental Assessment Act* and received project approval in March of 1998. However, during a subsequent judicial review, the court determined that the review did not adequately address sustainability, one of the purposes of the *Environmental Assessment Act.* The court ordered that a revised project committee report be prepared that specifically addressed "whether the project was a sustainable development in the sense that it would protect Tlingit environmental interests and foster a sound economy and social well-being for the Tlingits."

Assessing whether proposed mines contribute or detract from sustainability is a challeging undertaking. Mines involve the extraction of non-renewable resources, an activity that by its very nature is not sustainable. However, it is generally accepted that mineral extraction can, under certain circumstances, contribute to sustainability, though there has been a shortfall in rigourous work to set out those conditions.

The sustainability assessment for the TCM is ocurring in the context of an environmental assessment. Until recently, environmental assessments did not directly address sustainability, but rather concentrated on predicting and mitigating negative environmental impacts. Projects could be approved if environmental impacts were mitigated to an acceptable level even if the net result detracted from sustainability. More recently, it has been recognized that environmental assessments conducted in a context where there is commitment to sustainable development involve a higher test, namely, that the project involve a positive contribution to sustainability.

[1] Formerly Redfern Resources Ltd. In this report Redcorp Ventures Ltd. or simply Redcorp will be used, even if at the time in question the company was named Redfern Resources.

This report helps fill two gaps: the lack of a rigorous sustainability assessment framework for proposed mineral developments, and the need for a sustainability assessment of the proposed TCM that goes beyond a conventional environmental assessment's focus on identifying and mitigating environmental impacts.

This report also starts from the standpoint that current environmental conditions and trends must be taken into account when addressing sustainability. A brief overview of global, provincial and regional trends indicates that current industrial economies are far from sustainable, and that there are many warning signs that humanity is exceeding ecosystem limits. Priority actions required to achieve sustainability at the global scale are identified. For the most part, decreased material throughput and greatly increased efficiency is required. At the provincial scale, although some progress has been made in specific areas, overall prospects for sustainability continue to deteriorate.

At a regional level, although there are some trends that indicate sustainability may be increasingly compromised, the fact that little industrial development has occurred in the area leaves many options open. Land use by the TRTFN is largely compatible with sustainability.

Following a literature review, nine sustainability criteria are developed to assess the sustainability of proposed mineral developments. These criteria are then applied to the TCM, based on readily available material from the first environmental assessment of the proposed mine or other published sources. Ideally, these criteria would have helped frame reports prepared for the environmental assessment. There are a number of areas where further information and research would have been useful in applying the criteria, though the available information was sufficient to get a general indication of the mine's performance against sustainability criteria.

The TCM performs poorly against the sutainability criteria set out in this report. Consequently, it is not likely that the project will positively contribute to sustainability, rather, project approval would move society further from sustainable conditions. In particular, the need for a 160 km road through a pristine area with high environmental values is seen to be a major factor in the project's performance. Although the proponent intends to decommission the road once the mine is closed, there is little confidence that road decommissioning will occur or that it will be successful. Furthermore, tailings management and the potential for Acid Mine Drainage with associated leaching of heavy metals presents risk to the local environment.

The TCM is seen to be a marginal to sub-marginal ore body with a short projected lifespan. There is a risk that the project will be abandoned prematurely and that insufficient funds will be available for reclamation. The returns to the province, the region, the Tlingit and indeed to investors are projected to be modest in comparison to potential risks and impacts. Certain preconditions that could be put in place to improve the project's potential to contribute to sustainability are identified.

A final chapter more specifically responds to the court's finding that evironmental assessment needs to address the mine's implications for the sustainability of Tlingit by protecting their environmental interests and fostering a sound economy. The current TRTFN economy relies significantly on subsistence production from the land. The land-based economy and the cash

economy are well integrated. Tlingit culture is going through a period of renewal. Indeed, the TRTFN appears to be doing well relative to many other First Nations across the North. In sum, Tlingit prospects for sustainability are presently good. However, Tlingit land use, the Tlingit economy and culture are all deemed vulnerable to the mine access road and to other project impacts such as the projected influx of workers, wages and spending into the regional economy. This vulnerability is due in part to the fact that the Provincial and Federal governements have yet to conclude a treaty with the TRNFN, and no ecosystem-based land use plan has been implemented for the region. Furthermore, until the province negotiates a treaty, and until Redcorp Ventures concludes an Impact Benefits Agreement with the TRTFN, Tlingit capacity to manage project impacts and the degree to which Tlingit will benefit from the project remains uncertain.

It is concluded that from a sustainability perspcetive, the TCM is at best premature, and at worst ill-conceived. Approval should not be granted at this time, but should be deferred until a treaty is negotiated with the TRTFN, an ecosystem-based land use plan is implemented, and it is established that the road can be effectively decomissioned. This deferral would also allow the proponent and regulatory agencies more time to improve baseline data for the region area, and to reduce uncertainties associated with the project. Finally, it should be demonstrated that the mine is viable in an economic environment where there is a likelihood that mineral prices will remain depressed.

1 Introduction, purpose, background

1.1 Purpose of this report

This report was commissioned by the Environmental Mining Council of British Columbia (EMCBC) to meet the following objectives:

- to provide a rigourous model on how mining can be reconciled with the requirements of sustainability, and to apply this model to the Tulsequah Chief mine (using available information);
- to establish a benchmark for assessing the sustainability of mining projects in a context where indigenous people are likely to be affected, and;
- to provide potential investors in mining projects with a screening tool to identify mining investments that contribute to sustainability.

The emphasis of this report is to identify conditions under which mining projects can be compatible with the requirements of sustainable development, using the Tulsequah Chief Mine (TCM) as an example. Because of the limited time and resources available to produce this report, and the diverse fields of knowledge involved in conducting an environmental assessment of a mine, this report is not intended to provide a definitive assessment of environmental impacts of the Tulsequah Chief Mine. It does draw on information generated in the environmental assessment under BC's *Environmental Assessment Act* to illustrate how the model developed here would be applied, to identify key issues and information requirements, and to provide a provisional opinion as to the project's sustainability.

1.2 Overview: the proposed Tulsequah Chief copper/gold/silver/lead/zinc project

Redcorp proposes to re-open, for nine years, an abandoned zinc, copper-lead, and precious metals mine on the Tulsequah River, 12 miles North of the Tulsequah's confluence with the Taku River, and 30 km upstream from the BC/Alaska border. The mine site is 100 km due south of Atlin, B.C. and 64 km northeast of Juneau, Alaska. Redcorp plans to access the Tulsequah Chief mine through the construction of an all-weather industrial highway from Atlin, heading 160 kilometers south to the Tulsequah River. The proposed road will have to pass over rugged, steep-sloped terrain that receives over 300 cm of precipitation annually and snow depths that in some valley bottoms can exceed 3 meters.

1.2.1 The local environment

The Taku River drainage, at 18,000 km^2, is the fifth largest watershed in the province. It is pristine, with the exception of the Golden Bear mine road that barely intrudes the watershed's southern boundary. The lower Taku lies within Alaska, and supports the largest salmon run north of the Skeena River.

The physiographic and climatic characteristics of the landscape present severe challenges to industrial activity. Steep slopes in the area have very little soil development. Avalanches, spring floods, and heavy fall rains are common throughout most valleys. Precipitation is 2 meters annually, 60% as snow. Extreme winds occur often.

The region is remote, inaccessible except by air, or by river boat from Alaska, and has healthy populations of internationally-significant large mammals, including grizzly bear, mountain goat, Stone sheep, and woodland caribou. More common boreal species such as moose, black bear, and other predators and fur-bearers are also present.

The Taku River is part of a larger system of undeveloped transboundary coastal watersheds between northwestern British Columbia and the panhandle of southeastern Alaska, including the Stikine, Alsek, Whiting, Iskut, Unuk, and Tatshenshini rivers. The ecological importance of these large intact ecosystems has attracted the attention of BC, national and international conservation groups, and work is underway to develop a regional Conservation Areas Design (CAD) for the combined watersheds in the transboundary area.

1.2.2 Land Ownership

The area affected by the mine and the access road is the traditional territory of the Taku River Tlingit First Nation (TRTFN). The economic well-being and cultural identity of the Tlingit people is dependent upon their ability to utilize this territory and harvest the plant and animal resources within it. While the mine will have localized effects, the proposed road is likely to impose much more significant and broader effects on wildlife resources and the Tlingit. The impact of the mine and the access road on the sustainability of the Tlingit land use, economy and culture is discussed in more detail in Section 6.

In 1983, the TRTFN submitted their comprehensive claim to the Federal and Provincial governments, and in 1993, they submitted their statement of intent to negotiate settlement under the BC Treaty Commission Process. In July 1996, TRTFN, Canada and BC signed a Framework Agreement for the purpose of negotiating a treaty. Negotiations for an agreement-in-principle are currently underway; these negotiations are proceeding slowly. The entire Taku watershed, the area of the access road, and the mine are included in a revised Statement of Intent and map submitted to the BC Treaty Commission on July 7, 1997 (Staples, 1997).

1.2.3 Ore transportation

Twelve truck loads of ore per day will be hauled from the site to port destination at Skagway, Alaska, with mine supplies brought in on haul back, for a 1,034 km round trip. Approximately 20 service vehicles will visit the mine daily. Total traffic on the access road will be 64 vehicle transits per 24-hour period.

1.2.4 Mining history/deposit characteristics

- deposit discovered in 1923
- volcanogenic massive sulphide - precious metals rich deposit
- two other nearby deposits: Big Bull and Polaris Taku

- Tulsequah Chief and Big Bull acquired by Cominco Ltd. in 1946
- production from 1951 to1957
- processed approximately 450 tons per day using river transportation
- tailings were dumped into Tulsequah River
- abandoned mine found to be resulting in Acid Mine Drainage (AMD)
- pollution abatement order issued to Cominco in 1989
- Cominco failed to meet terms of the order
- order was rescinded after rehabilitation plan was prepared
- Cominco sold property to Redcorp Ventures Ltd.
- new pollution abatement order issued to Redcorp, but was deferred
- geological reserves: 8.9 million tonnes @ 1.31% copper, 1.24% lead, 6.61% zinc, 2.53 g/t gold and 107.5 g/t silver
- reserves may continue at depth

1.2.5 Mine infrastructure

- camp accommodation - 160 people
- air strip - gravel 1,200 m long by 80 m wide, 3.5 km north of mine
- power generation to consist of 7 diesel generators of 1.6 MW capacity each
- 18 million liters of diesel fuel consumed annually

1.2.6 Project timing and key characteristics

- pre-production development: 2 years
- mine life: 10 years
- estimated project life: 12 years
- year-round production
- underground mine with conventional mill
- mining rate: 2466 tonnes per day or 0.9 million tonnes per annum

1.2.7 Employment

- 700,000 person hrs of employment per annum
- 399 peak construction workforce
- 199 people will be employed onsite during operation
- 131 employees on regular shift rotation
- 60 contract transport personnel

1.3 Requirement to address sustainability of TCM

The TCM was the subject of an environmental review under the British Columbia *Environmental Assessment Act.* The Environmental Assessment Office issued the final report of the Project Committee in March of 1998, with a majority recommendation for project approval subject to certain conditions. Following a lapse of time of only one day after the filing of the recommendation report, the government made its decision on the project. The project received

conditional approval from the Minister of Energy and Mines, the Minister of Environment, Lands and Parks, and the Minister Responsible for Northern Development. A Project Approval Certificate was issued on March 19, 1998.

The TRTFN sought a judicial review of the environmental review process and of the subsequent issuance of a Project Approval Certificate. The TRTFN was a member of the Project Committee that conducted the environmental review. The TRTFN raised a number of substantive issues, arguing that the review process had been flawed and, as a result, the report and recommendations provided by the project committee did not satisfactorily identify issues that the Ministers needed to make a responsible decision on project approval. Key to the present study is the TRTFN's original contention that the report and recommendations did not address the issue of sustainability as set out under the *EAA* act.

The court found that the review and the report did not meet the requirements of the *EAA* act, and in particular did not address the purpose of the act:

> 2 (a) to promote sustainability by protecting the environment and fostering a sound economy and social well-being.

The court held that the Ministers had acted unreasonably in approving the project, and that they must reconsider their decision based on a reconvening of the project committee and a revised project committee report which was to meaningfully addresses the Tlingit concerns, quoted at para 58 of Justice Kirkpatrick's decision[1] as,

> whether the Project was a sustainable development in the sense that it would protect Tlingit environmental interests and foster a sound economy and social well-being for the Tlingits.

An environmental assessment for the TCM was required by both the British Columbia *Environmental Assessment Act* and by the federal *Canadian Environmental Assessment Act*. Both pieces of legislation have as an explicit purpose the promotion of sustainability (see Table 1). To avoid duplication, BC and Canada have coordinated their respective environmental assessment processes under an agreement that provides that the assessment will only be conducted under the BC process.

Table 1: Sustainability and environmental assessment legislation

Legislation	Reference to sustainability
BC *Environmental Assessment Act*	Purposes: *Section 2 (a)* to promote sustainability by protecting the environment and fostering a sound economy and social well-being,
Canadian Environmental Assessment Act	Purposes: *Section 4(b)* to encourage responsible authorities to take actions that promote sustainable development and thereby achieve or maintain a healthy environment and a healthy economy;

As of writing, two things are occurring simultaneously. Justice Kirkpatrick's decision is under appeal by the Province and the proponent. The Environmental Assessment Office and the Project Committee are also redoing the assessment in order to explicitly address issues of sustainability. The Project Committee's revised report is to be issued in spring of 2001, after which point the Minister of Environment and the Minister of Energy and Mines will decide whether or not to issue a new Project Approval Certificate.

Though this report is being prepared for the EMCBC outside of the official review process, it is hoped that an independent opinion on the project's compatibility with the requirements of sustainable development will be a useful input to the new review process.

1.3.1 Scale/jurisdiction

Addressing sustainability in the context of BC and Canadian environmental assessment legislation raises the issue of the scale at which sustainability is to be assessed—provincial, national or global. Does BC environmental assessment legislation address the extent to which sustainability beyond the BC border is achieved? Likewise, does Canadian environmental assessment legislation imply a need to look at global level sustainability considerations?

The approach adopted in this report is that project sustainability needs to be assessed at all scales.[2] There are two main reasons. The first is the obvious point that sustainability in BC depends upon sustainability at national and global levels. For instance, efforts to achieve sustainability within the forestry sector in BC are likely to be futile if climate change drastically alters moisture and temperature regimes, and thereby alters growing conditions and the influence of fire, insect and disease. A BC project's contribution to prospects for global sustainability, and its demands upon global ecosystem processes are therefore relevant considerations under an environmental assessment.

The second reason for BC and Canada to take into account global level sustainability implications of a project is that Canada is a party to a number of conventions and international agreements that address aspects of sustainability that require actions and measures at provincial and national levels. The following non-exclusive list of treaties/conventions/agreements are both binding on the government of Canada and relevant to issues of sustainability:

- Convention on Biological Diversity
- Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar Convention)
- Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)
- Convention for the Protection of the World Cultural and Natural Heritage
- Convention on the Protection of Migratory Birds in Canada and the United States
- 1909 Boundary Waters Treaty
- Framework Convention on Climate Change
- North American Agreement on Environmental Cooperation.

For instance, the Convention on Biological Diversity was adopted at the United Nations Conference on Environment and Development in June 1992. It has three objectives: 1) the

conservation of biodiversity; 2) sustainable use of biological resources; and 3) the fair and equitable sharing of the benefits arising out of the use of genetic resources. The Kyoto Protocol establishes a commitment period between 2008 and 2012 in which average emissions for Annex 1 Nations are to be 94.8% of 1990 levels. Canada is to reduce its emissions by six percent from 1990 levels. The commitments included in the Kyoto Protocol are legally binding under international law, though the consequence of non-compliance are relatively inconsequential.

2 Context: EA, sustainability, and mining

2.1 Sustainability and environmental assessment

While environmental impact assessment precedes the Brundtland Commission report, and the adoption of sustainability as an objective of BC and Canadian governments, impact assessment has been recognized as an important tool to support sustainability and is evolving to meet this need. Gibson (2001) points out that incorporating sustainability into environmental assessments represents a significant change and that it implies a very different test for determining the acceptability of projects. No longer is it sufficient for projects to show that serious negative environmental affects will not occur or can be mitigated. This is important, because the conventional approach to environmental assessment allows for undertakings to be approved that take society in small, incremental steps ever further from sustainability. Instead, proponents are increasingly being asked, as they should, to meet a higher test, namely, that the project provide a "positive contribution to sustainability":

> Applied to environmental assessment, a commitment to sustainability implies requiring proponents to go beyond minimizing damage– they are to make positive contributions to improving ecological and community conditions for the long term. A sustainability objective in environmental assessment implies that **undertakings should maximize durable net gains.** (emphasis added)

Gibson elaborates that the requirement to maximize durable net gains does not imply rejecting all undertakings that involve unsustainable activities, rather, it requires limiting "the kinds of losses and unsustainable activities that are tolerable (e.g., mining may be acceptable where its immediate negative effects are largely corrected through remediation and its socio-economic benefits are designed to provide a bridge to a more sustainable future for the local community)." Furthermore, a sustainability assessment approach does not imply downplaying the traditional emphasis in impact assessment on ecological considerations given the need to consider social and economic sustainability, rather, sustainability assessment should "focus on the longer term where ecological, social and economic imperatives tend to coincide." Ideally, a project should only be approved "if there is good reason to expect overall positive contributions to sustainability."

The Red Hill Creek Expressway Review Panel, convened under the *CEAA,* set out the test to assess a project's contribution to sustainability as follows:

> The promotion of sustainable development (development that meets the needs of the present, without compromising the ability of future generations to meet their own needs) is a fundamental purpose of environmental assessment. ...
> The Panel interprets progress towards sustainable development as meeting the following goals:
> 1) the preservation of ecosystem integrity, including the capability of natural systems, local and regional, to maintain their structure and functions and to support biological diversity;
> 2) respect for the right of future generations to the sustainable use of renewable and non-renewable resources; and

> 3) the attainment of durable social and economic benefits.
> The Panel requires the Proponent to demonstrate how the Project meets the three goals directly noted above.[3]

Two recent papers have sought to elaborate on how sustainability should be addressed by environmental impact assessment. Lawrence (1997) suggests that integrating environmental impact assessment and sustainability implies a sustainability perspective at each stage of the planning process for the project in question. The impact assessment should explicitly address whether sustainability is fostered or inhibited:

> Impact significance interpretations should assess whether the proposed action threatens ecological limits, biological diversity, essential needs, or sustainable resource use. The potential to induce cumulative effects, adversely affect system sustainability and resilience, and reduce social equity should be considered. The values of those most likely to be affected should be thoroughly assessed.
>
> **Mitigation and Enhancement**
>
> EIAs should focus on measures to reduce pressures on ecological limits by enhancing key processes and functions and by restoring damaged and degraded ecosystems (i.e., sustainable redevelopment). Other priorities include avoiding the depletion of resources, minimizing effects on the most vulnerable, and avoiding situations where future generational options are foreclosed (Lawrence, 1997, p.38).

George (2000) notes that although environmental assessment predates sustainable development and does not automatically address sustainability, it is a ready-made tool for applying sustainable development criteria so long as the criteria are explicitly brought into the assessment. Furthermore, the importance of EIA for sustainability is recognized in Rio's Principle 17 which specifically calls for EIA to be undertaken for proposed activities that are likely to have a significant adverse impact on the environment.

George proposes that the Rio definition of sustainable development requires only two tests to see if development is sustainable: "is it equitable for future generations, and it is it equitable for the present generation?" He proposes to restate the principle of intergenerational equity as the principle of conservation of capital: "if the capital, natural or human made, that future generations inherit is no less than the current capital stock, then development is equitable intergenerationally." He further suggests that if EIA is to be used as a test for sustainable development, it should test whether each of the relevant principles of the Rio Declaration are upheld.

George explores two perspectives on the implications of a constant capital stock. A strong sustainability perspective, the more onerous of the two, implies that the stock of natural capital must be passed on undiminished to future generations. A weak sustainability perspective implies that natural capital can be consumed to create other forms of capital, so long as the value of the natural capital consumed is thereby offset by an equivalent accumulation of other forms of capital. The weak sustainability rule must also be considered in conjunction with the polluter pays principle and the principle of intergenerational equity. According to George this implies that the

public as a whole must draw an equivalent benefit from the replacement capital as it did from the converted natural capital.

George's reliance on the conservation of capital, while defensible conceptually, may actually add confusion rather than assist in environmental assessment, particularly if a weak sustainability perspective is adopted. There are a host of problems involved in valuing capital, and in particular natural capital, and in determining the conditions under which total capital stock is maintained intact (Norgaard, 1993; UN, 1993; El Serafy, 1989, 1993; Friend, 1991). The key problem however, is that the weak sustainability criterion assumes the proceeds from converting natural capital will benefit future generations as they are invested in human (e.g., education and training) and physical capital (e.g., plants, infrastructure), so there is no need to invoke specific measures to distribute benefits across generations and to maintain the opportunities available to future generations. However, rather than being invested, the proceeds may well be frittered away in wasteful and environmentally demanding consumption (e.g., jet skis, luxury items, trips to Hawaii). Furthermore, even if investments are made, the investments themselves may add to the demand on ecosystems or the need for non-renewable resources (e.g., we build more highways), or if training is irrelevant to or impedes sustainability (e.g., we train more advertisers who encourage consumption), then future generations are not likely to benefit; indeed, they may be worse off as a result.

If a strong sustainability perspective is adopted, rather than going through the difficulty of valuing changes in the stock of natural capital, it would be easier and more relevant to ensure that ecosystem integrity and productivity is maintained.

From the above literature review, it is clear that it is relevant and appropriate, if not imperative, for environmental assessment to address the issue of sustainability. There appears to be consensus that doing so implies the need for sustainability criteria. There is also agreement that the test previously implied in environmental impact assessments, namely the developments may only proceed if their impacts are acceptable once mitigated, is no longer sufficient. Rather each development should make a positive contribution to sustainability, either by actually improving the sustainability of the overall economy by reducing its demands on ecosystems and by helping society to live within ecological limits, or by resulting in some low level of environmental tradeoffs in exchange for social and economic benefits which will clearly be used to bridge society towards a more sustainable future.

2.2 Precedents for sustainability driven environmental assessments

In the Canadian context there are at least two environmental impact assessments which have explicitly addressed the issue of sustainability. Guidelines issued by both the Voisey's Bay Mine and Mill Environmental Assessment Panel (1997) and the Red Hill Creek Expressway Review Panel required the proponent to demonstrate a positive contribution to sustainability.

In the Voisey's Bay EIA, the panel devoted a chapter of its report to considering the project's overall contribution to sustainable development, taking into account the precautionary principle. It concluded that while there were a number of significant challenges, the project could be operated in a way that would not impair ecosystem integrity or biodiversity, without significantly

damaging local and regional ecosystem functions, or reducing the capacity of renewable resources to support present and future generations.

The panel also sought to ensure that the project would deliver durable and equitable social and economic benefits to the indigenous people affected by the project other residents of the region and of the province. The panel concluded in the durable and equitable benefits would only be achievable if the project lasted for at least 25 years.

The panel also devoted a chapter of its report to the need for the project and for resource stewardship and agreed that conservation of mineral resources is an important objective. It did not feel however, that it could satisfactorily address issues of global nickel use and conservation at the project level. The panel preferred an approach that would see a land claims agreement or equivalent binding measures put in place before the mine proceeded or authorizations were issued. Such agreement is essential if "durable and equitable benefits" are to be achieved. This is an important element of sustainability assurance and is, therefore, sound public policy (VBEAP, 1999:29).

While the panel ultimately recommended approval of the Voisey's Bay Mine, it set out 106 recommendations that it felt were necessary to insure the conditions under which the project would indeed contribute to sustainability.

The panel's report shows the from its perspective for the mine to contribute to sustainability it had to:

- not impair ecosystem integrity or biodiversity;
- not significantly damage local and regional ecosystem functions;
- not reduce the capacity of renewable resources to support present and future generations;
- deliver durable and equitable social and economic benefits, with special attention to the needs of aboriginal peoples;
- proceed in a manner compatible with stewardship of non-renewable resources, and;
- respect aboriginal rights and not prejudice land claims agreements.

If EIAs were to follow the Voisey's Bay panel's lead, mining projects would have to respect ecological limits, maintain the capacity of ecosystems to provide environmental services and renewable resources, deliver lasting and fair social and economic benefits, and fit a larger global imperative for resource stewardship and efficiency.

2.3 Project vs. class environmental assessments

This report seeks to fit within the framework implied by BC and Federal environmental assessment legislation. Some of the issues addressed in this report might be better addressed under a different framework such as that provided for by class assessments. For instance, with respect to the need for minerals, it may well be more efficient to examine need for various minerals on a periodic basis at a national or global level.
In work relevant to such macro level issues, Daly (1992) proposed that one of the key measures required to achieve sustainability is that depletion quotas for non renewable resources be set by

government so as to control the rate of resource use and hence pollution. These depletion quotas would be auctioned off to the highest bidders who would then have the right to extract and sell the quantity of minerals covered by their quota amount. Although Daly was writing about measures that could be implemented at the national level, depletion quotas would be most effective at the international level.

Assessments of need from either class environmental assessments, or from higher level governments or institutions, or from Daly's depletion quota mechanism, would then feed into individual environmental assessments of proposed developments where project-specific issues could be addressed. For instance, if at a higher level process it was determined that there was indeed a need for given mineral concentrates, this information would flow into environmental assessments of mines producing such concentrates, and the issue of mineral need would not have to be revisited as each project was reviewed. However, at the present time there are no formal processes to address such higher level sustainability issues relevant to mine development. Government is also in the role of promoting resource extraction as a tool for economic development, and has yet to rigourously address the how resource extraction and use relates to sustainability. Recognizing current circumstances, this report addresses both site specific and higher level implications of proposed mines, though this approach is perhaps less than ideal.

2.4 Limits to environmental assessment in the context of complexity

Since environmental assessment first came into use as a tool to improve societal decisions with respect to natural resource use and infrastructure development, our appreciation for the complexity of natural system-human system interactions has greatly increased. We have a better understanding of how our ability to predict the behaviour of complex systems is hampered by surprise, non-linearities and discontinuities. Earlier efforts to establish cause-effect relationships and thereby predict environmental impacts have been found wanting when the issues involved relate to longer time periods, larger spatial scales, and interactions of complex systems that have adaptive, interactive and evolutionary characteristics (Ruitenbeek and Cartier, 2001).

Each level within a complex system undergoes a cycle of growth, conservation, release and reorganization. Panarchy is the term adopted by Gundersen and Holling (2001) to describe the structure in which natural and human systems are interlinked in these adaptive cycles.

Sustainability then involves both change and stability. To achieve sustainability and to avoid surprise, managers must seek to accumulate knowledge of ecosystem processes through safe-fail experiments, e.g., experiments where the consequences of failure are acceptable. These experiments allow managers to explore the stability domain, but as experimentation carries some risk that the system will be moved out of a desirable range, experiments should be carefully selected based on existing knowledge (Carpenter et al, 1999).

Human efforts at adaptive ecosystem-based management or managing for sustainability are constrained by the resilience of the ecological system and the flexibility of the coupled social system. Resilience describes the amount of disturbance that a system can absorb before the system flips out of the adaptive cycle and into a new, and usually less desirable domain. If ecosystem resilience is low due to past interventions or existing ecosystem characteristics, or if

the social system is not flexible and cannot adapt to changing potential for ecosystem use, then adaptive management is unlikely to be successful. Ecosystem resilience either needs to be restored to reduce the likelihood of an undesirable shift to a new stability domain, or social flexibility needs to be enhanced (Gunderson, 1999). Maintaining ecosystem resilience typically requires maintenance of redundancy, while resource managers often see redundancy as involving inefficient use of resources (Ruitenbeek and Cartier, 2001).

This brief and incomplete incursion into complexity suggests a number of lessons in an environmental assessment framework. First, it is essential to recognize our limited ability to predict how ecosystems will be affected, and precaution is therefore advised. Second, the behaviour of regional ecosystems will depend on changes at higher levels in the hierarchy. In the current context where a number of broad scale changes are already taking place (e.g., global warming, rapid colonization by exotics, long-range transport of persistent pollutants), existing regional ecosystem capacity for resilience and built-in redundancy will be diminished by these stresses, providing less room for error and narrowing the range within which manipulation of ecosystems by human managers produces acceptable results. Third, the "go/no go" dichotomy of conventional environmental assessment is unsatisfactory. In most circumstances, it is still appropriate to have a go/no go decision point—there is a need to eliminate projects that will push ecosystems out of the stability domain and hence out of the desirable range, and result in an unrecoverable loss in the system. However, once the decision to proceed with a project is taken, many researchers and practitioners who grapple with issues of complexity suggest that an adaptive approach to ecosystem management is desirable if not essential.

Effective adaptive management involves affected parties, provides for learning, is based on adequate initial understanding of the ecosystem involved, retains redundancy, requires that ecosystem responses be carefully monitored, that learning be integrated into management decisions, and that if conditions are detected that suggest that the system may flip out of the desired stability domain, corrective measures are taken. Management decisions that may lead to significant irreversibilities are avoided.

From an adaptive management perspective then, there may be certain circumstances in an environmental assessment context where a decision might be made to proceed with a project as an experiment to increase understanding of ecosystem processes and ecosystem responses to resource use and other management interventions. For instance, it might be decided to approve in a pristine area the construction of a road that was to be obliterated after a given time frame to learn about ecosystem responses to roads, mechanisms for obliteration, wildlife recovery following obliteration, and human use of the road corridor before and after obliteration. This learning could then be used to advantage in future circumstances where roads into pristine areas were proposed. For such an experiment to be defensible from an adaptive management perspective, it would have to be established that such learning could not come from comparing existing roaded areas with non-roaded areas, with obliterating an existing road in an otherwise pristine area, etc. Furthermore, the area proposed for learning would need to be carefully screened to ensure it did not contain a concentration of environmental values, critical habitat for rare or endangered species, and to ensure that if the ecosystem did change states such that losses were unrecoverable, the consequences would not be grave. To give a simple analogy, one would not

want to use the Mona Lisa to perfect art restoration techniques. Instead, a painting of limited artistic merit from the same period would be the better place to start.

There is a danger that adaptive management becomes an excuse to continue with status quo approaches (e.g., non ecosystem-based, limited incorporation of existing ecological knowledge) to the extraction of resources and to the manipulation of ecosystems on the basis that the manager is committed to monitoring, to learning, and to taking corrective action. In many circumstances, more than adequate information exists to show that existing approaches are unsustainable.

Adaptive management is subject to wide variation in interpretations, and it is often misinterpreted as "using information as it becomes available to modify decisions" or as an excuse for flexible management (Halbert, 1993). Walters, one of the fathers of adaptive management, notes that of the 25 major planning exercises using adaptive management that he has participated in, only two could be considered to be well-designed from an experimental perspective (Walters, 1997). Much of the adaptive management practices should be labeled passive adaptive management, which is not far from basic trial and error learning, where learning occurs slowly. By contrast, active adaptive management requires the manager to:

- define competing hypotheses about the impact of management activities on ecosystem functions;
- carefully design experiments to prove or disprove the hypotheses, and;
- deliberately perturb systems, often with several alternative types of management activities, in order to observe and compare results (Ohlson, 1999).

Evidence from efforts to implement the approach in New Brunswick, British Columbia and the Columbia River Basin indicates that promises that adaptive management increases knowledge acquisition rates, enhances information flow among policy actors, and provides opportunities for creating shared understandings have not been met. The data show that scientific adaptive management relied excessively on the use of linear systems models, discounted nonscientific forms of knowledge, and paid inadequate attention to policy processes that promote the development of shared understandings among diverse stakeholders (McLain and Lee, 1996). Given such results, it is prudent to see adaptive management as a potentially useful tool, that is as yet unproven over the long term. It is also humbling to realize that instances where there is evidence of long-term sustainable management of ecosystems, such as management by the TRT of their traditional territories, there was no formal adaptive management in place. Given the above-noted limitations and at best partial success in past implementation, adaptive management should not be an excuse to avoid carefully assessing the impacts of major proposed developments, or to proceed with undertakings when adequate baseline data does not exist. Humanity needs to recognize that our ability to manage complex ecosystems is limited. Ultimately, ecosystem management is largely about managing human activities within and demands upon ecosystems.

2.5 Reconciling mining with the requirements of sustainability

> *As long as continued growth in economic output implies continued growth in material inputs to and waste outputs from the economy, there is little hope of limiting the impacts of human activity on the natural environment.*

(Matthews et al., 2000, page v)

Confronted with growing evidence of "environmental trends that threaten to radically alter the planet, that threaten the lives of many species on it, including the human species," the World Commission on Environment and Development issued an urgent call for sustainable development. According to the Commission, sustainable development is "...development that meets the needs of the current generation without compromising the ability of future generations to meet their own needs" (WCED, 1987:43). Both the Canadian and BC governments have made a number of commitments to sustainable development.

Discussions about sustainability are complicated by the need to take into account the level or scale of analysis. For sustainable development to be achieved at a global level, there are ecological limits that cannot be exceeded, and rules to ensure that these limits are not surpassed can be set out. Yet such rules may not be appropriate to apply to individuals, firms, regions or even countries. For instance, it might be deduced or agreed that sustainable development requires that some fossil fuel resources be passed on to future generations, and hence, fossil fuel resources should not be exhausted. However, a given corporation could exhaust its oil deposits and move on to a new line of business, so long as other companies or governments conserve a portion of oil stocks or develop substitutes to fossil fuels. Beginning at the other end of the scale, there is the need to take into account the cumulative effects of many small decisions. Thus, an environmental assessment examining a given activity carried out by one individual might conclude that the environmental impacts of the activity are trivial, but if the environmental assessment is examining that same activity as behaviour generalized across the population, the conclusion may be that the activity leads to severe environmental degradation. For example, the impact on climate change of one person using a car would be non-detectable, but as car use becomes generalized human behaviour then in the aggregate it would be expected that climate change would significantly accelerate.

2.5.1 Tradeoffs and sustainability

The quest for sustainability is further complicated by the reality that achieving sustainability in one locale or at a given scale may imply that a lower level of sustainability must be chosen in another locale or at a different scale. For instance, reclaiming an abandoned mining site so as to improve prospects for local sustainability is likely to require fossil fuels that add to global warming. If an ore body was one of a handful of occurrences of a rare mineral that allowed for greatly improved fuel efficiency, then the local loss of biodiversity and ecosystem function implied by a mine to exploit the deposit may well be an acceptable trade-off for enhanced prospects for global sustainability.

2.5.2 Sustainable development strengthened by precautionary principle

The interpretation of sustainable development has since been strengthened by the adoption of the precautionary principle at the 1992 UN Conference on Environment and Development. This principle imposes a duty to take cost-effective actions to prevent serious or irreversible damage to the environment, despite scientific uncertainty as to the causes or consequences of environmental deterioration (Common, 1995). It requires the safeguarding of ecological space, a recognition of the need to allow natural processes to function and of the need to redress the accumulated

ecological debt (O'Riordan and Cameron, 1994). The precautionary principle implies that the environment must not be harmed unless the opportunity costs of environmental protection are very high (Pearce, 1994). The precautionary principle implies changes to the polluter pays principle. The resulting precautionary pollution pays principle (4P) requires that "the full costs of outputs from the economy to the environment are charged to the polluter in a way that adequately deals with the uncertainty about the impacts of pollution and encourages technological innovation" (Costanza and Cornwell, cited in Costanza et al., 1997).

Common (1995) notes that whole-hearted adoption of the precautionary principle reorients approaches to project evaluation:

> Currently, the situation is generally that there is a presumption in favour of going ahead with commercially viable projects. The presumption may be overturned in any particular case if it can be established that serious or irreversible environmental damage is entailed. According to a strong interpretation of the precautionary principle, the presumption is reversed. **Since all projects have some environmental impact, it is necessary that any particular project be shown not to have serious or irreversible consequences before it can be approved.** A loose analogy is a shift from the judicial assumption of the accused person's innocence unless guilt can be proved, to an assumption of guilt unless innocence can be proved (Common, 1995:214; emphasis added).

The precautionary principle is directly relevant to the consideration of need. A precautionary approach would avoid a new development that results in environmental damage if it were unnecessary, and would give full consideration to alternatives to the undertaking.

Davidson (1999) examined the application of the precautionary principle in relation to the Salmon Aquaculture Review under BC's *Environmental Assessment Act*. The review had to address the appropriate burden of proof in a context of ecological complexity and uncertainty. A discussion paper on fish health set forth the main question in a non-precautionary manner, placing the burden of proof on those who had concerns that the farmed fish presented a disease threat to wild stocks:

> Is there a reasonable basis from which to conclude that the current practices and regulation of salmon farming in BC create new opportunities for exposure to disease risk factors or alterations in the susceptibility of non-farmed species in such a way as to create serious or irreversible damage to the health of non-farmed animals (Stephen and Iwama, 1997).

A peer review criticized the fish health discussion paper for being non-precautionary. A precautionary framing of the main question would have been:

> Is there a reasonable basis from which to conclude that the current practices and regulation of salmon farming in BC do not create new opportunities to disease risk factors or alterations in the susceptibility of non-farmed species? (Thorburn, 1997)

The difference between these two research questions clearly illustrates how the precautionary principle should influence environmental assessment and the overacting pursuit of sustainability. Davidson concludes that application of precautionary principle still leaves much to be desired:

> The salmon aquaculture case also reveals that the precautionary principle is still not well understood or appropriately implemented in current public policy decision making. The precautionary principle is meant to respect uncertainties and avoid risks of environmental damage to the environment…So did the judgements [violate the precautionary principle] within the review that treated the absence of proof of damage as ground for assuming the absence of negative effects, despite the evident weakness of available information. **The precautionary principle, recognizing uncertainty, favours avoidance of potentially serious but ill-defined risks and implies that the burden of proof should fall on those who claim an activity is harmless, not on those concerned that it may be damaging** (1999; emphasis added).

2.5.3 Sustainable development as set out by WCED unsustainable

Despite the breakthrough achieved by the Brundtland Commission in getting governments to agree that new approaches were required to economic development, there are two serious problems with the concept of sustainable development. First, general usage of the concept of sustainable development is dangerously vague, and contains significant conceptual weaknesses (Lélé, 1991, Willers, 1994), allowing various parties to define and use the concept so as to serve the particular interests in question (Daly, 1996). Secondly, it is now acknowledged within the sustainability literature that the solutions proposed by the WCED would not be sufficient to achieve long-term sustainability (Goodland et al., 1992). Particularly problematic was the WCED's call to the international community to "speed up world growth while respecting environmental constraints" (p.89). Duchin and Lange (1994) constructed a materials input/output model of the WCED's policy prescriptions and conclude "...the prescriptions in the Brundtland Report are not adequate to arrest the growth in global emissions of the pollutants that were examined. On the basis of this analysis, we believe that far more strenuous actions need to be taken..." (page 27). A more recent report based on material flows through the economies of Austria, Germany, Japan, The Netherlands and the United States adds clear evidence that sustainable development as originally envisioned by WCED is unworkable:

> Over the next 50 years, while the world's population is forecast to increase by 50 percent, global economic activity is expected to increase roughly fivefold. Conventional demand studies suggest that global energy consumption is likely to rise nearly threefold and manufacturing activity at least threefold, driven largely by industrialization and infrastructure growth in developing regions. Global throughput of material is also likely to triple, according to conventional projections. These projections indicate that some measure of "decoupling" is probable: that is, the world economy is expected to grow faster than the rate of resource use. However, a 300 percent rise in energy and material use still represents a substantial increase.
>
> Between 1975 and 1996, total quantities of conventional wastes, emissions, and discharges in the five study countries increased by between 16 percent and 29 percent. Despite the rapid rise of e-commerce and the shift over several decades from heavy industries toward knowledge-based and service industries, we found no evidence of an absolute reduction in resource throughput in any of the countries studied. (Matthew et al*.,* 2000, page v).

Three key findings from this study are worth noting:

> Industrial economies are becoming more efficient in their use of materials, but waste generation continues to increase;
>
> One half to three quarters of annual resource inputs to industrial economies are returned to the environment as wastes within a year, and;
>
> Outputs of some hazardous materials have been regulated and successfully reduced or stabilized but outputs of many potentially harmful materials continue to increase. (Matthew et al*.,* 2000, page xi).

2.5.4 Current Economy Dangerously Unsustainable

Much of the sustainability literature is written as if sustainability is a desirable but not particularly pressing goal. Unfortunately, the evidence is that the challenges faced by humanity are enormous. The next 50 years represent an "ecological bottleneck", where high human population levels, the time lags involved in phasing out unsustainable consumption patterns, and delays replacing the existing stock of inefficient and wasteful technologies will act together to put intense pressures on ecosystems and natural processes. In turn, the environmental degradation and resource scarcities will put increasing stress on societies, communities and individuals, increasing the potential for conflict.

2.5.5 Global level sustainability considerations

> *Human beings and the natural world are on a collision course. Human activities inflict harsh and often irreversible damage on the environment and on critical resources. If not checked, many of our current practices put at serious risk the future that we wish for human society and the plant and animal kingdoms, and may so alter the living world that it will be unable to sustain life in the manner that we know. Fundamental changes are urgent if we are to avoid the collision our present course will bring about.*
>
> – statement signed in 1992 by 1500 prominent scientists, including over half of the living Nobel Laureates in the sciences.

Since the WCED's report, and the commitments of Canadian and British Columbian governments to sustainable development, the environmental trends identified by the commission have generally worsened. It is essential to understand that the problem of *un*sustainability is not something that humans will only face in the future. Already, the economy has exceeded many ecological limits (World Resources Institute, 2000; Munasinghe, 2000; US State Department, 1997; Walker and Steffen, 1997; Meadows et al., 1992). The issue is not whether grave ecological deterioration will occur; rather, it is the degree of deterioration that will occur, what deterioration we will be able to avoid, and what deterioration we will be able to reverse. Furthermore, deteriorating environmental conditions and depletion of resources, particularly renewable resources, is reducing future economic prospects and the potential for human well-being (Cleveland and Ruth, 1997).

A 1997 OECD study concluded that the organization faced a "challenge as urgent, difficult, far-reaching in its implications as any in history. All major global ecosystems are in decline amid rapid population growth and continuously rising real incomes and increasing global economic activity" (OECD, 1997a). Signs that ecological limits have been exceeded include:

- humans are estimated to appropriate 40% of the net primary productivity of terrestrial photosynthesis (Vitousek et al., 1986), and have appropriated half of the world's freshwater runoff (Redford and Richter, 1999);
- while present CO_2 concentrations have likely not been exceeded in the last 20 million years (IPCC, 2001), temperatures rose in the last century at a rate unprecedented in the last millennium (Bradley, 2000), climate change will make Canadians especially vulnerable to health problems, changes in agricultural potential, risks to wildlife, increased frequency of forest fires, and increased frequency of severe weather (Environment Canada, 1998);
- the ozone layer has thinned, increasing the penetration of UV radiation through the atmosphere and the consequent risk of skin cancer—the ozone hole over the southern pole grew in 2000 to three times the size of the continental US (NASA, 2000);
- human action has profoundly changed the extent, distribution and condition of forest, coastal, freshwater and grassland ecosystems; human activities have significantly disturbed the global water, carbon, and nitrogen cycles upon which all life depends, and the capacity of ecosystems to produce many of the goods upon which humanity depends is declining (World Resources Institute, 2000);
- biodiversity is now being lost at rates which rival all mass extinctions in geological history (Ward, 1994), with the current rate of extinction estimated to have reached 10 000 times pre-human extinction rates;
- the proliferation of exotic species is by some estimates second only to habitat loss as a mechanism for ecological deterioration (Bright, 1996);
- humans now move more earth by mining then is carried to the sea by all the world's rivers (Young and Sachs, 1994), and;
- exponential growth has occurred in the use of nearly all metals for several decades (Ayres, 1996), and the extraction and processing of such metals carries with it a significant "ecological rucksack" that is already exceeding ecological limits.

There are also many social indicators which point to a system gravely out of balance:

- the average income in the richest 20 countries is 37 times the average in the poorest 20—a gap which has doubled in the past 40 years;

- almost half of the world's population lives off less than $1.50 per day (Thomas et al., 2000);
- world population is expected to grow by 2 billion in the next 25 years, and;
- human vulnerability to old and emerging infectious diseases is increasing, as is the danger of a major epidemic, due to the number of malnourished people, inadequate living conditions, land conversion and biodiversity loss, and climate change (Daily and Ehrlich, 1995).

2.5.6 Indications of unsustainability: BC context

The Ministry of Environment, Lands and Parks publishes a biennial entitled: *Environmental trends in British Columbia.* The following data and trends are condensed from the 2000 version, and show several areas where BC resource management, consumption patterns and economy are far from sustainable conditions.

General trends

- In 1998, the average BC resident generated 1050 kg of wastes, 440 kg of which was recycled.
- In 1997, BC emitted the equivalent of 61.9 megatonnes of CO_2.
- CO_2 emissions have gone up 21% since 1990 and 94% since 1970, and are expected to climb a further 38% from 1997 levels by 2010.
- Cumulative stream restrictions are seven times higher in the 1990s than they were in the 1960s.

Species at risk

In British Columbia 75 species of vertebrate animals and 241 vascular plant species are listed as either threatened, endangered or as candidates for these designations. An additional 420 vertebrate animals (including the Grizzly Bear) and vascular plant species are classified as vulnerable. Ten species are now extinct or extirpated

Since 1996, six birds, one amphibian and one mammal have been added to the threatened or endangered species list. One bird and two mammals have been removed from the threatened or endangered species list.

British Columbia is home to an estimated 18,700 Caribou divided into 42 sub-populations. Today these populations are stable in 32% of their historical range, declining in 11% and extirpated in as much as 40%.

Species lists have been expanded to include invertebrate animals, moss species and plant associations of which 120, 306 and 241 respectively are listed as threatened, endangered or vulnerable

Forty-four percent of the 36 forest-dwelling mammals with known range trends have contracting ranges, a trend that may be an early-warning signal that species are moving towards endangerment. Two of the three species that have expanded their ranges are associated with early-seral forests and hence often benefit from logging (Moose and White-tailed Deer).

Of the 51 fish species with a high dependency on forests, eight are threatened or endangered (16%). Although some widely distributed forest-dependent salmonid species, such as Coho, Steelhead and Chinook, are not threatened or endangered across their entire range, specific genetic stocks are considered to be at risk of extinction.

The status of 43% of the salmon stocks in British Columbia is unknown. Of the 5,476 stocks which could be classified, 3% (142 stocks) are extinct 13% are at moderate to high risk of extinction and 4% are of special concern. An additional 22% of the unknown stocks may be at high risk or extinct, but the existing information is inconclusive. In recent years the low numbers of adult salmonids returning to spawn has raised alarm.

Roads

Total roads in BC as of 1988: 387,021km; primary and secondary roads – 21,924; other non-forest roads – 59,858; forest service roads – 34,952; other forest roads 270,287.

Since 1988 the Ministry of Forests has built approximately 800 km of new roads per year, while it is estimated that forest companies build three times this number per year. In the past 12 years, this amounts to over 38,000 km of new roads on forest land. Since 1994, under the Watershed Restoration Program, administered by Forest Renewal BC, over 19,600 km of logging roads have been permanently or semi-permanently deactivated.

Roads can lead to increased development, habitat fragmentation and loss, roadkill, stream sedimentation and increased access by off-road motorized vehicles, such as snowmobiles and all-terrain vehicles.

Road density on about 35% of the forest land in the province is greater than 0.5 km/km^2. At this density many wildlife populations are compromised. Avoidance of road networks has significant negative impacts on the behaviour of both vertebrate and invertebrate species. Other negative repercussions include population fragmentation, which in turn can diminish the genetic health of a population. Grizzly Bear are negatively impacted at road densities above 0.4 km/km^2.

While a number of other sources could be consulted to draw fill in this picture of BC's current challenges in reaching sustainability, the above is sufficient to illustrate how far BC has to go to get consumption levels to sustainable levels and to improve provisions to protect biodiversity and environmental quality generally. These trends need to be examined in the context of BC's performance against global sustainability requirements. For example, CO^2 emissions continue to climb instead of dropping towards the Kyoto target, or indeed towards the IPCC's finding that emissions need to drop to a very small fraction of today's levels.

2.5.7 Local level sustainability considerations

While the study area is widely recognized for its exceptional wildlife values and for its qualities as a large, undeveloped, unfragmented landscape, there are some signs of unsustainable resource use or trends that threaten long term regional sustainability. These include the following issues as reported by Staples and Poushinsky (1997):

- hunting pressure by non-local residents and ease of access with ATVs and snowmobiles is perceived by the TRT to be a significant contributor to the decline of game in certain areas—though provincial wildlife officials indicate their harvest data does not suggest a decline has occurred;
- provincial wildlife officials have a limited presence in the area and a limited capacity to monitor wildlife populations or to enforce hunting restrictions;
- the region attracts hunters from Whitehorse, Prince George, Vancouver and beyond. While TRT feel there is insufficient control of access by the general public, provincial policy specifically provides for equal access to any resident of BC;
- there has been long outstanding conflicts between the TRT approach to management and that of the province, and;
- TRT are concerned that special or critical habitat areas are not recognized by the province or given special management attention. The Atlin caribou herd, which is part of the Southern Lakes caribou herd, has very low population levels and is at risk.

While there are few studies and limited wildlife monitoring, data for the Taku Region, experience elsewhere in Northern BC, the Yukon and Alaska suggests some worrisome trends. Roads and trails that provide access to four-wheel drive vehicles "…has allowed hundreds, even thousands of Whites to hunt or fish deep inside the heartlands of many Indian hunting territories and traplines…This access causes the most direct threat to the Indian interest in northeast British Columbia" (Brody, 1981).

Yukon big game hunting statistics for the period 1979 – 1986 provide troubling evidence of the effect roads have on wildlife populations. Following an initial boom in kills in management zones close to Whitehorse, hunting success has declined. As hunting success declined, hunters traveled further but concentrated their efforts along road corridors, while hunter success along these road corridors also dropped (Staples and Pouchinsky, 1997).

Like other areas in the North, the study region is likely to experience considerable changes in climate due to global warming. Changes in temperatures and precipitation are likely to have pronounced effects on flora and fauna over the long term (Environment Canada, 2001). The North is also vulnerable to long-range transport of atmospheric pollutants.

2.6 Priority Actions to Achieve Sustainable Development

The basic idea of sustainability is straightforward: "a sustainable system is one that survives or persists" (Costanza and Patten, 1995:193). If a definition of sustainable development allows for actions and policies which, if pursued, allow continued environmental deterioration, then that definition should be rejected. Achieving sustainability will require aggressive action and tough decisions, and imply changes to both production and consumption patterns (OECD1997b). In general, the following conditions relevant to the mining sector have been proposed by various researchers as prerequisites to achieving global sustainability:

- the rate of worldwide material consumption needs to be reduced by 50%;
- to ensure equitable sharing of burdens, and an adequate quality of life in the developing world, the material consumption of OECD countries will need to be reduced by a factor of

between 2 and 10^4 (Schmidt-Bleek, 1994; Rees and Wackernagel, 1994; Young and Sachs, 1994; Weizsäcker et al., 1997);
- greenhouse gas emissions in OECD countries will need to decline by 80% (World Energy Council, 1993, cited in Weizsäcker et al., 1997);
- substances extracted from the lithosphere must not systematically accumulate in the ecosphere (Azar et al, 1996), and;
- the productivity of land and the biodiversity of ecosystems must not worsen significantly from current conditions.

With respect to non-renewable resources, the concept of sustainable development entails particular challenges. Continued extraction of a non-renewable resource will eventually lead to the depletion of the resource, suggesting that future generations may not be able to meet their needs. This could be taken to imply that any level of extraction of a non-renewable resource is likely to be inconsistent with sustainable development. However, there is no value in non-renewable resources if they can never be extracted. Furthermore, in most instances it is not the possibility of shortages in non-renewables that is likely to endanger prospects for future economic activity. Rather, it is the likelihood that the extraction, processing, manufacturing, usage, and ultimate disposal of non-renewables over the next half-century will result in cumulative ecological impacts of grave severity. This is not to say that the possibility of exhaustion can be completely set aside. The Canadian Network for Sustainable Mining states that the mining industry "has been unable to maintain a reasonable inventory of proven deposits for future mining in Canada. National reserves of most ores have been significantly depleted" (Canadian Network for Sustainable Mining, 1998). Ore grade has generally declined and mining depth has increased indicating that the better deposits have largely been mined (Cutler, 1991).

In plain English, the ability of future generations to meet their needs is mainly at risk because the current generation is causing ever-worsening environmental damage. It is likely that future generations would forgive us for using up, say, all exploitable copper deposits to allow us to build solar collectors, if doing so improved humanity's chances of making it through the next 50 years without ecological collapse. Furthermore, technological progress is likely to improve humanity's ability to make efficient usage of minerals, to substitute scarce minerals with alternatives, and to extract minerals from deposits that are currently unexploitable. Yet a prudent approach would suggest that we not count too heavily on such technological progress. For instance, while it is clear that lower grade ores can now be successfully mined, this success is at least partly contingent on heavy inputs of energy, typically fossil fuels.

The above review makes clear that the highest priority is to stop further ecological deterioration, and to pass on adequate stocks of renewable natural resources and ecosystems that will be viable over the long term. This is likely to require dramatic reductions in the level of extraction and usage of most minerals not because they may be needed by future generations, but because of the environmental burden that extraction implies. A lower priority is to ensure that we pass on adequate stocks of non-renewables. Current extraction of non-renewables should proceed in a way that contributes to achieving sustainability. A recent high level study commissioned by the director general of the OECD reached similar conclusions (citing the von Weizsäcker et al. 1997 study with approval), stating:

> ...the OECD should begin placing as much emphasis on improving resource efficiency as it has traditionally put on improving labour productivity. This would promote eco-efficiency in the broadest meaning of the term (OECD, 1997a).

2.6.1 BC: committed to sustainability?

The province of BC is ostensibly committed to sustainability. Sustainability concepts have been embedded in the *Environmental Assessment Act*, in the *Forest Practices Code Act*, and in a variety of policy statements—though often interpretation has been weak. The province, like most governments, has been reticent in tackling sustainability issues head on (Dovers and Handmer, 1993). Nonetheless, in the context of the environmental assessment of the TCM, it is the fact that BC's has made a commitment to sustainability, rather than success to date in implementing provisions to achieve sustainability, that is most relevant. Two documents in particular provide a detailed enunciation of the implications to BC of sustainable development.

The British Columbia Round Table on the Environment and Economy (1991) identified six principles of sustainable development, proposing that:

> …each time society makes a major land and water use decision, we should ask if the resulting action:
> - limits our impact on the living world to stay within its carrying capacity;
> - preserves and protects our environment;
> - minimizes the depletion of non-renewable resources;
> - promotes long term economic development that increases the benefits from a given stock of resources without reducing our stocks of environmental assets;
> - aims for a fair distribution of the benefits and costs of resource use and environmental protections, and;
> - promotes values that support sustainability.

In 1993, the Government of BC approved in principle a Land Use Charter proposed by the Commission on Resources and the Environment (CORE, 1993). This Land Use Charter suggests a strong commitment to sustainable development (see Figure 1), though since approval in principle it has been basically ignored by government and is no longer mentioned in recent public documents.

Figure 1: Extracts from the Land Use Charter 1993

THE PROVINCIAL COMMITMENT

The Government of British Columbia is committed to:

- protecting and restoring the quality and integrity of the environment, and
- securing a sound and prosperous economy for present and future generations.

…Finally, the Province shall ensure that present-day decisions do not compromise the ability of future generations to meet their own environmental and economic needs.

PRINCIPLES

SUSTAINABLE ENVIRONMENT

4. The Province shall ensure that environmental and social costs are accounted for in land, resource use and economic decisions.

SUSTAINABLE ECONOMY

1. The Province shall promote a dynamic and competitive economy that maintains options for future land and resource uses.

2. The Province shall encourage diversified economic development that increases the

employment and other benefits derived from a given stock of resources.

4. The Province shall encourage optimum use of natural systems and resources, consistent with their inherent capability to support our economic, social and environmental needs.

5. The Province shall ensure that renewable resources are used in a manner that is sustainable over the long term.

SOCIAL SUSTAINABILITY

1. The Province shall aim for a fair distribution of the costs and benefits of land use decisions. The Province is committed to social stability, and will support economic and social measures to address the economic effects of land use decisions.

2. The Province shall promote a good quality of life by fostering opportunities to:

a) earn a living;
b) obtain education and training;
c) access social, cultural and recreational services; and
d) enjoy a quality environment.

ABORIGINAL PEOPLES

Aboriginal title and the inherent rights of Aboriginal people to self government are recognized. Land use decision-making shall incorporate, support and not interfere with negotiations on Aboriginal self government and treaties. Aboriginal peoples shall be encouraged to be active participants in decision-making.

(Approved in principle 1993)

2.6.2 Interpretations of sustainable development in a mining context

Government and industry commonly interpret sustainable development in a way that would allow for a continued degradation of the world's ecosystems (e.g., Natural Resources Canada, 1995, 1997; Whitehorse Mining Initiative, 1994). Duerden (1992) concludes that in Canada's north there is a significant difference between those activities touted as sustainable and the true requirements of sustainability. The Minerals and Metals Policy of the government of Canada (Government of Canada, 1996) accepts the Brundtland definition of sustainable development, but interprets it with respect to minerals in the following way:

- finding, extracting, producing, adding value to, using, reusing, recycling, and, when necessary, disposing of mineral and metal products in the most efficient, competitive, and environmentally responsible manner possible, using best practices;
- respecting the needs and values of all resource users, and considering those needs and values in government decision making;
- maintaining or enhancing the quality of life and the environment for present and future generations, and;
- securing the involvement and participation of stakeholders, individuals, and communities in decision making.

> In defining sustainable development in the context of minerals and metals, it is recognized that the economic and social benefits of mineral development are not all consumed by the present generation. Current investments in human and physical capital benefit future as well as present generations (Government of Canada, 1996, page 4).

Several flaws are apparent with this interpretation:

- it does not directly address the need to reduce current levels of extraction and consumption of minerals on a global scale;
- it does not address the need to confine economic activity within ecological limits;
- it is open to interpretation and it provides no basis for determining required actions;
- it fails to acknowledge that given the currently alarming state of ecological deterioration, "maintaining or enhancing" quality of life and the environment will require aggressive and immediate action that will conflict with other goals such as finding and extracting additional minerals, and;
- it assumes that current investments in human (e.g., education and training) and physical capital (e.g., plants, infrastructure) will benefit future generations, so there is no need to invoke specific measures to distribute benefits across generations. However, if the investments themselves add to the need for non-renewable resources (e.g., we build more highways or enable higher levels of consumption), or if training is irrelevant to or impedes sustainability (we train more advertisers who encourage consumption), then future generations are not likely to benefit; indeed, they may be worse off as a result.

Because of the above flaws, the utility of the federal government's Minerals and Metals Policy as an appropriate benchmark against which to test proposed mines to see if they are consistent with

sustainable development is highly questionable. Other attempts to address the implications of a commitment to sustainable development to mining are equally deficient. While Miller (1998) sets out to address how mining fits with sustainability, he focuses instead on a broad overview of the mining industry's environmental initiatives without providing criteria to assess progress towards sustainability. He is also inconsistent in critiquing government initiatives to reduce the environmental impact of the mining sector as interfering with the competitive position of Canada's mining industry, without recognizing that progress towards sustainability will require new institutions, regulatory regimes and constraints on economic activity.

The Whitehorse Mining Initiative (1994) does not address the need to stay within ecological limits; the need to reduce global consumption levels of minerals and to increase the material and energy efficiency with which minerals are used; and the requirement to distinguish between needs and artificially stimulated wants.

In 1998, Placer Dome issued a sustainability policy. While this policy is generally better than many, it still fails to address fundamental issues. It does acknowledge, however, that "essential to all definitions of sustainability is a respect for earth's carrying capacity..." (Placer Dome, 1998).

Increasingly, some participants in the Canadian mining industry recognize that the industry has a long way to go towards reconciling mining with sustainable development. The joint industry-academia Canadian Network for Sustainable Mining research proposal[5] argued that Canada needs a new paradigm of *holistic mining* to better harmonize mines with their ecological and social host environment. The network put forward an ambitious research program with many goals, including:

- reducing the quantity of waste rock generated by discriminating more precisely between ore and waste;
- maximizing the return of waste material back to the mine excavation as backfill;
- facilitating more responsible stewardship through maximizing the mineral reserve and mine life;
- increasing workforce and community safety;
- improving the capability to predict long-term metal release from waste rock piles, and to develop innovative strategies to control metal release;
- advancing the capability of mining companies to practice sustainable social, environmental, and economic development, and;
- improving the quality of public dialogue between proponents and local communities.

Warhurst and Mitchell (2000) note that as mining has pursued mechanization and automation, benefits to local communities from mining have diminished, reducing the acceptability of mining to local communities and increasing pressure for corporate social responsibility which they define as "the internalization by the company of the social and environmental effects of its operations through pro-active pollution prevention and social impact assessment so that harm is anticipated and avoided and benefits are optimised."

The international mining industry has increasingly realized that it needs a more rigourous response to the challenge of sustainability, and a Mining, Minerals and Sustainable Development project has been set up, which plans to issue a final report in 2001. Unfortunately, the draft

outline of the final report suggests that it will not tackle the issue of sustainability head on, as it does not appear to address the need for decreased material throughput, or increased resource efficiency (Mining, Minerals, Sustainable Development, 2000).

A fundamental flaw with approaches to sustainable development reviewed above is that they for the most part do not recognize that economies must be constrained within ecological limits (Daly, 1977, 1991, 1996; Georgescu-Roegen, 1971; Rees, 1988, Wackernagal and Rees, 1997 and many others). Where there is such recognition, the limits are not explicitly identified, nor are measures put in place to ensure they are not exceeded. Instead, the approaches put forth by those involved in the mining industry suggest that economic and environmental considerations should be given equal weight. This starting point leads to compromise without ensuring that the requirements of sustainability are met. As Bartlett has observed:

> It is urgent that we be aware that these compromises reduce the rate of destruction of the environment (which is good), but in most instances, the ultimate result of a succession of many compromises is the destruction of the environment... One needs to know that a series of ten such compromises, each of which saves 70% of the remaining environment, will result in the loss of all but 3% of the environment (Bartlett, 1994:13).

Unfortunately, the literature on sustainability and non-renewable resources is still in its infancy. Many of the guidelines for enhancing the sustainability of non-renewable sectors are not convincing or are difficult to operationalize, particularly at the project level. Daly (1996:82) argues that society should only "deplete non-renewables at a rate equal to the development of renewable substitutes," but while this rule might be sensible for oil, which can be replaced with ethanol or solar derived hydrogen fuel, it is not clear what a renewable substitute to most minerals would be. Daly recognizes difficulties with such a rule, concluding that full-cost pricing[6] should be used so as to encourage investments in measures that increase material efficiency, thus reducing impacts of use and increasing the life expectancy of non-renewable resources.

Bartlett (1986) calls for "sustained availability," where the extraction of non-renewables declines a fixed fraction per year, such that the resource is never exhausted. According to Bartlett, this would ensure that the needs of future generations are taken into account. While Bartlett's proposal does not directly address the ecological impact of resource extraction, processing, use, and disposal, it would indirectly contribute to such solutions by slowing the rate of consumption. But for the short term at least, the emphasis needs to be on maintenance of ecological integrity, rather than on passing on adequate stocks of non-renewables. It is the former that represents the limiting factor in the quest for sustainability.

Goodland and Daly (1995) propose eight physical measures to be used as an index of environmental sustainability, of which several are relevant to the exploitation and use of non-renewable resources:

- energy intensity: the lower the energy intensity, the greater the sustainability;
- material intensity: the lower the material intensity, the greater the sustainability;

- recycled proportions: how much of a given fraction of material (e.g., nickel) is recycled, and how much is dissipated (e.g., used in forms where it is not practical to recycle, but instead returns to the environment, such as rust);
- transport intensity: how much transport is involved to produce and distribute the good, and;
- water use: how much water is required, how it is obtained, and in what state it is returned to the ecosystem. (Adapted from Goodland and Daly, 1995).

It seems obvious that lacking from these proposed measures are measures which address the intensity of habitat loss or fragmentation, and other measures to address the intensity with which ecosystem processes are affected (e.g., bioaccumulation, exceeding assimilative capacity).

Ideally, then, humanity's needs should be met in ways that do not involve intensive use of materials, energy, or transport. The need to extract minerals should be reduced through efficient use and secondly, by ensuring high recycling rates and by avoiding dissipative uses. The need for virgin minerals should be met with mining operations that do not substantively reduce water quality.

Duerden (1992) discusses the relationship between mining and sustainable development in Canada's North. Mining, while by definition unsustainable, can be used to set up a trust fund to enhance community-based renewable resource activities (note Duerden's emphasis on renewable resources as the basis for long-term sustainable economic activity). However, Duerden cautions that such a mechanism could make local aboriginal communities dependent on the rate of resource extraction. Providing northern and aboriginal communities with the right to prohibit unsustainable activity (or recognizing an *a priori* right to make such decisions based in aboriginal title) "...would promote global sustainability by forcing urban regions that demand energy and minerals from the North to conserve" (page 224).[7]

Professor of Business Ethics A.W. Cragg has examined the ethical implications of sustainable development as they relate to the mining industry. Cragg concludes that sustainable development requires:

> "That the costs and benefits be accounted for and shared fairly"
> "That costs not be imposed from which those on whom they are imposed are unlikely to recover or alternatively from which they can recover only with great difficulty"
> "…efficient and effective resource extraction…[based on identification of] the value of natural resources in accurate and insightful ways and then to extract those resources in ways that do not needlessly destroy the value of what is 'down stream' or what is left behind for present and future generations." (Cragg, 1998).

With respect to the impacts of industrial development on aboriginal peoples, Cragg argues that the moral content of sustainability must be unpacked: much of what is argued to be sustainable represents "pervasive cultural bias." Those who benefit from resource extraction should bear the costs it generates, but what counts as a cost and as a benefit are a function of the values and ways

Mining and Sustainability: A View from Australia

The Australian Conservation Foundation has concluded that achieving ecologically sustainable development in the mining sector requires adherence to the following fundamental principles:

- Improvements in material and non-material well-being, both within and between generations. This in turn requires:
  - the achievement of equity between generations;
  - the maintenance of constant natural capital and sustainable income;
  - recognition that there are biophysical limits on natural resource use;
  - appropriate pricing of environmental values and natural resources;
  - social equity and community participation, including recognition of the rights of indigenous people to control mining on their own land;
  - pursuit of qualitative development rather than quantitative growth as the objective of government policy; and
  - external balance, based on a diverse and resilient economy.

- The conservation of biodiversity and the maintenance of ecological processes, systems, and integrity.
- Adopting an anticipatory and precautionary policy approach to possible irreversible environmental damage or losses.
- Giving consideration to the global perspective and the rights and aspirations of other countries and their peoples for ecologically sustainable development (Burton et al., 1994, page ix).

of life of those affected. The active cooperation and participation of those affected is essential, to ensure that costs and benefits are accurately reflected (Cragg and Schwartz, 1996).

Most of the sustainability and non-renewable resources literature does not address the implications of resource extraction on a landscape level. From the conservation biology and landscape ecology literature, it is evident that systems of parks and nature reserves will not be sufficient to protect landscape-level ecosystem functioning (Grumbine, 1992, 1994; Newmark, 1995; Pimental et al., 1992). To conserve biodiversity over the long-term, development outside of parks and reserves should retain essential habitat features, structures and processes of the undeveloped ecosystem; habitat fragmentation should be minimized, as should the contrast between developed and undeveloped landscapes (Grumbine, 1994; Burton et al., 1994; Mangel et al., 1996; Christensen et al., 1996).

3 Sustainability assessment for proposed mines

Drawing on the literature reviewed in the previous section, the following criteria have been developed to assess the sustainability of proposed mines. These sustainability criteria should be seen as a means to evaluate proposed mines on a continuum from contributing to sustainability to highly unsustainable. These criteria recognize that detecting unsustainability is easier than detecting sustainability (Ruitenbeek and Cartier, 1998). Given the current overall unsustainability of the global economy, and thus the need for dramatic changes in both production and consumption, few, if any, mining projects would score well on all criteria. Over the long-term society should proceed only with projects which make a positive contribution to sustainability on all criteria. Over the short-term, projects which are relatively high performers should be selected in preference over low performers. Projects which are poor performers should not proceed.

The following critieria are written in descriptive language to characterize the desirable state or outcome that would be achieved by proceeding with a proposed mine to score highly on a given criterion.

3.1.1 Need—Present Generation

The mine produces minerals that contribute to meeting the needs of the present generation.[8] For present need to be established, three dimensions of need require evaluation.

1) The minerals in question contribute significantly to human well-being—end uses made possible by the minerals would avoid identifiable human hardships or end uses made possible by the minerals would result in enhanced quality of life with priority consideration for those whose needs are not currently being met?
2) The minerals in question contribute significantly to prospects for sustainability—minerals are used in processes or goods which reduce human impacts on ecosystems while by-products of such processes and goods do not interfere with sustainability?
3) The mineral concentrates produced by the mine are required over the short to medium term, and this requirement for either the minerals in question or the services provided by products embodying the minerals cannot reasonably be provided in one of the following four ways:
    - reuse and recycling of existing stocks of the applicable metals currently circulating in the global economy or embedded in manufactured capital (e.g., recovery of scrap metal);
    - increased resource efficiency (e.g., better designs reducing material requirements);
    - substitution of minerals with an environmentally preferable alternative (e.g., phasing out lead additives used for gasoline);
    - existing mines or mines under development taking into account reserves, production levels, and cost functions.

Rationale:

Sustainability involves meeting the needs of the present generation without compromising the ability of future generations to meet their own needs. Need in this context is not the need of a proponent to generate profits, nor is it market demand when few efforts have

been made towards sustainability. Rather, need is the requirement for virgin minerals in order to provide for a sufficient[9] and ecologically sustainable existence for the present generation once all reasonable efforts towards the efficient use of the previously extracted stock of mineral have been made. Given the vast inequities presently found between North and South [10] priority must be given to meeting the needs of the world's poor, and consumption by the affluent must be curtailed. [11]

Given the extreme stress faced by ecosystems across the globe, if the mine produces metals which are used in a way that helps to reduce human demands on ecosystems (e.g., significant proportion used for devices such as catalytic converters which reduce pollution), the mine has the potential to contribute to meeting present need.

If the mineral's contribution to human well-being and/or to enhancing prospects for sustainability is not established, in the context of sustainability there is at best market demand as opposed to need.

Assessing need is obviously complicated by the fact that minerals are incorporated into a broad diversity of products, so weighting is required to assess the proportion that is used in end uses that address well-being and sustainability rather than consumerism or harmful end uses. A given mineral could be incorporated into roofing for the poor, cars for the rich, weapons, and a sewage treatment plant. If most of it is used in cars and weapons, then mining more of the mineral in most instances would make little contribution to meeting need.[12]

Sustainability requires greatly increased resource efficiency. The rate with which virgin minerals are extracted, processed and used must be significantly lowered to reduce ecological impact across the globe.[13] The possibility of substitution must also be considered, where either a non-mineral alternative or a mineral in greater supply and with lesser environmental burdens would replace the mineral in question such that the underlying need is met with lesser environmental impacts.

3.1.2 Future Need

Exploiting the deposit in question now does not deprive future generations of access to deposits of sufficient quantity and quality that they will be able to extract minerals to meet their needs, taking into account the likelihood of future scarcities of fossil fuels, the likelihood of severe restrictions on future fossil fuel use, the likelihood of technological change in the extraction and processing of ores, projected stocks of metal already circulating that will be available for use, and likely improvements in material efficiency.

Rationale:

Sustainability requires that the activities of the current generation not compromise the ability of future generations to meet their own needs.[14] Given that part of the present generation's legacy will be an atmosphere with elevated greenhouse gas levels,[15] the accumulation of heavy metals in the biosphere,[16] and significantly depleted oil reserves,[17]

and given that the average ore grade of deposits is expected to decline over time as the best deposits are mined first[18] exploitation of low grade deposits tends to result in higher energy use[19] and results in greater pollution levels,[20] it is not sufficient to only pass on to future generations low grade deposits that will be too energy-intensive or pollution-intensive to exploit. At the same time, it must be recognized that technological progress may well reduce the reliance of future generations on given minerals, may enable deposits of lower grades to be extracted, and may enable better environmental controls. Furthermore, a portion of minerals extracted by the present generation are used in forms that will be available to future generations, while other more dissipative uses will preclude future reuse or recycling. A prudent course of action is to recognize that technological progress is constrained within physical limits, to assume that technology will not be sufficient to overcome all challenges faced by future generations, and to therefore make deliberate provisions for the needs of future generations for deposits that are likely to be realistically exploitable.

3.1.3 Acceptable Legacy

The mine is developed in such a way that there is low risk that future generations will be burdened by the need to undertake ecological restoration, or by the need to provide ongoing treatment and decontamination of site discharges.

Rationale:

The mining sector is notorious for abandoning mines without proper reclamation and restoration, and for leaving environmental legacies that require ongoing treatment, such as Acid Mine Drainage, that may last decades or centuries following mine closure.[21] Leaving such a legacy is inequitable and inconsistent with sustainable development—present generations derive the benefits of mineral use, while future generations are left with the burden of cleanup and treatment.[22]

3.1.4 Full-Cost

Minerals are extracted, refined, and processed in such a way that the producer is responsible for mitigating, compensating, or offsetting the mine's known social and environmental costs. The mine must be clearly financially viable at the low range of predicted mineral prices to reduce the risk of premature abandonment, to ensure rehabilitation is carried out, to enable the owner to redress unanticipated impacts, and to avoid externalizing environmental and social costs.

Rationale:

One of the key requirements for achieving sustainability is that producers pay the full costs of their economic activity using a precautionary stance.[23] Otherwise, producers have a financial incentive to cut costs by imposing burdens on society and the environment. At the same time, mineral prices that are low because environmental and social costs have not been factored lead to economic inefficiency, excessive consumption and consequently high social and environmental burdens.[24] While the difficulty of assessing values to the

loss of environmental and social assets or services, and the fact that markets do not result in these costs being internalized makes full cost accounting an elusive goal, the more that costs can be internalized the more market decisions will be sustainable.

The mining industry is notorious for the number of mines abandoned in a state that generates significant downstream effects. Mineral prices are highly volatile, and have generally not kept pace with inflation. The mining industry has generated low returns on investment; marginal returns lead to many mines being closed suddenly without proper decommissioning or restoration. Advances in mining technologies which enable new types of deposits to be mined (such as laterite nickel deposits) and more recent openness of third world countries to private sector investment in mineral exploration and mining, have together resulted in downward pressure on mineral prices. The possibility that existing or proposed mines may face financial difficulties is real. In other contexts it has been shown that there is a systematic tendency to overstate project benefits, to underestimate project costs, and to only include in project evaluation a narrow range of social and environmental costs.[25] Therefore, mines which are strong performers and are owned by companies with several operating mines, are preferable as they are more likely to be able to weather cyclical downturns without resorting to premature abandonment, and will better be able to afford measures that avoid creating social and environmental costs and have a greater stake in maintaining a good public reputation for corporate social responsibility.

3.1.5 Contribution to economic development

The mine provides local and regional economic benefits that contribute to the long-term viability of the local and regional economies and facilitates a shift to sustainable economic activities. Boom/bust cycles are avoided, production is likely to be viable for twenty years or more in order for the local residents and entrepreneurs to have sufficient long-term security to make long-term investments that result in diversification. Opportunities that could be foreclosed by proceeding with the mine are carefully assessed, and actions taken to maintain such opportunities. In particular, assets and resources that currently allow local populations to meet basic need or that could make an important contribution to long-term local economic activity are not degraded.

Rationale:

Mining can often impede local economic development and diversification due to the cyclical nature of the industry, recognition of the limited lifespan of mining projects, workforce mobility, limited opportunities for upstream or downstream processing, mining skills being poorly transferable to other occupations, creation of a dependency mindset, corporate dominance of community affairs, wage expectations that cannot be met in other sectors, and ongoing requirements for government subsidies.[26] If mining diminishes ecological entitlements available to residents, particularly indigenous peoples, or reduces their ability to meet their own needs, it impairs local economic prospects and human well-being.[27] When local environmental amenities are degraded and prospects for enterprises that depend on a quality environment are diminished, local regimes lose their attractiveness as a place to live and do business.[28] For economic diversification to occur in

regions dependent on mining, long lead times before mine closure are required. Long mine life (e.g., 50-100 years) greatly enhances prospects for diversification.[29]

3.1.6 Equity

Benefits from proceeding with the mine are shared between those who develop the deposit, those who work at the mine, and those whose landscape and community are affected. Furthermore, through controlling the rate of depletion, implementing a heritage fund, and/or by remediating past mining damage, benefits are shared by several generations.

Rationale:

Sustainable development requires equity between and within generations. Those who are to be most affected by a development should have the right to a significant portion of the benefit. Because deposits that are mined will no longer be available to future generations, compensating mechanisms are required to spread benefits across generations.[30]

3.1.7 Consent

The informed and voluntary consent of indigenous people and local communities who are most affected by the burdens imposed by the proposed mine is secured before the mine proceeds.

Rationale:

Sustainable development requires effective participation in decision-making by local communities,[31] and the precautionary principle puts a duty of care or onus of proof on those who propose change[32]. International law recognizes the special circumstances faced by indigenous peoples, who are particularly prone to bear the burdens of development, and recognizes their rights. Within Canada, aboriginal rights are constitutionally guaranteed, although the Supreme Court of Canada's *Delgamuukw* decision sets out circumstances where governments may infringe upon such rights. The World Commission on Dams has recommended as a policy principle that "Decisions on projects affecting indigenous peoples are guided by their free, prior and informed consent achieved through formal and informal representative bodies." It further elaborates: "The requirement for free, prior and informed consent gives indigenous peoples… the power to consent to projects and to negotiate the conditions under which they can proceed."[33] If consent is obtained, it suggests that those who will be affected by the project are satisfied with mitigation and compensation measures.

3.1.8 Respect for ecological limits, maintenance of ecological integrity and landscape requirements

The mine does not result in impairment of ecosystem processes, or result in significant loss of ecosystem goods or ecosystem services, either at local, regional or global scales. An important

precondition for ecosystem health and the maintenance of ecological integrity often overlooked is that the mine and associated infrastructure should not significantly interfere with the maintenance of landscape-level ecosystem patterns, ecological functions, processes, nor should it significantly reduce habitat, species, or genetic diversity. Habitat fragmentation is minimized. In particular, the mine and associated infrastructure fit within the landscape as determined in an ecosystem-based management planning approach so as to not impede the protection and viability of sensitive ecosystem components, representative habitats (of sufficient size to contain viable natural populations), sensitive habitats, along with landscape level connections. The primary focus is on maintaining ecological integrity while allowing only compatible human uses and development.

Rationale:

For long-term sustainability and maintenance of biodiversity it is essential to ensure that ecosystem processes not be pushed beyond the range in which they are resilient[34] and able to provide ecosystem goods and services, and that landscape-level patterns, functions and processes be maintained.[35] Fragmentation of large undeveloped landscapes should be avoided.[36]

3.1.9 Offsetting Restoration

The mine operator goes beyond ensuring that the new mine site will be reclaimed and restored to regulatory requirements and best practices. Part of the wealth generated by the mine is used to undertake equivalent offsetting restoration at a previously abandoned mine site or sites to ensure that there is no net loss in the ecological value and services provided by regional ecosystems due to the new mine.

Rationale:

Humanity has surpassed many, if not most ecological limits, and in this context further ecological degradation is inconsistent with sustainability.[37] This implies that there should be no net increase over time in the extent of environmental disturbance and contamination. Despite best restoration efforts, by the time they close, mines sites and associated access infrastructure will ultimately have lower ecological value than existed prior to mine development.[38] By requiring operators of new mines to undertake offsetting restoration work at a previously abandoned site, the net level of environmental disturbance would be reduced to close to zero.[39] Since the precautionary principle implies that those who have created a large ecological burden in the past have greater responsibility to remediate past damage[40], it is appropriate to impose a condition on the mining industry intended to ensure no net loss of ecological value which helps clean-up old sites.[41]

4 Applying the Sustainability assessment to TCM

4.1 Need—present generation: TCM performance

Assessing present need is difficult, given the multitude of factors involved, and the fact that the mine produces five metals, recovered from three concentrates. Net production is shown in Table 2.

Table 2: TCM Estimated net production[42] during projected mine life

	Copper (tonnes)	Gold (ounces)	Silver (M ounces)	Zinc (tonnes)	Lead (tonnes)
Copper-lead concentrate	89,000	35,150	19.9		80,100
Zinc concentrate		7,700		396,300	
Gravity concentrate		176,315	.1		
TOTAL	**89,000**	**219,165**	**20.0**	**396,300**	**80,100**

Source: derived from Bartek, 1998.

The next step is to evaluate whether these metals contribute to meeting human needs, or reducing human impacts on the biosphere. A complete assessment would take more resources than those available to complete this report. If the assessment concludes that the minerals extracted from the mine do in fact contribute to human well-being, and/or enhance prospect for reducing human impacts on ecosystems, the next issue is whether existing stocks and projected production by operating mines is sufficient to meet projected requirements, taking into account measures to enhance resource efficiency. For illustrative purposes, the cases of gold and zinc are examined here.

4.1.1 Gold

Gold has long been seen as an essential component of the official reserves for national banks. This view is increasingly seen as an anachronism. Gold is losing its importance as an official reserve, and many central banks have begun selling their considerable holdings, seeking to reduce reserves before the price of gold drops further. Gold holdings of central banks and international financial institutions currently totals 34,000 tons—enough to satisfy eight years demand if all currently operating mines shut down. If private reserves were also sold, no new gold would need to be mined for 12-15 years (Young, 2000).

Does gold contribute to human well-being/prospects for sustainability? Jewelry accounts for 85% of global demand for gold, with 12% going to diverse applications such as electronics and dental fillings, and the remaining 3% being bought up by investors (Young, 2000). These figures indicate that extracting additional gold can hardly be said to be of great importance for human well-being or for enhancing prospects for sustainability.

If gold use was shifted from jewelry and investment to those other uses that make up 12% of demand and that for the purposes of this study are assumed to contribute to human well-being, and assuming none of the gold so used was recovered, current holdings of 57,000 tonnes would satisfy human needs for over 120 years, assuming all currently operating mines immediately ceased production. Clearly there is no need for addition extraction of gold in the foreseeable future. The TCM would contribute about 10 tonnes of gold over its lifespan—satisfying less than .025% of demand during the same period, and less than .003% of current need.

4.1.2 Zinc

One half of the refined zinc currently used in the US is for galvanizing, over a quarter for zinc-based alloys and in brass and bronze, and the remainder in agricultural, chemical, paint and rubber industries. The US EPA recently included zinc on its list of chemicals that are persistent, bioaccumulative and toxic. A partial ban on zinc has been approved in some European countries (Plachy, 2000).

While there is no doubt that corrosion-resistant zinc coatings and other uses contribute to human well-being, the fact that zinc has been deemed persistent, bioaccumulative and toxic suggests that on the whole it is neither contributing to human well-being or prospects for sustainability. Furthermore, the fact that the US alone consumes 20% of the world total suggests that zinc is not being used in a way that gives priority to those with the greatest needs.[43]

While world demand for zinc reached 8 Mt in 1999, world reserves at operating mines currently stand at 190 Mt, or a 24 year supply assuming no change in demand (a conservative assumption given emerging awareness about zinc toxicity). Therefore, the need for zinc from TCM is not established, especially given that the mine will contribute to less than 0.5% of world demand while it is operating. TCM is a relatively small mine: only nine months of production at 1999 rates at the Red Dog Zinc Mine in Alaska (the largest zinc mine in the US) would be needed to produce the equivalent of TCM over its lifespan. Reserves at the Red Dog Mine are equivalent to 23 Mt of zinc (Plachy, 2000). Return on capital invested for US zinc companies during the past decade was below 3.5% (Plachy, 2000), indicating that markets are not providing incentives for increased output.

Further indication of market demand for minerals from TCM can be inferred by examining the price of metals over the last century. The US Geological Survey's metal price index, which includes copper, lead, zinc, gold and iron ore, shows a slight downward trend in constant dollar prices over the last century (Sullivan et al., 2000).

4.1.3 Need in the context of environmental assessment

Setting aside sustainability for the moment, fundamental to conventional environmental impact assessment is the requirement to consider both the need for the proposed undertaking and alternatives to the undertaking (Wood, 1995). It is important in the context of environmental

impact assessment to understand how "need for an undertaking" should be interpreted even before one tries to incorporate sustainability considerations.

Market forces and shareholder requirements for an adequate return on investment force corporations to seek profitability through revenue-generating activities—such as extracting and selling ore. This results in the corporation's "private" need for a project. Similarly, local governments and communities may need tax revenues and jobs. However, these are not the needs that are to be considered in EIA. Need in the EIA context refers to a societal need for the good or service produced by the undertaking.

If an EIA is initiated to review a proposed highway from A to B, then the assessment process should consider whether there is a need for transportation services from A to B. Note how this differs from arguing that the highway is needed because of the jobs it will create. By carefully specifying the need, the full range of alternatives becomes apparent. In this instance, the need for transportation services could be met by a highway, a railway, better use of existing roads by investing in public transit, and by making drivers pay the full cost of road use. By first considering whether there is a need for a project, society avoids paying for unnecessary highways, dams, and the like. By not confusing the need for transportation services with a desire for more local jobs, the assessment process avoids making decisions based on flawed reasoning. For instance, while building a highway creates jobs, so does running a public transit service. Both measures may increase government expenditures and hence the tax burden, which reduces the number of jobs elsewhere in the economy, so often the net effect of such projects on jobs is neutral or negative at the provincial or national level.

If an EIA is considering a proposed private hazardous waste dump, the need to be evaluated is not the private concern's need for profit, nor local need for jobs, but the need for a means to eliminate hazardous wastes. Alternatives would include reducing waste generation to avoid the requirement for disposal, diverting wastes from generators to companies that can use them as an input to a process, existing disposal sites, or incineration.

The above discussion shows that an environmental assessment of the TCM should first focus on the services provided by minerals, and alternative means of providing these services, rather than on expanding the supply of minerals through extraction. The next level is to examine alternative means of satisfying the requirement for minerals (e.g., resource efficiency, recycling, existing mines). Only after these matters are addressed is focus on the TCM itself appropriate. However, while there are many encouraging signs that material efficiency can be greatly increased (von Weizsäcker et al., 1992, 1997; United Nations, 1997; Lovins et al, 1996), increasing mineral efficiency involves a considerable time lag. More relevant to the present case then is existing reserves at operating or approved mines.

Based on the above considerations, the TCM scores low on "meeting current needs." One area where the TCM has an advantage over many other mines it that it is in a country with an extensive regulatory framework to address environmental and labour issues, scientific and technical expertise and capacity, a credible judiciary, and with a number of NGOs that have some limited capacity to apply pressure on government to enforce laws and on industry to act responsibly. Mines in developing countries often proceed in a context of minimal environmental

or labour requirements, where regulatory agencies have little or no technical capacity, an ineffective judiciary, and where dissent is suppressed. Impacts on the environment and communities are often severe in such circumstances (Marr, 1993). However, the BC environmental assessment process and mining legislation have not proven to be an effective framework for ensuing environmental protection, and government has been more concerned about creating an attractive investment climate for mining than ensuring environmental protection (Sierra Legal Defence Fund, 1998).

4.2 Future need—TCM performance

The TCM contains geological reserves of 9 million tonnes at 1.31% copper, 1.24% lead, 6.61% zinc, 2.53 g/t gold and 107.5 g/t silver. Although Redcorp has demonstrated through metallurgical test work that a highly marketable zinc concentrate can be obtained, other concentrates produced by the TCM will be of poor or unexceptional quality. Given the marginal quality of the deposit, and the limited reserves, future generations are unlikely to suffer from the loss of mineral reserves if this deposit is exploited by the present generation. As future generations are likely to be less materials intensive, many lead and zinc uses are likely to have been phased out for environmental reasons, and given that large, intact ecosystems like the Taku Watershed will be even more scarce than at present, it is unlikely that they would proceed with the mine except as a last resort. Proceeding with the TCM at this time does not deprive future generations of the ability to meet their needs for minerals. (The needs of future generations for intact, large landscape ecosystems, biodiversity, etc., are addressed below and are not meant to be covered by this criterion).

With respect to the future need criterion, the TCM is compatible with sustainability.

4.3 Acceptable Legacy: TCM Performance

4.3.1 The Mine

The TCM is a volcanogenic massive sulphide deposit, which implies that waste tailings have Acid Mine Drainage (AMD) potential.[44] AMD can last for centuries post closure, and require on-going treatment if aquatic effects and contamination are to be avoided. The old Cominco workings and the outside waste dump were discharging to the Tulsequah River an average load per week of 2389 kg of acid, 135 kg of dissolved copper and 540 kg of dissolved zinc over 1992-1995 (Pearse, 1998: 73).

A potential environmental benefit of proceeding with the mine is that it will provide Redcorp with the resources to meet its obligations with respect to historic workings. The proponent's plans call for drainage from historic workings to be collected and treated before discharge to the Tulsequah River. The old workings are to be filled in, and broken ore is to be removed, thereby reducing AMD potential.

Redcorp proposes to store rock with AMD potential generated from new mining on the surface temporarily until sufficient room is available in the new workings for underground disposal as cemented back-fill. As the mine is largely below sea level, it is anticipated that submersion will

prevent AMD and metal leaching, such that the legacy from new workings are likely to be acceptable. There is uncertainty with respect to premature closure or insolvency of the proponent, in which case waste rock temporarily stored above ground could leave an unacceptable legacy if underground disposal does not take place as specified. The risk associated with waste rock storage above ground could be reduced somewhat through a security deposit and adequate contingency plans (Taggart, 1999; Costanza and Perring, 1990).

There is also some uncertainty as to whether on-going drainage water treatment will be required post-closure. Groundwater movement and metal concentrations are to be monitored. As a contingency plan, contaminated groundwater would be pumped for treatment. Redcorp was initially confident that post-closure treatment would not be required. More recently, it has become evident that treatment of drainage water will need to continue for a number of years post closure. The road may need to remain open to allow access for personnel and supplies.

The State of Alaska has indicated that until a detailed contingency plan is developed, it remains concerned about the potential for and impacts of seepage on aquatic life (EAO, 1998: 53). The US EPA and the Fish and Wildlife Service remain concerned about the geotechnical stability of the tailing impoundment and believe this is a strategic issue that should be addressed prior to permitting (Riley, 2001; Wilson 2001). In addition, the EPA suggests it is "widely agreed" that the tailings impoundment would require perpetual maintenance, and that this maintenance may necessitate keeping the access road open, yet it is unclear how provisions for long-term maintenance and access will be secured (Riley, 2001). At present then there are indications that the tailings impoundment could present an unacceptable legacy—both in requiring that the road be kept open, and if further geotechnical data indicates the alluvial fan underlying the impoundment is not sufficiently stable or if perpetual management requirements are onerous and cannot be secured by the proponent's commitments or likely revenues.

Recent BC experience also indicates that engineered solutions to avoid acid mine drainage are not always effective. The Samatosum silver and base metals mine near Kamloops, BC operated between 1989 and 1992. It was put forth as a model of how mining could proceed with minimal environmental impact. The waste rock dump at Samotosum mine had been carefully designed to prevent acid mine drainage through blending acid generating rock with an acid consuming rock of ninefold excess neutralizing capacity. However, by 1996 the waste rock dump began to go acid and to generate heat, and now drainage from the dump must be treated through an add-on lime treatment plant. Acid mine drainage may continue for decades and perhaps centuries (Sierra Legal Defence Fund, 1998).

Ore from the TCM will be processed through a mill on-site, and while about 20% is removed as concentrates to be trucked to Skagway for shipping to refineries, the remaining fine-grained tailings require disposal. Redcorp has proposed that tailings be disposed of through three waste streams:

- 3.3 million tonnes of pyrite-depleted tailing neutralized with 200 thousand tonnes limestone placed in a permanent surface impoundment at Shazah Flats;

- 3.3 million tonnes pyrite-depleted tailings back filled in mine workings below water level, and;

- 1.2 million tonnes pyrite concentrate tailings back filled in mine workings below water level.

The tailings dam at Shazah Creek is of concern due to the significant wildlife and aquatic values at the nearby Shazah wetlands. The wetlands are important to species such as trumpeter swans, moose, grizzly and coho salmon. Metals are expected to move through the bottom of the impoundment into the groundwater and to the wetlands, though there is uncertainty concerning the amount of metal involved. As the mine winds down, tailings will be mounded so that future precipitation runs off the sides and thereby reduces the potential for AMD generation.

While giving Redcorp approval to proceed with the TCM does improve the likelihood that Redcorp will meet its obligation to fix AMD caused by historic workings, it results in significant uncertainty as to future legacies created by new workings. Predicting and managing AMD is an imperfect science, and if AMD does result, treatment may be required for centuries.

Taggart (1999) provides a detailed examination of the environmental legacy of the bankrupt Faro mine in the Yukon, and draws four lessons to avoid similar problems with future mines:

1. that all mines post a substantial bond prior to beginning operations,
2. that all mines have a trust or sinking fund with payment requirements that have some bearing on the reality of clean-up costs rather than on the mining company's current financial position,
3. that the required payments to the clean-up fund be ruthlessly enforced, and
4. that the bond posted at the onset be gradually placed into the fund as the mine approaches the end of its life (page 174).

Warhust and Mitchells (2000) note that in the Summitville mine disaster (now a Superfund site), not only was the reclamation bond amount inadequate, but much of the bond was effectively worthless as it was in the form of equipment that could not be removed from the site for liquidation to generate required reclamation funds (e.g., treatment plant for AMD). Whether or not the TCM will leave an acceptable legacy depends in part on the effectiveness of measures implemented to ensure proper closure and to provide for ongoing treatment where required.

4.3.2 The Mine Site

Because the mine itself is underground, the physical footprint exclusive of the road is 130 hectares, which is relatively insignificant at the landscape level. During operations, noise emissions and human activity will tend to extend the zone of influence, as many species of wildlife avoids these stresses, though this impact is temporary. Through careful site design and rehabilitation, surface disturbance is likely to present an acceptable legacy to future generations.

4.3.3 The Road

As noted previously, the mine will require a 160 km long access road from Atlin to the mine site into the last major Pacific drainage that has so far yet to face significant industrial activity. The road involves 69 stream crossings. The total area taken up by the road is 382 hectares, resulting according to the proponent in a loss of carrying capacity of 1-2 mountain goats, 5-10 moose, and

3-7 caribou. But this description does not capture the highly significant impacts entailed by such linear development in an unroaded landscape. Redcorp sees these impacts as temporary, given its intent to decommission and reclaim the road such that it is no longer useable by vehicles and local vegetation can be reestablished. There is high uncertainty with respect to decommissioning and reclaiming the road. The State of Alaska expressed concern that:

> We know of no previous examples of a new road, of the length and profile of that being proposed for this project, that has been decommissioned... Since procedures exist to allow additional "new" users of the road, and to transfer liability and responsibility for road maintenance to these users, a strong possibility exists that this road will not be decommissioned in the foreseeable future[45]

Indeed, the existing regulatory framework in BC makes it likely that the road will in fact continue to be used, since governing legislation makes clear that it is in the public interest for owners of private roads on crown land to allow access by the public and other industrial users. The road will improve the financial viability of other mineral deposits or allow for forestry operations in the region, such that if another mine goes into production or if logging takes place, the road, or a significant portion thereof, is likely to remain operational. The EAO recommendations explicitly acknowledge the real possibility that another user will keep the road open prefacing the discussion of road deactivation with the statement, "On closure, if no other legitimate use has been established, the road will be deactivated by…" (EAO, 1998: 79). Furthermore, as ongoing treatment of AMD is required post closure, and as the tailings impoundment is likely to require perpetual care (Riley, 2001), the road may have to stay open longer than anticipated, although the proponent suggests that air access to the site will be sufficient for post-closure needs.

The road's legacy can be assessed assuming two outcomes. The first is that once the mine is closed down, the road is abandoned and effectively decommissioned. The second is that the road is not successfully decommissioned, either because effective decommissioning proves difficult (e.g., those seeking access can find a way to use the deactivated road bed, deactivation is excessively expensive) or because during the mine's lifespan a new industrial activity starts up along the road corridor which precludes closure.

In the best case scenario of successful closure and decommissioning, the decommissioned road may, but will not necessarily, represent an acceptable legacy. In the 12 years (or longer if the ore body continues at depth) that the road is actively used, the road might result in irreversibilities that imply an unacceptable legacy (Trombulak and Frissell, 2000; Havlick et al., 1997). This might occur for instance, despite the best efforts of the proponent, if unauthorized access increases local hunting pressure, and local wildlife populations are unable to recover once the road is decommissioned. Roads also act as vectors for diseases and invasive species (Zobel at al., 1985; Tyser and Wosley, 1992), which have the potential to irreversibly alter local ecosystems. The road will also alter slope hydrology, and could thereby result in high sediment flows. There should be no illusion that the decommissioned road does not imply some loss in natural capital.

The more relevant scenario, however, is that it is likely the road will not be decommissioned, or that if it is decommissioned, decommissioning will not effectively stop usage of the road corridor. In the case of past industrial roads, the BC government has not demonstrated its interest in

decommissioning or its ability to ensure decommissioning occurs. As the report by Staples and Poushinsky (1997) for the EAO notes:

> In the remote corners of the province and throughout the Yukon there is no history of successful long-term road abandonment and reclamation that the study team is aware of. Generally such linear developments are left untended and unmanaged, orphaned by those who built them, with little attention by governments to their long-term impacts on habitat and wildlife, and the significance of unregulated and unmanaged public access.

The challenge is particularly great given the fact that the road is 160 km long in an intact area of such significant environmental values. For the decommissioned road to be an acceptable legacy, effective provisions to ensure closure need to be identified, evaluated and implemented before the mine proceeds.

4.4 Full-cost

Companies have conventionally focused on the financial rate of return generated by their projects (e.g., returns from the shareholders' perspective). From a sustainability perspective and a full cost accounting perspective, more relevant is the economic rate of return (e.g., the broader societal perspective). The economic rate of return entails subtracting the user, social and environmental costs from the revenue stream generated by mining. If a project propsed by a private sector proponent does not demonstrate financial viability, it is unlikely to be economically viable. Before addressing the extent to which the proponent would address the full social and environmental costs of proceeding with the development, I first address the issue of clear financial viability.

The financial viability of the TCM needs to be considered in the broader context of the mining industry generally. The price of metals in the US shows a slowly declining trend in constant dollars over the last century, with copper declining more rapidly, losing about 6% per year (Sullivan et al., 2000). Gold is particularly vulnerable to depressed prices over the next decade, as the long-term price trend is downwards, mining technology has enabled extraction from low grade deposits, and further gold sales by central banks are likely (Young, 2000).

Mineral economist Tom Bartek's analysis (2001, 1998) shows that the TCM is marginal to submarginal and that markets will have to perform well for TCM to have a positive net present value using a discount rate of 10%. His analysis also shows that it would not take much of a change in prices before the mine has a negative net present value. Bartek's analysis shows the TCM is particularly sensitive to changes in zinc prices, accounting for approximately 50% of net smelter return, while gold and copper account for 20% each (relative proportions depend on price relationships between metals). The US Geological Survey noted in its 1999 Yearbook that the Western world is in the midst of a boom in zinc mining, with a number of new mines slated to come on stream. A shortfall until 2002 in zinc smelting capacity will tend to limit supply of refined zinc (Plachy, 2000). Other than 1997, zinc prices from 1995-2000 have been lower than those used for the proponent's feasibility study of the TCM.

The TCM does not appear to be financially robust. Cost overruns, the need for additional mitigation, depressed markets, or high smelter penalties for contaminants in concentrates could

easily push the project into negative territory. Concern that the TCM is not robust is compounded by the fact that Redcorp Ventures Ltd. is a very small company with the TCM as its only mining project. Redcorp's 2000 financial statements show that of current assets of $29 million, $24 million is deferred exploration expenditures that can be offset against future revenues and $1.8 million is deposits held for future remediation. Annual revenue is less than $200,000 (Redfern Resources, 2000). Redcorp has limited expertise and resources to address unanticipated environmental problems, and does not have other active mines to provide greater corporate stability. Larger, well established mining companies have shown little interest in acquiring the Tulsequah Chief property or in purchasing Redcorp shares.

If the project turns out to be as marginal as Bartek's independent evaluation suggests, then the mine only needs result in the generation of fairly modest social and environmental costs to result in a negative economic rate of return on investment. In such a case, economic welfare will actually be reduced if the project goes ahead, and investment in the mine diverts society's resources from more productive activities that would make a greater contribution to economic welfare. This appears to be the case: the project will have significant opportunity costs, it entails a loss of significant natural capital in the roading of a large, intact ecosystem, and it is likely to impose costs on the Taku River Tlingit (discussed below). Once the user cost is included in these deductions (see 4.5.6), the mine is even more likely to show a negative economic rate of return on investment. The TCM performs poorly from a full cost accounting perspective.

4.5 Contribution to economic development

4.5.1 Not all increases in economic activity contributes to economic development

Economic growth is frequently used interchangeably with the term "economic development." Daly (1992) notes that "growth" implies "quantitative increase in the scale of the physical dimensions of the economy," while development implies "qualitative improvement in the structure, design, and composition..." (page 224). Continued economic growth is both impossible (the Earth is finite) and undesirable (ever more growth involves using up resources, creating pollution, and crowding the Earth with ever more infrastructure, factories, goods, and wastes). Economic development can continue indefinitely—we can increase knowledge and wisdom, improve technologies, better learn to meet human needs. Even conservative institutions such as the World Bank have come to acknowledge that the pursuit of economic growth has been too narrow, and that much growth has been achieved by sacrificing natural capital and long term economic prospects. A World Bank study recently advocated that development needs to focus on improving the quality of people's lives; more equitable education and job opportunities; greater gender equality; better health and nutrition; a richer cultural life; broader civil and political freedoms; and a sustainable natural environment (Thomas et al., 2000).

With this clarification we can see that TRT have experienced economic growth, but not necessarily development. The TRTFN "GDP" pre contact would be small compared to GDP in 2001, as no long-term surplus was accumulated and production was geared towards household consumption. However, many indicators such as nutrition, health, education relative to skills required for participation in the economy, etc., would suggest that the Tlingit economy has

developed modestly if at all. This is not to say that Tlingit have not benefited from modern goods and services and opportunity to participate in an industrial economy, but rather that in sum, economic growth has had little to do with improving Tlingit well-being.

Growth in GDP is not desirable in and of itself. For instance, resource depletion and degradation of the natural environment appear misleadingly in GDP as desirable components of economic progress (El Serafy, 1997). Many adjustments are needed to subtract defensive expenditures, to account for resource depletion, environmental damage, to factor in unpaid labour, etc., before a more useful measure of economic welfare can be constructed (Daly and Cobb, 1994; Daly, 1996). Indeed, the economy can grow as resources are depleted, as people have less leisure time, as poverty rates increase, and as people are harmed by environmental degradation (Thomas et al., 2000; Daly and Cobb, 1994; Stockhammer et al., 1997).

The more relevant indicator is Net Domestic Product (NDP), which is obtained by deducting the depreciation that occurred over the accounting period from GDP. Given that the proponent's project involves depleting stocks of provincial mineral resources, the project's contribution to the province's economy should be net of the user cost. To do otherwise inflates the project's contribution to the provincial economy. The main point of the above is that while mining usually contributes to economic growth, as commonly measured, it does not necessarily result in economic development.

4.5.2 Mining as a pathway to economic development

Common sense would suggest that countries or regions which are rich in mineral resources would have an easier time developing their economies. Experience often suggests the reverse, something known as the resource curse thesis: "It is widely believed that natural mineral resources are desirable. However...it seems that this 'natural asset' can distort the economy to such a degree that the benefit actually becomes a curse" (Auty, 1993: preface).

A number of authors (Taggart 1999; Auty, 1993; Power, 1998; Kendall, 1992; Keyes, 1992; Locke, 1986; Wall, 1987; O'Faircheallaigh, 1992) have identified other reasons for mining's lackluster performance in encouraging regional and local economic development. These include:

- businesses and individuals limit exposure to cyclical downturns and to eventual exhaustion of the ore body, by avoiding investments in mining-dependent regions;
- mobility of mining workforce discourages long-term investment by businesses and individuals living in the region;
- mine viability and lifespan is dependent on volatile mineral prices and many projects must be abandoned suddenly and with little or no notice to the local community;
- mining company dominance in the local economy and politics encourages dependency; corporations benefit from dependency because it weakens labour and local government's bargaining position; poor bargaining positions allow more of the resource rent to be captured by the corporation;
- the mining industry has been faced with a long-term decline in resource prices;
- the mining industry has frequently been heavily subsidized by government through outright payments, preferential loans, the provision of infrastructure, preferential utility rates, reduced royalties and an ability to externalize social and environmental costs;

- heritage funds or other measures to spread the benefits of non-renewable resource exploitation over several generations (where they exist) have been squandered, dissipated through dividends or to reduce taxes, or often invested in other jurisdictions thereby limiting the potential to diversify the economy and wean government and the economy off revenue derived from extraction;
- substantial investments in infrastructure are typically abandoned or written off when the mine is closed;
- poor linkages between mining and the rest of the economy;
- the major decisions affecting the region are made in distant corporate headquarters and reflect international markets, removing local sense of control and responsibility;
- in most mining communities there are few prospects for downstream development (processing the ore) or upstream development (supplying the mine with goods and services);
- mining skills are not easily transferable to other workplaces;
- miners become used to above average wages and often leave the region when the mine closes to move on to another mining project;
- mining towns are built and managed with a narrow emphasis on creating conditions that are conducive to the efficient extraction of mineral resources to meet the financial targets of resource companies. This limits the ability of women to participate in community decision making, limits their prospects to participate in economic development, limits the social roles available to women and severely limits the role of women to that of providers of support so as to enhance social stability;
- earnings and royalties usually do not remain in the region where the resources are extracted;
- the environmental legacy of mining detracts from the quality of life or hinders other economic activities;
- inadequate provisions for reclamation, restoration and clean-up burden governments with environmental liabilities that can quickly exceed available funds;
- mining companies take advantage of cyclical downturns to reduce the expectations of the workforce, local communities, and government, so as to gain concessions, and;
- mining culture, being that of hard work and rough play, with frequent instances of violence amongst men and towards women, results in high levels of social distress and lessened ability of income to contribute to economic development.

Tilton (1992) finds that the disappointing development results engendered by mineral wealth are partly explained by the failure to appropriately invest resource rents in a way that will provide for the long-term flow of goods and services. Rents are often used to finance current spending, rather than being focused on the long-term. Examining the relationship between mining employment and total employment during the 1980s in twelve western states, University of Montana economist Tom Power, concluded, "There was either no significant impact from mining or a negative relationship" (1996:92).

Tom Power is not optimistic about the potential contribution of mining to local economic development:

> Mining contributes too little to local economic development to justify its permanently scarring local environments while disrupting local communities. (1996:129)

BC has its share of boom and bust towns that demonstrate how mineral development frequently fails to provide the basis for long-term economic development. The late nineteenth century mining frenzy in the Kootenays created towns of hundreds or even thousands of inhabitants that no longer exist or that are now a mere fraction of their former selves. More recent mine closures such as Kisault, Cassiar, Granisle, Tumbler Ridge, Endako, Equity, and Mt. Washington speak of the social dislocation that occurs when mines fail or close, the costs for environmental remediation, and the opportunity costs that are rarely recognized at the time the mine was first developed.

Instead of providing Tlingit, Atlin and Northern BC/Yukon residents with a legacy of skills, the project, unless carefully designed, developed, and closely regulated, could be "a shocking lurch into a potential dead end" (Power, 1996). It is therefore essential to determine conditions that can be imposed to improve prospects for local economic development.

4.5.3 Conditions conducive to local development

The influx of wages into the region during the project's lifespan may provide a window of opportunity for new businesses to become established, and for owners and employees to learn business skills. For some local retail or service-oriented businesses, the mine could create a temporarily forgiving business environment with greater than usual demand and high disposable incomes, where prices may be kept relatively high, thereby offsetting mistakes or inefficiencies as owners and employees learn efficient business practices. Early efforts will be required to wean such businesses from being dependent on the mining economy if they are to outlast the mine.

At the same time, high mining wages and increased competition for housing could increase the cost of living and increase wage expectations in other sectors, decreasing the viability of local businesses. Where current retail and service businesses are utilized below capacity in isolated communities, a marked influx in local disposable income frequently leads to little or no spending induced increases in retail or service sector employment (Gagnon, 1992).

To build up a diversified business base, efforts by different stakeholders and the TRTFN will need to be closely coordinated and will need to get underway before the mine is operational. New businesses require a trained workforce, access to resources, access to capital, and appropriate markets. New businesses in small remote communities typically take between 5 to 10 years from initial concept to proven economic viability. However, given the remote location, transportation difficulties, available resources, the relatively short projected life mine span and other factors, it is likely that even well resourced economic diversification efforts will yield modest results.

In a thorough survey of local development in Canada, Brodhead et al. (1993) conclude that:

> ... "top-down", large-scale strategies emphasizing the attraction of outside industries...have not often been effective in promoting long-term development... In contrast, the [Economic Council of Canada] case studies have shown that the "bottom-up" strategies based on mobilizing previously underutilized community

resources can lead to both social and economic benefits, albeit on a small scale at the outset (p. 316).

Their study suggests several preconditions for successful long-term local economic development:

- a long-term commitment (10 year minimum) to proactive planning;
- recognition that lasting results will take a decade to materialize;
- emphasis on building local capacity, through training, education, and work experience;
- access to capital funds and capacity to invest surplus funds locally through loans to local small businesses;
- access to information on markets and market conditions;
- mechanisms to improve access to information, ideas, and new technologies;
- focusing on partnerships between private business, non-profit organizations, and government, and;
- focusing on economic development efforts and helping communities to direct their own future, to meet local needs, and to increase self-reliance.

Lewis and Hatton (1992) examine the preconditions for successful aboriginal joint ventures — ventures intended to capture wealth, experience, and skill from large projects that would otherwise drain to outside economies. Economic development premised on attracting outside enterprise fails because it does not strengthen "the capacity of the community's members to plan and build an economic future which suits their values, priorities, and needs" (page 6). Due to poor self-esteem, low levels of formal education, substance abuse problems, lack of resource base, a small or non-existent business sector, high costs of infrastructure provision, over-extended leaders, political instability, and heavy dependence on outside expertise, aboriginal communities face many disadvantages in pursuing economic development. Lewis and Hatton emphasize four essential ingredients for local economic development:

1. planning and research to understand the regional economy;
2. financial equity available for investment;
3. access to loans, and;
4. comprehensive training programs.

Using the TCM as a vehicle to develop and diversify the local economy will be very difficult, particularly given the mine's life-span and the small existing economy. Diversification and development will require a proactive approach, including:

1) capacity-building before the mine proceeds, so as to ensure effective participation in the project;
2) identification of TRTFN economic development needs, priorities, and values;
3) proactive planning between TRTFN, Redcorp, and government, which identifies barriers to economic development and training needs, and ensures that required programs take place;
4) setting up a substantial investment fund for seed funding of new enterprises;
5) provision of business planning and management expertise;
6) access to equity and financing, and;
7) equity participation in joint ventures related to the TCM.

4.5.4 Local economic development

During operations, the proponent has estimated that 199 direct jobs will be available, 51 from the Atlin area, 43 from the Yukon, 67 from Northern BC and 38 from elsewhere in BC. Staples estimates that up to 20 jobs might be available for TRTFN members. Average salary and benefits will be $77,000, for a total of $15 million annually. A further 60 positions will be created by contract transportation requirements. Of annual operating costs exclusive of labour of $32 million, the proponent expects to expend $7 million annually in Atlin. While this may seem like a large sum relative to the local economy, most of the purchases will be goods that merely flow through the economy without incorporating significant local value-added.

High mine wages and mine spending will undoubtedly serve to fuel the local economy, but are also likely to increase local wage expectations, the price of housing, etc., thereby distorting the local economy. This will push up the cost of living for those who are not earning industrial wages, and increase disparities in income. Existing businesses that do not benefit from mine related spending will need to adjust.

Whether project jobs, wages and spending will benefit a local economy needs to be evaluated considering local circumstances and objectives (Power 1996). If local residents do not feel a need for new employment opportunities, or do not desire the type of jobs created by the project in question, the fact that a project creates new positions can actually detract from community economic well-being. Positions created may be filled by outsiders, leaving TRT members and other local residents with the same employment problems that existed before the project was initiated. Shifts in prestige, decision-making influence, ability to fund land-based activities, etc., can together create social tensions, as Staples (1997) makes clear:

> These income inequalities can be problems in themselves, as well as producing other social divisions and tensions. For instance, those who benefit or stand to benefit substantially from the proposed project may develop a strong interest in promoting it over the objections and concerns of others, creating or exacerbating conflicts within the community. Conflicts in values might arise, where economic values and associated benefits are viewed as superior to non-economic cultural and social values. Conversely, there might be concern that substantive economic benefits will be outweighed by non-economic costs. Where those who stand to benefit from projects are politically influential, these tensions can be further exacerbated if decision-making is or appears to be based on narrow self-interest rather than the common good of the broader community…
>
> … if TRTFN households become more dependent on cash income to meet their household requirements with a coincident decline in traditional land use and domestic production, it is likely that the TRTFN community will become less socially cohesive and more economically fragmented, in the absence of any countervailing social, economic or cultural forces.

The EAO report concluded that the direct, indirect and induced employment during operations will be substantial, totaling 600 positions (page 68). Indirect and induced employment figures always need to be regarded skeptically. They are derived from multipliers using economic base models which are useful in limited circumstances to assess short-term economic impacts. The

economic base model has serious shortcomings and is easily misinterpreted, leading one economist to suggest that the economic base model should be "buried…without prospects for resurrection" (Richardson, 1985). With regard to its use to help guide forest management decisions in the Pacific Northwest another economist concluded that the model "…has been both dumb and dangerous, so that decreases are called increases, and up is called down." (Niemi and Whitelaw, 1999; p. 44). In an extensive review of the theory and empirical evidence supporting the economic base model, Krikelas (1992) concludes the economic base model is not a defensible theory of long-run economic growth and that the model has severe limitations for economic planning and policy analysis.

If investors decide not to proceed with the TCM, they may invest their funds elsewhere in BC in either other mines or projects which would also generate direct, indirect and induced jobs. Also, proceeding with the project may involve foreclosing other opportunities, and such employment impacts would also need to be factored in to determine net employment impacts. There will also be adjustment costs when the mine is closed. Given the limitations of the economic base model and the above reasons, it is inappropriate to consider direct, indirect and induced jobs when evaluating the TCM. Only direct jobs need or should be considered.

Given access requirements, Pearse (1998:84) does not see the TCM as contributing to Tlingit economic development; rather, "Like the plug on a bathtub, the road will become an unstoppable drain for natural resources of the Taku to be siphoned away so as to enrich other economies."

At the present time, the conditions that would help ensure that the local economic activity and wages from the TCM translated into lasting economic development for the local economy are not in place. This is not to deny that the project will create a substantial influx of money and an expansion of job opportunities. However, proceeding with the mine at this time is likely to generate few lasting benefits while disrupting existing economic activity, particularly in the land based sector.

4.5.5 Regional/provincial economic development

The EAO report concluded that project tax revenues would be $200 million over the project's lifespan. Several adjustments are necessary to gain a more accurate understanding of net revenue impacts:

- revenue must be adjusted to take into account the fact that the project depletes non-renewable natural capital. An ore body which is an asset to BC and TRTFN will be depleted (though in this case it appears to be marginal);
- subsidies from government to Redcorp for proceeding with the project, and a share of general subsidies to the mining industry, need to be deducted from revenues (it is not known whether and to what extent the project will be subsidized, nor whether the BC government would intervene if and when the project experiences cash flow difficulties);
- increased government expenditures necessitated by the TCM must be deducted from revenue. These expenditures include government funded infrastructure upgrades required for the project, costs to regulate the project, and long-term costs absorbed by government, and;
- the TCM may preclude other projects which would also generate revenue or decrease the need for government expenditures, and these opportunity costs should be factored in.

Fully addressing all of the above matters would require further study and better access to financial data concerning the TCM. The present study focuses on adjusting for capital depletion.

4.5.6 Differentiating between income and capital depletion

There are two main reasons not to count all the proceeds flowing to government from the depletion of non-renewable resources as revenue, or as income for government. First, the definition of income used by economists, advanced by economist Sir John Hicks, is based on the idea that income is that which can be consumed while maintaining capital intact. Hicks writes:

> The purpose of income in calculations in practical affairs is to give people an indication of the amount which they can consume without impoverishing themselves. Following out this idea, it would seem that we ought to define a **man's income as the maximum value which he can consume during a week, and still expect to be as well off at the end of the week as he was at the beginning** (Hicks, 1946:172; emphasis added).

Income, or, in the instance at hand, government revenue, should be generated without stocks of capital being drawn down . The idea makes intuitive sense. If any business treated business receipts as income, without taking into account expenses, it would soon face bankruptcy. As Brown et al. (1991) explain, such accounting practices are a disguised form of deficit financing that inflate current output:

> ...it is as though a vast industrial corporation quietly sold off a few of its factories each year, using an accounting system that did not reflect these sales. As a result, its cash flow would be strong, and profits would rise. Stockholders would be pleased with the annual reports, not realizing that the profits were coming at the expense of the corporation's assets. But once all the factories were sold off, corporate offices would have to inform stockholders that their shares were worthless (page 29).

A second reason not to count all the proceeds as revenue is that doing so impedes sustainability. If society is serious about moving towards a sustainable economy, then it needs to move from an economy built largely on the liquidation of natural resources, to an economy that relies on sustainable use of a renewable resource base. Government expenditures will have to be brought in line with the level of revenue that is sustainable. As El Serafy and Lutz (1989) put it, "Prudent economic management requires that government know the maximum amount that can be consumed by a nation without causing its eventual impoverishment..." (page 2).

The need to account for the depletion of non-renewable resources has been recognized by economists (e.g., El Serafy, 1989, Daly and Cobb, 1994) and the UN now recommends that member countries prepare satellite accounts which make such corrections (UN, 1993). The Yukon government, which is heavily dependent on the mining sector, commissioned research on the best means of making such corrections to its territorial accounts. The recommended approach for the Yukon involves the "El Serafy method", or the user cost approach (Victor, 1990). It is based on the observation that depleting a non-renewable resource involves two types of costs. The first type

of costs are the current extraction costs—the costs that will be faced by Redcorp in mining and processing the ore. The second cost—the loss of future net receipts—reflects the fact that as the mine is depleted, the asset base depreciates and society loses a potential source of future income. Accordingly, to determine sustainable income, net revenue is divided into an income stream and a user cost stream. The principle is that the user cost stream would be based on the amount that would need to be reinvested in order to provide a permanent income stream once the ore body is depleted. Assuming n, the number of years until the resource is depleted can be estimated in advance, and that investments may be made in renewable resources that obtain a rate of return of r[46] per year, true income is given by the formula,[47]

$$\text{True income} = \text{Net Proceeds} \times [1-1/(1+r)^n]$$

As the mine is worked the value of sub-surface assets gradually declines. Depending on the ultimate resolution of the treaty negotiations, one or both of the TRTFN and the Province need to be compensated for their loss of this value. As noted above, the user cost implicit in extraction can be estimated according to a formula that takes into account: (a) the life expectancy of the mine at the current extraction rate and (b) the expected rate of return of alternative investments. By investing the equivalent of the user cost at the assumed rate or return, income, as estimated, may be perpetuated. Otherwise, when the mineral contents are exhausted, the income stream declines to zero. By investing the user cost regionally, the economies of affected communities will become diversified and losses in employment when mining ceases will be offset by jobs in the new, diversified businesses.

There are a number of technical issues to resolve in applying the user cost method, which will not be covered here. A government intent on ensuring user costs are accounted for would also have a number of approaches it could take depending on its policy objectives. Government could charge the user cost to the corporation directly, such that the corporation's revenue would be net of the user cost, and the government would collect the user cost as the royalty generated by the resource. This would be the most appropriate approach given the theory behind user cost. Alternatively, it could decide to allow the corporation to maximize its income by not assessing a user cost. The corporation would end up with higher levels of revenue then in the above approach, which would provide a higher level of corporate revenue to be taxed, but the taxes and royalties collected (assuming royalty regimes do not change significantly) would be lower than the amount collected if user costs were charged directly against corporate revenue. Then, government could adjust its own revenues to ensure sustainability of income by calculating its user cost. The user cost would be set aside to provide for sustainability of regional income. Finally, government could require that each mining company deduct the user cost from gross mine revenues to be deposited in a user cost fund held by the company. While the company could not draw on the capital from the user cost fund to boost present revenues, it would be free to invest this capital in sustainable enterprises within the region. Income generated by such investments would benefit the mining companies once the ore bodies in question were exhausted. In this way, it is the mining companies themselves that would benefit from the sustainability of income.

The approach that appears the best aligned with the economic theory behind user cost and the realities of the present case, given the information available to the author, is that first, where user cost is assessed against gross project revenues and deposited in a trust fund to promote

sustainability and diversification of the regional economy. This is based on the observation that the TRTFN has rights that have yet to be resolved in the mineral resources of the Tulsequah deposit, and that these rights encumber those of Redcorp, and the provincial government. Accordingly, the deposit is part of the TRTFN's capital assets, though their ownership may not amount to 100% of the asset. If the asset is depleted, the TRTFN has incurred a user cost. The user cost in question should thus be deducted from the entirety of proceeds from the mining operations (gross revenue net of costs), and a significant portion of this user cost should be invested in a fund to provide for the sustainability of the regional economy. A smaller proportion could be invested to promote sustainability of the provincial economy. Finally, because the federal government also earns revenue by taxing mining companies, the federal government needs to address how it will address revenue from non-renewable resources.

If such a user cost regime were applied, then it would be inappropriate to collect royalties from the mine, because in theory, a properly assessed royalty is equal to the user cost. The user cost would amount to a substantial fund, which would then be used to provide for regional economic sustainability, either by investing in local renewable resource projects, or to invest elsewhere with the proviso that the income from investments would return to the local region. In this way, a depletable asset will have been converted into a perpetual source of income (so long as investments made are wise).

It may be that for a variety of reasons government is unwilling to apply such a significant change to royalty regimes for mines. If the mine were to proceed as per current legislation, and assuming for the moment that there was not the complicating factor of TRTFN rights to the resource, then the proponent's revenue would not be affected. Instead, direct government revenues and royalties would be adjusted according to the user cost method. The result would be shown as in Table 3 below.

Table 3: User cost adjustment of government revenue from the TCM

Scenario		Federal Revenue			Provincial Revenue		
Years to deplete deposit	Sustainable rate of return	Gross Revenue	User cost	Sustainable revenue	Gross Revenue	User Cost	Sustainable revenue
10	2%	$56.3	$46.2	$10.1	$83.3	$68.3	$15.0
15	2%	$56.3	$41.8	$14.5	$83.3	$61.9	$21.4
20	2%	$56.3	$37.9	$18.4	$83.3	$56.1	$27.2
25	2%	$56.3	$34.3	$22.0	$83.3	$50.8	$32.5
10	4%	$56.3	$38.0	$18.3	$83.3	$56.3	$27.0
15	4%	$56.3	$31.3	$25.0	$83.3	$46.3	$37.0
20	4%	$56.3	$25.7	$30.6	$83.3	$38.0	$45.3
25	4%	$56.3	$21.1	$35.2	$83.3	$31.2	$52.1
10	8%	$56.3	$26.1	$30.2	$83.3	$38.6	$44.7
15	8%	$56.3	$17.7	$38.6	$83.3	$26.3	$57.0
20	8%	$56.3	$12.1	$44.2	$83.3	$17.9	$65.4
25	8%	$56.3	$8.2	$48.1	$83.3	$12.2	$71.1

User cost calculation with a rate of return for renewable investments of 2, 4 & 8%, demonstrating the cost of depletion and how it varies with projected returns on renewable investments and the rate at which the deposit is depleted (in this instance it is assumed that the same amount of minerals is extracted in all scenarios, and that total government gross revenues are identical). Government revenues from the TCM are adjusted to subtract the user cost to derive sustainable revenue, using the El Serafy method. The user cost should be invested to provide for regional economic sustainability. The amount of government revenue that can be used for current expenditures is substantially reduced.

By slowing the rate of extraction, the user cost is reduced. All dollar figures are in millions of constant 1998 dollars. Revenues are shown as a total over the mine life; the actual user cost would vary with year to year changes in extraction rates.

The key concept to appreciate is that the revenue generated by the project is not equivalent to income—only part of the profits, taxes and royalties collected should be available for current expenditures. The remainder should be used to invest in making the regional economy more sustainable. Furthermore, the apparently high levels of corporate and government revenue generated by the project need to be evaluated against the cost of depleting this non-renewable asset. The faster the rate of depletion, the higher the user cost. Because there are no provisions at the present time to collect and reinvest the user cost, the mine's potential to contribute to economic development is further diminished.

4.6 Equity

4.6.1 Intragenerational equity

In examining intragenerational equity, a key issue is the distribution of costs and benefits between the project promoters, the province, workers, and the Tlingit. This distribution will depend in part on whether an Impact Benefit Agreement (IBA) is signed between Redcorp and the TRTFN, and the content of such an agreement (e.g., provisions to provide employment opportunities to individual Tlingit, revenue sharing, contributions to community infrastructure, decision-making protocols, and access to management). It will also depend on agreements between Tlingit and the province.

At present, given the fact that there is no IBA in place, and that there is no treaty, no interim measures agreement, nor revenue sharing provisions, and that the framework for controlling project impacts is deficient from TRTFN's perspective, there is much uncertainty. The Tlingit are at risk of having to deal with the impacts, while receiving few benefits. The province will gain revenue, but the net effect on the province's treasury is likely to be considerably less positive than either Redcorp's or the Province's figures would suggest, once subsidies, loss in provincial assets and other costs faced by the province are taken into account. Ironically, project promoters and shareholders may not do that well either, as the project appears to be marginal to sub-marginal. Workers are the only ones who appear to be guaranteed good wages in exchange for participation as long as the mine can remain in operation, though poor financial results are often used to extract wage concessions.

Before the distribution of benefits and costs can be assessed from a perspective of equity, it is important to come to agreement on what outcomes are beneficial and which are considered negative. For instance, if Tlingit are by and large uninterested in industrial work and prefer land-based harvesting activities, then the fact that 20 local jobs will be available to Tlingit is of limited value. If the 20 jobs are taken by Tlingit, but social cohesion diminishes or substance abuse increases, then Tlingit may deem this outcome to be negative.

The fact that an IBA might be signed is also insufficient to ensure equity. Staples notes several characteristics of successful IBAs that do not appear to apply to the TCM:

- projects are large in capital scale
- projects last 15 years or more, and
- aboriginal people involved have fee simple ownership and can enforce the IBA (Staples 1997:44).

Overall, Staples appears wary about the distribution of impacts and benefits:

> The potential distribution of impacts and benefits resulting from the project suggests that the greatest risks and uncertainties associated with these will be born by the TRTFN. There is no certainty that the TRTFN will succeed in capturing and utilizing the employment and business opportunities provided by the project. The performance of IBAs in meeting their objectives is highly uneven. An IBA, in itself, can provide no certainty that its objectives will be met. This falls to the capacity, commitment and authority of the parties to such agreements. Indeed, the risks for the province associated with the capture of project royalties and taxes appear far less than the risks for the TRTFN associated with the impacts and benefits, which may affect TRTFN traditional land use.

At the global scale, the TCM does not appear to contribute to intragenerational equity. Proceeding with the project will result in incremental burdens on global ecosystems (e.g., CO_2 emissions, bioaccumulation, increased pressure on globally significant ecosystems). As ecosystems deteriorate as a result of global-level stresses to which the TCM contributes, it is often the poor who suffer the most, as they are already living close to the margin and have few resources with which to adapt. While the TCM's contribution to climate change is minute in comparison with the overall scale of global emissions (18 million liters of fuel per annum for power generation, enough fuel for 12 tractor trailer round trips of 1000 km per day, $C0_2$ emissions associated with lime production), the fact that over 180 tonnes of CO_2 will be emitted annually from fossil fuel consumption[48] to create each job in a developing country that has a greater responsibility within the global community to reduce emissions is significant.

There is little to offset the project's burden at the global scale. Wealth generated by the TCM is likely to benefit poor individuals in other countries. Some wealth will inevitably trickle down to the economically disadvantaged in Canada, and some unemployed individuals will find work as a result of the mine. However, overall the Tulsequah Chief Mine in its proposed form does little to promote intragenerational equity.

4.6.2 Intergenerational equity

There are no mechanisms in place to share the benefits of proceeding with the TCM between generations. Ideally there would be some form of heritage fund into which mining royalties or the user cost could be invested. The fund would be managed so as to keep the principal intact, while interest revenue would be used to invest in long-term economic development for the region. Alternatively, royalties could be used to clean up past mining damage, thereby passing on to future generations a province with a higher stock of natural capital.

Because there are no mechanisms to spread benefits between generations, and because the TCM implies significant loss of natural capital due to the road, the exhaustion of a mineral deposit,

fossil fuel consumption, CO_2 emissions…the TCM as presently described detracts from the achievement of intergenerational equity.

4.7 Consent

At the early stages of the project, the TRTFN was under pressure by Redcorp and some of its own members to negotiate an economic benefits agreement and to give the go-ahead "…without any appreciation of the environmental risks the Tlingit were being asked to accept" (Pearse 1998:5). Despite this pressure, TRTFN took a cautious approach to the TCM, deciding to carefully evaluate project impacts before making a decision. The TRTFN can be said to be highly informed about the project. TRTFN:

- decided in 1994 at a community meeting to hold an independent environmental review before deciding to support or reject the project;
- retained a number of independent experts to address wildlife impacts, water quality and aquatic effects, waste management, AMD, tailings chemistry, and community impact assessment, and;
- was represented on the environmental assessment project committee.

After conducting its own review, and participating in the province's review process, TRTFN has made it clear that the project, as presently envisioned, is at best premature and poorly conceived, and at worst a bad idea. Proceeding with the project now would prejudice TRTFN land rights negotiations, and would pre-empt either implementation of the TRTFN land protection plan, or the preparation of a provincial Land and Resources Management Plan (LRMP). As the TRTFN member of the environmental assessment project committee, Susan Carlick, wrote in her dissenting report:

> The right recommendation is to reject the proposed project as being premature and too beset with information inadequacies, undetermined but significant environmental risk and naïve optimism about future management capacity. We so recommend (Carlick, 1998).

The TRTFN's main concern with the TCM project revolves around the road, the access it provides to TRTFN territory, the road's impacts on wildlife populations, and how the road will prejudice both land rights negotiations and proper land use planning.

Given longstanding and ongoing TRTFN opposition to the project, their concerns that wildlife baseline studies are inadequate, that proposed mitigation means are inadequate, and that the TRTFN went to court successfully to have project approval overturned, the project fails the consent test.

4.8 Respect for ecological limits and landscape requirements

The TCM's impact on ecosystem processes and the provision of ecosystem goods and services needs to be assessed at site, regional and global levels. Its fit within the landscape needs to be assessed against an ecosystem management approach.

4.8.1 Global level ecosystem processes

Two categories are of primary relevance here: CO_2 emissions and contribution to heavy metal accumulation in the biosphere.

Although reports prepared for the environmental assessment do not appear to include an estimate of project-related CO_2 emissions, available information indicates it is significant. With 18 million liters of diesel burned annually for electricity generation, and twelve 1000 km round-trips for concentrate tractor-trailers per day, emissions are likely to be in the order of 40,000 tonnes of CO_2 per annum. The IPCC has determined that just to stabilize CO_2 levels at 450ppm (90% higher than 1750 levels, and 23% above current levels) by 2100, global emissions need to decline to 1990 levels within a few decades and then decrease to "a very small fraction of current emissions" (IPCC, 2001). This will be a challenging undertaking, and require special efforts by industrialized nations. Canada has committed to, but currently seems unlikely to meet the Kyoto protocol requirement for a 6% reduction in CO_2 emissions from 1990 levels by 2008-2012. The project clearly leaves humanity and BC further, rather than closer, to achieving a healthy atmosphere.

With respect to the flows of metals to the environment, Ayres argues that one of the necessary conditions to achieve sustainability is that there be:

> No further net mobilization or accumulation of toxic heavy metals…in soils or sediments beyond some uncertain multiple of natural levels. This implies an end to virtually all dissipative uses of scarce metals and most other extractive resources: i.e. closing the material cycle (Ayres, 1996:242).

Ayres argues that if the ratio of the anthropogenic flow to natural flow of a heavy metal is high, it follows that the economy is far from being sustainable. Unfortunately, estimates of natural flows are tentative, and results presented by different sources vary widely. The available evidence indicates that for copper, lead and zinc, the system is far from sustainable (see Table 4).

Table 4 Indicators of unsustainability in mineral resources use

	Ratios of anthropogenic flows to natural flows (per Ayres, 1996)	
Mineral	Galloway et al. (1982)	Azar et al. (1994)
Copper	14	24.0
Lead	333	12.0
Zinc	23	8.3

Ayres divides end-uses of metals into three categories:

1) those that are routinely recycled;
2) those that could be recycled but are not, and;
3) end-uses that are inherently dissipative whereby the metal cannot be recovered (e.g., coatings, pigments, pesticides, preservatives, flocculents, anti-freezes, explosives, propellants, detergents, fertilizers, small components that cannot be efficiently separated).

To achieve a long-term sustainable state implies near-total recycling of heavy metals, and thus moving all of category 2) end-uses to 1) and phasing out category 3) end-uses. The fraction of new extraction to total consumption therefore provides a good indication of sustainability (Ayres, 1996). With respect to lead, considerable progress has been made largely because of human health concerns. The ratio of primary production to total consumption dropped from 0.49 in 1970 to 0.25 in 1993-94 (Interagency Working Group on Industrial Ecology, 1998). With respect to zinc and copper, less than half of US apparent consumption comes from recycling (Ayres, 1996), allowing for significant improvements in recovery rates.

Flows of heavy metals including copper, lead and zinc were modeled for the Dutch economy by Guinée et al. (1999) who found that projected metal accumulation in the economy implied "…a warming signal as to the sustainability of the current metal metabolism" (p. 63). Given that the TCM introduces considerable quantities of CO_2 into the atmosphere, and further quantities of lead and zinc into the economy that will make their way to the biosphere, and that these metals pose toxicity concerns and have high ratios of anthropogenic flows to natural flows, the TCM is found to perform poorly.

4.8.2 Landscape level considerations

The province has not yet completed a Lands and Resources Management Plan (LRMP) for the area affected by the TCM. While such plans address some aspects of ecosystem management (Yaffee, 1999), they are only a small step in the right direction. While ecological considerations influence LRMPs, the plans are largely constrained in their ability to promote stewardship objectives by provincial commitments to resource extraction industries and trade-offs resulting from compromise amongst stakeholders. LRMPs are an inadequate basis for selecting land uses and siting access infrastructure if compatibility with landscape level requirements is the desired end result.

The TRTFN has initiated work for a Tlingit Land Protection Plan and has carried out a least one field season of ecological mapping at the regional level. This plan will be delineated on a protected landscape network that will set constraints for human uses of the land, and, in particular, commercial or industrial uses. The plan will also be based on Tlingit cultural and ecological knowledge, and will present the overall vision that the Tlingit community has for its future. The entire Tlingit traditional territory, which includes the Taku River watershed will be encompassed by the land protection plan. Because the TCM involves such a linear intrusion into a pristine area with high environmental values, in a context where the requirements to maintain landscape level ecosystem linkages and function have yet to be identified, the TCM performs poorly.

4.9 Offsetting Restoration

While Redcorp does not propose to rehabilitate an abandoned mine site, the fact that Redcorp intends to remediate problems caused by the currently abandoned mine contributes to offsetting restoration. However, it should be noted that when Redcorp purchased the property from Cominco, there was a pollution abatement order in effect that Redcorp took over as part of the sale. Therefore Redcorp has an obligation to remediate problems whether or not the mine

proceeds, so there is little offsetting restoration involved with meeting preexisting abatement requirements (i.e., if Redcorp had not purchased the property, the former owner, Cominco, already had the responsibility to undertake pollution control measures). There is some offsetting restoration to the extent that Redcorp's remedial work goes beyond the results called for in the abatement order. For the TCM to fully meet the offsetting restoration criterion, restoration work at another abandoned mine site would be needed.

With respect to the road, there is considerable uncertainty as to whether the road will be decommissioned, and if decommissioned, whether this effort will be effective at restricting access. Assuming decommissioning takes place, there will be some loss of habitat, likelihood of surface erosion, increased sediment flows and other such impacts that will last for varying timeframes. While decommissioning might eliminate usage of the road corridor by regular vehicles, the road corridor is likely to remain accessible to off-road vehicles and skidoos. Ideally, Redcorp would strive to meet the no net loss objective by both careful and effective decommissioning of the TCM access road and decommissioning another abandoned road of suitable length and environmental impact in the region (or elsewhere in Northern BC as applicable). The TCM does not score well on the offsetting restoration criterion, though this deficiency could be remedied by a commitment to undertake offsetting restoration.

4.10 Overall sustainability performance of the TCM

While the TCM shows the potential for acceptable performance in some respects, it is clear that in its current configuration it does not contribute to but rather impedes the achievement of sustainability. In the current context of a highly unsustainable global economy, and the need to implement aggressive measures at global and national levels to slow and eventually reverse widespread ecological deterioration, there are some criteria where Redcorp's opportunities to improve the score are limited, except by abandoning the project. For instance, Redcorp cannot extract minerals without adding to anthropogenic flows that already greatly exceed natural flows. However, Redcorp can act to improve its scores on the criteria of acceptable legacy, full-cost, contribution to economic development, equity, consent, maintenance of ecological integrity and offsetting restoration. The TCM's performance is visually summarized in Table 5.

Table 5: Overall performance of TCM against sustainability criteria

CRITERIA	PERFORMANCE			
	Positive Contribution	Neutral Contribution	Interferes with sustainability	Severely interferes with sustainability
1) Need—present generation				
2) Need—future generations				
3) Acceptable legacy - mine				
3) Acceptable legacy - road				
4) Full-Cost				
5) Contribution to economic development				
6) Equity				
7) Consent				
8) Respect for ecological limits (global scale)				
8) Maintenance of ecological integrity and landscape requirements				
9) Offsetting Restoration				
Overall performance				

Note: this table is intended to provide a visual overview of the mine's performance against the sustainability criteria. Arrows show the range within which existing data suggests the project will fall. See the assessments under individual criteria of section 5. Criteria where Redcorp has the potential to considerably enhance performance are shown shaded. The road and the mine are shown separately for acceptable legacy and respect for ecological limits/landscape requirements.

5 Sustainability, the Tlingit, and the TCM

This chapter addresses more specifically the question of whether the project is a sustainable development in that it contributes to, or at least does not detract from, the sustainability of Tlingit land use, economy and culture. Key characteristics of Tlingit land use, economic activity, and culture are briefly reviewed. The proposed TCM is then superimposed on this context to evaluate whether the project is likely to contribute to or detract from sustainability.

The province, the public and investors should be interested in the sustainability of Tlingit land use, economy and culture for reasons beyond that of respect for Tlingit rights and well being (Clarkson et al., 1992). As the WCED (1987) recognized:

> Tribal and indigenous peoples will need special attention as the forces of economic development disrupt their traditional lifestyles—lifestyles that can offer modern societies many lessons in the management of resources in complex forest, mountain and dryland ecosystems. … Their traditional rights should be recognized and they should be given a decisive voice in formulating policies about resource development in their areas (page 12).
>
> These communities are the repositories of vast accumulations of traditional knowledge and experience… Their disappearance is a loss for the larger society which could learn a great deal from their traditional skills in sustainably managing very complex ecosystems… The starting point for a just and humane policy for such groups is the recognition and protection of their traditional rights to land and the other resources that sustain their way of life… These groups' own institutions to regulate rights and obligations are crucial for maintaining the harmony with nature and the environmental awareness characteristic of the traditional way of life (page 114).

The WCED also recognized that if the needs of people who live off the land are not being met, they are forced to meet their needs in unsustainable ways. If BC can ensure that Tlingit land use, economy and culture are sustainable, then overall sustainability for BC is more readily achievable.

The data and observations in this chapter are largely drawn from Staples and Poushinsky (1997) and Staples (1998). The TRTFN has slightly more than 300 members. About 140 live in Atlin, while other members live in Whitehorse, Carcross/Tagish, Teslin, Juneau and the lower mainland. The median age for TRTFN members is 30 years. While lower than the BC median age of 35, it is considerably higher than that for many other First Nations (for instance, the median age in Davis Inlet, Labrador was 16 in 1991). The age distribution of the TRTFN allows for knowledge to be transferred between generations. The ratio of adults to children is conducive to children having positive adult influences during the early years that are most critical to development, and to allow for transmission of cultural values and norms—both important prerequisite for the sustainability of TRTFN culture.

The level of education attainment of the TRTFN membership (assuming the on-reserve membership is indicative of the general membership) is also unusual compared to that of other First Nations, with 16% > grade 12, and 53% grades 9-12.

Although much of the TRTFN membership is dispersed outside of Atlin, there remains a strong connection with the TRTFN traditional territory. Members regularly travel to Atlin to hunt, fish, gather, and visit with family and friends.

5.1 The TRT economy—the cash sector

Staples focuses on the Atlin based membership in his analysis of the TRT economy. He describes it as "mixed and adaptive". Participation in cash-based activities is integrated with the bush sector. The level of wage employment is again atypical for First Nations: at the time of his survey, of 24 respondent households, only seven households did not have at least one full-time wage earner (see Table 6). Of the seven, one had a part-time wage earner, while four received income from pensions, honoraria and other sources. At the same time, only three households indicated that they did not participate in any harvesting activities.

Table 6: Source of household income for Atlin-based TRTFN membership

	Wages	Social Assistance	E.I.	Children's Payments	Honoraria
# of households drawing on	19	3	1	5	6
Avg./household/year	$21,261	$3,193	$612	$2,182	$9,217

(Source: Staples and Poushinsky, 1997)

This breakdown of cash income shows that a high proportion comes from wages, and that while social assistance payments make an important contribution to the cash economy, they do not dominate. Staples and Poushinsky sum up their description of the cash sector as follows:

> In conclusion, the TRTFN economy's cash economy is a robust, adaptive and vital sphere of economic activity reflecting and well-adapted to a way of life that includes a variety of seasonal and cyclical variations. It is typically characterized by reliance on many sources of cash typically anchored by one steady job. Further, it is a sector that can be severed from the bush sector only with great practical and analytical difficulty. To so diminishes the strategies of mutual aid and social and economic cooperation which tie the two together and which makes TRT traditional land use the social and economic bedrock of the TRT economy.

5.2 The TRT economy—traditional land use

Data from 1996/97 indicate that country foods make a significant contribution to household consumption, providing on average per person: 104 kg. of moose meat, 35 kg. of salmon, 13 kg. trout/whitefish, 3.5 quarts of berries, and a variety of other animal, fish and plant foods and medicines. Community members have made significant investments in equipment needed to

harvest food from the land, such as boats, all terrain vehicles, skidoos, nets, freezers and rifles. Although not every household has all the equipment needed for harvesting, there is a high degree of sharing such that social consolidation is a key feature of traditional land use.

> The data show that harvesting is much more than simply a household activity. It is an activity that knits the community socially and contributes to the physical survival of the members. Although the households have invested considerably in harvesting technology, many households do not own each and every item of necessary equipment. The community shares as a strategy for ensuring that a household does not suffer from the lack of harvesting technology. The primary form of sharing is that of the harvester sharing the harvest with the community. Indeed, only 3 of the households surveyed did not receive a share of the harvest or share their take with community members.

The data also indicates that the traditional economy is by no means an anachronism. Participation occurs in all age levels; indeed, Staples and Poushinsky reported that Tlingit sense a resurgence of interest in traditional activities. Food from the land is important economically, culturally, and nutritionally. The nutritional value of country foods over store bought foods has been documented in many instances. Country foods provide meaning, reasons to get together to share a meal, and are part of ceremonial events.

Contemporary Tlingit harvesting is often an expensive proposition. New technology such as ATVs, skidoos and outboard motors have been integrated into harvesting activities, but imply the need for cash to purchase equipment, parts, ammunition and gas. The cultural importance of harvesting can be seen in that households will often engage in harvesting activities that would not make sense from a strictly financial perspective, such as spending $15 on gas to collect $10 worth of berries.

Participation in employment and harvesting data collected by Staples and Poushinsky also show how the cash sector and the land use sector are closely integrated. As Staples and Poushinsky state it, the data "…shows a remarkable commitment on the part of household members to marrying both the bush and cash sectors. One can surmise that for the respondents to the survey, there may be only a very indistinct barrier between these complementary activities of their lives".

While fur harvest data show that trapping still interests a number of Tlingit, it has declined in economic importance in recent years due to depressed fur prices. Tlingit also have felt the effects of local reductions in wildlife populations, some of it related to placer mining. The TRTFN also holds six commercial fishing licenses and owns one landing station. Of the non-commercial fisheries, the Taku is of great importance:

> The links to the Taku are as important today for the TRTFN as they were for their ancestors. In many respects it represents the heartland of their territory. The trails which connect to the Taku follow the same historic routes used by the Tlingit people of a century ago. Maintaining these and other trails throughout their traditional territory has become a means for both reaffirming their past as well as revitalizing an ancient infrastructure for accessing the full extent of their traditional territory. The use of these trails has become more critical in facilitating the use of

other less frequently harvested areas as hunting areas closer to Atlin are subject to increasing resource competition, development impacts and wildlife declines.

Taken together, subsistence harvesting, commercial activities like trapping and fishing together illustrate how contemporary Tlingit use of the traditional territory is extensive. All of the territory and its component hunting and fishing areas function as a system to support the TRTFN economy.

The key importance of the land to the Tlingit economy and culture can be seen from the TRTFN Constitution Act, 1993.

> 2.3 It is the land from which we come that connects all life. Our land is our lifeblood. Our land looks after us, and we look after our land. Anything that happens to Tlingit land affects us and our culture.
>
> 2.4 As Tlingit, we accept that we are a part of and responsible to our land. Everything that is a part of the land has life and spirit. Thus, we respect, protect and preserve all life and land.
>
> 2.5 As Tlingit, we do not recognize the borders imposed by any other government because we know where we come from and only we can define our traditional territory. We know that we come from this land and we are rooted in this place. It is this place, our traditional territory, that makes us Tlingit.
>
> 2.8 Historically, our people had laws and customs through which they successfully governed our traditional territory and protected it for future generations. Now, we are the caretakers for those yet to come. We are thankful and shall only take from our traditional territory what we need to ensure our well-being and self-determination as Tlingit.

An important but often overlooked aspect of First Nations economies is the informal or mutual aid economy, which exists in both and cash and land use sectors (Ross and Usher, 1986). Through clan systems, extended families and other relationships, there is an extensive set of mutual-aid relationships. People share equipment, help each other with repairs, care for the elderly, for children, for the sick, and elders pass on knowledge to grandchildren. In some instances, money changes hands, but in many it does not. This informal activity allows many needs to be met despite reported incomes being rather modest.

As someone who has worked with a number of First Nations, and has an ongoing interest in First Nations economies, I am impressed by the many signs that the TRTFN economy is healthy and that it has good prospects for the future. The TRTFN traditional territory is to a great extent yet to be compromised by industrialization, careless or inappropriate development. Regional wildlife populations, with localized exceptions, and with the exception of the Atlin caribou herd, appear to be in good health. Tlingit have a high participation rate in traditional activities, while the integrity of the clan system and the ratio of youth to adults allows knowledge and cultural values to be transferred to young Tlingit. At the same time, educational attainment and employment levels are

relatively high, while there is limited dependency on social assistance and other transfer payments. The suicide rate, an indicator of social distress, is low relative to other First Nations.

Given the ecological integrity of their traditional territory, the TRTFN also has opportunities to branch out into a number of land-based economic activities compatible with Tlingit values and conservation priorities, such as eco-tourism. The traditional land based economy acts to stabilize shocks from the cash economy, providing a consistent source of high quality, nutritious foods and other goods.

5.3 Tlingit sustainability without the TCM

Although Tlingit land use, economy and culture is currently relatively sustainable, Tlingit face their own challenges to ensure long-term sustainability. The cultural challenges are obvious, as a small First Nation ever more immersed in the cultural noise of the dominant society. Messages from television ads and program content encourage or glorify behaviour that is often at odds with Tlingit values around sharing, not taking too much, and focusing at the extended family, clan or First Nation level rather than at the individual level.

As a people who have adopted many modern technologies, Tlingit face some of the sustainability issues faced by the rest of Western society. For instance, the use of motors and fossil fuels to facilitate access to traditional lands raises issues around global warming and use of minerals. There is pressure to join in with the prevailing consumerism and pursuit of wealth. Although it will be important to wrestle with such issues, it should be kept in mind that the overall ecological footprint of the entire TRTFN as a people is small when compared to their traditional territory. The ecosystem goods and services provided by Tlingit territory to humanity more than makes up for the Tlingit footprint. The greater threat is that Tlingit culture could be overwhelmed by the dominant culture, in which case a unique and largely sustainable way of relating to the land and to the Taku River watershed would be lost.

5.3.1 Culture and Industrialization

Prospects for the project to provide net benefits to affected TRTFN are presently limited for cultural reasons. It should be recalled that the industrial revolution was slow to take off at first, largely because there was no workforce available at the time that was adjusted to factory working conditions, repetitive tasks, taking orders, and set hours of work. Instead, the workforce had been accustomed to a craft industry setting where workers were their own masters, and where work was rewarding in its own right (Polanyi, 1957). In a similar way, Tlingit culture is significantly at odds with that of the ideal industrial workforce. For most First Nations, values and cultural attitudes that contribute to success in land based activities are highly different from those of a successful shift worker:

- there is no boss, nor is there a tradition of giving or following orders; rather, leadership is fluid and contingent on the consent of other hunters;
- accumulation is frowned upon, sharing is valued and expected;
- activities occur not according to the dictates of a clock, but rather in response to environmental conditions and harvesting opportunities, and;
- work is valued in its own right, and is integrated with other parts of life.

Culture is dynamic; there is no implication that Tlingit culture needs to be put on ice. Tlingit culture has and currently is undergoing rapid change—but if change occurs too fast, culture does not evolve but breaks down. At present, Tlingit culture strongly retains many of the above values, so that partaking in wage labour can result in inner conflict, conflict within the extended family, and a crisis of identity. The above suggests that if significant numbers of Tlingit are to become wage labourers and entrepreneurs as a result of participating in the TCM project and its spin-offs, either culture will change significantly, or the TCM project needs to be carefully molded to enable aboriginal participation with minimal loss of cultural identity.

Wage employment can, in certain circumstances, boost self-esteem, allow one to better provide for one's family and buy goods helpful for engaging in harvesting activities, and replace dependency on government. The opportunity to start new businesses unrelated to the TCM could also provide such benefits, and more, if the business allows for independence, a good fit between work requirements and Tlingit culture and personal values, and flexibility to engage in harvesting activities. The challenge for Tlingit will be to find ways of participating in the economy that enrich rather than weaken culture. Tlingit can only do so much in this direction if projects are thrust upon them that are incompatible with Tlingit priorities, if the projects are simply too large, or if change occurs too rapidly.

It is likely that only a small number of Tlingit will benefit directly from wage employment or spin-offs created by the TCM. In exchange for allowing an ore body within their territory to be depleted, Tlingit should benefit from a social dividend, not just work for a minority within their communities. For Redcorp, wages are a regrettable cost of business, and whether indigenous people or others wear the hard hats is of little import. Therefore, if the TRTFN membership merely obtain work from the project, then they have not shared in the project's payoffs.

A social dividend implies that TRTFN members should not have to work at the project in order to participate in the project's benefits. If an individual feels that mining is simply not a way of life that they want to pursue, then he or she should derive benefits from the project without actually working at the mine. The *James Bay and Northern Quebec Agreement* has shown how this can be done through the income support program for hunting and trapping. If proceeds from the project are used to improve the long-term viability of renewable resource harvesting and the ability of Tlingit to pursue this livelihood, then the project will have provided social and cultural benefits and added to long-term economic viability of the Tlingit economy.

5.4 Will the TCM impede Tlingit sustainability?

The context for assessing proposed development in the TRTFN traditional territory is quite unique. Although some TRTFN members support the TCM, there is not the desperate unemployment levels common to so many First Nations across the North. Nor is there a major employer about to close down, which would have created pressure for a short to mid-term project, sustainable or otherwise, which could bridge the community to a more sustainable long-term economic activity. The TRT economy is already by and large sustainable and represents a sound base to build upon. However, signs of relative health should not be taken to imply that the Tlingit economy and culture can absorb large perturbations. There are all too many examples across the

Canadian north of how major industrial projects have undermined First Nations land use, economies and culture (Royal Commission on Aboriginal Peoples, 1996; Richardson, 1993). Once a First Nation economy and culture is undermined, costs to redress cultural and economic collapse, despair, substance abuse, health problems and other such ills skyrocket (Royal Commission on Aboriginal Peoples, 1996).

The proposed TCM risks upsetting these relatively healthy patterns of land use and economic activity, which together support a viable culture. For major industrial development to contribute to TRTFN economic and cultural well-being, past experience and relevant literature indicate that several conditions must exist:

- Tlingit ability to pursue land use activities and wildlife populations must be maintained, such that the land use sector continues to be a foundation for the TRT economy;
- Tlingit must have control over the decisions that affect Tlingit as a people;
- Tlingit determine what they understand by economic development;
- economic development should fit with cultural values, and while benefits of industrial activity should be broadly shared amongst Tlingit, actual participation in the industrial economy should be voluntary;
- mechanisms/institutions are in place provide a framework to protect Tlingit land use, to guide economic development, to ensure benefits and costs are equitably shared, and to protect the interest of future generations of Tlingit;
- development that creates the potential for major economic shocks is avoided in preference for gradual economic change where possible, in order to allow Tlingit institutions and culture time to adapt—the pace of change is within the range where Tlingit culture remains resilient;
- Tlingit have the time and resources to gain training necessary for participation in and oversight of economic development projects, and to manage change;
- adjustment mechanisms are in place to address temporary shutdowns and mine closure;
- strict environmental controls are applied, any impacts that cannot be mitigated by are compensated for, and measures to encourage traditional harvesting activities are adopted, in order to ensure that the renewable resource economy is not negatively impacted by the project, and;
- the mineral resource rent is invested in a way that procures long-term economic benefits for Tlingit.

Staples' (1997) *Addendum on Impacts* provides a thorough assessment of the TCM's likely impacts on Tlingit land use, on the Tlingit economy and on Tlingit culture. This assessment provides several indications that the above preconditions will not be met, and that the TCM "…will very likely lead to changes that can substantially affect the sustainability of TRTFN traditional land use, produce associated conflicts with TRTFN social, cultural and economic values, and increase significantly the economic uncertainties and dependencies of the TRTFN."

The available evidence strongly indicates that the TCM as currently envisioned is incompatible with Tlingit sustainability. This does not mean that the TCM could never proceed in a manner that contributed to the sustainability of Tlingit land use, economy and culture. However, the available evidence indicates that the prerequisites to ensure sustainability in the case of the TCM are quite demanding. There is no great loss to the province, to Northern BC, or to the Tlingit in deferring

the project. Indeed, the project appears marginal or even sub-marginal and Redcorp shareholders may be better off if the project does not proceed at this time. By deferring the project, financial and environmental uncertainties around the project can be reduced and the preconditions for ensuring the project makes a lasting contribution to Tlingit, local and regional economic development can be put into place. However, it should also be recognized that, at present, the best economic use of the TCM ore appears to be when it is left in the ground to maintain existing regional environmental quality and to avoid decreasing economic welfare. It is unlikely a means can be found to ensure the mine contributes to sustainability in the foreseeable future.

The key issues that need to be rigorously addressed are:

- ensuring adequate baseline data, inventories and analysis is assembled to evaluate impacts, to finalize project design and to mitigate impacts;
- ensuring government, proponent and TRTFN monitoring programs and management systems are designed and implemented to protect wildlife and ecological values and to provide early warning where unanticipated impacts occur and to provide for adaptive management;
- ensuring institutions and mechanisms are in place to allow the TRTFN to guide development and land use and to ensure TRTFN control over the development which occurs within their own territory;
- ensuring that before road construction commences access control mechanisms have a high likelihood of success, that the road can and will be effectively decommissioned and that the road will not enable other development unless such development passes its own sustainability test;
- ensuring Tlingit share in revenue generated by the project, and;
- ensuring Tlingit capacity to participate in managing the impacts of the TCM on their economy and culture.

6 Conclusions and recommendations

Project-specific data and analysis generated for the environmental assessment of the TCM was used to evaluate the TCM's contribution to sustainability. Ideally, if future environmental assessments are intended to address sustainability head-on—as they should—then data and analysis should be generated that more specifically address sustainability criteria and identified prerequisites to achieve sustainability. Available information was sufficient to demonstrate that proceeding with the TCM at the present time and as presently proposed would not contribute to, but would undermine sustainability, defeating the purpose of *The Environmental Assessment Act*. It is unlikely that further data or analysis in the areas where there is limited information to assess sustainability criteria would reverse these findings, though some refinement of assigned sustainability performance would be expected.

The Tulsequah Chief Mine does not perform well against sustainability criteria. It detracts from sustainability at regional, provincial and global scales, and it does not foster, but impedes a sound economy and social-well-being for the Tlingit. The mine is premature given that both an ecosystem-based land use plan and a treaty between the TRTFN and the Province of BC have yet to be prepared and agreed upon. The TCM performs so poorly in a sustainability assessment largely because it requires a long access road through an undeveloped region with high environmental values, a region of great importance to the TRTFN.

In delaying the TCM until meaningful measures can be put in place to make the mine more compatible with sustainability, there is little overall loss to the Province of BC, to the regional economy or to the TRTFN. Indeed, there may be no way to configure the project in a manner that makes a positive contribution to sustainability. The status quo in this instance is one that should be manipulated or departed from with great caution. The undeveloped and unfragmented landscape affected by the project currently represents an asset that is increasingly rare. It contributes to the maintenance of biodiversity, to the provision of ecosystem services and it sustains significant wildlife populations including large carnivores and other species that depend upon unfragmented habitat. The TRTFN economy and culture is relatively healthy, unlike so many other First Nations in Canada's North.

If the mine does not go ahead now, the ore remains available for future extraction. There is a risk that if the mine is delayed, technological evolution in the mining sector and other broader economic changes will cause this deposit to no longer be considered commercially viable and that in this sense the ore body will be "lost". While this would imply that Redcorp Ventures, the Province and the Tlingit had lost an asset, it would also indicate that either the metals were not needed or that alternative sources were more efficient to develop. In any event, if this is where technological innovation and market conditions are likely to lead, then it may well be that market conditions would have become unfavourable during the mine's lifespan, such that the mine would have been abandoned prematurely. Premature abandonment is likely to result in unaddressed environmental liabilities and social dislocation.

The prudent course of action from a sustainability perspective is to reject the mine at present. Meaningful and effective institutional arrangements, designed to promote sustainability for the region and the TRTFN, must be put in place prior to authorizing the type of development represented by the TCM. In all likelihood, such arrangements will at least comprise a negotiated treaty with the Tlingit and an ecosystem-based land use plan that is developed with the full involvement of the Tlingit. Until these are in place, the mine should not be authorized to proceed if it is the intent of the province to promote sustainability and to meet the purpose of the province's *Environmental Assessment Act*.

If there was a shortfall of mineral concentrates that would not be met unless new mines were brought on stream, then it would be appropriate to compare the TCM's performance against the performance of other mines around the world. Those mines that performed well would be given preference over those that perform poorly. However, there is no impending shortfall. Also, it is recognized that it is unlikely that international will exists now or in the foreseeable future to set in place mechanisms to determine which proposed mines are most compatible with sustainability, and then to proceed first with those mines that are good performers. To do so would reduce national sovereignty, and may reduce economic development opportunities for some countries (though mines that detract from sustainability are not likely to contribute to economic development, except in the short term). Countries may also feel that they should produce minerals for strategic military reasons. However, given that there is no projected shortfall for the minerals in question, there is no need to undertake this comparison before deciding whether or not to approve the TCM under BC's *Environmental Assessment Act.*

Finally, whether or not governments decide to utilize sustainability criteria, these criteria will be useful for companies and indigenous peoples, communities, and other stakeholders affected by mining. Having a set of criteria to judge mining operations presents an opportunity to raise the bar, to measure and improve performance, and to improve accountability and thereby corporate social responsibility.

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Endnotes

[1] Taku River Tlingit et al. V Ringstad et al. 2000 BCSC 2001

[2] The need to consider all scales in a environmental assessment that addresses sustainability was confirmed during a meeting of environmental assessment and sustainability experts convened as part a research project titled *Specification of Sustainability-Based Environmental Assessment Decision Criteria and Implications for Determining the Significance of Environmental Effects*. The project is funded by the Canadian Environmental Assessment Research and Development Programme and is directed by Dr. Robert Gibson of the University of Waterloo. Gibson, R. and Whitelaw, E. (in press) "The Environmental Assessment, Sustainability and Significance Workshop." Cecil Green College, University of British Columbia, 7-8 June 2001.

[3] Red Hill Creek Expressway Review Panel, Environmental Impact Statement (EIS) Guidelines for the review of the Proposed Red Hill Creek Expressway North-South Section Project, October 15, 1999.

[4] The need for a 90% reduction in material intensity in OECD countries was acknowledged in the October 1994 Carnoules Declaration, endorsed by prominent individuals including the former executive directors of the Business Council for Sustainable Development and the Brundtland Commission.

[5] Unfortunately, the research initiative to did not get funding.

[6] Full-cost or true cost pricing involves setting prices or adjusting prices so that they better reflect the social and environmental costs of production.

[7] For such rights to make a significant contribution to global sustainability, indigenous peoples and local communities around the globe would need to have the right to refuse inappropriate development. The way resources are extracted would likely change so that fewer social and environmental impacts resulted, contributing to sustainability, and the price of raw materials would likely increase, leading to improved resource efficiency over the long-term.

[8] This is not to imply that it is possible or necessarily desirable to control global mineral production and consumption by approving or rejecting individual mining projects, just as allowing or prohibiting a given farmer from growing tobacco may not materially affect total tobacco or food production and consumption. However, if there are two farmers, the first of whom grows food, while the second grows tobacco, the first is likely to be contributing to meeting human needs while the second is likely to be contributing to a public health problem. Market prices and total quantities of minerals produced and consumed would respond to the decision to approve or reject a given mining proposal in a manner that reflects the elasticities of supply and demand for the minerals in question, with a decision to reject a larger projects generally resulting in larger impacts on these variables than a decision to reject a small project. Short-term demand is relatively inelastic, as demand for minerals is as a result of derived demand in that people want, say, energy storage capacity facilitated by lead batteries, not lead itself; it takes time to increase resource efficiency or to develop substitutes. Short-term supply is less elastic than long-term supply as it takes time to locate and develop mineral resources, to improve extraction techniques, or to develop the capacity to increase the rate at which minerals are recycled. Therefore, short-term impacts of a decision to reject a project on mineral prices will generally be greater than long-term impacts. However, effects on the time-path of total consumption will be more difficult to predict. If a given mine does not proceed, other mines may fill in the gap and total consumption may be unaffected. However, if the mine is large, or if the marginal change in production levels has a non-trivial effect on prices and consumption, total consumption may decline. It may also turn out that withholding production at a given mine does not materially affect the time-path of total consumption, but that price is increased. All this being said, from a sustainability perspective it is relevant to examine what a mine produces and how this output is likely to be used, and to give higher scores to mines that produce minerals that meet human needs.

[9] See Daly, 1996, pages 220-222, Durning, 1992, Max-Neef, 1992

[10] "The average income in the richest 20 countries is 37 times the average in the poorest 20". Almost half of the world's population lives on less than $2 US/day. (World Bank 2000 p. 3)

[11] Goodland et al., 1992; Daly, 1996; Wackernagel and Rees, 1997.

[12] Given that demand for weapons is largely inelastic, it may in fact imply a perverse result that if total production of minerals is reduced, minerals will first be used to meet weapon production requirements, and other uses that would make a contribution to human well-being would not be satisfied as they could not compete against higher mineral prices. This is one of the higher level issues that cannot be resolved at the project level.

[13] See for instance Ayres and Ayres, 1996; Azar, Holmberg and Lindgren, 1996, Daly, 1992, 1996; Duchin and Lange, 1994; Goodland and Daly, 1995; Meadows, Meadows and Randers, 1992; OECD 1997b; United Nations, 1997, von Weizsäcker, Lovins, and Lovins, 1997.

[14] WCED 1987.
[15] See various assessments by the Intergovernmental Panel on Climate Change.
[16] Azar, Holmberg, and Lindgren, 1996; Ayres, 1996.
[17] Campbell and Laherrère, 1998.
[18] Cutler, 1991.
[19] Georgescu-Roegen, N., 1971; Cutler, 1991, Ayres, 1978.
[20] Cutler, 1991; Ayres, 1978.
[21] EMCBC, n.d.; Sierra Legal Defence Fund, 1998.
[22] WCED, 1987; Common, 1995; Cragg and Schartz, 1996; Goodland and Daly, 1995; Daly, 1996; Young, 1992; Young and Sachs, 1994.
[23] OECD, 1989; Costanza and Cornwell, 1992; Conference Board of Canada, 1993.
[24] Pigou, 1920; Pearce and Turner, 1990; Daly, 1992,
[25] WCD 2000, p. 18; Bartek (2001) explains why this problem is particularly severe for junior mining companies.
[26] Taggart, 1999; Power, 1996; Auty, 1993; Wall, 1987; O'Faircheallaigh, 1992; Myers, 1998.
[27] Sen, 1987; Ruitenbeek, 1996.
[28] Power and Whitelaw, 1997; Power and Niemi, 1998; Power, 1996.
[29] Taggart, 1997.
[30] WCED 1987; El Serafy, 1989; Daly, 1992, 1996; Common, 1995.
[31] WCED, 1987, Cragg and Schwartz, 1996; WCD, 2000.
[32] O'Riordan and Cameron, 1994
[33] WCD, 2000:218.
[34] Holling 1994; Grumbine, 1994; Azow et al., 1996.
[35] Lindenmayer, et al, 2000; Callicott, et al., 1999; Yaffee, S. 1999; Grumbine, R. 1997, 1994, 1993; Mangel et al., 1996; Noss et al., 1996; Duak, 1995; Burton et al., 1994,
[36] Duak, 1995; Grumbine 1997, 1994, 1993.
[37] Jacobs, 1991.
[38] Jordan et al., 1987
[39] This parallels the Canadian government's "no net loss" principle for fish habitat management.
[40] O'Riordan and Cameron, 1994
[41] Many abandoned sites significantly contribute to ecological deterioration and stress, yet funds for reclamation and restoration are limited, and the responsible companies have dissolved, are insolvent, or are protected from liability. This approach would allow two problems to be simultaneously solved.
[42] Note that depending on whether the copper-lead concentrate is sent to a copper or lead smelter, copper or lead will be the main metal recovered. There is also the possibility that the copper-lead concentrate could be subject to further differential flotation to produce a lead concentrate and improve the quality of the copper concentrate. For the purposes of this study, it is assumed both are recovered. As well, the mineral concentrates are contaminated with cadmium, mercury, arsenic and antimony in small amounts. Proceeding with the TCM, therefore, introduces more of these heavy metals into the environment, though smelters face increasingly strict emission standards.
[43] If most US consumption of zinc was incorporated into products that were then exported to the Third World, this conclusion would not necessarily hold. However, overall, the US is a highly material intensive society.
[44] When sulphide bearing rocks are broken up and exposed to water and oxygen, sulphuric acid is created that leaches out metals. The metal-laden acidic solution is known as Acid Mine Drainage; it can be more acidic than battery acids.
[45] Letter from Howard, K. to Norm Ringstad, November 15, 1997. Cited in Pearse (1998), p.22.
[46] El Serafy suggests that the rate r should be based on the prospective real rate of return that can be achieved in new investments. The author believes that such a rate of return should be based on factoring in all social and environmental costs. Given how unsustainable most industrial activity currently is, and the already high rates of renewable resource use, rates of return of new investments in renewable resources in a sustainable economy are likely to be modest. Accordingly, this study would advocate a precautionary r of between 2 and 4%. Higher values of r increase the level of risk faced by future generations.
[47] Two formats can be used. Typically it is written in the form n+1 and applied when payments are made at the beginning of each year. In this case the form n is preferred and receipts occur at the end of each year.
[48] Does not include significant emissions of CO_2 as a by-product from lime production required to neutralize AMD.