World Nuclear Association Annual Symposium
3-5 September 2003 - London

Impact of Nuclear Regulation on Uranium Project Sustainability

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Nuclear Regulation as Applied in Canada

As in many countries, Canada has established a national regulatory agency that deals solely with the development and application of nuclear energy. While there are other federal regulatory agencies that deal with specific aspects of the nuclear fuel cycle business in Canada, a federal nuclear agency, the Canadian Nuclear Safety Commission (CNSC), usually takes the lead role. There is some involvement from the national environmental agency, Environment Canada, as well as an agency structured to deal with Canada's fisheries (Department of Fisheries and Oceans), the national health care regulatory agency, Health Canada, and the national labour regulator, Human Resources Development Canada. In the case of Canadian uranium mine development, there is also a strong provincial regulatory interest. The provincial environmental agency, Saskatchewan Environment, takes a co-management role on regulating environmental matters with the CNSC, as does Saskatchewan Labour on health, safety, and radiation protection issues. The two lead regulatory agencies, the CNSC and Saskatchewan Environment, generally dedicate one project officer each per uranium mine site. This helps coordinate regulatory efforts, both within a given agency and between the various agencies charged with regulating Cameco's affairs.

There are two main phases to the regulatory approval process. First is general government approval to proceed with the project. It currently takes in the order of one decade to obtain these conceptual approvals for a major new nuclear fuel cycle operation. A large portion of that time is spent in environmental assessment. Early on in a project's life, there is fairly wide ranging assessment of the more generic, or "big picture", issues. A modern uranium project must convincingly demonstrate how it will not generate significant environmental impact either during operation or upon completion. The project must also demonstrate social and economic benefit to local communities. In northern Saskatchewan, these objectives are codified in the initial government approval process through a surface lease arrangement.

The second regulatory approval phase is the actual licensing process. This involves approvals by government-created regulatory agencies, as opposed to the government itself. Permits are required to construct, operate, modify and decommission a particular facility or part of a facility.

As outlined above, and as practised in other countries, there is an extensive regulatory oversight mechanism for the nuclear fuel cycle. This regulatory system has a major influence on Cameco's business. Consequently, the regulatory system can also have a large influence on such matters as incorporation of sustainable development concepts into our business plans. The key is to demonstrate that no significant trade-offs are required to ensure that both the environment and health and safety of people are protected, while maximizing social and economic benefits for impacted communities. The purpose of this Paper is to outline how the regulatory system, as practised in Canada, influences Cameco's ability to manage its affairs in alignment with sustainable development goals.

Definition of a Sustainable Uranium Project

Although the term 'sustainable development' is commonly used today, there is no one commonly accepted definition as it applies to Cameco's business. It could be argued that the term is simply a modern name for the long-standing practice of diligent, responsible management. Most definitions of sustainable development encompass what has become known as the triple bottom line: economic growth, environmental protection, and social progress. For Cameco, it means that sustainable growth is realized by building on our core business strengths through socially, environmentally and economically responsible conduct. The key measures of our success will be a healthy workplace, a clean environment and supportive communities wherever we operate, together with solid financial performance, all reflected in a growing return to shareholders.

The thesis of this Paper is that modern uranium mining and processing facilities follow the principles espoused in sustainable development. Mining and milling of uranium must not inhibit the health of, or use of, adjacent resources, water or land. However, we must also keep reminding people that the concept of sustainable development includes the word development, not just the word sustainable. Nuclear advocates, generally being forward looking, optimistic people, are supportive of the view that material human progress through energy development is both a desirable goal and one which can be carried out in an environmentally sustainable fashion.

The issues that are raised about uranium production have changed little over the past three decades. There seems to be little acknowledgment from over-detractors that the industry has evolved and that issues are being addressed. There has been strong regulatory influence on these advancements.

Areas of Regulatory/Sustainable Development Alignment

Preamble

One of the hallmarks of nuclear industry regulation is the assemblage of a group of people with specialized expertise, tasked with the job of technically regulating a fairly complex industry. These experts are charged with the responsibility of representing the public, and are consequently primary stakeholders in all nuclear project developments. Not only must we convince ourselves that what we are doing has long-term sustainability, but we must also convince an independent,

technically astute regulatory agency that this is the case. While the presence of such a third party reviewer may provide limited comfort to ardent nuclear opponents, it forces us to examine the long-term impact of our activities and to justify them. In short, the specialised nature of the business leads to a specialized set of regulators, which, in turn, leads to a rather extensive analysis of our affairs. Public opinion creates this need for extensive examination, which means that nuclear projects approved for development, and for continued operation, must factor in sustainable development considerations if they are to succeed. We must have both regulatory and social licenses to operate. The purpose of this section of the Paper is to show how the current stable of regulatory priorities and initiatives is fully compatible with the pursuit of sustainable uranium project development.

Current Regulatory Priorities as Viewed in a Sustainable Context

Openness, Transparency and Public Consultation:

There is a growing trend for Canadian regulatory agencies to be more open and transparent in their decision-making processes. This is also their expectation for licensees as well. More public consultation is expected, not just in early phase project development environmental assessment, but also in the day-to-day affairs of the facility. In northern Saskatchewan, the provincial government has established environmental quality committees, which play a major role in local community public consultation. In addition to regular review of environmental performance and discussion of new initiatives, local consultation efforts have generated both a community-based environmental monitoring programme and environmental indemnification agreements to ensure nearby communities that the impacts of our operations are as minimal as we claim. Maintaining a dialogue with neighbours is a hallmark of sustainable development. Both industry and regulators have responsibilities for community engagement, and must do so in a cooperative fashion.

Continual Improvement:

In addition to the use of ALARA optimization to reduce workforce and public radiation dose, there is a similar theme of promoting continual improvement in environmental activities. This is enshrined in the ISO 14000 series guidelines for environmental management systems, and is either overtly or implicitly assumed in the regulation of fuel cycle facilities. Endorsement of this international standard, both by the regulator and the Canadian uranium industry, complete with a commitment to continual improvement, is another hallmark of sustainable development.

Non-Prescriptive Regulation and Promotion of Self-Management:

The promotion of additional measures of non-prescriptive regulation and licensee self-management is a trend within the nuclear sector. There is an existing, relatively high level of regulatory control. Therefore, change from the status quo often manifests itself as less, rather than more, regulation. It may not be immediately clear how this relates to sustainable uranium projects. In fact, some would argue that this trend is antagonistic to sustainability, since the regulator should be relied on to control the impact of the project, and not the licensee.

Three comments are offered. First, a hallmark of sustainable development is the willingness to be held to higher order societal standards, not just environmental standards. This means there must be a higher level of industry self-management. Secondly, in the long run, sustainability, like responsibility and accountability, must be entrusted to those most capable of influencing outcomes. Finally, industry self-management of regulatory matters does not mean less regulatory control, just a different form of control. It manifests itself in such concepts as formal environmental and safety management systems, regulatory required quality control, or quality management systems, as well as organizational and management effectiveness audits. The regulator promotes use of all of these management system analytical tools. In Cameco's case, operating license conditions have required the development of both corporate and licensed site quality management systems.

Long-Term Environmental Modeling:

One of the hallmarks of a sustainable uranium project is a well thought-out waste management plan. From an environmental perspective, waste management is the most critical long-term post-closure impact. In the case of a mine/mill complex, this means uranium mill tailings and waste rock. Much effort is put into developing confidence that there will be good long-term control of these waste materials. Much of the pre-development environmental assessment work needed to obtain a licence centres on post-closure rather than operational phase impact. Long-term modelling is the tool which must be used to predict future behaviour. While there are some obvious flaws in assuming that we can do a completely accurate job of predicting environmental impact some thousands of years hence, just going through this rigorous process has undoubted benefit in a sustainable world, forcing one to ask questions and think about long-term behaviour. *Figure 1* is an example of the estimation of long-term waste rock performance, illustrating the anticipated effects of various contaminant interactions and retardation mechanisms as water migrates through a waste rock pile. In the case of radionuclides, one must also factor in variable decay and in-growth times.

There is reason for some confidence in this long-term modeling. There are natural performance analogues, such as the lack of significant radionuclide migration from high-grade deposits, and uranium presence in lake sediments deposited over geologic time, commonly used to explore for new deposits. A classic decaying exponential-type response of contaminant concentrations with time is the most common result in laboratory simulated long-term leach testing. This provides every reason to believe that the environmental impact from such waste material contaminants will decline with time, not just from nuclear decay, but also from soluble mineral depletion.

Concepts such as pervious surround tailings disposal and segregation of problematic waste rock while it is being mined are good examples of long-term thinking. One of the more interesting aspects of this work is the fact that long-term design considerations for these waste materials tend to focus not so much on the radionuclides as on the other contaminants, such as arsenic and nickel. Whether the design objective is a walk-away solution or long-term institutional control, there must be safety for the occasional future visitor to the site and the

liability must not be allowed to grow unbounded. Sustainable development demands careful control of waste materials, and such considerations are front and centre in the regulatory approval process. The inability to generate credible long-term waste management plans would prevent project approvals in the modern regulated world. Unlike other nuclear waste management projects, waste management for uranium projects generally does not have to deal with the issue of where to dispose the wastes, this being settled by the location of the ore body. Regardless, good analysis of the issue is required.

Application of the Precautionary Principle:

The general application of the precautionary principle in government policy has had strong influence on the regulatory approval process. While it has not gone as far as assumed guilt before proving innocence, it has tended to promote conservative decision-making. As the level of uncertainty increases, so does the level of conservatism. While detractors may accept nothing short of a moratorium on new development in pursuit of the precautionary principle, a less extreme version of this principle is clearly at play within the regulatory approval process. Precautions, in combination with prudence, are an important aspect of sustainable development.

Environmental Research:

In Canada, there has been heightened regulatory promotion of the idea of industry-sponsored environmental research. In the context of northern Saskatchewan, this includes the need to develop region-specific environmental effects data, in addition to the normal requirement to advance basic understanding of environmental behaviours. In conjunction with our colleague, Cogema, we have undertaken a number of initiatives to better understand the interactions of our facilities with the environment. Primary focus has been on prediction of future waste rock and tailings behaviour as well as better understanding of the impact of our effluents on the aquatic environment. Being able to better understand current and future environmental impacts from our operations aligns well with sustainable development concepts.

There has been a significant shift in the area of the aquatic environmental assessment. Traditionally, the focus was almost exclusively on chemical analysis of treated effluent. While such analysis still defines the core regulatory requirement, we now routinely carry out acute, and in some cases sub-acute, or chronic, toxicity testing of fish, as well as more detailed analysis of the near-field receiving environment. This includes such things as phytoplankton enumeration and benthic invertebrate toxicity testing in addition to the more conventional analysis of contaminant pickup and growth rate in fish. All of this additional study leads to a better understanding of both current and future environmental interaction.

Comprehensive Environmental Assessment:

Canada, like many other countries, has developed a comprehensive environmental assessment process, which must be completed before new fuel cycle facilities are licensed, or for significant changes to existing facilities. These wide-ranging,

independent processes provide a high level of assessment before a project is allowed to proceed. As shown in *Table 1*, the McArthur River project took 11 years to evolve from exploration discovery to production mining. The Cigar Lake project is currently in a construction licensing phase environmental assessment. This ore deposit was discovered in 1981.

There have been major increases in both the time required to carry out environmental assessment and the necessary scope of such assessments over the last two decades. While, as an industry, we may have concerns with the amount of time necessary to develop a new project, there is no doubt that the process of thorough, independent analysis prior to design, construction, and operation of a new facility is fully compatible with sustainable development, particularly in the area of post-closure analysis. One would be hard pressed to find many other industrial sectors that go through such extensive pre-development assessment on a consistent basis.

Safety Culture:

The CNSC is becoming increasingly interested in the concept of safety culture as practised within its licensees' organizations. A safety culture delves into factors that influence human behaviour, particularly those dealing with an individual's perception of the importance of safety to the organization. A safety culture must foster a genuine desire to make the process of seeking improvements a hallmark of the type of behaviour expected within the organization, tackling issues head-on in a non-accusatory and constructive fashion. One of the desired outputs is a reduced frequency of accidents. As shown in *Figure 2*, Cameco has seen significant strides in lost-time accident frequency since its inception in 1988. We do not claim that this favourable trend is the exclusive output of a healthy safety culture. For instance, the trend towards more reliance on remote mining to control radiation exposure has conventional safety benefits as well.

Promotion of safety culture is complementary to the concepts of sustainable development. Safety of workers and members of the public is the number one social obligation we have in sustainable development. A safely run organization is less likely to encounter significant problems and consequently less likely to generate negative impact on people and the environment. There is good correlation between high-performance in dealing with current day issues, and high-performance in dealing with long-term issues. The same sort of questioning attitude is required in both instances. The extent to which we protect the health and safety of employees can also translate into the attitude held towards public safety.

Risk Management:

Much of the day-to-day business of managing and regulating a nuclear enterprise focuses on risk management. Both the licensee and the regulator want to practice risk-informed decision-making, putting the effort where it can generate the most benefit. Debates as to where to put this effort are a sign of a healthy risk-based decision making process. Tools such as the establishment of performance indicators in key environmental risk areas, and the use of risk assessment tools

such as Hazop analysis are commonly applied in the nuclear industry. Fuel cycle activities are much less likely to use tools such as probabilistic risk analysis, but it must be borne in mind that such facilities live in two worlds, both the nuclear and the mining worlds. This means that we need to manage both natural and man-made risks. With natural risk comes the need for higher levels of adaptability to changing conditions.

Risk reduction initiatives have become commonplace. For instance, major strides have been made in waste minimization and recycle, reduced water usage, and such concepts as secondary containment around key pipelines and processing facilities. Suffice it to say that ongoing risk reduction is a hallmark of sustainable development.

Decommissioning Financial Assurances:

It has become standard practice to provide hard financial assurances for the eventual decommissioning of fuel cycle facilities in Canada. Bank-issued letters of credit (LOC) are the most commonly used form of financial assurances for non-government-owned companies. Not only does this process provide financial assurances that the licensee rather than the public will bear the reclamation costs, it also promotes such concepts as "design for decommissioning", full cost decision-making, and progressive decommissioning, or reclamation of facilities once they are no longer required, rather than at the end of a facility's life. At present, the six Cameco-operated Canadian fuel cycle sites carry C$143.4 million or €90.2 million LOCs. As shown in *Table 2*, a significant percentage of the anticipated decommissioning costs are focused on the waste management aspects of the business. In many respects these financial assurance requirements address the intergenerational equity issue which is so often discussed in sustainable development.

Conclusions

Potential Areas of Conflict:

The fundamental conflict lies in the perceptions of sustainability that each of the stakeholders hold, and the ability of the proponent, or operator, to meet those expectations. Operators naturally view sustainability in the context of the sustainability of the enterprise. Regulatory agencies impact primarily on the environmental aspect of sustainability. Their prime role is to ensure that the environment and health and safety of workers and the public are well protected. They have some interest in the social dimension of sustainability, but very limited interest in the economic dimension of the issue. While trade-offs between social and environmental requirements are not permitted, the demands of both must be met. Progress can be made on both fronts. *Figure 3* shows the impact of employment objectives in the development of the mining sector in northern Saskatchewan. Steady progress is evident in the ability to provide social benefit to northern communities.

While regulatory agencies can help licensees maintain the path towards sustainability, overuse of the precautionary principle carries with it the potential for overuse of conservative decision-making. Similarly, if regulatory agencies

judge us against the wrong set of performance indicators, or develop an over-reliance on grading various programme elements, there is the risk of driving risk reduction efforts in a non-optimal direction. For example, ongoing focus on routine emission reduction would not be desirable if done at the expense of reducing the risk of significant accidental release.

While ongoing research into the environmental impacts of our operations has merit, efforts are needed to ensure that research needs do not become confused with licensing requirements. Licence decision-making will always take place in the presence of some level of uncertainty. Similarly, while progressive decommissioning during operation is a laudable goal, it also requires some progressive regulatory decision-making as well.

There are also practical social problems associated with the development of sustainable uranium projects. For instance, we can meet some, but not all, economic expectations of local communities, and there are problems with aligning operational requirements with the level of technical knowledge within the workforce. A significant commitment to training and education is needed to meet these social needs and regulatory requirements.

Outlook:

Regulatory agencies quite naturally reflect the current thinking and priorities of the society in which they work. If sustainable development has some societal priority, it evokes government policy, which then generates supporting regulatory initiatives. In applying sustainable development policy, nuclear regulators have the benefit of thorough assessment tools to judge sustainability. Significant progress towards sustainability has been made over the past few decades, a fact that is often overlooked in discussion of the issues surrounding uranium development.

With ongoing industry consolidation comes the expectations of common approaches to issues. In terms of international development, lenders, NGO's and shareholders are all demanding the use of common environmental standards throughout the world. This too aligns well with sustainable development principles.

On balance, we hold the view that the pursuit of sustainable uranium projects is compatible with modern regulatory requirements. Pursuit of these regulatory requirements helps drive us to the desired goal. Having said that, there are obvious and necessary tensions between the regulator and the regulated, since the mandate of the regulatory agency can never be totally aligned with the mandate of a modern industrial enterprise. Cameco has multiple stakeholders - employees, communities, customers, and business partners in addition to regulatory agencies. All demand that we meet the highest possible standards of social, environmental and economic responsibility. Cameco has embedded these principles of conduct in its corporate vision and mission statements. We have agreed that the measure of our success will be a clean environment, a healthy workplace, and supportive communities, along with solid financial performance.

Table 1. Modern Uranium Project Timelines

Milestone	**McArthur River**	**Cigar Lake**
Initial Discovery	1988	1981
Test Mining Environmental Assessment	1992	1987
Start Test Mining	1993	1988
Main Project Environmental Assessment	1995	1995
Government Approval to Proceed	1997	1998
Waste Rock Environment Assessment	N/A	2002
Construction Licence Environmental Assessment	N/A	2003
Construction Licence Issuance	1997/1998	2004*
Operating Licence Issuance	1999	2006/2007*

* Forecast

Table 2. Distribution of Uranium Mine/Mill Decommissioning Costs

Area	**Key Lake/McArthur River**	**Rabbit Lake**
	(% Overall Project Costs)	**(% Overall Project Costs)**
Env. Assessment/Licensing	4.6%	5.3%
Project Management	16.4%	16.7%
Mine	1.0%	14.4%
Mill	4.5%	9.7%
Support Facilities	5.8%	1.2%
Tailings	48.6%	35.6%
Waste Rock	9.7%	10.9%
Revegetation	6.7%	2.2%
Post-Decommissioning Monitoring	2.7%	4.0%
Total	**100% ($53.6 M)**	**100% ($35.9 M)**

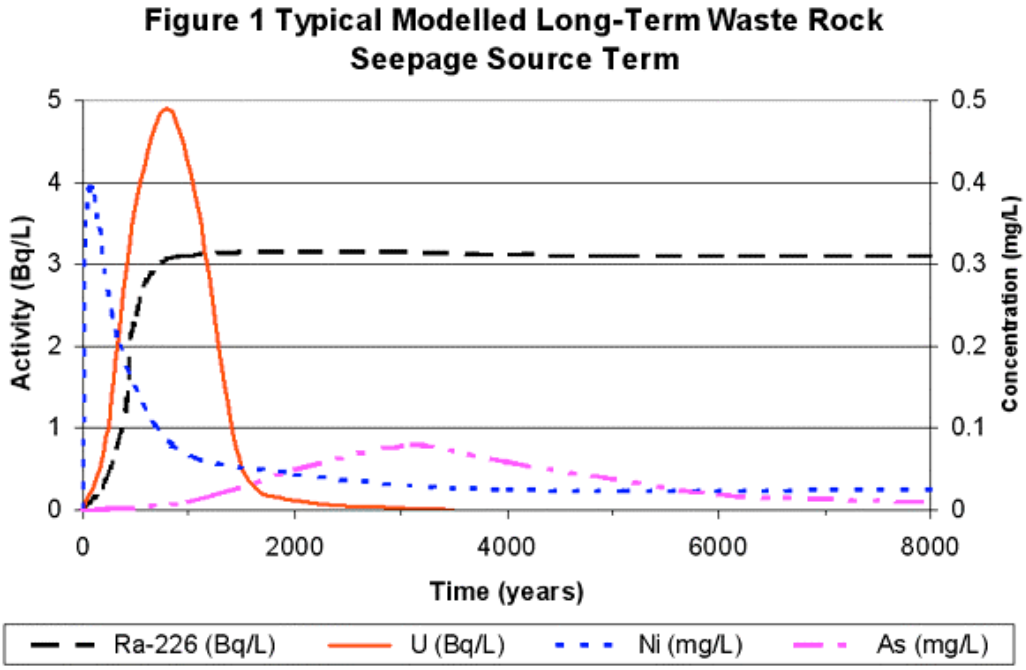


Figure 2. Cameco Employee Lost Time Injury Experience

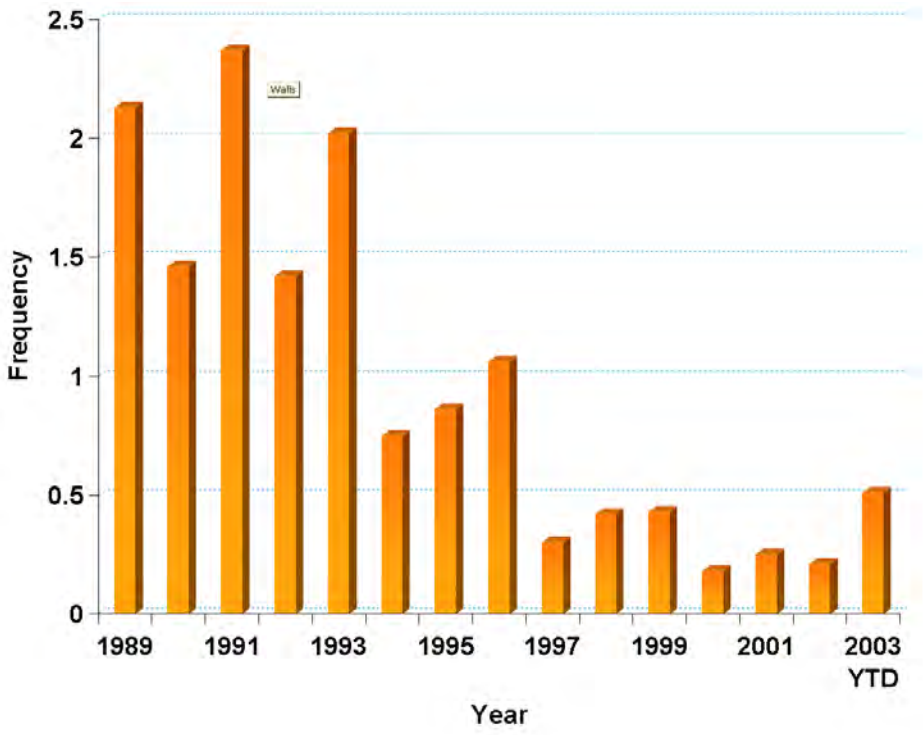
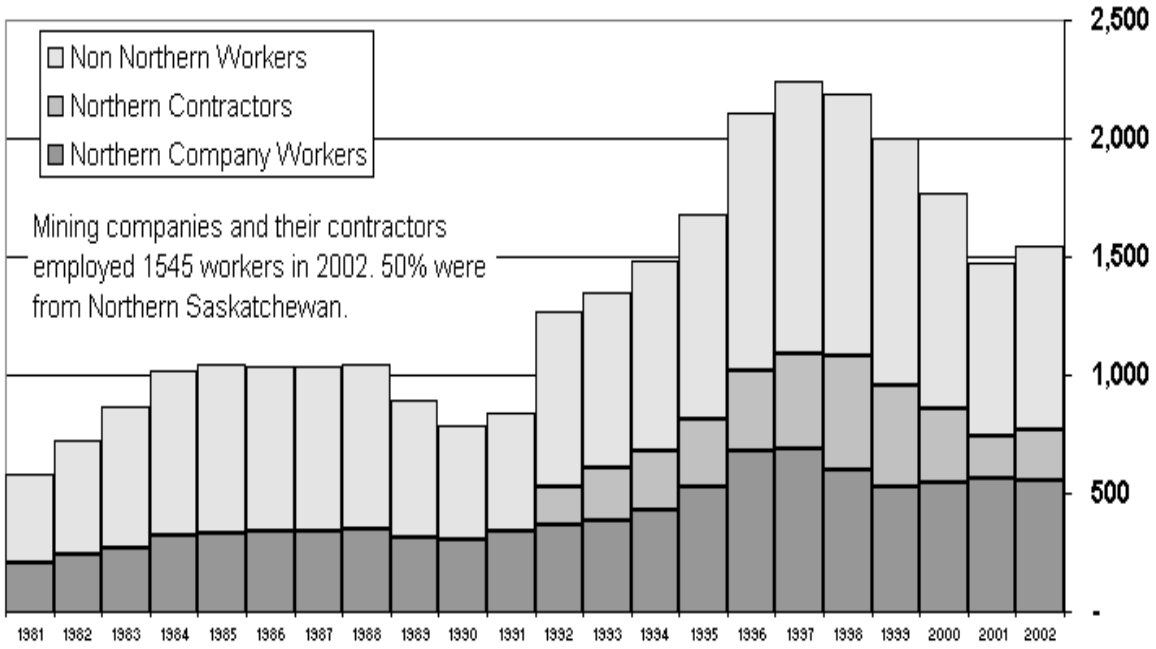


Figure 3. Trends in Northern Saskatchewan Mine Site Employment



Source: Saskatchewan Learning, La Ronge. Yearly averages of Quarterly Reports from Mine Companies and Contractors. April 17, 2003