CANADIAN ZINC CORPORATION

PRAIRIE CREEK MINE
DEVELOPER'S ASSESSMENT REPORT

APPENDICES 19 to 33 Volume 4 of 4

SUBMITTED IN SUPPORT OF:

Environmental Assessment of
Prairie Creek Mine EA 0809-002

SUBMITTED TO:

Mackenzie Valley Review Board
Yellowknife, NT X1A 2N7

SUBMITTED BY:

Canadian Zinc Corporation
Vancouver, BC V6B 4N9

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LIST OF APPENDICES

APPENDIX 19

Socio-Economic Impact Assessment for the Prairie Creek Mine

Canadian Zinc Corporation and

Impact Economics

3/1/2010

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Executive Summary

The Prairie Creek Mine Project is 100% owned by Canadian Zinc Corporation. It is situated in the southern Mackenzie Mountains of the Northwest Territories, approximately 100 kilometres northwest of Nahanni Butte. Much of the site was built up 30 years ago, having received land and water permits in 1980 and 1982 respectively. Three months prior to the mine going into operation, all activities were halted and the project was placed into receivership. The site has been on a care and maintenance schedule ever since.

Because much of the property was previously developed, the Project's construction phase will be modest at $59 million. This investment will raise the Northwest Territories gross domestic product (GDP) by $24 million when considering the direct and indirect impacts. Construction activities will span two years with the majority taking place in the second year and will require a workforce of up to 120 people at its peak.

Once into its operations phase, the Project will employ approximately 220 people, working a three-week in/three-week out schedule. The known lead and zinc deposit is expected to sustain an underground mining operation for 14 years. Total expenditures will approach $1 billion (based on 2008 prices) over this time frame. This will raise the Territory's GDP by an average of $68 million annually, create 138 additional jobs, and raise labour income by a total of $28.4 million.

The real economic and social impact of this project will be generated through the participation of local labour and business from within the Project's defined Study Area which includes the communities of Nahanni Butte, Fort Simpson, Fort Liard, Wrigley and Lindberg Landing. Participation will come in the form of direct employment, direct supply of goods and services, and through spin-off activities described as indirect and induced effects of the mining expenditures.

Local labour and business will be given preferential treatment when accessing jobs and goods and services contracts. This measure will help raise the level of participation over time. Based on a review of the existing labour pool and a projection of the potential workforce, direct employment at the mine could rise to as many as 70 Study Area residents over the medium to long term. When coupled with participation of local business and the related employment opportunities, the Project could increase overall employment across the Dehcho region by 153 jobs and result in an $11 million rise in labour income.

The participation by labour and business will have positive and negative impacts for the Study Area communities. In assessing potential economic and social impacts, Canadian Zinc has studied in great detail the socio-economic conditions present in the region including an assessment of the prospects for economic and social performance should the Prairie Creek Mine not go ahead. Poor education, high unemployment, low income levels, inadequate housing and high crime rates are well known socio-economic realities in these communities. These conditions, when considered in combination with the lack of any new economic growth opportunities over the medium term, elevates the importance of the Prairie Creek Mine from perspective of economic, social and long-term sustainability.

Similar to what occurred in communities affected by the rise of the diamond industry, there will be a period of adjustment as people and communities integrate into the wage economy. The negative impacts will be mitigated in part through what will likely be a gradual increase in local participation and through a commitment from the proponent to implement its mitigation program in full over the entire life of the Project. Canadian Zinc has proposed a mitigation strategy specific to the needs of the Study Area communities that will include Impact and Benefit Agreements with local First Nation groups, that supports long-term, sustainable growth of the Study Area communities, and will reduce or eliminate potential negative social impacts that might occur as a direct, indirect or induced effect of the mining operations. Regardless of residency, all employees of the Company will receive a competitive compensation package and will be supported by a modern human resource management plan.

Canadian Zinc is confident that the Study Area communities will succeed in increasing their resilience to outside pressures and become better able to cope with and benefit from future projects. The rise in financial wealth and all that it affords directly and indirectly will more than offset the anticipated adjustment period. For those living in the Study Area, the Prairie Creek Mine offers an opportunity for a generation of employment, leaving as a legacy a population that is better educated, better trained and better able to cope with, adapt to and capture new opportunities in the future. Through the individual and collective efforts of employees and their families, communities and their residents, and with cooperation from governments at all levels in providing the right network of support, including effective implementation of existing public programs, the economic growth that the Prairie Creek Mine will bring to the region offers an opportunity to initiate positive and sustainable socio-economic change throughout the Study Area.

Conformity Table

	SEIA Section(s)
3.2.4 Description of the Existing Environment: *Human Environment*	
13) The location and description of any historic developments related to the Prairie Creek Mine outside the scope of currently proposed development (e.g., the Cat and Grainger Camps, exploration roads and drill sites);	–
14) Any other physical infrastructure present in the EA Study Area, including habitations, roads, buildings, quarries, power lines and industrial works;	–
15) Current and proposed protected areas status of the EA Study Area, with an emphasis on the Prairie Creek Mine's proximity to the current and proposed NNPR boundaries, and a description of how the *Final Draft Dehcho Land Use Plan* treats the EA Study Area;	–
16) Existing traffic patterns along Territorial Highway 7 (the Liard Highway) from the Northwest Territories border to the winter road turnoff north of Lindberg Landing, as well as identification of any seasonal road use restrictions;	5.3.4,7.7.6.2
17) The availability and average training/skill levels of the local and Dehcho regional labour pool and local and regional business capacity	5.2.2,5.2.3,5.3.3, 5.4.1,7.3.2.2
18) Current socio-economic conditions and relevant trends in the potentially-affected communities and the Dehcho region as a whole, using appropriate indicators of well-being and quality of life	Chapter 5
19) A summary of historic and present land use in the study area, including identification of traditional land use groups and the areas they tend to frequent;	TK and Archaeology Reports,7.8.1
20) Traditional harvesting activities for - and traditional values about – all relevant animal (including fish) and plant species, including annual average harvesting data by species;	TK and Archaeology Reports,7.8
21) Known physical heritage resources locations, areas of high potential for unfound physical heritage resources such as mountain passes, and cultural values associated with the EA Study Area,; and	TK and Archaeology Reports
22) Other economic activities the EA Study Area is currently used for, with emphasis on traditional economic activity, outfitting and Parks-related tourism.	5.3.2
3.4.1 Employment and Business Opportunities The developer will assess the potential impacts of the Prairie Creek Mine on the economy of the Mackenzie Valley, with a focus on the Dehcho region and each potentially-affected community. In assessing access to employment and business opportunities, the developer will provide:	
Employment	
1. An estimate of human resource requirements for the development that includes a listing of all direct and contract employment requirements by skills category for each phase of the life of the Prairie Creek Mine. The developer will identify the skill-levels that each position requires, and shall include employment in all aspects of the operation of the mine, including for example transportation and monitoring activities	7.1.3,7.2.3,7.3.1.1, 7.3.2.1,7.3.2.3,7.5
2. An assessment of the likely percentage of direct employment for northern and aboriginal residents at the Prairie Creek Mine, in light of the current and likely future (extending for the expected 20 year life of the mine) labour pool context (i.e., likely available numbers of workers in light of total regional economic activity), and identification of any target goals for northern and Aboriginal employment;	7.3.2.2,7.5
3. A description of any barriers to direct or contract employment, advancement and retention for Mackenzie Valley residents, with particular emphasis on Dehcho residents and Aboriginal people. This description must include employee availability and employability in light of minimum skill requirements and an investigation of current training opportunities for community members. The developer will also discuss:	7.3.2.1,7.7.2
a. Current skills gaps in the available labour pool that require additional training programs;	5.2.3,7.3.2.2,7.7.2
b. Hiring and retention policies related to minimum education levels, criminal records and drug and alcohol use;	IBAs, HR Management Plan,7.7.2,7.7.3,7.7.4,7.7.6,Chapter 10,11.2
c. Any identified barriers to maximizing regional and Aboriginal employment.	7.3.2.2,7.7.5,Chapter 10
4. The developer's plans, strategies and commitments for maximizing direct employment and retention of Dehcho residents, northern and Aboriginal persons, including elaboration of its "Hire First" policy for Dehcho communities	IBAs, HR Management Plan,7.7.2,Chapter 11

5. A description of any plans, strategies or other commitments the developer has to support increasing the mine-ready workforce, support career path in mining, and assist training program in related support activities.	IBAs, HR Management Plan, 7.7.2, Chapter 11
6. A discussion of whether and how the developer's strategies and commitments for maximizing employment of Aboriginal and Northern residents will extend to its contractors.	7.3.11,7.3.2.3,7.6
Business Opportunities	
7. An estimate of all contractor and subcontractor goods and services that the Prairie Creek Mine will require, by project phase, as well as an estimate of what percentage of required goods and services can feasibly be sourced from local and regional businesses;	7.3.1,7.3.2
8. The developer's policies, plans, and commitments associated with maximizing contracts to Aboriginal and Northern-owned businesses, with emphasis on assisting business development initiatives and joint ventures with Dehcho-based businesses.	7.7.2,7.5,11.1
9. An assessment of any barriers to maximizing the utilization of northern businesses	7.3.1.2,7.3.2.3
10. The developer's prediction for any training, education or other improvements necessary to maximize local and regional business capacity to benefit from the Prairie Creek Mine.	—
3.4.2 Distribution of Beneficial and Adverse Socio-economic Impacts	
The developer will provide the following information and analysis:	
1. Qualitative and quantitative estimates of all beneficial and adverse economic impacts from the Prairie Creek Mine, including at minimum:	Chapter 7
c. Federal, territorial and municipal taxes that the developer may remit by year, as well as from linked economic development (a +/- 20% range is acceptable);	7.4
d. Total employment impact on the Dehcho region and Mackenzie Valley, including a prediction of employment multipliers from the development;	7.1.3,7.2.3,7.3.1,1,7 .3.2.1,7.5,7.6
e. A prediction of any adverse impacts the development may have on public infrastructure maintenance and associated costs (with emphasis on the Liard Highway);	7.7.1,7.7.5,7.7.6.2
2. Discussion of potential impacts of the Prairie Creek Mine on other economic development activities, with special emphasis on:	
a. Whether and how tourism opportunities may be adversely or beneficially impacted by the presence of the mine and winter road (including consideration of whether the presence of an active mine will reduce the "wilderness values" associated with the NNPR and how that may alter tourism demand);	5.4,7.8
b. What mitigation the developer will put in place to minimize disturbance to tourists.	7.8.1.2,7.8.3
3. Discussion of any plans, strategies or other commitments the developer has to help potentially-affected communities avoid over-exposure to "boom and bust" economic fluctuations, with a focus on:	7.6.1,7.10, Chapter 10
a. Potential social and economic effects of mine closure (including unforeseen early closure or project hiatus) on potentially-affected communities and the Dehcho region;	7.6.1
b. Any plans to assist post-closure transition for mine employees;	7.6
4. Discussion of the following:	
a. Socio-economic impacts potentially resulting from increased disposable income and larger reliance on the wage economy;	7.7,7.7.1,7.7.2,7.7.3 ,7.7.4,7.7.5,7.7.6
b. Any impacts on social services provision, infrastructure and costs that may occur as a result of the Prairie Creek Mine (e.g., emergency medical care or family social services); and	7.7.4,7.7.5
c. Whether and how the project may create or contribute to impacts on other organizations and businesses servicing the region through mobilization of local skilled labour away from smaller Dehcho communities and associated impacts on maintenance of infrastructure and basic service provision; and	7.7.1,7.7.5,7.7.5.2
5. The developer's policies, strategies, plans, and commitments, alone or in combination with other parties, for the mitigation of any adverse socio-economic impacts.	Chapter 11
3.4.3 Social Impacts While conducting a social impact assessment, the developer will give consideration to:	
1.Potential impacts associated with the development on community wellness and population health issues such as	7.7
a.population in and out migration	7.7.1
b. alcohol and drug access and use	7.7.4
c. sexually transmitted infections rates	7.7.4
d. crime rates	7.7.6.1
e. access to child care	7.7.3
f. language retention and other key indicators of cultural maintenance	7.7.7,7.8
g. education completion rates by level	7.7.2
2. How each identified potential impact may affect individual potentially-affected communities	7.9
3. The physical, mental, and cultural health of mine workers and mine workers' families, considering potential impacts of long-distance commuting and greater engagement in the wage economy on the population health status of small, primarily aboriginal communities. This discussion should identify any alternative shift rotations considered by the developer, with the rationale for the chosen rotation	7.7,7.73,7.74,7.75
4. Human resource management plans and programs the developer will offer at the mine	HR Management

site to identify and mitigate potential social problems associated with the Prairie Creek Mine, that will include but not be limited to discussion of	Plan, Chapter 9, Chapter 11
a. increased income and money management	Chapter 11
b. potential stressors associated with long-distance commuting and stress management programs	11
c. substance abuse and treatment policies	11
d. avoidance of cross-cultural conflicts at the work site	11
e. "home" community and family support programs	11
5. Potential impacts on public safety, especially in regards to the use of the winter road and increased truck traffic and road degradation issues along the Liard Highway and in/around Fort Liard, and identification of mitigation to minimize the potential for vehicle accidents	7.7.6.2
6. Potential social impacts on the residents of Lindberg Landing and Fort Liard from Prairie Creek Mine transportation activities	7.7.6,Chapter 8
7. Potential safety issues associated with increased use of the existing Prairie Creek airstrip, including discussion of how the developer has or will work with responsible government agencies to identify and address any issues	7.7.6.3
8. Potential social impacts caused by a reduction of wilderness values associated with the NNPR	7.7.7
9. Any lessons learned about short and long-term social and economic impacts of previous mine developments in the Mackenzie Valley and the Canadian North, and how the developer has incorporated such lessons into its impact assessment and mitigation commitments for the Prairie Creek Mine.	Chapter 6
3.4.4 Cultural Impacts *The analysis of heritage resources is inclusive of both sites and objects of cultural significance, and cultural impacts include both tangible and intangible aspects of culture.* ***Physical Heritage Resources*** The developer will report on:	
1. Consultation with traditional knowledge holders, archaeologists, anthropologists, and the Prince of Wales Northern Heritage Centre, that the developer conducted during its cultural impact assessment, indicating how such interactions influenced: a. Heritage resource survey locations; b. The identification of locations of known or high potential for heritage resources; or c. Heritage resource management plans; 2. Identification of all known archaeological and heritage resources, sites or areas of cultural significance, and areas of high potential for unfound heritage resources in the EA Study Area; and 3. All recommended mitigation measures that consultation produced for the protection of local known and high potential areas of physical heritage resources and other sites of cultural significance, and associated developer's commitments or reasons for not adopting recommendations.	TK and Archaeology Reports
Traditional Land Use and Wildlife Harvesting *The developer must identify any adverse impacts the Prairie Creek Mine may have on land use and traditional economic harvesting activities. Of specific concern to the potentially-affected communities during scoping was the lack of traditional knowledge and up-to-date wildlife baseline information to assist prediction of impacts on wildlife and wildlife harvesting by regional Aboriginal people. The potential for increased access along the winter road to out-of-region hunters, tourists and mine-related traffic were all cited as potentially impacting on wildlife abundance and harvesting success.* The developer will:	
4. Describe any potential impacts of the Prairie Creek Mine on traditional harvesting activities for Aboriginal residents of the potentially-affected communities including:	
a. Loss of harvesting success, with a focus on the impacts of increased traffic along the winter road, and associated mortality and disturbance impacts on wildlife; and	7.8.1
b. Increased access to non-resident hunters via the winter road increasing wildlife mortality along the eastern portion of the winter road, or increased access to tourists in an expanded NNPR disturbing wildlife;	7.7.7,7.8.1.2,7.8.3
5. Provide a prediction of the total impact of the Prairie Creek Mine on traditional economic activity in the areas (expressed in dollar terms as well as in terms of reduced or increased harvesting success); and	7.8.1,7.8.2
6. Identify all mitigation commitments by the developer, alone or in combination with other parties, to minimize adverse impacts on traditional land use and resource harvesting, or to compensate for losses that the developer cannot prevent. This should include discussion of:	
a. How access along the winter road will be monitored and, if feasible, managed;	7.8.3
b. NNPR boundaries in relation to the winter road, and what rules in relation to wildlife harvesting will be in place (if boundaries have not been set at the time of the analysis, the	7.7.7,7.8.3

management implications of different boundary options will be compared); and	
c. Plans for any ongoing monitoring, adaptive management and/or harvester compensation	7.8.3
3.4.5 Human Environment Monitoring and Management Plans	
1. The developer will provide description of any commitments, plans and strategies to engage with responsible authorities and potentially-affected communities in monitoring impacts on the human environment such as:	Chapter 9
a. Success of local and regional residents and Aboriginal people in gaining employment at the Prairie Creek Mine, and the success of training initiatives;	9
b. Success of local and regional businesses in providing goods and services to the Prairie Creek Mine, with identification of gaps to maximizing engagement;	9
c. Employee retention and worker and family wellness;	9
d. The contribution of the Prairie Creek Mine to beneficial and adverse social impacts at the regional and local levels across a spectrum of appropriate indicators;	9
e. The use of the winter road; and	9
f. Impacts on wildlife harvesting and practice of traditional culture on the land.	9
2. The developer will identify relevant existing initiatives monitoring community wellness and investigate how it will engage with, contribute to, and consider results from these programs in its ongoing monitoring and adaptive management programs;	Chapter 9, Chapter 11
3. How human environment monitoring results will be evaluated and reported to regulators, responsible authorities and potentially-affected communities	Chapter 9
4. What adaptive management systems will be in place to deal with issues identified during monitoring; and	Chapter 9
5. A summary table listing all human environment monitoring and management systems and where they are described in the *Developer's Assessment Report*.	Chapter 9
3.6 Cumulative Effects *Pursuant to Section 117(2)(a) of the* MVRMA*, the Review Board considers cumulative effects in its determinations. Cumulative effects are the combined effects on a specific valued component of the development in question and other past, present or reasonably foreseeable future developments and human activities. In addressing cumulative effects, Canadian Zinc is encouraged to refer to Appendix H of the Review Board's* Environmental Impact Assessment Guidelines*.* The following items are required for consideration of cumulative effects:	
1. Inclusion of the following developments, at minimum, considering how their effects will likely combine with those of the Prairie Creek Mine, on the noted valued components: a. The Cantung Mine on the Flat River, for impacts on water quality in the South Nahanni River watershed; b. Exploration and development activities in the Howard's Pass district, Cantung and Mactung mines, as well as increased road access in the Yukon and the NWT, for consideration of cumulative impacts on "wildlife at risk" in the southern Mackenzie Mountains, in particular for consideration of increased hunting pressures and habitat fragmentation for woodland caribou (Northern Mountain Population); c. The proposed Mackenzie Gas Project, for how it could influence social and economic impacts in the Dehcho region if both projects proceed at the same time;	5.4, Chapter 10

1 Introduction

This Socio-Economic Impact Assessment (SEIA) report provides a detailed investigation of the human environment in the Study Area into which Canadian Zinc Corporation will be entering should the proposed Prairie Creek Mine be developed.

The Study Area has been defined primarily as the communities of Fort Liard, Nahanni Butte, Fort Simpson, Wrigley, and Lindberg Landing and secondly as the Dehcho region in its entirety. The distinction between the two areas will be made throughout the report. The Dehcho region will be defined as including the following communities: Fort Providence; Jean-Marie River; Trout Lake; Hay River Reserve; and Kakisa; in addition to those included in the Study Area.

The small population of Lindberg Landing prevents its inclusion in the quantitative analysis presented in this report.[1] Therefore, issues related to Lindberg Landing are presented separately.

This report deals with issues related to social and economic matters. These are considered "Subjects of Note" in the Terms of Reference for the Environmental Assessment of the Prairie Creek Mine[2] (herein referred to as 'Terms of Reference'). Other Subjects of Note including those related to archaeology and traditional knowledge are presented in their own reports. There is some duplication of analysis between these aspects of the human environment (social, economic, and cultural).

The report is comprised of twelve chapters. To avoid the need for cross referencing, a brief description of the economics of the project follows this introduction. This is followed by a chapter on the approach and methodology, which is presented as a single chapter to improve the readability of the later chapters. This is followed by several chapters relating to the specific questions given in the Terms of Reference. A conformity table with the Terms of Reference is provided for easy navigation of the report. First, Chapter 4 is a summary of the socio-economic circumstance of the communities within the Study Area. A detailed investigation of the current human environment including a baseline forecast is presented in the next chapter, followed by a review of socio-economic outcomes from other NWT communities that have faced the opportunities and challenges of resource development and economic growth. A detailed assessment of the economic and social impacts of the proposed Project is presented in Chapter 7. The special case of Lindberg Landing is presented next as it own chapter. Chapter 9 is a description of the monitoring and management plans associated with the socio-economic impacts described earlier. This is followed by a discussion regarding possible cumulative impacts which is then followed by a summary of the mitigation strategies outlined throughout the previous chapters. The report concludes with a summary of the SEIA report.

2 Project Description[3]

The Prairie Creek Mine Project is 100% owned by Canadian Zinc Corporation. It is situated in the southern Mackenzie Mountains of the Northwest Territories. The deposit contains economic amounts of lead and zinc. Much of the site was built up 30 years ago having received land and water permits in 1980 and 1982 respectively for the production of lead, zinc and silver. Three months prior to the mine's start-up, all activities were halted and the project was placed into receivership as a result of a collapse in the world silver market. The site has been on a care and maintenance schedule ever since.

Canadian Zinc Corporation is proposing to bring this mine into production. Measured and indicated resources amount to 5.1 million tonnes, containing 10.8 percent lead, 11.3 percent zinc, 175 grams per tonne gold, and 0.4 percent copper.[4] The mine will operate as an underground operation exclusively. The production rate is estimated at 1,200 tonnes per day. With this tonnage and production rate, the estimated life is presently defined as 14 years. A reclamation phase will begin once production activities have ended.

Because much of the property is already developed, the construction phase of this project will be smaller than would otherwise be the case. Initial expectations are for construction expenditures to equal $59 million. Activities will span two years with the majority taking place in the second year. The construction will require a workforce of up to 120 people at its peak.

Once into its operations phase, the Project will employ approximately 220 people, working a three-week in/three-week out schedule. Total expenditures will approach $1 billion (based on 2008 prices) over this time frame.

Opportunities will exist for local labour and business to participate in the economic activities through direct employment, the direct supply of goods and services and through spin-off activities such as the indirect and induced effects of the mining expenditures.

Local labour and business will be given preferential treatment when accessing jobs and contracts. Canadian Zinc will offer a competitive compensation package and modern human resource management and socio-economic management plans that will extend to all employees.

3 Approach and Methodology

The results presented in this report flow from several methods of analysis and from original and secondary research. These methods are described in this chapter separate from the results in an effort to improve readability of the later chapters.

3.1 Overview of the Study Area Communities

Chapter 4 presents general information on each of the Study Area communities. It is not meant as an exhaustive list of assets in each community. Rather, it is a summary of some of the basic statistical facts collected throughout this SEIA.

The information was collected through numerous means, including statistical surveys, government and community websites and publications, community visits, comments from community members, and general knowledge of these communities.

3.2 Description of the Existing Human Environment

It is important that the proponent of any major project in the NWT understands fully the human environment they are entering. Canadian Zinc has a history of working in the Study Area to develop the Prairie Creek Mine that spans 15 years. Over that time, the company has developed a strong relationship with the local population and has a deep understanding of the socio-economic realities of the potentially-impacted communities.

But as strong as that relationship might be, dedicating time and effort to the investigation of statistical information on the impacted communities remains an important exercise for the company. Not only can this exercise advance Canadian Zinc's knowledge of the human environment in which they will operate, it also offers the opportunity to confirm or refute their own perceptions and understandings of socio-economic conditions and places quantitative facts alongside qualitative statements and local opinion.

The description of the existing economic and social environment was developed principally through the use of survey data produced by the NWT Bureau of Statistics, Statistics Canada and the Canadian Census. Particular mention should be made of the NWT Bureau of Statistics that compiles community and regional data from its own surveys and that of other organisations, including other government departments and Statistics Canada into a single report to provide data users with a kind of "one-stop shop" for statistical analysis in the NWT. The data presented in these reports were augmented by other territorial and federal data sources and by research reports produced by various federal agencies such as Indian and Northern Affairs Canada and Parks Canada, by individual departments within the Government of the Northwest Territories, and by government and non-government organisations working in the Dehcho region.

There are some limitations in the existing economic data, though they do not hinder the assessment of socio-economic conditions. Some statistics are unavailable for the

Study Area communities. In most cases, this is because the populations are small and data are withheld for reasons of confidentiality. Some macroeconomic data such as gross domestic product (GDP) are not calculated for individual regions within the Territory.

The description of the existing human environment is divided into three sections: social performance, economic performance and the future socio-economic performance in the absence of the proposed Project. The latter section is important because it provides a baseline forecast of existing conditions that can be used as a comparator once the project is introduced. In other words, whether we are discussing a future with or without the Project, the human environment cannot be viewed as static. This introduces a forward-looking time element to the description of the existing human environment which allows for an appropriate temporal analysis of the Study Area's future.

The baseline forecast was estimated using trend analysis coupled with a study of the future economic opportunities in the Dehcho region. The NWT Bureau of Statistics produces a projection of community and regional populations. Statistics Canada`s *Demography Division* and the *NWT Demographic Satellite Model* were used to clarify and confirm the accuracy of those projections.[5]

A complete and thorough investigation of the existing human environment produces a clear picture of the region's opportunities and challenges and lends itself to a relatively straightforward assessment of potential socio-economic impacts from the proposed Project and a similarly straightforward mitigation strategy.

3.3 Lessons Learned from Economic Growth in other Regions within the NWT

The focus of this chapter is an investigation into the socio-economic impacts of the diamond mines operating in the Tlicho and North Slave Region of the NWT. The past ten years of socio-economic changes in these regions provide evidence of how and where people and communities are affected by sudden and sustained economic growth, what programs and policies were effective in influencing the pattern and direction of change, and how industry, government and communities in the NWT interact.

The sources for information are similar to that of the previous sections, including data from the NWT Bureau of Statistics and Statistics Canada. Research reports and specific data related to the socio-economic monitoring of these mining operations are added. They include information released by the mines' owners, government, and non-government organisations.

3.4 Description of Future Environment with the proposed Project

Financial and production data were provided by Canadian Zinc. From these data, economic impacts were determined using Statistics Canada's *Interprovincial Input-*

Output Model and portions of the *NWT Economic Impact Model (NWTEIM)*.[6] An overview of these models is provided on the following page.

The economic impacts that are reported include gross production, gross domestic product, employment and labour income. These results do not take into account potential capacity issues that might influence local participation. These determinations are made through separate analysis. Thus, a thorough investigation into the most likely participation scenario was completed incorporating historical and forecasted demographic, education, and other socio-economic statistics.

Social impacts were determined through a combination of statistical analysis, socio-economic research, and the estimations for direct and indirect participation of community members. The Project activities (expenditures on labour and capital) and the existing baseline characteristics of the human environment were viewed through a lens that included the socio-economic impacts on Tlicho and North Slave regions from resource developments in those areas and value statements from community stakeholders regarding their vulnerabilities and adaptability.

Government revenue estimations were generated through input from the Project proponent, the use of financial accounting models, and from the Interprovincial Input-Output Model. As with all the results, these flow from several assumptions regarding revenues and costs, the production schedule, and the future tax regime.

A table is provided below each sub-section within this chapter that summarises the direction, geographic range, magnitude, and duration of the impact. The criteria for each of the impact categories are provided in Table 3-1.

Table 3-1: Definitions of Criteria Used in the Impact Assessment

Direction	Range	Magnitude	Duration
Neutral: no measurable change from existing conditions	Local: within the Study Area communities	Negligible: statistically insignificant (no measurable change) from existing conditions	Short Term: less than three years
Negative: a decrease relative to existing conditions	Regional: within the Dehcho region	Low: the impact is within the natural variation of existing conditions	Medium Term: three years to ten years
Positive: an increase relative to existing conditions	Territorial: the impact is felt beyond the Dehcho region	Moderate: the impact is approaching but still within the upper or lower limits of variation from existing conditions	Long Term: ten years to twenty-five years; within the life of the Project
		High: the impact is beyond the upper or lower limit of variation from existing conditions; causes a shift from baseline	Indefinite: more than twenty-five years; extends beyond the life of the Project

This approach has been adapted from those often used when assessing impacts on the natural environment. It can be a useful means to summarise the impacts on the human environment, however, one must understand that in some cases, the magnitude of impact will be different depending on the geographic range. For instance, the Project will attract labour from throughout the Territory however the magnitude of the impact will be far greater in the Study Area than elsewhere. These differences are noted where appropriate.

3.4.1 Description of Economic Models and Modelling Techniques

A model is a scaled-down representation of something larger. In the same manner in which a model airplane is a small representation of a real airplane, an economic model is a scaled-down representation of an economy in whole or in part. Broadly speaking, the discipline of economics is the study of choices. Economic models improve the study of these choices and their outcomes. Economic models are used in this research because they provide an approximation of the economic outcomes that flow from the construction and operations of the Prairie Creek Mine.

3.4.1.1 Input-Output Models

Input-Output models are one of many tools used in economic analysis. It is best suited when investigating the economic impacts of a change in production, and especially in cases where that change can be thought to occur without significantly altering the structural make-up of the economy.

An input-output model utilises the expenditure patterns from an existing or potential producer to depict the impact those expenditures will have on an economy. This is often described as a “shock minus control” analysis, where the control is defined as the current economy and the shock is the same economy having added or removed the production of a firm or an industry. Adopting this approach allows us to assess the economic value of Prairie Creek Mine’s *production*; that is, its lead, zinc and silver mining, processing and shipping activities.

Determining the value and location of the thousands of transactions that occur as a result of construction and operations at Prairie Creek would be virtually impossible to do manually. Input-Output models are resource allocation models that perform these calculations for us. They track the value-added component of every round of transactions that occur along the supply chain when a shock is introduced to the economy.[7]

In Canada, Statistics Canada builds and maintains the *Inter-provincial Input-Output Model*. In addition to calculating the impacts of a shock on Canada’s GDP, this model has the added complexity of tracing trade flows between Canada’s provinces and territories as well as international imports and exports. As of 2003, it separates the economies of Nunavut and the Northwest Territories, enabling us to better understand the results of Prairie Creeks’ operations in the NWT.

Input-Output models calculate both *direct* and *indirect* impacts. Direct impacts are those generated immediately from the expenditures on goods and services required to build, maintain and operate a business (in this case the Prairie Creek Mine).

Indirect impacts are those generated by the new expenditures made by the directly-impacted business sector as a result of their need to deliver their good or service to the Prairie Creek Mine. The majority of indirect impacts flow from the manufacturer of goods because of their need to purchase more inputs. The producers of these inputs are then impacted, causing further rounds of transactions. Indirect impacts sums the value added from every additional round of transactions until they become statistically indistinguishable from zero. Indirect impacts are typically low in the NWT regardless of the industry being studied because of its limited manufacturing base.

Input-Output models are useful for studying impacts of changes in production, but one must be cautious when interpreting the results. Like any other model, Input-Output models are predicated on numerous assumptions that alter or influence the results. Therefore, any results should be viewed as approximations and be combined with other knowledge of the firm or industry being studied. Other important considerations include:

- Input-Output models are linear, meaning they do not make adjustments for the size, scale or direction of any shock to an economy.
- Input-Output models do not reflect limitations of capital and labour.
- Input-Output models are static, meaning they are based on the economy as it exists at a single point in time.
- The data used to develop the relationships between industrial sectors are the result of surveys. They must be treated as approximations of actual relationships because an unknown variability is embedded in the mathematics.

With the areas of caution noted, Input-Output models provide a sound starting point for understanding economic impacts. They provide good estimates of gross production, gross domestic product, employment and labour income and indirect taxes.

There is a third round of impacts from a change in production that must be considered. The labour income gained or lost by employees affected by the direct or indirect effects of a shock results in a change in disposable income and thus a change in consumer expenditures. The change in household spending has its own impact on gross production, GDP, employment and labour income. These impacts are called the *induced* effect of a change in production.

Adding the induced effects to the results of a shock brings with it additional challenges. While accounting for the response of households to the shock, the model does not do the same for government or industry. Determining induced effects requires assumptions on the level of taxation, consumer imports, and household savings, all of which would be affected by the gain or loss of income. These assumptions are exogenous to the Input-Output model. Other complexities arise when someone is working in one jurisdiction, but resides and pays taxes in another. The combination of these issues has a profound effect on the results of production shocks in the NWT. As a result, Input-Output models are not used in this report to determine induced effects. Instead, a satellite model within the NWTEIM that was built specifically to deal with these and other 'local' issues is used.

3.4.1.2 NWT Economic Impact Model

NWT Economic Impact Model (NWTEIM) was developed to help understand and explain the impact of industrial developments on the people of the NWT. Specifically, it couples a financial accounting and taxation model[8] with the NWT Input-Output model maintained by the NWT Bureau of Statistics as the basis for additional analytical models including a demographics model and territory impact model.

Each satellite model is linked to one another to produce a dynamic response to a change in production.

- The financial accounting and taxation model demonstrates the potential for public revenue streams and computes a project's viability.
- The Input-Output model calculates impacts on GDP, employment and labour income and can be used to confirm results flowing from Statistics Canada's *Inter-provincial Input-Output Model*.
- The results from these two models then feed the demographic and territory impacts models that collectively demonstrate impacts on population, labour force, migration and any induced impacts.

3.5 Monitoring and Management Plans

Canadian Zinc will establish a system that will ensure that it has the information necessary regarding socio-economic changes taking place in the Study Area to make quality decisions and alterations to its mitigation strategy. The socio-economic monitoring and management plans are described in Chapter 9 and are based largely on components of the mitigation strategy and the human resources management plan.

3.6 Cumulative Effects

The investigation into the potential cumulative effects in the Study Area communities is based on an assessment of economic opportunities and challenges present in the region. The largest and most crucial of these opportunities is the Mackenzie Gas Project. Its potential economic and social impacts have garnered much attention in the NWT. But the project must move forward for them to occur. The possibility of this project moving forward is discussed. Additional projects were researched including:

- Cantung Mine
- Mactung Mine
- Dehcho Natural Gas Production
- Dehcho Bridge Construction
- Howard's Pass Lead/Zinc Mine

This section of the report follows closely the results from section 5.3.3 on the socio-economic potential for the Study Area communities and Dehcho region in absence of the proposed Project. The viability of the projects was assessed using available research and some economic modelling.

3.7 Mitigation Strategy

Canadian Zinc's socio-economic mitigation strategy was developed with the goal of maximising local participation and benefits, while mitigating or reducing any negative impacts from participation in this project.

The Project's proponent has been working in the Study Area for approximately 15 years. In that time, it has come to know and understand the people living there and the challenges they face. This SEIA provides additional enlightenment regarding the vulnerabilities of Dehcho society. Together, these details help in the design and implementation of a quality mitigation strategy.

Many components of the mitigation strategy are presented throughout the report to correspond with the impacts being described. These are summarised in a single chapter at the end of this report.

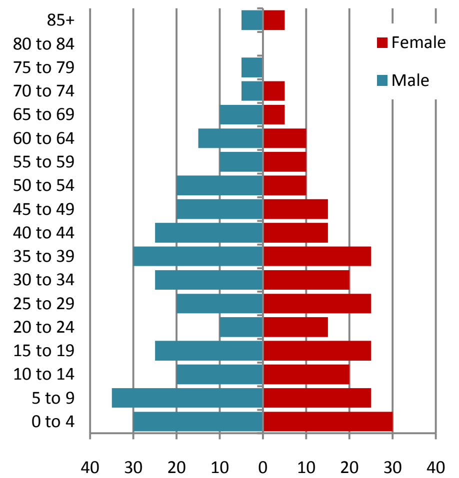
4 Overview of Study Area Communities

This chapter is meant as a brief introduction and comparison of the Study Area communities using readily-available socio-economic statistics. From this introduction, and later in the more detailed analysis of the current human environment, the socio-economic condition of these communities will become better understood.

4.1 Fort Liard

Fort Liard is a community of 591 people as of the 2007 population estimate.[9] There are 62 more people living in the community than there were ten years earlier, but a few less than five years ago. The age distribution of residents is in line with the averages across the Territory (see Figure 4-1).[10] That is, the population is relatively young with 43 percent of the population below the age of 25 compared to 40 percent for the NWT. The majority of residents are Aboriginal (95 %).

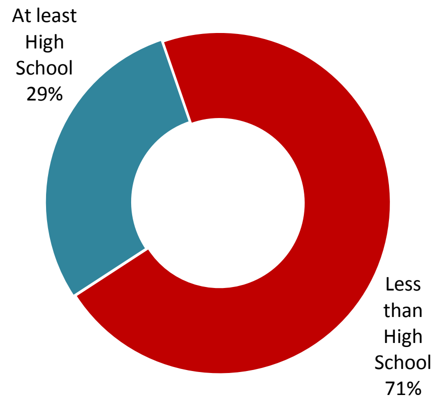
Figure 4-1: Fort Liard Population Distribution



Source: Statistics Canada. 2007. 2006 Community Profiles. 2006 Census

Education levels are low amongst the population aged 15 and over. The estimates produced through the 2006 Census show of the 415 residents in this age cohort, 295 (71 %) did not have a high school diploma (see Figure 4-2).[11]

Figure 4-2: Fort Liard Educational Attainment (2006, population 15 years and over)



Source: Statistics Canada. 2007. 2006 Community Profiles. 2006 Census

The employment and labour force statistics for Fort Liard are indicative of a small, remote community. This is especially the case now since activity in the oil and gas industry has all but disappeared. The employment rate in 2006 was 44.6 percent. Jobs are particularly hard to come by for young people. The employment rate for the 15 to 24 year age-cohort was 22 percent.

Statistics Canada's 2006 Census found the unemployment rate to be 27.5 percent. But this is calculated based on a strict definition of labour force participation. The number falls even lower if one broadens that term to include those unemployed but who are not seeking work because they know there aren't any jobs available in their community. A wide gap between the two definitions of the unemployment rate can be an indication of similar economic conditions in neighbouring communities and a lack of mobility amongst large segments of the potential labour force.

Table 4-1: Potential Available Labour Supply in Fort Liard, 2004	
Number of Unemployed	55
% Do Rotational	80
% Male	74.5
% Aboriginal	98.2
% less than High School	81.8

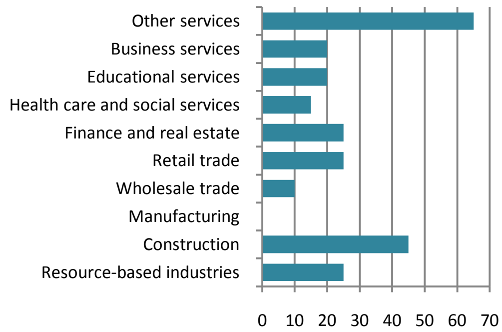
Source: NWT Bureau of Statistics, 2004 Community Survey.

The NWT Bureau of Statistics, in its *2004 Community Survey*, studied the extent of this potential available labour force and its characteristics. The results are provided in Table 4-1. The group of potential workers not in the labour force at that time were predominantly male, Aboriginal, without a high school diploma and willing to work a rotational schedule.[12]

For those who are working, most are employed in the public sector, whether in education, health, social services or administration (which is included under the category 'other services' in Figure 4-3).

The percentage of households in *Core Need* of new housing or renovations has dropped from 67.6 percent in 1996 to 32.4 percent in 2004. Countering this improvement is an increased number of income support beneficiaries. That number averaged 34 in 2000, but has since climbed to 51 in 2007, reaching its peak in 2003 at 57. Across the Territory, the number of beneficiaries has been dropping at a relatively steady and consistent rate.[13]

Figure 4-3: Fort Liard Occupation Distribution



Source: Statistics Canada. 2007. 2006 Community Profiles. 2006 Census

With high unemployment, a dependency on income support, and little education, it is not surprising that the average personal income in Fort Liard is $29,392 per year as of 2006. That year, less than 19 percent of the community's taxfilers had incomes in excess of $50,000. The income figures are made worse by the fact that cost of living in Fort Liard was estimated to exceed that of Edmonton by 32 percent, while the cost of food exceeded that of Yellowknife by 35 percent.[14]

The community is active in traditional Aboriginal pursuits—60.7 percent of the population hunt or fish, 14.9 percent trap, and 39.6 percent of households consume country food most or all of the time. The use of Aboriginal languages is dropping in Fort Liard, as it is throughout the Territory. From 88.3 percent in 1984, 74.5 percent of the population reported in 2004 that they spoke an Aboriginal language.[15]

4.2 Nahanni Butte

Nahanni Butte is a community of 129 people as of the 2007 population estimate.[16] There are 54 more people living in the community than there were ten years earlier, and 14 more than five years ago. The small population of this community prohibits accurate descriptive analysis because of the impact of rounding. Formal surveys are conducted in Nahanni Butte however the results are very susceptible to sampling error.

The age distribution of residents is in line with the averages across the Territory, though not quite as young as other Study Area communities with 36 percent of residents below the age of 25. The majority of residents are Aboriginal, at approximately 93 percent.

Education levels are low amongst the population aged 15 and over. The estimates produced through the 2006 Census show of the 70 residents of the 75 who are in this age cohort did not have a high school diploma.[17] Unlike Fort Liard and Fort Simpson, Nahanni Butte does not offer Grade 12 education in the community. Students wishing to graduate must leave home after Grade 10 to do so.

The employment and labour force statistics for Nahanni Butte are indicative of a small, isolated community with only a few marketable assets. The employment rate in 2006 was 47.1 percent. Statistics Canada's 2006 Census found the unemployment rate to be 20 percent.

The NWT Bureau of Statistics, in its *2004 Community Survey*, studied the size and characteristics of the potential available labour force in Nahanni Butte. These are individuals who do not qualify as being part of the labour force under Statistics Canada's definition, but nevertheless want a job. The results are provided in Table 3-1. The group of potential workers not in the labour force at that time was made up almost entirely of males who were of Aboriginal descent, willing to work a rotational schedule, and were without a high school diploma.[18] For those who were working, 60 percent were employed in the public sector, whether in education, health, social services or administration.

Table 4-2: Potential Available Labour Supply in Nahanni Butte, 2004

Number of Unemployed	14
% Do Rotational	85.7
% Male	85.7
% Aboriginal	92.9
% less than High School	57.1

Source: NWT Bureau of Statistics, 2004 Community Survey.

The percentage of households in *Core Need* of new housing or renovations has dropped from 62.5 percent in 1996 to 47.2 percent in 2004. This is much higher than the territorial average which was 16.3 percent in 2004.[19]

Accurate personal income data is not available for Nahanni Butte, though one could assume that average personal income in the community is low relative to the territorial average. One can further assume poverty is a concern in Nahanni Butte, factoring in the cost of living that is 45 percent higher than Edmonton, and the cost of food that is 69 percent higher than that found in Yellowknife.[20]

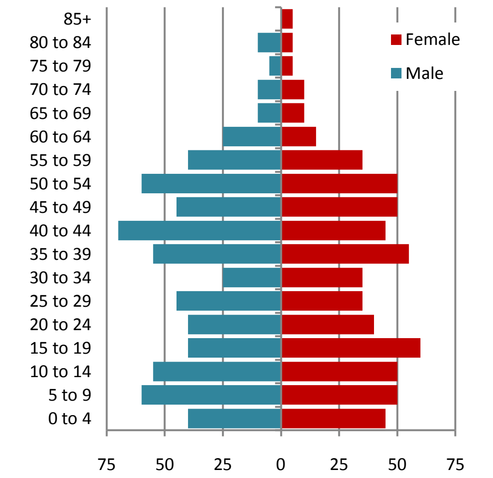
The community is active in traditional Aboriginal pursuits—58.5 percent of the population hunt or fish, 11 percent trap, and 33.3 percent of households consume country food most or all of the time. The use of Aboriginal languages has dropped in Nahanni Butte, but not by the same magnitude as in other NWT communities. From 88.9 percent in 1984, 73.5 percent of the population reported in 2004 that they spoke an Aboriginal language.[21]

4.3 Fort Simpson

Fort Simpson is a community closest to the territorial average in most statistical respects however one should not interpret this as being a positive outlook on its human environment. It lags well behind any national comparators (though a national comparison is not made in this report).

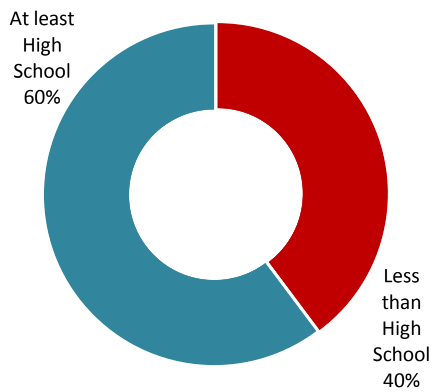
Fort Simpson is a community of 1,264 people as of the 2007 population estimate.[22] There are 33 fewer people living in the community than there were ten years earlier, but 10 more than five years ago. The age distribution of residents is in line with the averages across the Territory (see Figure 4-4).[23] That is, the population is relatively young with 39 percent of the population below the age of 25 compared to 40 percent for the NWT. The majority of residents are Aboriginal (69 %). But at 31 percent, Fort Simpson has the largest non-Aboriginal population in the Dehcho region in both absolute and relative terms.

Figure 4-4: Fort Simpson Population Distribution



Source: Statistics Canada. 2007. 2006 Community Profiles. 2006 Census

Figure 4-5: Fort Simpson Educational Attainment (2006, population 15 years and over)



Source: Statistics Canada. 2007. 2006 Community Profiles. 2006 Census

Education levels in Fort Simpson are the closest to that of the territorial average of any Dehcho community. Amongst the population aged 15 and over, the 2006 Census reveals that of the 905 residents in this age cohort, 360 (40 %) did not have a high school diploma (see Figure 4-5).[24]

Table 4-3: Potential Available Labour Supply in Fort Simpson, 2004	
Number of Unemployed	76
% Do Rotational	76.3
% Male	73.7
% Aboriginal	88.2
% less than High School	56.6

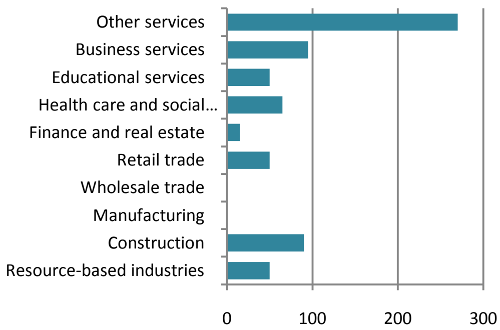
Source: NWT Bureau of Statistics, 2004 Community Survey.

The employment and labour force statistics for Fort Simpson are different from the other communities in the Study Area, and more representative of an economy that is somewhat diversified and more vibrant.

The employment rate in 2006 was 67.4 percent, very close to the territorial average. The distribution of employment is also similar to that of the Territory. The employment rate for people between the ages of 15 and 24 was 48.6 percent, which is an indication, among other things, of the availability of entry-level jobs such as those found in retail and food services industries.

Statistics Canada's 2006 Census found the unemployment rate to be 12.1 percent. This figure does not account for people not in the labour force but who would like a job. The NWT Bureau of Statistics conducted a survey to assess the size of this *potential* available labour force (see Table 4-3). The results of that survey found 76 people fit the expanded definition of labour supply, and of that group most were male, Aboriginal, without a high school diploma and willing to work a rotational schedule.[25]

Figure 4-6: Fort Simpson Occupation Distribution



Source: Statistics Canada. 2007. 2006 Community Profiles. 2006 Census

For those who are working, 46 percent are employed in the public sector, whether in education, health, social services or administration (which is included under the category 'other services' in Figure 4-6 and includes Aboriginal government employment).

Some additional important statistical facts include:

- The percentage of households in *Core Need* of new housing or renovations has dropped from 38.7 percent in 1996 to the territorial average of 16.4 percent in 2004.
- The average monthly number of income support beneficiaries has changed little in the past eight years, going from 34 in 2000 to 42 in 2007.[26]
- Average person income levels are high in Fort Simpson in comparison to the other Study Area communities at $39,465 per year as of 2006.
- The cost of living in Fort Simpson is high. Research conducted by Statistics Canada shows the cost of living was 37 percent higher than Edmonton, while the cost of food exceeded that of Yellowknife by 42 percent.[27]

The community is less active in traditional Aboriginal pursuits than elsewhere in the Dehcho region. This is indicative of the fact that the percentage of Aboriginal people living in the community is lower than elsewhere. In 2003, 39.1 percent reported participating in hunting and fishing activities, 8.7 percent reported they had trapped in the past year, and 17.8 percent said the meat they consume is mostly or entirely made up of country food.

The use of Aboriginal languages has dropped a lot in Fort Simpson over the past 20 years. Again, this is in part a function of an increased number of non-Aboriginal residents. From 74.8 percent in 1984, 48.4 percent of the population reported in 2004 that they spoke an Aboriginal language.[28]

4.4 Wrigley

Wrigley is a community of 170 people as of the 2007 population estimate.[29] There are 13 fewer people living in the community than there were ten years earlier, and 9 fewer than five years ago. The small population of this community prohibits accurate descriptive analysis because of the impact of rounding. Formal surveys are conducted in Nahanni Butte however the results are very susceptible to sampling error.

The age distribution of residents is in line with the averages across the Territory with 42 percent of residents below the age of 25. The majority of residents are Aboriginal, at approximately 97 percent.

Education levels are low amongst the population aged 15 and over. The estimates produced through the 2006 Census show of the 65 residents of the 90 who are in this age cohort did not have a high school diploma.[30] Unlike Fort Liard and Fort Simpson, Wrigley does not offer Grade 12 education in the community. Students wishing to graduate must leave home after Grade 9 to do so.

Table 4-4: Potential Available Labour Supply in Wrigley, 2004

Number of Unemployed	30
% Do Rotational	76.7
% Male	80
% Aboriginal	80
% less than High School	56.7

Source: NWT Bureau of Statistics, 2004 Community Survey.

The employment and labour force statistics for Wrigley are indicative of a small, isolated community without any marketable assets. The employment rate in 2006 was 38.9 percent. Statistics Canada's 2006 Census found the unemployment rate to be 30 percent.

The NWT Bureau of Statistics, in its *2004 Community Survey*, studied the size and characteristics of the potential available labour force in Nahanni Butte. These are individuals who do not qualify as being part of the labour force under Statistics Canada's definition, but nevertheless want a job. The results are provided in Table 4-4. The group of potential workers not in the labour force at that time was made up almost entirely of males who were of Aboriginal descent, willing to work a rotational schedule, and were without a high school diploma.[31] For those who were working, 70 percent were employed in the public sector, whether in education, health, social services or administration.

Unlike the other Study Area communities, the percentage of households in *Core Need* of new housing or renovations has not changed in Wrigley over the period 1996 to 2004, remaining equal to or above 50 percent during that time.[32]

Personal income data is available for Wrigley on an inconsistent basis. The last year in which these data were published was 2004. At that time, the average personal income of Wrigley residents equalled $23,550. The number of income support beneficiaries has grown over time from 4 in 2000 to 13 in 2007. Poverty has to be a concern in Wrigley, factoring in the cost of living that is 52 percent higher than Edmonton, and the cost of food that exceeds that of Yellowknife by 75 percent.[33]

The community is active in traditional Aboriginal pursuits—47 percent of the population reported in 2003 that they hunt or fish, 20.1 percent trap, and 40.7 percent of households consume country food most or all of the time. The use of Aboriginal languages has dropped in Wrigley. In 1984, every resident (100 %) spoke an Aboriginal language. In 2004, that number had dropped to 79.2 percent. A small increase in the number of non-Aboriginal people contributes to this change.[34]

4.5 Community Perspective

Canadian Zinc initiated a survey in Nahanni Butte in an effort to clarify and confirm the correct interpretation of the statistical information that was collected and to understand the local perceptions of the socio-economic realities in the Study Area. The survey was conducted by a Study Area resident without the presence of the Canadian Zinc management team. Because the survey was exclusive to Nahanni Butte, one should exercise caution in extrapolating results to other communities, though the socio-economic data from Fort Liard and Wrigley are similar, and would be similar to a segment of Fort Simpson’s population as well. The results of the survey are relevant to many of the topics discussed in this SEIA. These results confirm many of the conclusions drawn from this research. The report from this exercise is included in the DAR as an appendix.

The residents were asked “How do you think Canadian Zinc’s mine will impact you?” The survey was meant to draw out information related to social issues, however, responses went beyond individual, family and community socio-economic impacts. Some chose to comment on issues related to the Territory’s regulatory regime, government structure and the division of powers, and public programming. Others commented on their perceptions related to environmental issues and the development’s timing. For the purpose of the SEIA, we are most interested in comments regarding social and community impacts.

In those two areas, the respondents had a number of specific and useful comments. With respect to social impacts, most comments were directed toward their concern for youth. These concerns included

- their education,
- cultural ties and links to community elders,
- employability,

- mobility,
- addictions and drug use,
- work ethic, and
- crime and community justice.

At the community-level, respondents cited the need for

- early prevention programs,
- training and human resource strategies,
- social events in the community,
- community healing,
- community justice,
- greater safety and security (including policing), and
- greater historical and cultural knowledge.

These comments speak to a society that is concerned about their present and future quality of life, especially that of their children. They suggest that life in Nahanni Butte is without many freedoms and without the resources or capacities to change that fact. A case in point is that there are public programs available to assist communities and its residents in most if not all of the areas of concern, but clearly, these programs are not working, not being used, not being implemented or not being properly managed. The greatest concern, however, is that these challenges faced by Nahanni Butte residents can escalate quickly, creating additional issues and concerns that further weaken a society's social and economic performance, creating a vicious circle of decline.

These social and community comments only partly relate to the Prairie Creek Mine; that is, they are challenges these people face on a daily basis regardless of whether the Project exists or not. But Canadian Zinc understands that its project, if managed well, can offer Nahanni Butte a starting point from which its challenges can be addressed. Through the provision of employment and business opportunities, training and skills development, a family-oriented camp setting, open dialogue with community members and leadership, and the commitment and ability to listen and adapt to the needs of the community with respect to the mining development are all components of what will become Canadian Zinc's offer to the community should the Project proceed.

Canadian Zinc cannot mend the relationship between elders and youth, or strengthen the cultural ties within the community. It cannot prevent residents from consuming alcohol or taking drugs. And it cannot take on the sole responsibility of education, health care, policing or any other public program offered by the territorial or federal government. But it can have a positive influence on all of these things through its own involvement, its active management, and its mitigation strategy.

It is worth noting that the First Nations people of Nahanni Butte, Fort Liard and Fort Simpson have given they support to Canadian Zinc and its Prairie Creek Mine through formal letters.[35] It would seem society there understands their plight and recognises the opportunity presented to them through the Prairie Creek Mine.

Nevertheless, an important takeaway for Canadian Zinc from this survey is the acknowledgement that its work at the community-level must continue and that its efforts to build relationships and earn the trust of community stakeholders are critical to the success of this project. The second important takeaway is that its interpretation of the socio-economic data is accurate. A more thorough discussion of these data is presented in the next chapter.

5 Description of Existing Human Environment

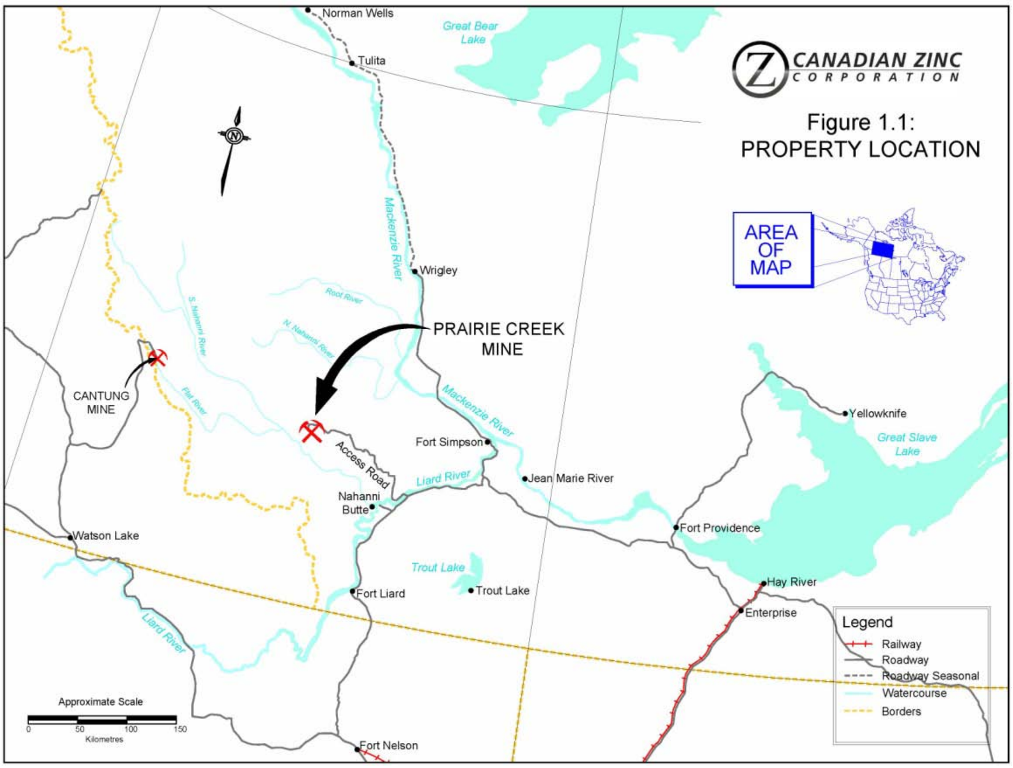
This chapter reports on the baseline conditions of the Study Area and Dehcho region. This description includes discussions on economic and social factors. The historical timeframe of this baseline is limited to recent history unless additional years of history are relevant to the discussion.

The Prairie Creek Mine was built 30 years ago and has been dormant ever since (notwithstanding the clean up, exploration and care and maintenance activities of Canadian Zinc and its predecessor Cadillac Exploration Ltd.). To investigate the human environment prior to this development would mean a look at the Study Area communities prior to 1980. A historical investigation of that nature would not reveal useful information for this section of the SEIA. Instead, the baseline study is centred on the socio-economic issues and trends over the past ten to twenty years.

The baseline includes a forecast of population and a discussion of future economic and social opportunities and challenges in the absence of the proposed Project.

5.1 Geographic Setting

The Dehcho region is located in the southwest corner of the Northwest Territories. Its spatial boundaries include the Mackenzie Mountains and Yukon Territory to the west, Cameron Hills and the Alberta and B.C. border to the south, the western shores of Great Slave Lake to the east, and the Mackenzie Valley just beyond Wrigley to the north (see Map 1). The Nahanni National Park Reserve exists within the boundaries of the Dehcho region.



In addition to the Study Area communities, the Dehcho region includes Trout Lake, Jean Marie River, Fort Providence, Hay River Reserve, and Kakisa. Statistics Canada and NWT Bureau of Statistics include the community of Kakisa with the South Slave Region for the purpose of data organisation, despite falling within the geographic boundaries of the Dehcho region. The omission of Kakisa from the Dehcho region's statistics has a negligible impact on research in the area because the community's population is statistically irrelevant, and falls below the level that would allow any statistical agency from reporting it. The communities of Enterprise and Hay River are also within close proximity to the Dehcho region, but are not a part of the statistical boundary.

5.2 Social Performance

5.2.1 General Socio-economic Assessment Indicators

Table 5-1 offers a selection of the most commonly-used, socio-economic indicators for the NWT, the Dehcho region and the Study Area communities.

When looked at together, these data offer a sense of the overall well-being of the Study Area communities and are an opportunity for comparison with the Dehcho region and the Northwest Territories.

A comparison with the Canadian average is not provided. The purpose of the SEIA is to improve our understanding of the human environment in which the proposed Project will enter. A comparison of standard of living and overall well-being between the local population and the majority of Canadians living in metropolitan areas assumes both populations define their quality of life goals in the same way.

The *Royal Commission for Aboriginal Peoples'* in discussing various development issues and options for Aboriginal people stated that:

Inhabitants of smaller communities often prefer the quality of life there—with its unique dimensions of time, culture and relationships—to the anonymity and pressure of cities. Many would choose a different mix of cash and other types of income if the prospect of healthy and sustainable communities were attainable. Measurements of social and economic well-being would be different for those communities because of the choices people make. While these communities may never be fully self-reliant, they could make far better use of existing public resources if allowed to do so in a way that corresponds to local conditions.[36]

One must be cautious in making assumptions about the quality of life of people living in Study Area communities or the Dehcho region from a review of statistics without understanding how the local people view their own conditions. At the same time, one must be careful not to misinterpret input from the community as a defence of poverty or any other social ill. The variables in Table 5-1 will be investigated in greater detail later in this chapter.

Table 5-1: Selected Socio-economic Indicators and Social Determinants of Health						
			Study Area Communities			
	Northwest Territories	**Dehcho region**	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
POPULATION, 2007	42,637	3,415	591	129	1,264	170
0 to 14 years	10,057	802	155	x	296	x
60 Yrs. & Older	3,650	357	58	19	97	28
Aboriginal	21,617	2,893	563	120	839	166
Non-Aboriginal	21,020	522	28	x	425	x
EDUCATION, 2006						
% with High School Diploma or More	67	45.3	31.3	23.8*	59.1	33.3*
Employment Rate (Less than Grade 12)	42.2	38.1	31	38.5	45.2	30.8
Employment Rate (At least Grade 12)	81.6	75.8	72	75	81.7	100
LABOUR FORCE, 2006						
Participation Rate	76.5	69	61.4	58.8	77.3	55.6
Selected Employment Rates						
Aboriginal	52.2	49.5	38.4	43.8	59.7	37.5
Non-Aboriginal	82.8	81.8	80	-	83.9	100
INCOME, 2006						
Average Personal Income ($)	48,396	34,287	29,392	..	39,263	..
Average Family Income ($)	101,622	68,154	56,175	..	81,211	..
HOUSEHOLDS, 2006						
Number of Households	10,875	835	155	25	305	30
% Couple Families	78.6	76	77.4	100	75.4	66.7
% of Households with > 6 people	6.2	8.9	14.3	28.6	4.6	11.1
% of Households in Core Need (2004)	16.3	24.9	32.4	47.2	16.4	50
CRIME , 2007						
Violent Crime Rate (per 1,000 persons)	70.7	115.1	108.3	..	136.1	..
Property Crime Rate (per 1,000 persons)	58	54.8	69.4	..	75.9	..
INCOME SUPPORT, 2007						
Beneficiaries per capita (average)	5%	9%	9%	2%	3%	8%
TRADITIONAL ACTIVITIES, 2003						
Households Consuming Country Food (most or all meat consumed) (%)	17.5	33	39.6	33.3	17.8	40.7
ABORIGINAL LANGUAGES, 2004						
% that Speak Aboriginal Language	44	61.7	74.5	83.5	48.4	79.2
PRICES						
Living Cost Diff. (Edm = 100), 2005	..	..	132.5	145	137.5	152.5
Food Price Index (YK = 100), 2004	100	..	135.4	169.1	142.1	175.4

Source: Compiled by NWT Bureau of Statistics, Summary of NWT Community Statistics, (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed September 21, 2009.
Note: * ten-year average

The Study Area communities can be considered small and relatively isolated.[37] Fort Simpson is the only community within the Dehcho region with a population that exceeds 1,000. Similar to the territory as a whole, the population is dominated by young people below the age of 25 and especially those under the age of 15. Aboriginal people make up the majority in all Study Area communities. Fort Simpson has the largest number of non-Aboriginal people in relative and absolute terms. The differences in Aboriginal and non-Aboriginal social and economic performance found in territorial data can be seen in the Study Area communities when comparing Fort Simpson to the others.

Education levels are low. This is especially true for those living outside Fort Simpson. While the economic opportunities in the Dehcho region are limited, statistics reveal that the employment record of those with at least a high school diploma is more than twice that of those without Grade 12 or its equivalent. There is also a clear division between Aboriginal and non-Aboriginal people in the Study Area communities when it comes to employment. The average employment rate of Aboriginal labour is less than 50 percent whereas non-Aboriginal employment rate exceeds 80 percent.

Overall, a weak economy and low participation means average incomes are similarly low. When coupled with the cost of living and cost of food in comparison to Edmonton and Yellowknife, these low incomes suggest higher rates of poverty among the population and in particular amongst the Aboriginal population.

Housing conditions appear to be worse in the Study Area communities than is the average. A larger percentage of houses are home to more than six people and the number in *core need* is higher than average.[38]

Violent crime rates are high in comparison to the territorial average, while property crime rates are on par. Income support is lower in two of the three reporting communities within the Study Area, though as a region, the Dehcho has a larger percentage of people receiving income support than the territorial average.

Traditional activities and the use of Aboriginal languages are more common in the three smaller communities within the Study Area than they are in Fort Simpson which is very close to the territorial norm in these regards. The statistics on income and cost of living suggest that subsistence hunting and fishing is as much a necessity for some as it is a part of local traditions and culture.

5.2.2 Demographics

5.2.2.1 Basic Statistics

The population of the Dehcho region was estimated at 3,415 in 2007 (see Table 5-2). Fort Simpson is the largest community in the Study Area and the Dehcho region with 1,264 residents. Jean Marie River and Trout Lake have the smallest populations with 71 and 85 residents, respectively.

From Table 5-2, it is also evident that this is a predominantly Aboriginal region of the Northwest Territories. Aboriginal residents make up approximately 85 percent of the total population, with approximately 80 percent of the 522 non-Aboriginal residents living in Fort Simpson.

The age distribution of Dehcho residents is virtually identical to that found across the territory with approximately 40 percent of the population under the age of 25 and 10 percent of the population 60 years of age or older.

Table 5-2: Basic Demographic Profile (2007)						
			Study Area Communities			
	Northwest Territories	**Dehcho region**	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
	(figures)					
Total	42,637	3,415	591	129	1,264	170
Males	21,951	1,764	303	65	638	93
Females	20,686	1,651	288	64	626	77
0 - 4 Years	3,310	219	47	x	74	x
5 - 9 Years	3,201	250	54	x	91	13
10 - 14 Years	3,546	333	54	13	131	23
15 - 24 Years	6,972	561	101	22	200	17
25 - 44 Years	14,060	1,114	204	38	407	47
45 - 59 Years	7,898	581	73	26	264	34
60 Yrs. & Older	3,650	357	58	19	97	28
Aboriginal	21,617	2,893	563	120	839	166
Non-Aboriginal	21,020	522	28	x	425	x
	(percentage of the Northwest Territories)					
Total	100.0%	8.0%	1.4%	0.3%	3.0%	0.4%
Males	51.5%	8.0%	1.4%	0.3%	2.9%	0.4%
Females	48.5%	8.0%	1.4%	0.3%	3.0%	0.4%
0 - 4 Years	7.8%	6.6%	1.4%	-	2.2%	-
5 - 9 Years	7.5%	7.8%	1.7%	-	2.8%	0.4%
10 - 14 Years	8.3%	9.4%	1.5%	0.4%	3.7%	0.6%
15 - 24 Years	16.4%	8.0%	1.4%	0.3%	2.9%	0.2%
25 - 44 Years	33.0%	7.9%	1.5%	0.3%	2.9%	0.3%
45 - 59 Years	18.5%	7.4%	0.9%	0.3%	3.3%	0.4%
60 Yrs. & Older	8.6%	9.8%	1.6%	0.5%	2.7%	0.8%
Aboriginal	50.7%	13.4%	2.6%	0.6%	3.9%	0.8%
Non-Aboriginal	49.3%	2.5%	0.1%	-	2.0%	-
	(percentage of the Dehcho region)					
Total	-	100.0%	17.3%	3.8%	37.0%	5.0%
Males	-	100.0%	17.2%	3.7%	36.2%	5.3%
Females	-	100.0%	17.4%	3.9%	37.9%	4.7%
0 - 4 Years	-	100.0%	21.5%	-	33.8%	-
5 - 9 Years	-	100.0%	21.6%	-	36.4%	5.2%
10 - 14 Years	-	100.0%	16.2%	3.9%	39.3%	6.9%
15 - 24 Years	-	100.0%	18.0%	3.9%	35.7%	3.0%
25 - 44 Years	-	100.0%	18.3%	3.4%	36.5%	4.2%
45 - 59 Years	-	100.0%	12.6%	4.5%	45.4%	5.9%
60 Yrs. & Older	-	100.0%	16.2%	5.3%	27.2%	7.8%
Aboriginal	-	100.0%	19.5%	4.1%	29.0%	5.7%
Non-Aboriginal	-	100.0%	5.4%	-	81.4%	-

Source: Compiled by NWT Bureau of Statistics, Summary of NWT Community Statistics, (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed September 21, 2009.

5.2.2.2 Trends in Growth

The population base in the Study Area communities and across the Dehcho region is stable. The population grew by 70 people and 134 people, respectively, from 1997 to 2007 (see Table 5-3). For the Study Area communities, this is the equivalent to 0.3 percent growth per year when compounded annually. This rate of change is below the long-term annual replacement rate that is typically considered to equal 2.1 percent, but is not significantly different from the territorial average which has had some swings in growth but is averaging a little more than 0.2 percent per year compounded annually over the same period.

Table 5-3: Historical Trends in Population

	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
NWT	41,635	40,816	40,654	40,499	40,822	41,489	42,231	42,822	42,724	42,401	42,637
(growth rate)	-0.3%	-2.0%	-0.4%	-0.4%	0.8%	1.6%	1.8%	1.4%	-0.2%	-0.8%	0.6%
Dehcho region	3,307	3,303	3,358	3,375	3,389	3,397	3,384	3,403	3,423	3,407	3,415
(growth rate)	1.3%	-0.1%	1.7%	0.5%	0.4%	0.2%	-0.4%	0.6%	0.6%	-0.5%	0.2%
Study Area	2,084	2,061	2,097	2,113	2,128	2,147	2,108	2,129	2,134	2,137	2,154
(growth rate)	-0.6%	-1.1%	1.7%	0.8%	0.7%	0.9%	-1.8%	1.0%	0.2%	0.1%	0.8%
Fort Liard	529	530	537	573	581	599	585	599	601	611	591
(growth rate)	-2.0%	0.2%	1.3%	6.7%	1.4%	3.1%	-2.3%	2.4%	0.3%	1.7%	-3.3%
Nahanni Butte	75	82	105	107	110	115	111	112	119	125	129
(growth rate)	0.0%	9.3%	28.0%	1.9%	2.8%	4.5%	-3.5%	0.9%	6.3%	5.0%	3.2%
Fort Simpson	1,297	1,264	1,266	1,240	1,250	1,254	1,236	1,245	1,241	1,230	1,264
(growth rate)	-0.9%	-2.5%	0.2%	-2.1%	0.8%	0.3%	-1.4%	0.7%	-0.3%	-0.9%	2.8%
Wrigley	183	185	189	193	187	179	176	173	173	171	170
(growth rate)	5.8%	1.1%	2.2%	2.1%	-3.1%	-4.3%	-1.7%	-1.7%	0.0%	-1.2%	-0.6%

Source: Statistics Canada, NWT Bureau of Statistics *Community Profiles*

There are three variables to consider when studying population growth—births, deaths and migration. One can see from Table 5-4 that for the most recent years in which data are available, the Dehcho region has been losing people through migration on a consistent basis, which is keeping the overall pace of population growth down. This net out migration includes residents relocating within the Territory and those leaving the NWT altogether.

Table 5-4: Sources of Population Growth, 2001 to 2005

	Dehcho region				
	Births	Deaths	Natural Rate	Migration	Total
2001	48	24	24	-10	14
2002	45	13	32	-24	8
2003	42	21	21	-34	-13
2004	47	13	34	-15	19
2005	42	17	25	-5	20
	Northwest Territories				
	Births	Deaths	Natural Rate	Migration	Total
2001	613	163	450	-127	323
2002	635	169	466	201	667
2003	701	202	499	243	742
2004	698	153	545	46	591
2005	712	148	564	-662	-98

Source: NWT Bureau of Statistics, Summary of NWT Community Statistics, (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed September 21, 2009. To calculate net migration in the Dehcho region, the natural rate of change was subtracted from the total. Population is reported as the number of residents as of July 1 of each year whereas the natural rate is calculated on a calender-year basis. This introduces an unknown error to the results, though it is likely statistically insignificant over time. For the purpose of comparison, the same methodolgy was adopted to calculate net migration for the NWT. Note that this latter statistic is reporting inter-provincial migration while the figure for the Dehcho would also include intra-territorial migration.

5.2.3 Education

The Study Area communities lag behind the rest of the Territory in terms of educational attainment (see Table 5-5), though in both cases, the 20-year trend does show the percentage of residents with at least high school is improving. The most recent data is for 2006 and comes from Statistics Canada's *Census*. In that year, 45.3 percent of the Dehcho region's population aged 15 years and older had a high school diploma compared to 67 percent for the territory as a whole. A note of caution must accompany the community-specific data. Surveys conducted for Nahanni Butte and Wrigley are susceptible to sampling errors due to the small populations.

Table 5-5: EDUCATIONAL ATTAINMENT (population aged 15 years and older)

			Study Area Communities			
	Northwest Territories	**Dehcho region**	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
	% with High School Diploma or More					
1986	51.6	37.8	36.5	16.7	49.7	25
1989	59.8	37.4	13.9	16.4	55.1	25
1991	59.9	40.7	31.7	46.2	52.5	33.3
1994	63.2	39.7	19.7	11.1	54.3	22.6
1996	63.5	47.3	30.4	16.7	62.8	50
1999	66.1	45.3	28.6	34.8	62	28
2001	64.8	45	33.3	..	61.9	39.1
2004	67.5	46.6	31.3	31.7	63.4	37.6
2006	67	45.3	31.3	-	59.1	-

Source: Compiled by NWT Bureau of Statistics, Summary of NWT Community Statistics, (http://www.stats.gov.nt.ca/Profile/NWTCommunityStats (2008).pdf) accessed September 24, 2009. These data combine Statistics Canada *Census* data (1986, 1991, 2001, 2006) and NWT Bureau of Statistics data.

Within the *2006 Census* data, Statistics Canada has released detailed information specific to Aboriginal peoples. There is a marked difference in the education levels of Aboriginal and non-Aboriginal residents within the Study Area communities. The Aboriginal population from within these communities also underperforms in comparison to the territory's Aboriginal population. From the previous table, 67 percent of the territory's population 15 years of age and older have at least a high school diploma. This figure combines residents of all ethnicities. Table 5-6 contains the education figures specific to Aboriginal residents of the territory.[39] Here we see that for the Northwest Territories as a whole, 45 percent of Aboriginal residents have a high school diploma or its equivalent—this compares to 34 percent in the Study Area communities. Again, caution is advised with the data from Nahanni Butte and Wrigley where sampling error can have a statistically significant influence on the results.

Table 5-6: Aboriginal Educational Attainment

	Northwest Territories	Study Area	Study Area Communities: Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
Aboriginal Population 15 years of age and older	14,465	1,115	365	80	590	80
Less Than High School	7,920	735	285	70	315	65
At Least High School	6,545	380	80	10	275	15

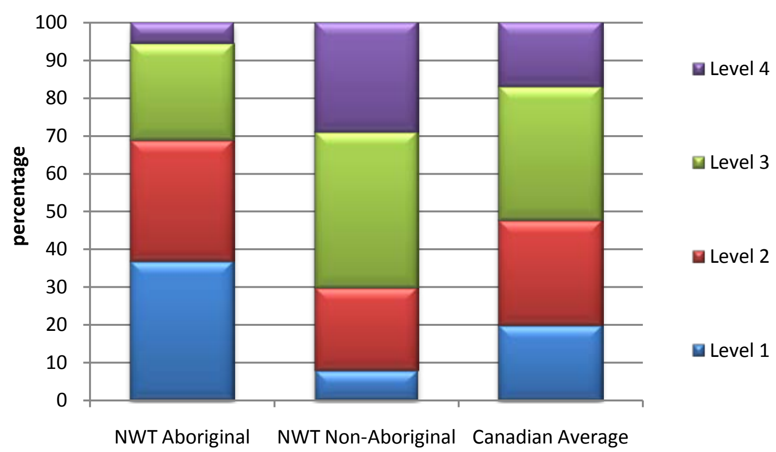
Source: Statistics Canada, Aboriginal Population Profile, 2006 Canadian Census.

Additional evidence of the education levels in the Study Area communities comes from the *International Adult Literacy and Skills Survey* conducted in Canada (see Figure 5-1). The scores are organised into levels of competency, with 4 being the highest.

The levels are defined within the survey and represent levels of competency. Level 3 is considered the minimum skills level suitable for coping with the demands of everyday life and work in a complex, advanced society. It denotes roughly the skill level required for successful secondary school completion and college entry.[40]

The results do not show intraregional scores for the provinces and territories, but do show the difference in scores between Aboriginal and non-Aboriginal adults. The percentage of NWT Aboriginal people who fall below Level 3 was approaching 70 percent in 2003 when the survey was conducted. This compares to less than 30 percent for the non-Aboriginal population.

Figure 5-1: Competency Levels in Prose Literacy, for population 16 years of age and over, by NWT Ethnicity and Canada (2003)



Note: Prose literacy is defined as the knowledge and skills needed to understand and use information from texts including editorials, news stories, brochures and instruction manuals.
Source: Building on our Competencies: Canadian Results of the International Adult Literacy and Skills Survey. Catalogue no. 89-617-XIE.

Similar to other regions in the NWT, the smallest communities in the Study Area are without a high school (see Table 5-7). Students from Nahanni Butte and Wrigley must travel to Fort Simpson, Fort Liard or elsewhere to graduate. For children from Wrigley, this means leaving home after completing Grade 9 which could be at the age of 14 or 15. In the Tlicho region, statistics show that bringing high school to the smaller communities has been a major factor in raising the number of graduates in those communities.

Table 5-7: Study Area Primary and Secondary Schools

Name	Community	Grades
Bompas Elementary School	Fort Simpson	K - 6
Thomas Simpson Secondary School	Fort Simpson	7 - 12
Charles Yohin School	Nahanni Butte	K - 10
Chief Julian Yendo School	Wrigley	K - 9
Echo-Dene School	Fort Liard	K – 12

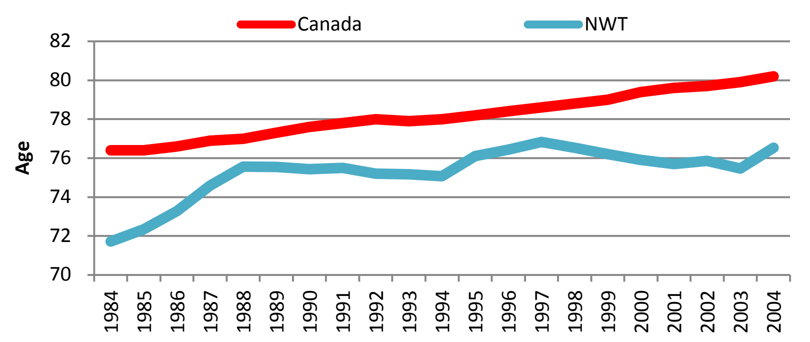
Source: Department of Education, Culture and Employment, GNWT

5.2.4 Health

Detailed health results specific to the Study Area communities are not available. Figure 5-2 and Table 5-8 offer health information for the NWT population as a whole and a comparison to the national average. Being careful not to associate these results exclusively to Dehcho residents, these data provide evidence that in comparison to Canada the NWT

- life expectancy is lower,
- the leading causes of death follow a different pattern,
- there are more smokers,
- there is less alcohol consumption but more heavy drinking,
- self-assessment of health is lower (note that in the previous year (2006), self-assessed health in the NWT was 63.3, so there is significant variation), and
- there is little difference in physical activity

Figure 5-2: Life Expectancy from Birth, NWT and Canada (1984 to 2004)



Source: NWT Bureau of Statistics, Socio-Economic Scan 2009

Table 5-8: Health and Health-related Statistics, NWT and Canada	NWT	Canada
Overall Life Expectancy from Birth	76.5	80.2
Deaths per 10,000, by Leading Causes (2001-05)[1]		
Neoplasms	10.42	21.33
Circulatory	9.06	22.25
Respiratory	4.28	6.35
Accidents (incl. suicides)	6.44	4.57
Self-Assessed Health Status, 2007[2]	52.6	59.6
Incidence of Cigarette Smoking, 2007[2]	38.0	21.9
Frequency of Alcohol Consumption in Past 12 Months, 2007[2]	51.6	55.1
Frequency of Heavy Alcohol Consumption, 2007[2]	40.1	22.1
Physical Activity Index, 2007[2]	48.6	48.2

Notes: (1) Statistics Canada, (2) National Population Health Survey, Canadian Community Health Survey
Sources: NWT Bureau of Statistics, Socio-Economic Scan 2009.

The study of health and population health goes beyond a review of health outcomes. The World Health Organisation defines health as "a state of complete physical, mental and social well-being and a resource for everyday life."[41]

*... good health is a major source for social, economic and personal development and an important dimension of quality of life. In corollary, the concept of **population health** is based on the understanding that health is determined as much or more by social, economic, environmental and cultural factors than it is by genetic or medical factors. That is, factors such as income, level of education, occupation, social hierarchy and housing, which are all **determinants of health**, have direct and indirect consequences for the health and well-being of the population. Many of these factors play out largely in Canadian communities – the cities, towns, neighbourhoods and regions where people live, learn, work and play.*[42]

Table 5-1 presented earlier includes many of these socio-economic determinants of health. These data reflect a population that is challenged with low income families, below average education levels, and issues of poverty, poor housing, and family violence and abuse. These are statistics that have been shown to be directly correlated with poor health outcomes such as lower life expectancy, lower rates of self-assessed health, and higher rates of diabetes.[43]

The Government of the Northwest Territories reports physician activities by region in its *Physician Services Report* that can be used for a comparison with the rest of the territory.

Table 5-9: Physician Activity (average from 2002-02 to 2006-07)			
	Dehcho region	Yellowknife	NWT
Patients per 1,000	662	840	776
Cost per capita	$572	$780	$722

Source: Physician Services Report, 2008, GNWT http://www.hlthss.gov.nt.ca/pdf/reports/health_care_system/2009/english/physicians_report.pdf accessed September 28, 2009.

The data shows the number of patients and the average cost per capita is lower than the territorial average (see Table 5-9). One should exercise caution in drawing conclusions from these data. Health care is a supply driven commodity; that is, the more health-care services are made available, the more they are used. Therefore, it is more likely that these data are reflecting the absence of health-care services throughout the Dehcho region, especially the smaller communities, rather than suggesting Dehcho residents are healthier than the average in the Territory.

5.2.5 Families

The statistics on housing, family income, and safety and security are presented together under the heading of "Families". While these topics are of concern for all residents, their importance is magnified in the presence of children and can have profound effects on early childhood development.

5.2.5.1 Housing

The number of houses within the Study Area communities with more than six permanent residents exceeds the territorial average, though the situation appears to be improving in all the communities (see Table 5-10).[44] Fort Simpson is the one community within the Dehcho region that is below this average. This statistic is used as a measure of overcrowded homes, though one should not interpret the results too strictly. Issues such as the size of house and age of residents would also need to be considered.

The percentage of houses in Fort Liard, Nahanni Butte and Wrigley in *core need* (defined below) is high in comparison to Fort Simpson and the territorial average (see Table 5-11). Again, the trend appears to be positive, with the percentage dropping between 1996 and 2004.

If a household has any one or more housing problems (suitability, adequacy, or affordability), and the total household income is below the Community Core Need Income Threshold, the household is considered to be in core need. The core need income threshold is an income limit for each community that represents the amount of income a household must have to be able to afford the cost of owning and operating a home or renting in the private market without government assistance.[45]

Table 5-10: Households with more than 6 people

			Study Area Communities			
	Northwest Territories	Dehcho region	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
1986	13.9	28.3	40	..	15.7	40
1986	11.5	21.9	26.3	..	13.8	28.6
1991	9.8	14.4	18.5	..	8	10
1996	8.6	9.3	13.8	..	6	-
2001	7.2	8.3	12.5	..	4.9	20
2004	7	8.2	9.3	2.8	5.9	11.1
2006	6.2	8.9	14.3	28.6	4.6	11.1

Source: Statistics Canada, *Canadian Census* (1981 to 2006), as reported by NWT Bureau of Statistics, Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20 (2008)) accessed September 30, 2009.

Table 5-11: Housing Conditions (% of Households in Core Need)

			Study Area Communities			
	Northwest Territories	Dehcho region	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
1996	19.7	50.1	67.6	62.5	38.7	53.3
2000	20.3	35.1	38.6	45.5	21	52.8
2004	16.3	24.9	32.4	47.2	16.4	50

Source: NWT Bureau of Statistics. Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed October 1, 2009.

5.2.5.2 Family Income

Income levels for families in the Study Area communities are considerably lower than the territorial average (see Table 5-12). The small populations in Nahanni Butte and Wrigley prevent this information from being reported by Statistics Canada or the NWT Bureau of Statistics for these communities. However, we can infer the results for these communities from those in Fort Liard and other information such as employment records and the average family income reported for the entire Dehcho region. In 2006, the average family in Fort Liard earned $56,175 compared to $81,211 in Fort Simpson and the NWT average of $101,622.

Table 5-12: FAMILY INCOME

			Study Area Communities			
	Northwest Territories	Dehcho region	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
			Average Family Income			
2002	87,143	62,501	58,773	..	71,632	..
2003	88,244	62,879	56,231	..	70,668	..
2004	91,362	65,331	54,359	..	76,597	53,667
2005	96,171	67,357	56,156	..	79,654	..
2006	101,622	68,154	56,175	..	81,211	..
			Percent Families Less than $25,000			
2002	15.3	17.3	13.3	..	13.5	40
2003	16.5	15.6	12.5	..	12.5	..
2004	16.2	20.8	29.4	..	15.4	-

2005	15.1	23.7	31.3	..	17.9	..
2006	14.3	21.1	25	..	18.4	..
	Percent Families More than $60,000					
2002	59.9	41.3	33.3	..	51.4	-
2003	59.7	41.6	31.3	..	50	..
2004	61.1	41.6	29.4	..	51.3	-
2005	63.2	43.4	31.3	..	56.4	..
2006	64.6	42.1	31.3	..	55.3	..

Source: NWT Bureau of Statistics, Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed October 2, 2009.

To get a proper sense of standard of living, family incomes should be considered in relation to local prices (see Table 5-13). There isn't enough detailed data on prices and consumer expenditures patterns to compute an exact purchasing power parity index between the Study Area communities and between the Dehcho region and the rest of the NWT, but enough information is available to get a good sense of the population's standard of living.[46] Living costs are 32 percent to 52 percent higher in the Study Area communities compared to Edmonton. For a local point of reference, living costs in Yellowknife were estimated to exceed that of Edmonton by 17.5 percent in 2005.

Combining these statistics with family incomes tell us that a family in Nahanni Butte must earn $87,000 to have a similar purchasing power as a family in Edmonton earning $60,000 and a family in Yellowknife earning $70,500. Similarly, a family in Fort Liard must earn $79,500 in this example. Given that 68 percent of families in Fort Liard earn less than $60,000 (which would be like earning $45,283 in Edmonton on a living cost basis) while 25 percent earn less than $25,000 (equivalent to $18,868 in Edmonton on a living cost basis), we can conclude that poverty is prevalent in Fort Liard and the other Study Area communities.

Table 5-13: PRICES

		Study Area Communities			
	Yellowknife	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
Living Cost Diff. (Edm = 100), 2005	117.5	132.5	145	137.5	152.5
Food Price Index (YK = 100), 2004		135.4	169.1	142.1	175.4

Source: NWT Bureau of Statistics, Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed October 2, 2009.

5.2.5.3 Safety and Security

Safety and security is a primary human need that can affect a multitude of socio-economic outcomes. One can view a broad cross-section of data when studying safety and security. Financial wealth, education, health, housing, access to nutritious food (including country food) and clean water and other environmental factors influence a society's safety and security. With these data covered elsewhere in the report, this section focuses on crime, but we note that this is not the only type of security issue people might have.

In the Study Area, the Royal Canadian Mounted Police have detachments in Fort Liard and Fort Simpson. These detachments provide police services in Nahanni Butte and Wrigley. The crime statistics for the Study Area communities are presented in Table 5-14. Note that the recorded incidents from a detachment may include incidents from the surrounding communities. Therefore, the per capita results should actually include the populations from these two communities, but also, the Fort Simpson data might also include incidents from Jean Marie River.

Regardless of some anomalies in the data, the information in Table 5-14 can be interpreted as showing that crime, especially violent crime, is problem in the Dehcho region. In 2007, this region within the NWT produced 13 percent of the territory's total number of violent offences while representing 8 percent of the territory's population. In the case of federal statute violations, which includes but is not limited to possession and trafficking of drugs, the number of offences has varied over the 5 years from 2002 to 2007, ranging from 6.5 percent to 11 percent of the territory's total.

Table 5-14: CRIME STATISTICS

			Study Area Communities			
	Northwest Territories	Dehcho region	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
			Violent Crimes			
2003	2,848	397	102	..	142	..
2004	2,942	354	93	..	118	..
2005	2,715	324	92	..	132	..
2006	2,717	308	98	..	112	..
2007	3,015	393	64	..	172	..
			Property Crimes			
2003	3,053	252	57	..	88	..
2004	3,187	232	57	..	100	..
2005	2,899	219	59	..	81	..
2006	2,680	180	49	..	64	..
2007	2,471	187	41	..	96	..
			Other Criminal Code			
2003	10,012	716	141	..	417	..
2004	11,933	916	186	..	586	..
2005	12,914	947	214	..	578	..
2006	12,076	849	180	..	525	..
2007	13,173	1,060	207	..	660	..
			Federal Statutes			
2003	595	66	7	..	46	..
2004	632	64	15	..	37	..
2005	742	77	10	..	55	..
2006	534	41	8	..	21	..
2007	657	43	5	..	17	..
			Traffic			
2003	633	80	17	..	43	..
2004	759	90	26	..	45	..
2005	881	71	22	..	28	..
2006	829	63	10	..	30	..
2007	865	87	11	..	50	..
			Violent Crime Rate (per 1,000 persons)			
2003	67.4	117.3	174.4	..	114.9	..
2004	68.7	104	155.3	..	94.8	..
2005	63.5	94.7	153.1	..	106.4	..

2006	64.1	90.4	160.4	..	91.1	..
2007	70.7	115.1	108.3	..	136.1	..
	Property Crime Rate (per 1,000 persons)					
2003	72.3	74.5	97.4	..	71.2	..
2004	74.4	68.2	95.2	..	80.3	..
2005	67.9	64	98.2	..	65.3	..
2006	63.2	52.8	80.2	..	52	..
2007	58	54.8	69.4	..	75.9	..

Incidents in a particular detachment may include incidents from surrounding communities.

Violent Crimes: Canadian Center for Justice Statistics, Statistics Canada. Refers to incidences of homicides, attempted murder, assaults (including sexual assaults), abduction and robbery.

Property Crimes: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of breaking and entering, theft, position of stolen goods and fraud.

Other Criminal Code: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of offensive weapons, bail violation, disturbing the peace and mischief (property damage).

Federal Statutes: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to indidences of possession and trafficking of drugs.

Traffic: Canadian Center for Justice Statistics, Statistics Canada. Includes but is not limited to incidences of dangerous operation of motor vehicle and impaired operation of motor vehicle.

Violent Crime Rates (per 1,000 persons): Bureau of Statistics, GNWT. Rates are determined using population estimates developed by the Bureau of Statistics.

Property Crime Rates (per 1,000 persons): Bureau of Statistics, GNWT. Rates are determined using population estimates developed by the Bureau of Statistics.

Source: NWT Bureau of Statistics, Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed October 5, 2009.

There are also safety and security issues related specifically to children. A report sponsored by the GNWT's Department of Health and Social Services in 2006 on the subject of child abuse and neglect show this to be an area of concern for the Territory, especially within the Aboriginal populations.[47] The report states that:

Ninety percent of substantiated cases or 628 substantiated maltreatment investigations involved children of Aboriginal heritage. [Of those cases,] 49 percent involved children with First Nations status, 8 percent involved Métis children, 29 percent involved Inuit children, and 3 percent involved First Nation Non-Status children.

The report did not provide a regional analysis or breakdown of the results. It did show that the number of child welfare case openings registered by the Dehcho Health and Social Safety Authority was 168 from a territorial total of 1,469. This would be close to the per child average across the NWT regions, where children are defined as those residents aged 0 to 15 years.[48]

For a point of reference, the number of children aged 0 to 15 years living in the Dehcho region in 2007 is estimated at 802. So without having specific evidence of the substantiated cases of child abuse or neglect in the Study Area communities, the broader evidence suggests that the 168 child welfare case opening (close to 20 percent of the child population) is a concern.

5.2.6 Language, Culture and Traditional Pursuits

The following discussion is given as a means to provide a brief summary of the status and trends in traditional activities, culture and language in the Study Area; all of which tie into our understanding of the existing human environment. More thorough discussions related to archaeology and to traditional knowledge are provided in their own sections within the Developer's Assessment Report. They are reported separately due to issues of confidentiality of the information they contain.

As noted earlier, a majority of residents living within the Study Area and Dehcho region are of Aboriginal decent. The communities meld together Aboriginal traditions and culture with modern Canadian activities and pursuits. Traditional activities such as hunting and trapping are important aspects of Dehcho society. Every indicator presented in Table 5-15 reveals Dehcho communities are more active hunters and fishers than the average for the territory and that the use of Aboriginal languages is more prevalent. At the same time, one can see that in the case of language, the trend is clearly downward. Over the past 20 years, the use of Aboriginal languages has declined consistently across all communities and throughout the NWT.

Table 5-15: TRADITIONAL ACTIVITIES AND LANGUAGES

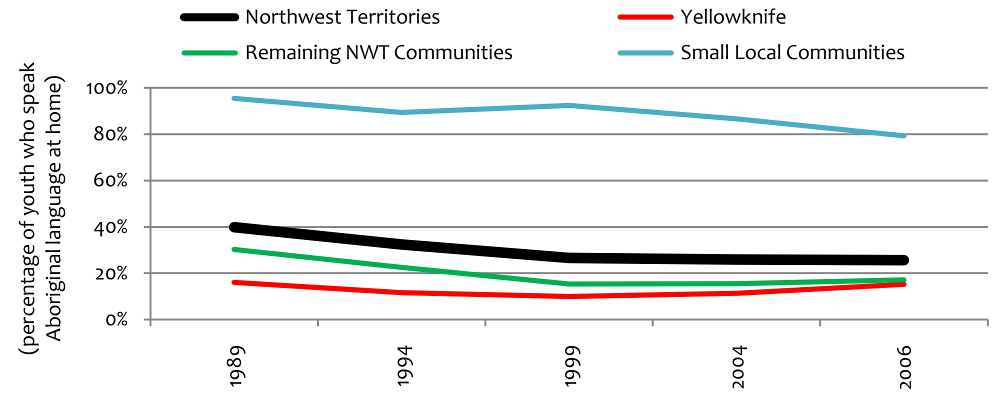
			Study Area Communities			
	Northwest Territories	Dehcho region	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
			Traditional Activities (2003)			
Hunted & Fished (%)	36.7	46.8	60.7	58.5	39.1	47
Trapped (%)	5.9	13.9	14.9	11	8.7	20.1
Households Consuming Country Food (Most or All meat consumed) (%)	17.5	33	39.6	33.3	17.8	40.7
			% Aboriginals that Speak an Aboriginal Language			
1984	59.1	81.6	88.3	88.9	74.8	100
1989	55.6	78.6	88.6	98.1	71.6	100
1994	50.1	71	82.4	98.7	60.9	96.2
1999	45.1	64.9	78.8	74.6	54.9	92
2004	44	61.7	74.5	83.5	48.4	79.2

Source: NWT Bureau of Statistics, Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed October 5, 2009.

5.2.6.1 Language

There has been a long, negative trend in use of Aboriginal languages in the NWT.[49] This trend was expected to worsen with the arrival of the diamond mines with all three diamond producers predicting further declines. However, there are some details that suggest the pace of decline is slowing and perhaps reversing in some communities.[50] From 1999 to 2006, the percentage of Aboriginal people between the ages of 15 and 24 who could speak an Aboriginal language has remained relatively constant (see Figure 5-3). For the Territory as a whole, the percentage of youth speaking an Aboriginal language at home has fallen from 26.6 percent to 25.7 percent; which cannot be considered a statistically significant change. Also, there has been a noticeable drop in the use of Aboriginal languages in Tlicho communities from 1999 to 2006 however this decline has been matched by a similarly noticeable increase in Yellowknife over the same period. The Government of the Northwest Territories' has surmised that this is due, at least in part, to migration into Yellowknife from the outlying communities in the North Slave region.[51]

Figure 5-3: Percentage of Aboriginal persons aged 15 to 24 who can speak an Aboriginal language at home, 1989 to 2006



Source: 1989, 1994 and 1999 NWT Labour Force Survey and 2004 NWT Community Survey; 2006 Statistics Canada Census as compiled in Community and Diamonds, 2008.
Note: The difference in surveys makes it difficult to compare results. For example, the overall results NTW Bureau of Statistics Household Survey show a decline in the use of Aboriginal languages; though this does not speak to youth specifically.

5.2.6.2 Arts and Crafts

Residents of the Study Area communities and the Dehcho region are very active in the making of arts and crafts (see Table 5-16). In a survey conducted by the NWT Bureau of Statistics, it was found that nearly a quarter of all residents were active in these pursuits. This was the highest percentage for the entire Territory. While not specific to the region, the same survey found that half of the respondents were engaged in sewing or needle work and 27 percent engaged in painting or drawing.

Table 5-16: Active Population in Arts and Crafts

	Population 15 years of age or older	Involved in making Arts and Crafts	%
Northwest Territories	30,459	5,407	17.8
Beaufort-Delta	5,116	662	12.9
Sahtu	1,951	349	17.9
Deh Cho	2,525	621	24.6
South Slave	5,157	1,213	23.5
Dogrib	2,051	344	16.8
Yellowknife	13,658	2,217	16.2
Males	15,834	1,536	9.7
Females	14,464	3,870	26.8
Aboriginals	14,022	2,691	19.2
Non-Aboriginals	16,211	2,643	16.3

Source: 2002 NWT Regional Employment & Harvesting Survey, as prepared by the NWT Bureau of Statistics

5.2.6.3 Traditional Activities

As mentioned, a more thorough discussion of the history of the Aboriginal people living in the Study Area and their Traditional Knowledge can be found in separate reports within the DAR. It should be noted that the First Nations from Fort Liard and Fort Simpson have indicated that they had little or no historical presence in the area immediately surrounding the Prairie Creek Mine site.[52]

Table 5-17 below indicates that the Dehcho region is not home to a lot of trappers. In the harvesting survey conducted by the NWT Bureau of Statistics, 240 people indicated they were involved in this activity; 8 percent of whom did so frequently. Most of those who trapped did so for day-trips, weekends, or a period somewhat longer, but not on a regular basis. The Traditional Knowledge report provides details on whether there are any trap lines in the vicinity of the Prairie Creek Mine or along the proposed winter road route.

Table 5-17: Population 15 Years & Over Who Trapped During the Past Year, by Frequency

	Trapped During the Past Year	Frequently Traps	%	More than Day-Trips or Weekends	%	Only Day-Trips or Weekends	%
Northwest Territories	1,514	329	21.7	366	24.2	546	36.1
Beaufort-Delta	420	45	10.7	94	22.4	219	52.1
Sahtu	141	32	22.7	78	55.3	17	12.1
Deh Cho	240	48	20.0	96	40.0	63	26.3
South Slave	257	78	30.4	61	23.7	66	25.7
Dogrib	290	125	43.1	36	12.4	39	13.4
Yellowknife	166	-	-	-	-	142	85.5
Males	1,199	281	23.4	305	25.4	430	35.9
Females	315	48	15.2	61	19.4	116	36.8
Aboriginals	1,388	313	22.6	366	26.4	478	34.4
Non-Aboriginals	114	8	7.0	-	-	66	57.9

Source: 2002 NWT Regional Employment & Harvesting Survey, as prepared by the NWT Bureau of Statistics

Table 5-18 offers additional details regarding the frequency of hunting and trapping in the Northwest Territories and the Dehcho region. Similar to the trapping statistics, these statistics show that few Dehcho residents hunt and fish on a regular basis compared to the average in other regions, but that there are a large number that do so on a more recreational schedule, including weekends or trips of a longer length.

Table 5-18: Population 15 Years & Over Who Hunted or Fished During the Past Year, by Frequency

	Hunted or Fished during the past year	Frequently hunts or fishes	%	More than day-trips or weekends	%	Only day-trips or weekends	%
Northwest Territories	12,244	1,934	15.8	2,742	22.4	4,835	39.5
Beaufort-Delta	2,235	300	13.4	773	34.6	874	39.1
Sahtu	910	171	18.8	255	28.0	338	37.1
Deh Cho	1,088	121	11.1	360	33.1	450	41.4
South Slave	1892	455	24.0	372	19.7	621	32.8
Dogrib	819	198	24.2	196	23.9	257	31.4
Yellowknife	5,301	688	13.0	786	14.8	2,296	43.3
Males	8,146	1,401	17.2	2,017	24.8	3,031	37.2
Females	4,030	533	13.2	719	17.8	1,752	43.5
Aboriginals	6,292	1,355	21.5	1,794	28.5	2,193	34.9
Non-Aboriginals	5,911	571	9.7	949	16.1	2,623	44.4

Source: 2002 NWT Regional Employment & Harvesting Survey, as prepared by: NWT Bureau of Statistics

5.3 Economic Performance

In this section, the existing economic conditions of the Study Area communities and the Dehcho region are discussed.

5.3.1 Overview of Study Area Economy

The wage-based economies present in the Study Area communities and the Dehcho region are small. There is no real economic driver present. That is, there are no activities attracting private investment or expanding local employment on a consistent basis. By-in-large, the economy is based on public-sector activity. There are some small-scale entrepreneurs operating in service-related areas such as tourism and retail. First Nations have formed development corporations that provide industrial and consumer goods and services. Some additional general points on the state of the economy in the Study Area communities are listed below.

- The region is a producer of natural gas and oil. This industry has been on the decline in recent years; the result of falling prices and a lack of new investment.
- Other minerals are present in the Dehcho region. In addition to the lead/zinc deposit at Prairie Creek, there are known deposits of tungsten which have been mined at different times in the past as well as known copper, nickel and silver deposits and indications of precious and semi-precious stones.
- Should the Mackenzie Gas Project go ahead, the Dehcho region would become a link in the transportation corridor for the pipeline.
- The tourism industry is a small but relatively stable component of the economy, with the Nahanni National Park Reserve being a central attraction. There are several licensed tourist operators servicing this market.
- There is the potential for a small forestry industry, based largely in the Fort Liard area and focussing on White Spruce and Trembling Aspen[53] for local use with some limited potential for value-added processing and export to the western Canadian market.
- Most of the money circulating throughout the region arrives via the public sector, whether through governments' own expenditures on administration, health or education, its spending on capital projects, its legal obligations to transfer funds to First Nations, its payment of unemployment insurance and social assistance, and its transfers related to the Dehcho Process including those related to the Interim Resource Development Agreement and other legal decisions.

A thorough investigation into the Study Area's economy does not reveal anything that might propel it forward. Economies with a strong government presence, like the one found in the Dehcho region, tend to be stable, especially in situations where the government's expenditures are in no way tied to the economic performance of that region. However, these economies rarely grow at a pace much beyond the minimum needed to sustain the population. And while this type of economy is sustainable on a small scale within Canada, it hampers social progress and other important socio-economic changes by limiting opportunities for the enduring population to expand their economic, social or political freedoms. For example, in economies such as these, residents living in poverty rarely have the opportunity to change that fact.

In these regions, government initiatives aimed at creating jobs can be effective in that regard but are short-lived especially when there is no underlying economy in which labour can transfer its newly-acquired work experience and skill set. A common outcome from such regions is out-migration—with the majority being young, educated and/or recently trained. A lack of job opportunities lends itself to low personal and family incomes, unproductive citizens and boredom. This in turn can spark a deterioration of social conditions, establishing a vicious circle of stagnation, poverty and further socio-economic decline.

For most Study Area residents, their future does not contain a lot of opportunities for advancing their economic objectives in the absence of the Prairie Creek Mine. Without proceeds from economic growth, progress in social conditions will be slow if at all, which, when viewed alongside present social conditions should be considered unacceptable. The following section is a more detailed investigation into the economic performance of the Study Area communities and Dehcho region. It will clarify and confirm the facts regarding the economy.

5.3.2 Wage-based Economic Activities

5.3.2.1 Occupations

The latest Canadian Census collected information on the distribution of employment by occupation.[54] Statistics Canada has grouped this data according to industry classifications. These data are presented in Table 5-19. Note that the information presented for Nahanni Butte and Wrigley are from small samples and suffer from rounding errors. Zeros in those cases can represent suppressed data.

These data show a reliance on the public-sector spending for employment throughout the Study Area communities. Of the 1,030 individuals working at the time of the survey, over 50 percent or 560 of them were working in health, education or other services. The classification ‘other services’ includes public administration. This is not too different from the distribution of employment across the territory.

Note however that this is 2006 data. Since that time, resource-based activities have increased in the North Slave Region with the addition of the Snap Lake Mine, while the extent of exploration and natural gas and oil activity in the Dehcho region has dropped very close to zero. Thus, this snap-shot of the occupations by industry has changed since 2006, meaning an increased dependence on public spending in the Dehcho region relative to the NWT.

Table 5-19: Occupation by Industry, 2006

		Study Area Communities			
	Northwest Territories	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
Total experienced labour force 15 years and over	23,450	250	50	685	45
Resource-based industries	2,130	25	10	50	0
Construction	1,610	45	0	90	0
Manufacturing	360	0	0	0	0
Wholesale trade	380	10	0	0	0
Retail trade	2,200	25	0	50	0
Finance and real estate	860	25	0	15	0
Health care and social services	2,145	15	10	65	0
Educational services	1,680	20	10	50	0
Business services	4,270	20	0	95	0
Other services	7,810	65	20	270	25

Note: Experienced labour force refers to persons 15 years and over, excluding institutional residents who, during the week (Sunday to Saturday) prior to Census Day (May 16, 2006), were employed and the unemployed who had last worked for pay or in self-employment in either 2005 or 2006. Canadian Census Definitions, Statistics Canada (http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/details/page_Definitions.cfm?Lang=E&Geo1=CSD&Code1=6106038&Geo2=PR&Code2=61&Data=Count&SearchText=Fort Simpson&SearchType=Begins&SearchPR=61&B1=Labour&Custom=&LineID=23000)

Source: Canadian Census, 2006. Statistics Canada. Community Profiles.

5.3.2.2 Prairie Creek Mine Exploration and Development

Canadian Zinc has been conducting clean up, exploration and site development work at the Prairie Creek Mine for over fifteen years. In that time, labour and capital spending has varied, but must be considered a part of the current or baseline economic conditions in the Study Area. In 2007, the company employed a crew of 47 workers on a seasonal basis; 22 of whom were Aboriginal people from the Study Area. In the four-year period starting in 2004, the payroll to the local workers exceeded $493 thousand. Over that same time period, First Nation development corporation businesses have earned revenues in excess of $1.26 million through direct contracts with Canadian Zinc.

5.3.2.3 Mining, Oil and Gas

Oil and natural gas reserves are present in the Fort Liard area and in the Cameron Hills. Production has fallen sharply over the past three to four years, however (see Table 5-20). By the end of 2008, the only gas field in production was operated by Paramount Resources in the Cameron Hills. This field produces oil and gas. Production at the remaining four fields near Fort Liard (and within the Study Area) has been suspended or abandoned. According to the *Northern Oil and Gas Annual Report, 2007,* Paramount Resources cited “low natural gas prices, few new gas finds and lack of new lands opening for exploration as the main reason for their actions.”[55] This trend in production is not expected to change over the medium term. There were no prospecting permits issued for the Dehcho region for 2009.

Table 5-20: Oil and Gas Production

	2000	2001	2002	2003	2004	2005	2006	2007	2008
	Oil Production (thousand m^3)								
Cameron Hills (Paramount)	0	0	1.1	28.5	48.6	47.2	70.3	53.3	47.8
	Gas Production (million m^3)								
Fort Liard ("F-36" - Paramount)	66.3	71.8	38.8	16.5	11.2	50.7	29.9	52.6	X [1]
Fort Liard ("K-29" - Paramount)	490	1214	834	680	465	203	59.1	49.1	X [1]
Fort Liard ("P-66A" - CNRL)	60.1	1.8	-	9.8	-	-	-	-	X [2]
SE Fort Liard ("N-01" - Paramount)	0	33.2	61.9	51.1	48.1	38.8	11.9	0	X [1]
Cameron Hills (Paramount)	0	0	124	104	92.8	91.3	93.5	99	80.3
Total Gas Production	**617**	**1320**	**1059**	**862**	**618**	**384**	**194**	**201**	**80**

Source: Northern Oil and Gas Annual Report (2004 through 2008), Indian and Northern Affairs Canada.
Notes: (1) Production Suspended (2) Abandoned

The Dehcho region was a producer of tungsten until late 2009. North American Tungsten Corporation had reopened the Cantung Mine in September, 2005 after its previous shutdown at the end of 2003.[56] In 2008, it produced 2,608 tonnes of tungsten valued at over $55 million.[57] Operations were suspened in October, 2009.

This deposit is located on the Yukon/NWT border and was being serviced almost exclusively out of Watson Lake, Yukon. Of the 210 employees, approximately 75 resided in the Yukon.[58] At the time of its closure, there was no one from the Study Area communities working at the mine. It is uncertain if or when it will reopen.

The same company also owns the Mactung deposit which also straddles the Yukon/NWT border but is yet to go into production. North American Tungsten is planning to develop the site entirely on the Yukon side of the border.

Stornaway Diamonds Corporation was active in the Dehcho region in 2006 and 2007.[59] It was granted prospecting permits for approximately one million acres of land separated into three parcels north of Fort Simpson. The company conducted airborne geophysical surveys over each property and subsequently let go of the Eetsee and Shegonla Properties, while retaining the Blackstone Property. Exploration was suspended in 2008 and remains on hold.

The only other existing mineral activities within the Study Area are those associated with the proposed Prairie Creek Mine.

5.3.2.4 Dehcho Bridge

The Dehcho Bridge is a four-year, $165 million construction project currently underway near Fort Providence. The project began in the spring of 2008 but underwent a shut-down in 2009. There were contract issues as well as a need for additional engineering.[60] The Department of Transportation with the GNWT suggested these issues will delay the project's completion date by one year. Even with a one-year delay, this Project should be completed prior to the start of operations at the Prairie Creek Mine.

However, during the time in which this SEIA was being finalised, the territorial government and Deh Cho Bridge Corporation announced that ATCON Construction would not be involved in the second phase of the construction project. It is unclear at this point in time how this will affect the project. One can assume it will mean further delays.

For the Aboriginal workforce involved in the project, there should be opportunities to transfer those skills developed on-the-job to the mine site. This is discussed in more details later.

The most immediate impact from this project is local employment. A report on Aboriginal benefits of the Deh Cho Bridge Construction pegged total Aboriginal employment during construction at 59.[61] Of this number, 11 were projected to be from Fort Providence, 45 from elsewhere in the NWT and 3 from Alberta. Once built, employment from operations will equal 10 person-years annually. All of these positions are expected to go to Fort Providence workers.

Over the longer term, the Dehcho Bridge is expected to generate a revenue stream for its owners through the tolls paid by commercial vehicles. The Deh Cho Bridge Corporation will be the owner; this is a 100 percent Aboriginal-owned business.

5.3.2.5 Tourism

There are several territorial parks within the Dehcho region (see insert) however the park that garners the most attention is the Nahanni National Park Reserve (Nahanni NPR). It is discussed in depth in its own chapter within the DAR. For the purpose of the report, we are most concerned with its contribution to the regional economy.

- Dory Point
- Fort Providence
- Fort Simpson Park
- Blackstone Park
- McNallie Creek
- Lady Evelyn Falls
- Kakisa River

In 2008, Parks Canada commissioned a series of studies on different aspects of the Nahanni NPR in advance of its recent expansion. One of these looked at socio-economic impacts from 1976 to 2005. The findings of this research are presented below.[62]

- The park attracts up to 1,000 visitors annually.
- Park expenditures over the 30-year time period amounts to $48.5 million in constant 2008 dollars, while park visitors have spent $16.9 million in constant 2008 dollars during that same time period.
- When combined, this spending has increased the Territory's value-added gross domestic product by $28 million, of which $21.9 million is labour income.

In addition to the Nahanni NPR's own operations, there were nine private-sector businesses listed as licensed tourist operators in the Dehcho region in 2008 (see insert).[63] The industry is centred on adventure-style tourism including fishing, hunting, canoeing and hiking.

Outside the Nahanni NPR, the Dehcho region promotes its system of highways as a driving tourism option for campers, nature enthusiasts and cultural tourists.[64] Fort Liard has the Liard Hot Springs to offer as an additional tourist attraction. Tourism information centres are located in Fort Simpson and Fort Liard.

Nahanni NPR Tourist Operators

- Black Feather - The Wilderness Adventure Company
- Nahanni Butte Outfitters Ltd.
- Simpson Air/Nahanni Mountain Lodge
- Nahanni River Adventures Ltd.
- Nahanni Wilderness Adventures Ltd.
- North Nahanni Naturalist Lodge Ltd.
- Northwest Expeditions

5.3.2.6 Government

As pointed out earlier, the public-sector is the principal economic agent in the Study Area. It is a primary employer at the federal, territorial, regional, local and Aboriginal levels. The largest employer in the region is the Government of the Northwest Territories. The GNWT's *Main Estimates* for 2009-2010 show 391 positions allocated to the Dehcho region.[65] Likewise, most of the monetary flows in the region are generated through public-sector spending and transfers.

5.3.2.7 Business Services

The business sector in the Study Area communities is limited. There are 146 directory listings for the four communities combined.[66] Less than half of these listings represent private-sector businesses, with the remainder being that for government offices or services (post office, RCMP detachment, schools, health centres, Aboriginal organisations, etc). By contrast, Yellowknife listings total 1,264.

While business services are limited, each First Nation in the Study Area operates Development Corporations capable of expanding to take on new roles or brokering joint venture arrangements with larger, southern-based firms. In Fort Liard, the Acho Dene Koe First Nation has developed several joint ventures in conjunction with natural gas production addressing service needs such as drilling, air and ground transportation, and environmental services. They have also pursued construction opportunities, camp services and catering business through its holding company, Beaver Enterprises.[67] The First Nation also operates a number of retail businesses selling crafts, other tourist products and fuel.

Fort Simpson offers the largest array of business services. The community is home to several transportation companies servicing industry, tourism and general transportation needs, and a number of accommodation services, including hotels/motels and bed and breakfasts. Other businesses provide expediting services, construction, contracting and general retail services such as grocery outlets, fuel, taxi service, etc.

The Liidlii Kué First Nation's development corporation is Nogha Enterprises. It is classified as a highway, street and bridge construction company by Industry Canada,[68] however, it is involved in a wider array of construction activities, general contracting, and services (see insert).

Nogha Enterprises Business Lines

- Highway Maintenance Services
- Fire Suppression Services
- Ferry operational Services
- Seismic Services
- Engineering and Environmental Services
- Helicopter Services
- Northern Orientation
- Hot Shot Services
- Rental Services
- Residential and Commercial Construction Services
- Ice Bridge Construction and Maintenance
- Winter Road Construction

Similar to Beaver Enterprises, it has the capacity to expand to meet new demands from industry either independently or through the formation of a joint venture.

Nahanni Butte and Wrigley are smaller communities where only limited business and retail services are available. The First Nations in these communities have formed development corporations. However, their ability to expand to meet the business needs of industry is largely untested.

5.3.3 Employment and Labour

The information available on labour force activity and employment for the Study Area communities comes from several different surveys. Surveys by the NWT Bureau of Statistics and the Canadian Census are the most relevant. These surveys do not occur on an annual basis. As well, Statistics Canada does not report on these communities in its monthly *Labour Force Survey*. The information contained within these different survey results is valuable, but should not be compared since there are differences in survey methodology and in definitions. Nevertheless, as already pointed out, the economies in these communities are quite stable as is the population so the shortcomings in survey data are unlikely to be hiding something that cannot be seen with what is available.

General information on labour force activity is provided in Table 5-21. There are three important observations. First, like the territory as a whole, the Study Area communities have a large percentage of adults not in the labour force. These are people who are 15 years of age or older and are not looking for work. Many are in school especially those in the age range 15 to 24, but the rest have left or have never entered the labour force. Common reasons for leaving the labour force include being stay-at-home parents, retiring, going back to school or stopping the search for work.

Second, the unemployment rate in the Dehcho region is consistently twice that of the territorial average. Rates outside Fort Simpson are particularly high. In Fort Liard, 27 percent of the labour force is unemployed. The figures in Nahanni Butte and Wrigley are similarly high, though these results come from small samples and should be treated with caution. The rate of unemployed in Fort Simpson is better, but at 12.2 percent is still above the territorial average.

The third part of this table contains information gathered by NWT Bureau of Statistics in 2004 related to *potential* labour. These are individuals who are defined as "not in the labour force" by Statistic Canada because they have not looked for work in the past six months but would work if a job were available. The survey also collected data on the number of people willing to work a rotational schedule, their gender, ethnicity and education. The results allow one to characterise the *potential* labour as predominantly male, Aboriginal, without a high school education and willing to work a job a rotational schedule.

Table 5-21: Labour Force Activity

			Study Area Communities			
	Northwest Territories	Dehcho Region	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
	Actual Labour Force Activity, 2006					
Population 15 & Over	31,140	2,385	415	85	905	90
Employed	21,350	1,315	185	40	610	35
Unemployed	2,475	315	70	10	85	15
Not in the Labour Force	7,310	745	165	35	205	40
	Unemployment Rates					
1986	11.2	20.5	14.8	40	14.6	30
1989	13.2	26.6	18.7	24.2	25	20.5
1991	11.3	19.9	20.5	42.9	13.9	29.4
1994	14.8	27.8	42.7	33.3	17.8	14.1
1996	11.7	22.8	18.6	25	18.1	26.7
1999	13.7	22.9	19	28.8	16.5	44
2001	9.5	17.8	19.2	..	12.9	26.7
2004	10.4	19.7	19	24.6	11	37.5
2006	10.4	19.1	27.5	20	12.1	30
	Potential Available Labour Supply (2004)					
Number of Unemployed	2,454	338	55	14	76	30
% Do Rotational	70.3	83.1	80	85.7	76.3	76.7
% Male	64.4	74.9	74.5	85.7	73.7	80
% Aboriginal	77.3	93.5	98.2	92.9	88.2	80
% Less than High School	52.3	63.3	81.8	57.1	56.6	56.7

Source: 2006 data from Canadian Census (Statistics Canada), 2004 data from NWT Labour Survey (NWT Bureau of Statistics), NWT Bureau of Statistics, Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed October 14, 2009.

More employment data is presented in Table 5-22. Of particular interest is the result showing the discrepancy between Aboriginal and non-Aboriginal employment rates and the low youth employment rate in the Dehcho region.

Table 5-22: Employment Details, 2006

			Study Area Communities			
	Northwest Territories	Dehcho Region	Fort Liard	Nahanni Butte	Fort Simpson	Wrigley
	Selected Employment Rates (2006)					
Males	70.1	56.5	45.5	44.4	70.7	27.3
Females	66.7	54.5	42.1	42.9	64	57.1
Aboriginal	52.2	49.5	38.4	43.8	59.7	37.5

Non-Aboriginal	82.8	81.8	80	-	83.9	100
15-24	49.8	29.5	22.2	-	48.6	-
25-34	76.2	63.1	52.9	66.7	77.8	100
35-44	81.4	69.7	52.6	66.7	76.7	100
45-54	81.9	73.8	69.2	50	77.5	66.7
55-64	67.7	54.4	50	-	66.7	66.7
65 & Over	16.4	-	-	-	-	-

Source: NWT Bureau of Statistics, Summary of NWT Community Statistics, 2008 (November). (http://www.stats.gov.nt.ca/Profile/NWT%20Community%20Stats%20(2008).pdf) accessed October 14, 2009.

5.3.4 Highway Usage

The Terms of Reference included questions related to the impact the proposed Project might have on the system of roads in the Study Area. A report on current highway usage is provided in this section to establish a baseline.

The small population of the Study Area, its remoteness relative to large centres, and distances between communities all contribute to low traffic volumes. The Government of the Northwest Territories' Department of Transportation surveys the traffic on an annual basis in different locations throughout the NWT including traffic just south of Fort Liard on Highway 7 and south of the junction of Highways 1 and 7, which is just past the turn-off for those travelling north to Fort Simpson or west to Lindberg Landing, Nahanni Butte, or Fort Liard.

The results of this survey work are presented in Table 5-23. It shows that traffic outside Fort Liard has averaged 110 vehicles per day for the last couple years, while traffic between the junction of Highways 1 and 7 and Nahanni Butte has averaged 50.

Table 5-23: Highway #7 Traffic Count

Counter Location	Km Marker	08	07	06	05	04	03	02	01	00	99
		Average Annual Daily Traffic									
2.6 km south of Fort Liard	35	110	110	140	120	-	120	120	120	-	-
0.3 km south of Highway 1 & 7	253	50	50	30	30	-	30	30	30	30	30
		Peak Summer Average Daily Traffic (June, July, August)									
2.6 km south of Fort Liard	35	-	-	-	130	-	130	130	130	-	-
0.3 km south of Highway 1 & 7	253	-	-	40	40	-	40	40	40	50	50

Source: Department of Transportation, GNWT (2009), all values estimated and rounded to nearest 10

5.4 Socio-economic Potential

5.4.1 Demographic Projections

Population projections to 2022 by the NWT Bureau of Statistics show the trend in the Study Area's population growth is not expected to change much (see Table 5-24). It predicts the region's population to reach 2,243 by 2022, equating to an average annual compound growth rate of less than 0.3 percent over the 15-year time period beginning in 2007. This is slower than the 0.9 percent annual growth the Bureau predicts for the Territory as a whole.

Within the Study Area, the population for the community of Wrigley is predicted to go down, while that for Nahanni Butte is predicted to remain virtually unchanged.

Table 5-24: Population Projections, 2007 to 2022

	2007	2012	2017	2022
NWT	42,637	44,878	47,038	48,919
(5-yr growth rate)		5.3%	4.8%	4.0%
Study Area	2,154	2,171	2,216	2,243
(5-yr growth rate)		0.8%	2.1%	1.2%
Fort Liard	591	608	627	632
(5-yr growth rate)		2.9%	3.1%	0.8%
Nahanni Butte	129	128	128	133
(5-yr growth rate)		-0.8%	0.0%	3.9%
Fort Simpson	1,264	1,271	1,304	1,327
(5-yr growth rate)		0.6%	2.6%	1.8%
Wrigley	170	164	157	151
(5-yr growth rate)		-3.5%	-4.3%	-3.8%

Source: NWT Bureau of Statistics *Community Profile*

5.4.2 Economic Opportunities

5.4.2.1 Mackenzie Gas Project

Mackenzie Gas Project proposes to develop natural gas fields in the Mackenzie Delta of Canada's Northwest Territories and deliver the natural gas to markets through a pipeline system built along the Mackenzie Valley.[69] From an economic perspective, this project offers numerous opportunities.

Construction:[70] The construction phase encompasses several major activities. These include three natural gas fields, a processing plant near Inuvik, gathering systems to move the natural gas from the fields to that plant, a natural gas liquids pipeline from Inuvik to Norman Wells, a natural gas pipeline from Inuvik to Alberta, and four compressor stations along the pipeline route. In addition, smaller construction projects will be necessary such as that for the work camps, airstrips, gravel pits, temporary and permanent roads, and barge landing sites.

The construction phase will span four years. Work would be seasonal. Job estimates vary, but in the first year alone, as many as 7,000 jobs will be created with a peak workforce of 8,600. These jobs will be located across 40 work camps—half of these would be stationary (ten for the pipeline, six for facilities and one in Hay River) and the other half would be mobile.

Operations: Once operational, approximately 50 people will be needed on a full-time basis to maintain the pipeline with another 90 to 100 jobs created in the production fields.[71]

Business Opportunities:[72] A project of this size will require a lot of goods and services to keep it going. Its proponents have committed to seeking out business opportunities for northern suppliers, ensuring these suppliers are aware of opportunities, and facilitating the contracts in a way that allows northern businesses to manage them. A sample of the required business services is provided in the insert.

Business Services Needed by the MGP

- Accommodation
- Communication
- Construction – Facilities
- Construction – Pipeline
- Equipment
- Fuel and Fuel Storage
- Office Requirements
- Personnel Requirements
- Safety and Medical
- Logistics
- Drillings, Completions and Well Servicing

Many questions remain with respect to the future of this project. The environmental assessment process has been underway for several years with a report from the Joint Review Panel released in the final days of 2009.[73] The Panel has approved the MGP on the condition that 176 recommendations are met. Beyond these recommendations, there are still hurdles to overcome before construction could start. Additional regulatory steps are required. Today's price of natural gas is not sufficient to cover the cost of this project. New technologies have facilitated an opportunity to access natural gas in other areas of the North American continent that are closer to high demand markets and less expensive to deliver. Improved access to these "unconventional" gas deposits will likely keep prices below those needed by the MGP.

If the project were to proceed, the construction phase will overwhelm the economy in the Mackenzie Valley. Any resource—labour or capital—that can be used in the project will be consumed by the project. But not all available labour and capital across the impacted regions are suitable for use by the MGP. So one should not expect zero unemployment or that all businesses in the Territory would be able to take full advantage of the opportunity.

Once built, the operational requirements of the pipeline will be minimal. Where work will arise is in exploration and field work, north of the Dehcho region. Depending on what capital and infrastructure is left behind from the project, additional opportunities might arise such as road maintenance.

5.4.2.2 Cantung and Mactung Mines

Both of these tungsten deposits are owned by North American Tungsten Corporation. As noted earlier, the Cantung Mine ceased operations in October, 2009 and it is not clear if and when a restart will occur. The mine's owners have said that reserves are depleted and they appear to be focussing more on their Mactung site.[74] In October, the company received "formal notification from the Yukon Environmental and Socio-Economic Assessment Board (YESAB) that its Proposal for the MacTung Project has been deemed adequate and that screening of the Proposal will commence pursuant to the Yukon Environmental and Socio-Economic Assessment Act.[75]

The Mactung Project is still at a feasibility stage in its development process with operations many years away. But similar to Cantung and Selwyn Resources lead/zinc deposit in Howard's Pass, Mactung's deposit straddles the NWT/Yukon border. North American Tungsten Corporation has established its operations in the Yukon Territory and will undertake its environment assessment through that territory's regulatory system. It is unclear whether this project will employ any labour or business from the Dehcho region.

5.4.2.3 Howard's Pass Lead/Zinc Deposit

The latest information available to the public for the Howard's Pass lead/zinc deposit is the January, 2007 *Preliminary Assessment Report* and is available through SEDAR.[76] This assessment shows promising results based on a 20,000 tonnes per day mining rate.[77] Using inferred resources, the Howard's Pass property has the potential to become the world's fifth largest zinc mine. Efforts to increase the measured and indicated reserves are underway.

This property is likely to encounter a complex regulatory process given its location right at the NWT/Yukon border, though most of the known deposits are on the Yukon side. Development would also require new transportation infrastructure, meaning a larger footprint and the need for more regulatory approvals. When combined, the need for further exploration, the likelihood of a lengthy regulatory process, and the current economic climate suggest that development of this property is a medium to long-term opportunity for the Dehcho region. It is also not clear at this stage how much the Dehcho region would participate. Similar to the Cantung and Mactung Mine, this project is most likely to be serviced out of Yukon Territory.

5.4.2.4 Fort Liard Natural Gas

The previous chapter described the recent shutdown of all natural gas production in the Fort Liard region. There have also been no new exploration permits administered for the region. The previously-active producers have shown no interest in returning to the area until changes occur in the North American price for natural gas, more land is opened for exploration, and the regulatory and political processes in place for the region are clarified.[78] For the purpose of the baseline projections for the Study Area communities, the assumption is the new status quo will remain for several years.

5.4.2.5 Forestry

In 2005, the Deh Cho Land Use Committee commissioned a study on the potential for the forestry industry.[79] The general conclusion of that study is summarised below:

- *The NWT does not have a large timber resource*
- *the allowable annual cut is probably less than 500,000 cubic metres per year*
- *given the distribution of the timber, lack of existing transportation infrastructure and the distance to major markets, the potential for a commodities-based major mill to be established ... does not currently exist*

- *the possibility exists for the development of locally-based commodities and value-added forest products ... to serve the northern markets with the possible eventual shipment of higher value products to southern markets*
- *for this business to proceed, maximum value must be obtained from the total forest resource available.*

A forestry industry in the Dehcho region would focus on White Spruce and Trembling Aspen. Within these species, there are issues related to the age mixture of forests which reduces the efficiency in which the logging industry can operate. It is unlikely that more than 12 percent of the aspen annual allowable cut will be suitable for sawlog production.[80]

Looking specifically at the forestry opportunities for the Study Area communities, it was estimated that Fort Liard and Fort Simpson have the potential for production of 100,000 cubic metres per year and 60,000 cubic metres per year, respectively. The cost of production and transportation to northern Alberta was estimated at a minimum of $49 per cubic metre and would demand a price ranging from $45 to $53.[81]

It is reasonable to conclude from this that the cost impediments to production means a forestry industry in the Study Area would serve local demand only. There are opportunities for small-scale operations in this regard, but should not be viewed as an important economic opportunity for the region. Instead, it has the potential to employ a few individuals on a seasonal basis.

5.4.2.6 Tourism

The socio-economic research report on the historical contribution of the Nahanni NPR also made ten-year projections of economic impacts from the park expansion.[82]

- A principal assumption was that Parks Canada would spend $10 million as a direct result of the park expansion.
- The added spending would increase GDP in the NWT by $7.9 million and create 59 full-time equivalent (FTE) jobs over the ten-year period. (This should not be interpreted as creating 59 jobs on an annual basis, but rather an average of 5.9 FTE jobs annually.)
- The expanded park would generate an additional $1.5 million in visitor spending on goods and services in the Territory over the initial 10 years—equivalent to an additional $150,000 annually.

The research did not evaluate the impacts beyond the ten-year window after the immediate impacts of the park's expansion have passed or with the potential opportunity costs associated with the park expansion. Namely, it did not compare the increased GDP and employment with any alternative scenarios, such as those associated with mineral exploration and development, big-game hunting tourism or forestry. The additional $150,000 of visitor spending the park expansion will generate on an annual basis was estimated to contribute $44,000 to the Territory's yearly GDP.[83]

The 2009 season saw the number of park visitors decline to approximately 700. Should tourist levels remain low (300 visitors less than its peak), the economic benefits from the park expansion described above would be all but eliminated.

5.4.3 Socio-economic future without the proposed Project

This section has shown there are several economic opportunities for the Study Area communities and the Dehcho region. All come with a high degree of risk; that is, none of the opportunities described are at all certain. There is potential for tungsten and lead/zinc mines in the Howard's Pass area, natural gas production, the Mackenzie Gas Project, and a small forestry industry, however, none of these projects will be underway in the short term and it is possible that none will proceed for at least five years. For the largest project of them all, the Mackenzie Gas Project, one must consider the possibility that development will be postponed indefinitely until such time as the North American price of natural gas improves. Meanwhile, the economic impact of the Nahanni NPR expansion has been shown to be small, positively affecting a similarly small number of businesses and workers in the Study Area communities. The most recent data from the park indicates visitations are down, which does not bode well for the future economic impacts.

For most Study Area residents, this baseline does not contain opportunities for advancing their economic freedoms. And without the proceeds from economic growth, progress in social objectives will be slow if at all.

Trending this analysis forward, there is no reason to believe that the population in the Study Area communities will grow beyond what was predicted by the NWT Bureau of Statistics over the next ten years and there is the possibility that some years will see a population decline as a result of migration. This would especially be the case if economic activity were to expand elsewhere in the Territory or if the economy in northern Alberta were to return to the pace it was setting prior to the 2008/2009 recession.

6 Outcomes from Recent Economic Growth in the NWT

There are many lessons to be learned from the social and economic impacts of previous mining developments in the Northwest Territories. By far the most relevant are those associated with the diamond industry currently active in the North Slave Region. Detailed statistics reveal that not only has this industry brought great prosperity to the territory in general, but one can observe that the population has been resilient in the face of these changes and is increasingly showing strong adaptation skills. There are, of course, some areas of concern.

The impacts from the diamond industry are investigated and then viewed through a lens appropriately-fitted to the proposed Prairie Creek Mine.

There are several advantages of using the diamond mines for comparison with the proposed Prairie Creek Mine.

- *The diamond industry is local*. It has affected local populations large and small, Aboriginal and non-Aboriginal.
- *It is current*. The diamond industry is affecting populations today. Any data collected, whether social, economic or environmental, will be influenced by other current social, economic and environmental changes.
- *It has been carefully scrutinised*. In its decade of operation, the diamond industry has been subjected to intense scrutiny with respect to its effect on the human and natural environment. The result is a wealth of data collected and organised according to the common concerns related to the affect of economic growth on the NWT population and environment.

There are other similarities such as

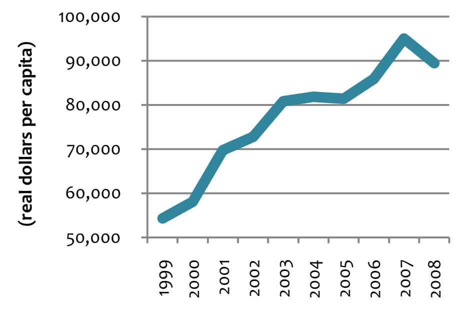
- most transportation needs take place during winter months;
- work will be on a rotational basis with employees flying in and out of the site;
- regional market access agreements such as Impact and Benefit Agreements will be put in place;
- the projects fall within the same basic regulatory regime;
- the deposits are being developed in areas subject to Land Claims negotiations;[84]

There are issues in using the diamond industry as a comparator. The most important difference to consider is that the diamond mines are larger than the Project proposed for Prairie Creek—approximately ten times larger. Combined, the three diamond operations employ more than 2,000 people directly, while spending in excess of $500 million annually on operations. The Prairie Creek Mine, on the other hand, will employ approximately 220 people and see an annual operational budget of $50 million to $75 million. The difference in size will affect the magnitude of impacts and will limit opportunities to benefit from economies of scale in a manner achieved in the North Slave region by the three operating mines.

6.1 Economic Impacts of the NWT Diamond Industry

The diamond industry is having a positive impact on the economic well-being of people living in the NWT. Real gross domestic product in per capita terms has almost doubled in the last ten years (see Figure 6-1). Similarly, labour income has doubled over the same time period—going from $1.1 billion in 2000 to $2.2 billion in 2008—while the employment rate has grown from 67.5 percent in 1999 to a peak in 2007 of 73.6 percent.

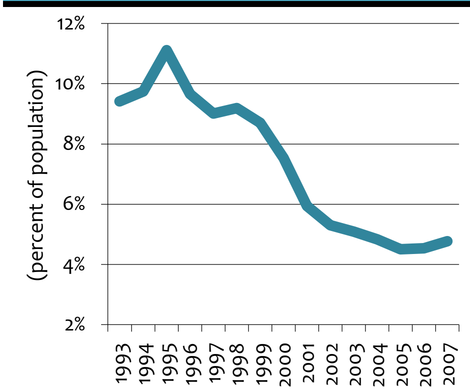
Figure 6-1: NWT's Real GDP per Capita, 1999 to 2008



Source: Statistics Canada, NWT Bureau of Statistics

One cannot attribute all of the economic success in the NWT to the diamond mines however it is the principal economic driver within the territorial economy. Its arrival has brought a period of economic growth and stability to the region and has brought a number of new entrants into the labour market, giving people living in remote or isolated communities the opportunity for employment and a higher standard of living—an opportunity that would not have existed otherwise. One can see the result of this in the decline in the number of income support recipients as a percentage of the population (see Figure 6-2).

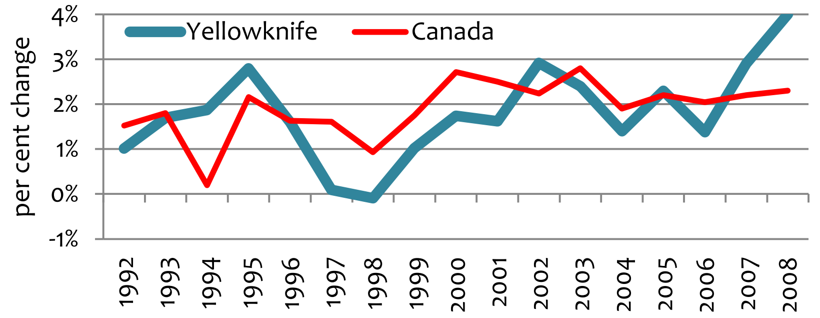
Figure 6-2: NWT Population Receiving Income Support, 1993 to 2007



Source: Education, Culture and Employment, NWT Bureau of Statistics

One potential impact that has not materialised is inflation. The rise in economic activity, employment and income as a result of the diamond mines were all anticipated. So was inflation. However, since 1998 when the Ekati Diamond Mine went into production, inflation in Yellowknife has not shown any movements that would suggest inflation is out of step with that of Canada. (see Figure 6-3 on the following page). This observation was made stronger after 2003 when the Diavik Diamond Mine began production with still no changes to the trend in consumer prices.

Figure 6-3: Inflation Rate, Yellowknife and Canada, 1992 to 2007

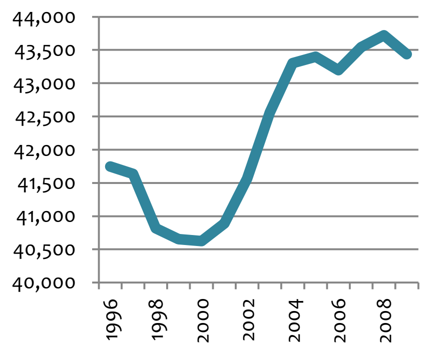


Source: Statistics Canada

There are several reasons why inflation has not risen as some may have feared. The NWT imports almost all of its consumer goods and therefore is a price taker; that is, the prices established in southern Canada dictate the prices in the NWT. Factors such as rising energy prices affect all Canadians and therefore are a function of the prices established in southern Canada.

The other reason is that the population of the Territory has not grown at the pace that was anticipated. There was an initial increase of 2,600 people over the five-year period 1999 to 2004, but in the five years since then growth has been flat with the 2009 population being 138 more than its 2004 mark (see Figure 6-4). This more recent lack of growth is primarily the result of negative out-migration. In a typical year, the NWT exports more people to southern Canada than it imports. Over the past five years, not once has this not been the case, with the average number of people leaving on net equalling 648.

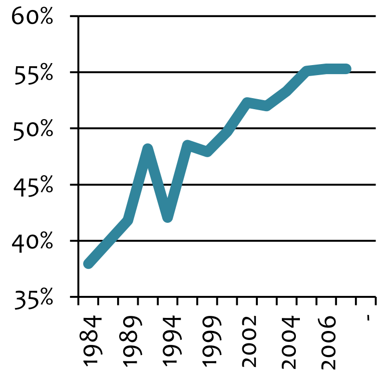
Figure 6-4: NWT's Population, 1996 to 2009



Source: Statistics Canada

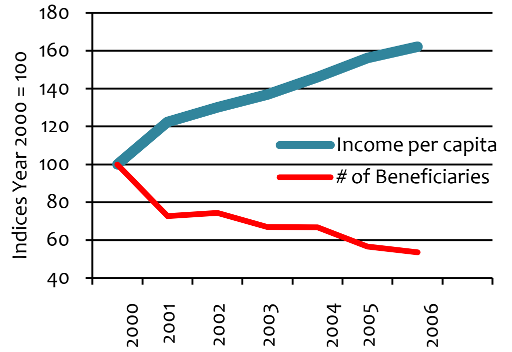
The positive economic impacts are being felt by Aboriginal and non-Aboriginal residents alike. Figure 6-5 depicts a rise in the employment rate for residents of the Tlicho region. Figure 6-6 on the following page shows the divergence in personal income and the number of income support beneficiaries. Since 2000, income per capita has risen steadily in the Tlicho region while the number of income

Figure 6-5: Aboriginal Employment Rate, 1984 to 2008



Source: Statistics Canada *Labour Force Survey*, NWT Bureau of Statistics Socio-Economic Scan 2009 support recipients has been on a steady decline.

Figure 6-6: Tlicho Personal Income vs Income Support, 2000 to 2007



Source: GNWT Department of Education, Culture and Employment, Statistics Canada, NWT Bureau of Statistics Population Statistics, Socio-Economic Scan 2009

It was noted earlier that the scale of economic success of the diamond mines will not be matched by the proposed Prairie Creek Mine. Its operations will be approximately one-tenth the size of the diamond mines when taken together. With that said, the communities most affected by the diamond mines, namely Yellowknife, N'Dilo, Detah, Lutsel'ke and the Tlicho communities, have a combined population of 22,523 which is approximately ten times that of the Study Area communities.[85]

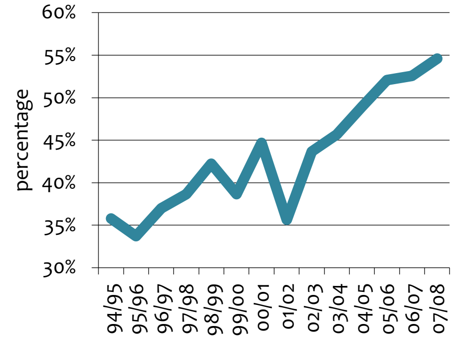
This is a brief review of the economic changes over the past ten years that in large part have come as a result of the territory's new diamond industry. The indications are all the same; that is, the NWT economy has benefited from the diamond industry. Adding other indicators of economic growth would return the same result. They show unequivocally that the economic objectives typical for any society are being met; that is, economic activity, employment and income levels have risen, and perhaps more importantly, the rising wealth is not isolated to a small minority of residents, but rather is affecting a majority of the population. Meanwhile, potential negative economic effects like inflation or a ballooning population have remained under control. This offers good insight for the proposed Project and its potential economic impacts, and the circumstances under which the economic growth can be beneficial to a broad cross-section of society.

6.2 Social Impacts of the NWT Diamond Mines

Much of the concern over socio-economic effects of the diamond mines focussed on social issues. This can be seen in the number and variety of indicators that the diamond mines are tracking as a part of their Socio-economic Monitoring Agreements.[86] The ten years of data since the opening of Ekati Diamond Mine show some mixed results regarding the social impacts. Many of the indicators have seen little to no change from their previous trend. Others have shown positive changes. Some have shown negative changes. In this section, we look at key indicators of social performance in the areas of education, health, safety and families.

Educational performance has risen steadily over the past ten years (see Figure 6-7 on the following page). Like all statistics, one must be careful in attributing the cause of this trend to a single change in the human environment such as the introduction of diamond mines. Coinciding with the growth in this industry, the Government of the Northwest Territories increased its capacity to deliver high school education in remote and isolated communities. For the first time, students living in these communities could graduate without having to spend their final years in a larger centre and away from home. There is no doubt this is having a positive influence on the number of youth remaining in school. Nevertheless, the possibility of obtaining a good job at a diamond mine while living in one's home community is also a likely reason for the increased graduation rates. Either way, graduation rates have improved steadily over the past decade in the NWT.

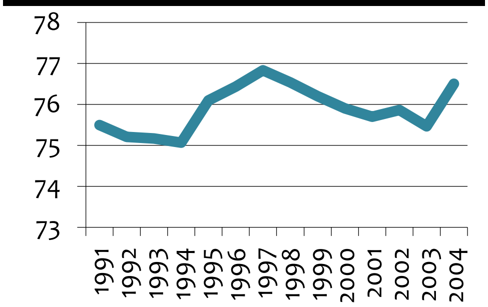
Figure 6-7: Graduates as a % of Residents 18 years of age or older, 1994 to 2008



Source: GNWT Department of Education, Culture and Employment, NWT Bureau of Statistics Population Statistics, Socio-Economic Scan 2009

As discussed earlier, the status of health in a region is difficult to assess. The last assessment of life expectancy for the Territory included data until 2004 (see Figure 6-8). That year, life expectancy had reversed its previous downward trend. It is impossible to know at this point whether that change is permanent or an aberration. It is worth noting that the previous decline has been small, dropping from 77 years of age in 1997 to 75.5 in 2003. Because there are few deaths in the NWT in part because of the small population and because many non-Aboriginal people migrate south prior to reaching 65 years of age, one must exercise caution when drawing conclusions from the results. They are provided here as a reference point.

Figure 6-8: NWT Life Expectancy at Birth, 1991 to 2004

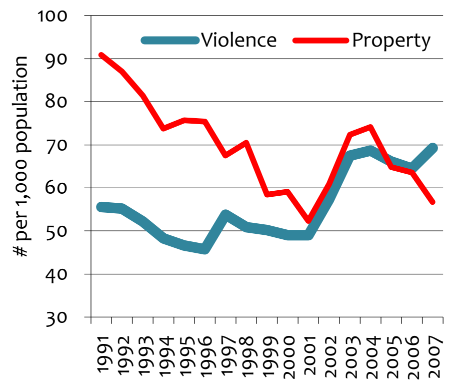


Source: Statistics Canada, NWT Bureau of Statistics Socio-Economic Scan 2009

The number of police-reported crimes had been on the rise starting in 2002 (see Figure 6-9). The change in trend was particular stark for violent crimes that had previously been on a long and steady downward trend. For the three-year period from 2002 to 2004, the number of violent and property crimes grew. Since then, the violent crime rates have falling back close to previous lows, while the number of property crimes have remained close to the new levels established in 2004.

The rise in crime rates earlier this decade led to some speculation that it was the result of participation in rotational work at the mines and the stress of increased wealth and new responsibilities for workers and their families. This runs

Figure 6-9: Crime in the NWT, 1991 to 2007

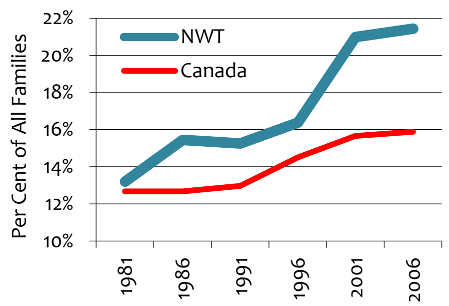


Source: Canadian Centre for Justice, NWT Bureau of Statistics Socio-Economic Scan 2009 counter to the typical assumption that increased wealth and improved employment opportunities are generally the root of improved social conditions. There isn't good evidence either way, but it does appear that the population went through a period of adjustment.

In its report on the impacts of the diamond mines, the Government of the Northwest Territories showed that RCMP statistics indicate the number of reported spousal assaults has been declining slowly over the past decade. The report also suggests that drug addictions are a likely cause of the rise in property crimes.[87]

It is reasonable to speculate that the adjustment of newcomers to the workforce did create tensions that had consequences to those individuals, their families and communities. [...] these early results were anticipated by the mine operators. Over time, it would be reasonable to expect [these] ... issues will decline as the NWT's new workforce becomes more accustomed to work life.[88]

Figure 6-10: Lone Parent Families, 1981 to 2006



Source: Canadian Census, NWT Bureau of Statistics Socio-Economic Scan 2009

The number of lone-parent families is on the rise in the NWT as it is across Canada (see Figure 6-10). This trend began in 1981. The five-year period 1996 to 2001 showed a marked increase in the NWT. There isn't enough detailed research to tell us the specifics of why this is occurring. Greater self-reliance amongst women which affords the opportunity to leave abusive relationships and increased social acceptance of divorcees are two theories. In the NWT, the effects of rotational work could also be a contributing factor.

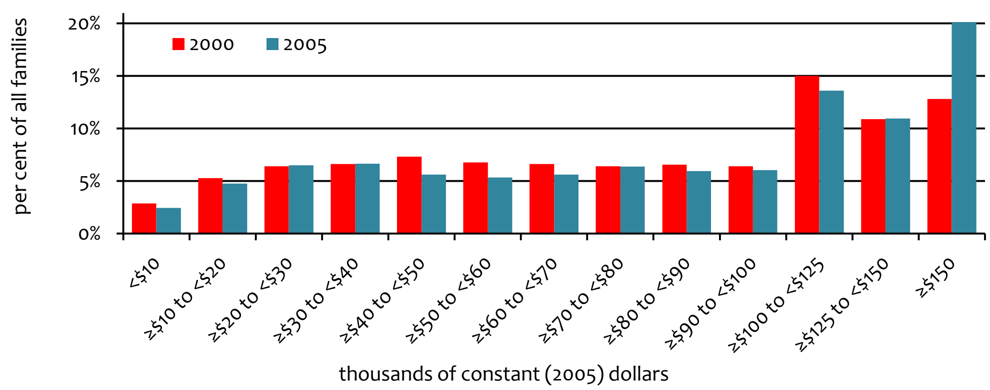
These results were predicted by BHP Billiton and De Beers Canada Inc. in the SEIA for their projects.[89] The Government of the Northwest Territories have made additional observations.

Families that have one parent are more often in a low-income home. In 2003, 44 percent of children in the NWT who lived in single-parent families lived in low-income homes. For children in two-parent families, this percent was only 11 percent. About 37 percent of children in Yellowknife lived in low-income single-parent families. 50 percent of children in Small Local Communities lived in low-income homes. These [percentages] have not changed much since 1997.[90]

Data released for the 2006 Census on family income is presented in Figure 6-11 on the following page. From 2000 to 2005, both individual and collective standard of living of families has improved. The number of families earning in excess of $125,000 has risen, while the number of families in every income bracket below $125,000 with one exception has decreased. Combining this information with the rise in Aboriginal employment data presented earlier and comparing this with data prior to

1999 suggests that the diamond mines have contributed to an expansion of wealth into new segments of NWT society which is raising the standard of living of residents throughout the territory.

Figure 6-11: Income Disparity, 2000 and 2005



Source: Canadian Census 2001 and 2006

6.3 Lessons Learned from the Diamond Mines

What can be learned from the socio-economic outcomes that are in part a result of the economic growth generated by the diamond industry? There are numerous observations relevant for the Study Area communities and the proposed Project. The three presented here are the most important:

- Economic growth that alters the structural make-up of a regional economy can have profound impacts; perhaps the most notable being the opportunity for newcomers to join the labour market.
- All three diamond mines made commitments to help the local population access the new opportunities, the result of which has been wide-spread economic success.
- Social performance issues, such as those related to health, education, safety, and families, are influenced by a multitude of social, economic and environmental factors and are often slow to change. Indicators of these changes have revealed a period of adjustment by the population to the new level of economic activity.

The Prairie Creek Mine project would do well to have a similar influence on the Dehcho region. The Project will alter the economic landscape of the region in a profound way. Canadian Zinc is prepared to assist the local population in an effort to increase its participation which should improve and broaden the total benefits received. And while this participation will bring about the need for adaptation, there is every reason to believe the medium to long term economic and social impacts will be almost entirely positive.

7 Future Human Environment: Potential Impacts of the Proposed Prairie Creek Mine

In this chapter, the results from the input-output simulation, the financial analysis, and simulations of satellite models within the NWTEIM are presented. Results from the construction and operations phases are reported separately, as are the induced impacts. This is followed by an analysis of the economic and social impacts from participation of local labour and business. Impacts on government revenues, transportation volumes, and traditional activities are also presented.

The total cost of construction for the Prairie Creek Mine was entered into Statistics Canada's *Interprovincial 'Industry-Based' Input-Output Model* to determine its direct and indirect impacts on gross production, GDP, employment, labour income and indirect taxes. These impacts are shown for the NWT and Canada.

The complete expenditure profile of the Prairie Creek Mine operations was entered into Statistics Canada's *Interprovincial 'Commodity-Based' Input-Output Model* to determine its direct and indirect impacts on gross production, GDP, employment, labour income and indirect taxes. These impacts are shown for the NWT and Canada.

This expenditure profile was combined with financial estimates from Canadian Zinc to estimate the impacts on government direct tax revenues. Induced impacts were approximated using components of the NTWEIM.

There is a reclamation phase associated with this Project. A model simulation was not required to assess the impacts of this phase of the Project because the overall expenditures associated with it will be small in comparison to the construction and operations components of the Project. The direct impacts from the reclamation activities are presented for the NWT.

The mine plan for the Prairie Creek Project was developed using 2008 prices. All figures used for this analysis have a variability of plus or minus 20 percent.

As was described earlier, the results from economic models are approximations. They provide a starting point for analysis. This fact is especially true for the Study Area. The results can be viewed as the region's economic potential. Reaching that potential is a function local labour and business participation and how that participation changes over time. Likewise, estimates of tax revenues are based on the best information currently available; any change in revenues, costs, production rates or the tax regime would cause a deviation from the results presented.

7.1 Impacts from Construction

The construction phase will span two years, though most activities will take place during the second year with the first year dedicated primarily to mine development. The results shown in this section are the total impacts over the two years.

Because much of the mine infrastructure is already in place, the total expenditures required to develop the mine are lower than what would otherwise be the case. All told, it is estimated that construction expenditures will total $59.3 million.

7.1.1 Gross Output[91]

The $59.3 million in expenditures is the direct gross output from the construction phase of the Project (see Table 7-1). It should generate an additional $11.3 million in business activity in the Territory for a total gross output of $70.6 million. For Canada as a whole, an additional $51.4 million in business activity is generated for a total gross output of $110.7 million.

Table 7-1: Gross Output from Construction ($,000)

	NWT	Canada
Direct gross output	59,310	59,310
Total gross output	70,613	110,681
Gross output multiplier	1.19	1.87

Source: Canadian Zinc, Impact Economics, and Statistics Canada Input-Output Division

7.1.2 Gross Domestic Product

Gross domestic product at basic prices is the sum of wages and salaries, indirect taxes less subsidies on production, and return on capital which includes depreciation and profits. In the Northwest Territories, the $59.3 million in construction expenditures translates to an $18 million increase in GDP (see Table 7-2). Thus, the direct GDP to gross output ratio for this project is estimated to equal 30 percent. The additional business demand increases the Territory's total GDP impact by $6 million. The GDP for Canada will rise by $43.9 million as a result of the Prairie Creek Mine construction.

Table 7-2: Gross Domestic Product from Construction ($,000)

	NWT	Canada
Direct GDP	18,071	18,071
Total GDP	24,098	43,904
Ratio of total-to-direct GDP	1.33	2.43

Source: Canadian Zinc, Impact Economics, and Statistics Canada

7.1.3 Employment

Canadian Zinc has estimated that employment during construction will peak at 120 jobs. This figure was determined by estimating the labour requirements in terms of total hours for the construction or upgrade of each building or component associated within the mine, including transportation infrastructure.

Statistics Canada's *Interprovincial Input-Output Model* was used to determine the overall employment impact. Its results are given in full-time equivalent (FTE) terms. This means that one person working full time for an entire year is counted as one FTE job. Likewise, 12 people employed full time for one month also translates into one FTE job, as would someone working double time for half the year.

Table 7-3: Employment from Construction (# of FTE Jobs)

	NWT	Canada
Direct jobs	161	161
Total jobs	212	426
Ratio of total-to-direct jobs	1.31	2.64

Source: Canadian Zinc, Impact Economics, and Statistics Canada
Note: Reported in Full-Time Equivalent terms for the entire construction period.

Using the FTE definition, Statistics Canada's model showed direct FTE jobs would total 161 with another 51 being created indirectly (see Table 7-3). Note that this number represents the number of FTE jobs over the two-year construction period—meaning that if the 161 FTE jobs were evenly distributed over the two years and all employees worked full-time, the employment impact would equal 80 jobs per year for two years. The number of indirect jobs created outside the Territory is much larger, where the manufacture of most of the mine's inputs will occur. It is estimated that indirect FTE jobs outside the NWT will equal 214 for a total Canadian FTE job count of 426.

The discrepancy between the mine plan and the model results was expected. First, the construction process requires a variety of labour force skills, some of which are needed for very short periods of time. For example, a computer technician might be involved for no more than one month when installing computer systems. This would increase the number of people on site but not necessary have a large impact on the number of FTE jobs. Furthermore, because most of the Prairie Creek Mine infrastructure is already in place with many buildings needing only minor refurbishment or upgrade, the expenditure pattern given by Statistics Canada's Input-Output model may deviate from the actual expenditure patterns incurred. This difference would impart only a slight bias on the results and does not alter expectations for local involvement and therefore remains a good starting point for understanding the economic impacts.

It should also be noted that recent experience of northern mining projects in the NWT and Nunavut has been for a larger labour requirement during the construction phase than was predicted in the construction plan.[92]

7.1.4 Labour Income

Table 7-4: Labour Income from Construction ($,000)

	NWT	Canada
Direct labour income	11,478	11,478
Total labour income	15,510	28,396
Ratio of total-to-direct labour income	1.35	2.47

Source: Canadian Zinc, Impact Economics, and Statistics Canada

The Input-Output model shows labour income including all supplementary income paid by employers will equal $11.4 million with indirect activities adding another $4 million (see Table 7-4).

The estimates for employment and labour income describe the totals that occur in the Northwest Territories however the extent to which these jobs and wages go to Northerners depends on the extent of local participation. This participation is described in section 7.3. The Input-Output model does not make any assumptions in that regard.

The labour income for Canada will increase by $28.4 million. Unless labour has to be imported from the international labour market—which is unlikely—this figure represents the total impact including the NWT results.

7.1.5 Indirect Taxes

The model computes indirect taxes and subsidies for the construction phase (see Table 7-5). Indirect taxes are paid at two stages within the production process, defined as taxes on production which are a part of the GDP at Basic Prices and taxes on products which are added to generate an estimate of GDP at Market Prices. The System of National Accounts lists the common areas of taxation within the two indirect tax forms as follows:[93]

Table 7-5: Indirect Taxes from Construction ($,000)

	NWT	Canada
Federal Indirect Tax on Products	**54**	**149**
Gas Tax	30	82
Air Tax	11	15
GST	12	50
Other	1	2
Provincial Indirect Taxes on Products	**42**	**224**
Gas Tax	39	117
PST	-	101
Other	3	6
Indirect Tax on Production	**143**	**665**

Source: Canadian Zinc, Impact Economics, and Statistics Canada

- Taxes on products, on goods and services themselves, include the Goods and Services Tax, provincial sales taxes, federal and provincial taxes on sales volumes of gasoline and other motive fuel taxes, tobacco and alcohol, etc. These taxes only arise as a result of the actual production or sale of goods and services.
- Taxes on production include property taxes, taxes on payrolls and capital, and the costs of business licences, permits and fees. These taxes are levied regardless of the current level of production of goods and services.

The construction phase of the Prairie Creek Mine Project will increase federal revenues through indirect taxes by $149 thousand, with most of this coming via the federal gas tax and goods and services tax (GST). At the provincial and territorial level, the GNWT stands to benefit to the tune of $42 thousand, with the majority coming from the territorial gas tax. In addition to the gas tax, provinces that levy a provincial sales tax (PST) will see this tax generate $101 thousand in additional revenues. Indirect taxes on production will total $143 thousand in the NWT and $665 thousand in Canada as a whole.

7.1.6 Summary of Impact Assessment from Construction

Table 7-6 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. These impacts are those generated by the Input-Output model, and do not account for local participation. That assessment is provided in section 7.3. The geographic range for the construction phase is primarily local. This does not suggest labour or businesses located elsewhere in the Territory will be excluded, but rather the magnitude of impacts across that geographic range are much lower. GDP is not calculated on a regional level, though clearly in this case, the value-added is occurring in the Study Area and is high relative to its existing baseline conditions. The revenues generated through indirect taxation total $808 thousand across Canada. In comparison to overall government tax revenues, this amount should be considered low. The construction phase will be two years and therefore its impacts will be short term.

Table 7-6: Impact Assessment of Economic Performance from Construction

	Range	Direction	Magnitude	Duration
GDP	Territorial	Positive	Low	Short Term
Employment	Regional	Positive	Moderate	Short Term
Labour Income	Regional	Positive	Moderate	Short Term
Indirect Taxes	Territorial	Positive	Low	Short Term

7.2 Impacts from Operations

The current mine plan is for an operations phase of 14 years. During that period, Canadian Zinc expects total expenditures will be close to $1 billion. This figure includes the cost of labour, consumables, sustaining capital and additional mine development. The description of results is based on the total impact over the 14-year mine life. The associated tables show annual impacts in addition to the overall totals. The annual figures are an average assuming a constant production rate over the life of the mine. Note that there will be a ramp-up period. In its initial year, Canadian Zinc anticipates production will be half that of a typical year. The mine is expected to be at full production by the end of the second year.

7.2.1 Gross Output[94]

Gross output for the operations phase can be calculated by adding together the mine's value-added contribution plus its total business demand. This will equal the total value of production. It is from the business demand, which is the total goods and services purchased to operate the mine, that indirect impacts are generated.[95] For the Prairie Creek Mine, direct gross output is estimated at $1.5 billion (see Table 7-7).

Table 7-7: Gross Output from Operations ($,000)

	NWT	Canada	NWT	Canada
	Average Annual		*Total*	
Value of Production	106,000	106,000	1,486,000	1,486,000
Direct gross output from business demand	21,813	38,453	305,141	538,347
Total gross output from business demand	28,139	66,909	393,383	937,748
Gross Output Multiplier	1.29	1.74	1.29	1.74

Source: Canadian Zinc, Impact Economics, and Statistics Canada

Almost half of this total, $688 million, will go toward the purchase of goods and services. The goods and services needed to operate the mine will come from within the NWT, from across Canada and from around the world. The input-output model uses production and trade records of each province and territory to estimate where each good and service is most likely to come from. As will be discussed later, where goods and services are imported to the NWT an opportunity for northern-based businesses might exist, depending on the cost structure and profitability associated with that business or industry.

The figures shown in the table indicate direct gross output in the NWT will increase by $305 million as a result of the Prairie Creek Mine's operations. This will spark an additional $88 million in local business demand. Nationally, the total gross output, including that from indirect activities equals $938 million.

7.2.2 Gross Domestic Product

Gross domestic product will rise as a result of Canadian Zinc's contribution to the Territory's value-added output and the direct and indirect value-added contribution of business services to the mine. For the NWT, these contributions will sum to $951 million over the life of the mine, with $772.7 million coming from mining itself and another $178.7 million from within the Territory's business community (see Table 7-8).

For the country as a whole, the overall figure is slightly larger as a result of direct expenditures related to transportation beyond the territorial border, the costs associated with Canadian Zinc's Vancouver office, and the direct and indirect business demand that will be imported to the NWT. All told, Canada's GDP will rise by $1.2 billion over the 14 years of operations.

Table 7-8: Gross Domestic Product at Basic Prices from Operations ($,000)

	NWT	Canada	NWT	Canada
	Average Annual		*Total*	
GDP—Mining	55,193	57,000	772,700	798,000
Direct GDP—Business Demand	9,737	16,013	136,323	224,187
Total GDP—Business Demand	12,766	30,155	178,723	422,173
Ratio of total-to-direct GDP—Business Demand	1.31	1.88	1.31	1.88
Total GDP	67,959	87,155	951,423	1,220,173

Source: Canadian Zinc, Impact Economics, and Statistics Canada

7.2.3 Employment

Canadian Zinc has estimated its employment during operations will average 220 positions on a full-time basis (see Table 7-9). An additional eleven employees will work out of the company's Vancouver office. Over the 14 years of operations, the 231 positions equates to 3,234 person-years of employment. In addition to the jobs at the mine, the business demand from within the NWT will generate an average of 110 FTE jobs that will in turn generate a further 28 FTE jobs annually. This is equivalent to 1,538 FTE jobs and 397 FTE jobs respectively for the life of the mine. Thus, the Prairie Creek Mine is expected to raise employment in the NWT by 358 on an annual basis.

The mine will create 519 jobs on an annual basis across the country.

Table 7-9: Employment Impacts from Operations (Full-Time Equivalent Jobs)

	NWT	Canada	NWT	Canada
	Average Annual		*Total**	
Employment—Mine Production	220	231	3,080	3,234
Direct FTE Jobs—Business Demand	110	161	1,538	2,259
Total FTE Jobs—Business Demand	138	288	1,931	4,028
Ratio of total-to-direct FTE Jobs	1.26	1.78	1.26	1.78
Total Employment	358	519	5,011	7,262

Source: Canadian Zinc, Impact Economics, and Statistics Canada
Note: * Total employment is given in FTE person-years of employment.

7.2.4 Labour Income

The operation phase will generate $28.4 million in labour income on an annual basis throughout the mine's life (see Table 7-10). Of this total, $19.8 million will be paid to mine staff, $6.8 million to staff working for businesses in the NWT that are supplying the mine with goods and services, and $1.9 million to staff working for companies working in the NWT to supply the suppliers. Over the 14 years of operations, this annual income will sum to $398.2 million. The labour income for Canada will increase by $40.1 million annually for a total of $561 million over the operations phase.

The portion of labour income that will remain in the Territory depends on the extent of local participation at the mine and with suppliers. Local participation is discussed later in this chapter.

Table 7-10: Labour Income Impacts from Operations ($,000)

	NWT	Canada	NWT	Canada
	Average Annual		*Total*	
Labour Income—Mine Production	19,764	21,571	276,700	302,000
Direct labour income—Business Demand	6,844	10,570	95,821	147,978
Total labour income—Business Demand	8,680	18,509	121,519	259,131
Ratio of total-to-direct labour income	1.27	1.75	1.27	1.75
Total labour income	28,444	40,081	398,219	561,131

Source: Canadian Zinc, Impact Economics, and Statistics Canada Input-Output Division

7.2.5 Indirect Taxes

The model computes indirect taxes and subsidies flowing from the business demand generated by the mine operations (see Table 7-11). Direct taxes and royalties are determined through separate calculations and are discussed in Section 7.4.

The operations phase of the Prairie Creek Mine will increase federal revenues through indirect taxes by $81.8 million, with most of this coming via the GST. At the provincial and territorial level, the GNWT stands to benefit to the tune of $19.9 million over the life of the mine, notwithstanding the claw-back of federal transfers which is discussed later, with the majority of this revenue coming from the territorial gas tax. In provinces that levy a provincial sales tax (PST), revenues from this source will reach $1 million over the 14-year time period.

Table 7-11: Indirect Tax Impacts from Operations ($,000)

	NWT	Canada	NWT	Canada
	Average Annual		*Total*	
Federal Indirect Tax on Products	2,160	5,840	30,233	81,764
Gas Tax	629	713	8,812	9,975
Air Tax	26	29	368	401

GST	1,493	5,085	20,896	71,190
Other	11	14	157	198
Provincial Indirect Taxes on Products	1,424	1,615	19,930	22,606
Gas Tax	1,370	1,480	19,183	20,714
PST	0	72	0	1,002
Other	53	64	747	890
Indirect Tax on Production	351	875	4,910	12,246

Source: Canadian Zinc, Impact Economics, and Statistics Canada Input-Output Division

7.2.6 Summary of Impact Assessment from Operations

Table 7-12 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. These impacts are those generated by the Input-Output model and do not account for local participation. For GDP, employment and labour income, the majority of the impacts will be felt in the Study Area communities; that is, the geographic range is primarily local. However, the expenditures on labour and capital will be felt in communities across the Territory.

At the territorial level, the magnitude of impacts is moderate when compared to its baseline which includes the economic contributions of the diamond industry and government, among others. GDP is not calculated on a regional level, though clearly in this case, the value-added is occurring in the Study Area.

The revenues generated through indirect taxation total $81.8 million across Canada. But again, in comparison to the total tax revenues, this amount should be considered moderate. All the economic impacts described will persist throughout the life of the Project.

Table 7-12: Impact Assessment of Economic Performance from Operations

	Range	Direction	Magnitude	Duration
GDP	Territorial	Positive	High	Long Term
Employment	Regional	Positive	High	Long Term
Employment	Territorial	Positive	Moderate	Long Term
Labour Income	Regional	Positive	High	Long Term
Labour Income	Territorial	Positive	Moderate	Long Term
Indirect Taxes	Territorial	Positive	Moderate	Long-Term

7.3 Impacts from Local Participation

There will be numerous employment and contracting opportunities associated with the proposed Prairie Creek Mine either directly or indirectly. Identifying the most likely local employment and business demand scenario requires consideration of several variables. These include

- the job descriptions of each position created at the mine,
- demographic and education statistics of the potential labour force,
- a forecast of this labour force,
- likely changes in the Territory's economy over the life of the Project, and
- the willingness of the local population to engage in rotational work.

Identifying business opportunities is somewhat more straightforward. Canadian Zinc has identified the categories of contracting opportunities that will be available as well as those that it believes local businesses will be capable of providing. In situations where the expertise required in providing a good or service to the mine is absent from the region, the opportunity for a local business to partner through a joint venture or other business arrangement with companies that do have that expertise will exist.

In this section, the potential for labour and business participation is presented. The focus is primarily on the participation of labour and business from the Study Area communities however opportunities will exist for any resident or business in the NWT.

The results described herein are estimates of the maximum potential for local labour and business participation. By describing the participation in terms of maximum potential, it ensures that the Project's proponent has fully accounted for the possibility of negative impacts flowing from this level of participation. However, from the standpoint of an economic assessment, there is a risk that one views these results as some type of guarantee. A concerted effort on the part of all interested stakeholders, including individuals, families, communities, government and Canadian Zinc will be necessary over the life of the Project to bring participation levels to their potential. Initially, expectations for labour participation should be approximately 50 percent of its long-term potential.

7.3.1 Construction Phase

As noted, the construction phase represents a relatively small building and renovation project. Employment and business opportunities will be similarly small in comparison to that of other mine developments and those associated with the operations phase. For instance, a construction workforce of 400 to 600 employees or more and a construction time frame of 3 years would be typical for a NWT mining project. In contrast, the Prairie Creek Mine construction will see its workforce peak at 120. Nevertheless, this project represents an opportunity for the resident labour force and business community to increase their participation, learn valuable skills on-the-job and ramp up capacities that will be useful once mine operations begin.

7.3.1.1 Construction Staff

Much of the construction activities will be completed by contractors. These contractors will be encouraged to hire from within the Study Area communities. To facilitate this local participation, Canadian Zinc will

- notify the Study Area communities of the construction schedule in advance of the activities,
- set out a schedule of when the contractors will be hiring,
- provide the names of past employees to the contractors,
- provide the names of contractors and their contact information to the communities, and
- pass applications from local labour to contractors.

Canadian Zinc has employed more than 20 local workers in recent years as part of its exploration and early mine development activities. It expects this number could grow to as many as 30 jobs once construction is fully underway.

7.3.1.2 Business and Indirect Labour Opportunities

The model results reported earlier suggested 51 FTE jobs will be created in the business sector during the construction phase. Many of these additional or indirect business opportunities will come in the transportation and warehousing industry, wholesale and retail trade, and mining services including camp catering. Canadian Zinc has been engaged with resident businesses in the past such as Acho Camps and Catering and Nogha Enterprises as well as transportation/air service companies based in Fort Liard, Fort Simpson and Yellowknife. Study Area participation could represent as much as 60 percent of this potential business through direct contracts and successful joint ventures.

7.3.1.3 Summary of Participation during Construction Phase

Estimates of employment and income for Study Area residents during the construction phase are presented in Table 7-13. These totals were arrived at by combining the direct labour force requirements and wage and salary estimates provided by Canadian Zinc and the results from the Input-Output model simulation for indirect business demand. It shows local labour taking 30 direct construction jobs and 30 indirect jobs. These jobs will combine to bring as much as $6.7 million in labour income into the Study Area economy during the entire construction phase of the Project.

Table 7-13: Summary of Employment and Income Impacts from Operations

	Number of Jobs	Labour Income ($,000s)[1]
Direct Construction Jobs	30	4,273
Indirect Jobs	30	2,389
Total	60	6,662

Note: Canadian Zinc, Impact Economics, Statistics Canada Input-Output Division
Notes: 1) includes wages and salaries and supplementary labour income for the two-year construction period.

Table 7-14 summarises the impacts according to the impact assessment criteria. Much of the participation during construction will be local. This is particularly true for employment. Given that Canadian Zinc has, in 2007, employed 22 local

Aboriginal workers, the overall magnitude of change should be considered moderate. Business participation could expand beyond the Study Area and Dehcho region, though most of the work will likely go to local businesses and joint ventures.

Table 7-14: Impact Assessment of Local Participation during Construction

	Direction	Range	Magnitude	Duration
Employment	Positive	Local	Moderate	Short Term
Business Activity	Positive	Local	Moderate	Short Term

7.3.2 Operations Phase

7.3.2.1 Mine Staff

Canadian Zinc has identified the following jobs connected to each aspect of the Project's operations:

- Mining jobs: development and production miners, backfill operators, stopers, bolters, maintenance, labourers
- Mine Staff: superintendent, engineers, surveyors, geologists, samplers
- Mill staff: operators, engineer, labourers, electrician, assayers, lab technician
- Mine Maintenance Staff: mechanics, welders, electricians, helpers, labourers
- General Maintenance Staff: millwright, pipefitter, instrument technician, plumber, carpenters, labourer
- Power Plant Staff: electrician, operators
- General and Administrative staff: manager, accounting, purchasing, buyer, first aid, mine rescue, warehouse
- Camp staff: catering, maintenance, expediting
- Environmental staff: monitors, surveyors, scientists

Each of the 220 jobs available at the Prairie Creek Mine have been assessed based on their job description and categorised into five levels of employment based on the skills, education and experience required. A description of these five categories is presented in Table 7-15.

Table 7-15: Work Skill Definitions:

	Requirements	Examples
Management	Includes high levels of work experience, education and people skills	Superintendents, Senior Staff, Mine Manager, etc
Professional	University Degree and related experience	Engineers, Geologists, Senior HR, Safety and Environmental Staff
Skilled	College or Technical Diploma and related experience	Senior Administrators, IT Staff, ET Staff, Accountant, Millwrights, Mechanics
Semi-skilled	High school plus work experience	Equipment Operators, Apprentices, Security, Production Miners
Unskilled	High school	Plant helpers, Mechanic helpers, Labourers, Clerk assistant

Within the list of staffing requirements, 64 jobs have been identified as unskilled positions (see Table 7-16). Another 95 jobs are considered semi-skilled, 46 jobs are considered skilled positions, 6 jobs require professional designations, and 9 jobs are management positions.

Furthermore, it is assumed that most people in the labour market who have Grade 12 accreditation would qualify for the unskilled jobs and with training and experience could qualify for most if not all semi-skilled jobs. This should not be understood to mean that local employment will equal 154 when the mine enters its operations phase. The total number of resident employees will be determined by the number of individuals ready, willing and able to participate. This means that their education or experience has adequately prepared them for the job, they are committed to the rotational work schedule, and are in a position to take the job. In the latter case, this means there are no barriers preventing participation such as family commitments, geographic location (not living in a pick-up point community and unable to commute to one), or any other social, physical or health issue.

Table 7-16: Number of Mine Jobs by Skill Level

Skill Level	Number
Unskilled	64
Semi-Skilled	95
Skilled	46
Professional	6
Management	9

The jobs identified as skilled, professional or management require a combination of qualifications. Within the Study Area and throughout the Territory, there are individuals who have all these qualifications however labour statistics show the vast majority are currently working. Therefore, filling these higher level positions from within the Study Area communities or from the NWT will be the result of

a) Someone currently working in a skilled, professional or management capacity elsewhere in the economy leaving that job to work at the Prairie Creek Mine
b) Attracting qualified workers from elsewhere in the country to relocate to the NWT (rather than commute from their home province or Territory)
c) A resident student gaining the appropriate qualifications through education, training and/or on-the-job experience, or
d) An existing project within the Territory ending, making available its entire workforce. Examples of this include the completion of the Dehcho Bridge and the slowdown or early closure of a diamond mine.

Within the list of mining jobs, 70 have been identified as ones that could be filled by labour from the Dehcho region over the medium to long term. This includes 35 unskilled positions, 30 semi-skilled positions, and 5 jobs in the skilled, professional, or management categories. This would likely be the maximum number achievable without substantial improvements in the education and skill levels of the region’s labour force overtime.

Expanding to the entire Territory, greater labour force participation is possible. This employment target will depend on the participation of labour from Yellowknife and those able to commute to a pick-up point, as well as the conditions mentioned earlier; that is, some residents leaving their existing job to work at the Prairie Creek Mine, labour moving into the Territory, students graduating and joining the workforce, and/or a slowdown or early shutdown of one or more of the operating diamond mines. Under the scenario where the labour pool does expand, the number of NWT residents working at the mine could double, and include 52 unskilled jobs, 56 semi-skilled jobs, and 32 jobs that are categorised as either skilled, professional or management.

Several variables were considered when arriving at these numbers. Assumptions were needed on aptitude, interest, education and growth of the labour force. This includes issues such as turnover, knowing that some workers with the education and without other constraints will ultimately decide that their job at the mine is not for them. Also noteworthy, Canadian Zinc will not designate specific positions as being strictly local, northern, or otherwise and the stated employment target is not a strict ceiling should more local or northern labourers show interest in work at the Prairie Creek Mine. A detailed description of the future labour market is provided below in section 7.3.2.2.

Table 7-17: Wages, Salaries and Supplementary Labour Income Achievable through Maximum Participation ($,000s)

Level of Participation	Income
70 Employees from Study Area	5,768
140 Employees from the NWT	12,359

Note: These figures are given as maximum employment and income levels that could be achieved under prudent assumptions regarding the existing, potential and future labour force.

Setting the two employment targets against the earnings associated with each job provides the maximum potential labour income for mine employees (see Table 7-17). Should local participation grow to 70 jobs as described, personal income to the Study Area communities would grow by $5.8 million annually. Expanding the labour market to the entire territory and under the conditions described earlier, personal income impacts would grow to $12.4 million on an annual basis.

7.3.2.2 Assessment of Labour Market

To help arrive at these targets, the current population within the Study Area, Dehcho region and NWT has been assessed to determine a reasonable estimate of the available pool of labour. An important part of this assessment is to first establish the pick-up locations. Pick-up points will include the communities of Nahanni Butte, Fort Liard, and Fort Simpson. Yellowknife will be added should there be enough interest from the labour force there. If labour currently engaged in work in the diamond industry becomes available either through a slowdown or early shutdown, the likelihood of a Yellowknife pick-up would increase. For residents living elsewhere in the Territory, the three-week rotation makes commuting to a designated pick-up point a reasonable proposition given that workers will have only eight or nine shifts per year.

The demographic make-up and education levels from the Study Area offer insight into the size of the local labour pool from which the Project can draw. The information needed includes:

- the number of people currently unemployed;
- the number of people not in the labour force but who would like a job;
- the characteristics of these unemployed people with respect to
  - education,
  - willingness to work a job with a rotation schedule, and
  - gender;
- projected graduations rates; and,
- growth in the labour force through the ageing of the population.

The exercise highlights the fact that not every unemployed person in the Study Area or across the territory would be a good candidate for employment at the mine. The calculations revealed approximately 100 suitable candidates for initial employment reside in one of the three primary pick-up point communities, with another 85 likely to enter the workforce over the life of the project (see Table 7-18). Expanding to the Dehcho region, the number of potential candidates rises to 216, with 144 suitable candidates joining the workforce over the life of the project.[96]

Table 7-18: Estimated Available Workforce

	NWT	Dehcho region	Fort Liard	Nahanni Butte	Fort Simpson
Unemployed (15 & Over)[1]	1,740	262	56	9	65
Potential Workforce Not in Labour Force[2]	823	103	8	5	25
Available Workforce	2,563	365	64	14	90
Assuming Gender bias[3]	1,452	216	37	9	53
Potential Graduates (2007 to 2022)[4]	6,335	557	94	22	211
Assuming a 45 percent graduation rate[5]	2,851	251	42	10	95
Assuming 45 % graduation *plus* gender bias[6]	1,639	144	24	6	55

Source: Statistics Canada Demography Division, 2006 Census, NWT Bureau of Statistics NWT Labour Force Survey.

Notes:

1) Information regarding willingness to do rotational work and education status of those counted in the labour force are unknown. We have assumed the same distribution regarding willingness to work rotation applies equally to this group as it does to those not in the labour market. We have assumed anyone in the labour force has grade 12 or the equivalent through work experience.

2) Calculated from the people surveyed who are not in the labour force according to Statistics Canada's definition, but who would like a job. From this number, we include only those willing to work a rotational job and those with at least high school (assuming even distribution across all data categories).

3) There are no gender specific jobs associated with the Project. However, there are natural tendencies that should be considered when projecting a potential workforce. The BHP Billiton and De Beers Canada Inc report gender statistics for their respective mines (Ekati and Snap Lake). Women have made up less than 15 percent of their collective workforce in recent years.[97] Assuming a similar gender employment record and assuming the gender for "Unemployed (15 & over)" is evenly distributed the available workforce would 25 % to 45 % lower after adding this bias.

4) This is a cumulative total of all Study Area residents who were between the ages of 10 to 18 in 2007. All of these people will have reached the age of majority prior to the end of Prairie Creek Mine's operations phase,

assuming a mine start date of 2012.
5) 45 percent is the current percentage of graduates within the Dehcho region. Any improvement in the education performance over the next 20 years would increase this figure.
6) Assumes an even distribution between genders and that the 15 percent employment rate holds.

7.3.2.3 Business and Indirect Labour Opportunities

The current plan for the mine operations is to conduct many of its activities in-house, meaning more employees will work directly for the mine owner rather than for contractors. Still, there will be a number of contract services that Canadian Zinc will depend on to operate the mine. As shown by the Input-Output results earlier, the demand for business services will create additional job opportunities. Canadian Zinc has identified the contract opportunities that local businesses are most likely to access. They include:

- *Transportation Industry*: truck operators, mechanics, fuel services, road construction and maintenance, ice bridge construction, traffic monitoring, continuing air services
- *Mine Support Services*: expediting, mine resupply, monitors, communications, training, community relations, sub-offices
- *Camp Services*: catering, accommodation management

Model results confirm this assessment by showing the majority of direct and indirect jobs flowing from the mine's operations will be in transportation and warehousing (40%), wholesale and retail trade (24%), and accommodation and food services (12%). Other sectors likely to grow through direct and indirect employment impacts include government services, construction and mining services. These industries combine for another 16 percent of the total job creation.

All of these business opportunities are in areas where the Study Area has capacity and thus it is reasonable to expect local businesses will fill many of these contracts. And expanding to the broader NWT business sector reveals enough capacity to cover all contracts. The only questions are related to interest in the work and then the number of local people these businesses can hire.

Similar to the discussion regarding employment at the mine, the results from the Input-Output model do not factor in constraints that exist in the local and NWT labour markets, meaning the 138 jobs created through business demand from the mine does not represent a guarantee of 138 jobs for NWT residents.

A part of Canadian Zinc's goal in hiring contractors from within the NWT and in particular from within the Study Area is that these businesses will be more inclined to hire locally. A review of the northern-based and Aboriginal contractors working in the diamond industry reveals that some perform better than others in this regard. Canadian Zinc will take a progressive position to improve the number of local hires.

- through its Impact and Benefit Agreement negotiations, it will discuss the importance of local hires with the Aboriginal development corporations, and

- when establishing tenders, will make northern employment a criterion for evaluating proposals.

The available labour pool will be divided between work at the mine and work for local businesses. The types of jobs available through contractors will follow a similar pattern as those at the mine in that the majority will be in unskilled and semi-skilled position. There are some important differences as well. Some of jobs will employ a more traditional Monday to Friday work schedule. This will appeal to workers unable or unwilling to work a rotation schedule. Also, there is little or no gender bias in many of the new direct or indirect jobs, and in fact, in some instances a bias exists towards women. Some work will be seasonal, such as that within the transportation industry.

To estimate local participation rates requires numerous assumptions. Using the results from the labour pool assessment exercise described earlier, but removing the issues of rotation and gender increases the Dehcho region's labour pool to 439 potential candidates of which 242 reside within the Study Area communities.[98] Similarly, the number of graduates entering the workforce over the mine's life would climb to 251 with 161 coming from the Study Area communities.

This suggests that, over time, the unskilled and semi-skilled jobs could be taken up by resident labour within the Dehcho region. This does not account for issues of mobility. For example, should a contractor operate out of Fort Liard, a potential employee living in Fort Simpson, Nahanni Butte, Lindberg Landing or Wrigley would be required to relocate, at least temporarily, since commuting is likely out of the question.

It is reasonable to assume that during peak times for certain industries, there will be labour shortages. For instance, the region may not have enough truck drivers to fill all jobs in that field. There will also be professional or management positions that will be filled with imported labour, at least initially. Initially, the Dehcho region may contribute approximately 30 percent of the labour force required. This translates into 41 new jobs. But similar to the mine employment results, local employment should grow over the life of the mine. Through strong management practices that support local hiring, local participation could grow to as much as 60 percent of the 138 additional jobs.

It should also be noted that the input-output model is based on the structure of an economy at a single point in time. Should the structure change; that is, if a different mix of goods and services become available within the Territory, then new opportunities for local participation will arise. This is possible under a scenario whereby local businesses are able to partner with more experienced firms to provide the mine with goods or services.

7.3.2.4 Summary of Impact Assessment from Operations

Canadian Zinc is not in a position to guarantee employment to individuals who are not qualified or cannot participate for personal reasons. However, it does want to maximize local employment to the extent possible. Through an assessment of the jobs created at the mine, the skills required to perform those jobs, the pool of potential workers from within the Study Area and the NWT, and the potential constraints to participation, it was determined that local employment could reach 70 jobs.

To increase the likelihood of meeting this potential target, Canadian Zinc has a mitigation strategy that includes

- promoting higher learning through a scholarship program,
- sponsoring training in conjunction with the mine training society
- taking an active role in the schools and communities,
- arranging visits to site for school staff to help them understand better the environment and the possibilities for their students,
- creating a highly visible community communication strategy that includes visits, promotions, sponsorships, and the attendance at community events.

Table 7-19: Summary of Potential Annual Employment and Income Impacts from Operations

	Number of Jobs	Labour Income ($,000s)
Mining Jobs	140	12,359
Local mining jobs	70	5,768
Direct FTE Jobs	66	4,107
Indirect FTE Jobs	17	1,101
Total	223	17,567

Note: Canadian Zinc, Impact Economics, Statistics Canada Input-Output Division

Canadian Zinc is currently working with the communities through its Impact and Benefit Negotiations to prepare an effective strategy for communicating with local Study Area residents.

Expanding the labour force assessment to the entire Territory, the potential local hires grows to 140 workers (see Table 7-19). The annual labour income, including wages, salaries and supplementary income, flowing from these employment levels equals $12.4 million.

New demand on local business will create 138 FTE jobs and a corresponding $8.6 million in labour income. At a participation rate of 60 percent, these additional opportunities translate to 83 FTE jobs and $5.2 million annually. This makes the potential employment and income impacts generated by Prairie Creek Mine's operations equal to 223 jobs, earning resident employees $17.6 million on an annual basis.

Table 7-20 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. The economic impacts from the operations phase will be felt beyond the Dehcho region however the relative magnitude of these impacts will be far greater within the Study Area communities. All the economic impacts described will persist throughout the life of the Project.

Table 7-20: Impact Assessment of Local Participation during Operations

	Direction	Range	Magnitude	Duration
Employment	Positive	Local	High	Long Term
Employment	Positive	Territorial	Low to Moderate	Long Term
Business Activity	Positive	Local	High	Long Term
Business Activity	Positive	Territorial	Low to Moderate	Long-Term

7.4 Impacts on Government Revenues

Input-Output Models do not produce estimates for direct taxes. Also, having run the commodity-based model for the operations phase, the results generated do not include resource royalties. Input from Canadian Zinc and components of the NWTEIM were incorporated to estimate the taxation results.

7.4.1 Corporate Tax and Resource Royalties

Corporate tax and resource royalties are a function of a mine's profitability. The calculations are based on the Government of Canada's corporate taxation regime and that of the Canadian Mining Regulations, which spell out how resource royalty payments are determined. The results presented in Table 7-21 were calculated by combining these taxation details with historical acquisition, exploration and development costs and the revenue and operating cost projections for the Prairie Creek Mine all provided by Canadian Zinc. The results show $50.9 million in federal corporate tax revenues, $39.1 million in territorial corporate tax revenues, and $41 million in federal mining tax revenues (resource royalties).

Table 7-21: Corporate and Mining Tax Impacts ($,000)

	Revenues
Federal Corporate Tax	50,930
Territorial Corporate Tax	39,050
Federal Mining Tax	41,040

Source: Canadian Zinc, Impact Economics

The Project's revenues and operating costs are based on prudent assumptions. Additional assumptions include a constant rate of production and that tax regimes at all levels of government remain unchanged over the life of the project. Future deviations in mineral prices, operating costs, production rates, and tax regimes will alter the estimated taxation revenues.

7.4.2 Personal Income Tax

Governments of any province or territory with a resident working on the Project will benefit through personal income tax revenues, as will the federal government.[99] The extent to which the territorial government will benefit depends on the level of direct and indirect employment. The results presented earlier showed total employment in the NWT could reach 60 jobs during construction and 223 jobs per year during operations. These were presented as best-case scenarios in terms of direct and indirect employment and should not be expected from day one. However, as noted, under scenarios whereby education levels improve, local businesses emphasise local hiring practices, and/or one or more of the diamond mines scale down their operations ahead of schedule, local employment numbers at Prairie Creek Mine would improve.

Table 7-22 contains the personal income tax implications for the federal and territorial governments. Federal personal income tax revenues will total $24.8 million over the 16 years of construction and operations at the Prairie Creek Mine, while that of the territorial government will total $11.5 million. In addition, social insurance plans will see increased contributions of $15.5 million. This includes $3.6 million to the federally-run employment insurance program, $3.1 million to regional workers' compensation programs, and $8.7 million to the Canada Pension Plan.

Table 7-22: Direct Personal Tax Impacts ($,000)

	Average Annual[3]	Total
Federal Personal Income Tax	1,550	24,801
Territorial Personal Income Tax[1]	721	11,534
Contribution to Social Insurance Plans[2]		
Employment Insurance	227	3,631
Workers' Compensation	196	3,140
Canada Pension Plan	546	8,733
Total Direct Personal Tax	3,240	51,839

Source: Canadian Zinc, Impact Economics, and Statistics Canada Input-Output Division
Notes: (1) These figures are not adjusted to reflect changes in Transfers from the Government of Canada. (2) Generated from local employment. (3) Annual taxation figures assume an even distribution of income over the 2 year construction period and 14 year operations period.

7.4.3 Territorial Formula Financing

At the territorial level, the increased tax base will result in a claw-back of transfers according the Territorial Formula Financing Agreement. The formula determines the annual transfer by subtracting eligible revenues from a general expenditure base. The eligible revenues are determined from the revenue potential that exists within a standardised tax base applied to the Territory and from an additional revenue block formulated to approximate the GNWT's ability to raise funds by additional tax means. Within the standardised tax base, there are seven tracked revenues:

- Personal income tax
- Corporate income tax
- Gasoline tax
- Diesel tax
- Tobacco tax
- Liquor tax
- Payroll tax

All eligible revenues are applied to the formula as a three-year moving average with a two-year lag. Furthermore, an economic development incentive (EDI) of 30 percent is applied to the eligible revenues.

Calculating the precise amount of claw-back is difficult because the eligible revenues are determined using the Territory's revenue capacity, not its actual revenues. If we assume these two revenue streams were equal, the total revenue implication for the Government of the Northwest Territories would amount to $21.1 million with the two-year lag applied. This total comes from the 30 percent EDI applied to the change in tracked revenues of $70.5 million, which includes corporate and personal income tax and indirect taxes (again, assuming actual revenues and revenue capacity are identical).

The Territorial Formula Financing Agreement excludes resource royalties from its calculation of eligible revenues. Therefore, should the Northwest Territories gain access to a share of these revenues, there would be no claw-back associated with them. Under the current regime, these revenues go to the Government of Canada.

7.4.4 Summary of Direct Tax and Resource Royalty Impacts

Table 7-23 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. The direct taxes and resource royalties from the project will impact the territorial and federal government revenues. Not shown in the table or discussed in detail in this report are the impacts on provincial government revenues. The federal government will see its revenues grow through the employment and business activities that take place within the NWT and across Canada. The magnitude for federal revenues is described as low since this is relative to its existing conditions, which would be the total federal government revenue base. In the case of territorial government revenues, the claw back of revenues through the Territorial Formula Financing agreement reduces the potential impact to one that is best describe as low to moderate. Should resource royalties go to the territorial government, the revenue impact from this Project would be high for the GNWT.

Table 7-23: Impact Assessment for Government Revenues from Direct Taxation and Resource Royalties

	Direction	Range	Magnitude	Duration
Federal Revenues	Positive	Territorial	Low	Long Term
Territorial Revenues	Positive	Territorial	Low to Moderate	Long Term

7.5 Induced Impacts from Participation

Several assumptions are necessary to determine the induced impacts from the Project. An estimate of local participation is necessary to determine the labour income that will remain in the Territory. An estimate of consumer's propensity to import is required. We must also factor in income taxes and personal savings. Components of the NWTEIM are used that incorporate historical information on these variables in determining an estimate. But because the assumptions impart a measurable bias on the results, one should regard these calculations as approximations, and be cautious if including them in the overall expectations flowing from the project.

Total personal income has been estimated at $254.9 million, with $51.8 million of that being paid in direct tax (see Table 7-24). This leaves $158.4 million in disposable income. Estimations of savings and imports total $55.4 million, suggesting consumers will spend $103 million on goods and services in the NWT as a result of the income earned directly or indirectly from the activities associated with the Prairie Creek Mine.

Table 7-24: Induced Impacts ($,000)

	NWT
Personal Income	210,252
Deduct: Direct Taxes	51,839
Personal Disposable Income	158,413
Total Consumer Expenditures	102,969
Induced GDP	32,232
Induced Employment	265
Induced Labour Income	11,853

Source: Canadian Zinc, Impact Economics, Statistics Canada

Applying this consumer activity to the NWT economy creates induced impacts which include a $32.2 million boost to GDP, 265 new jobs and $11.8 million in labour income. These impacts can be added to the total direct and indirect impacts reported earlier to get a complete sense of the overall economic impact of the proposed Prairie Creek Mine.

7.5.1 Summary of Assessment from Induced Impacts

Table 7-25 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. Induced impacts will affect the population throughout the Territory. Relative to the current GDP, employment and gross production, the induced impacts can be considered low in magnitude, but will persist throughout the life of the Project.

Table 7-25: Impact Assessment from Induced Impacts

	Direction	Range	Magnitude	Duration
Induced GDP	Positive	Territorial	Low	Long Term
Induced Employment	Positive	Territorial	Low	Long Term
Induced Business Activity	Positive	Territorial	Low	Long Term

7.6 Impacts from Reclamation Activities

The process of decommissioning the Prairie Creek Mine and all its workings will require a full year of activity. During that time, as many as 60 workers will be required as well as support staff, such as those providing camp services and transportation services. Total expenditures for this phase have been estimated at $3 million in current dollar terms.

This is a small project and the spin-off effects will be limited. A modelling exercise was not conducted to determine the direct, indirect and induced impacts of this phase of the Project. Similar to the construction phase, the Project proponent will contract most of this work to qualified businesses. The developer has assumed that Study Area communities will provide the majority of the required labour and business support for this phase. This is a reasonable assumption given these communities will have had 14 years of employment and business training leading up to this phase. This would mean the Study Area communities would receive the majority of the $3 million in expenditures, whether through direct wages or procurement of local businesses. The reclamation activities offer the Study Area communities an addition year of employment and contracts as they transition into other economic opportunities.

The Project Description provides greater details of the actual reclamation activities. For the SEIA, it is important to understand that there will be options regarding the mine site once mining activities have ceased. Discussions will continue with the Nahanni Butte First Nation on the possible uses of this infrastructure—in particular, the Access Road, but also the Access Road camps and some site facilities. The project proponent is prepared to conduct a full reclamation of the site should there be no interest from the local residents to retain any portion of the mine infrastructure.

7.6.1 Post-Reclamation Impacts

After the Project has ended and the reclamation phase in complete, the Study Area will find itself without a major employer for the first time in 17 years. This will introduce a period of transition, but should not be a period of hardship if the communities have been successful in increasing their resilience to economic change.

An important factor will be what other opportunities are ongoing at the time, and whether any new opportunities have surfaced in the later years of the Project's life. Chapter 5 includes a review of the known economic opportunities. It showed that the near term and medium term prospects for economic growth are not good outside the opportunities presented by the Prairie Creek Mine. However, it also showed that there are opportunities over the long term and in particular, there are additional resource development opportunities.

An important outcome for the Prairie Creek Mine and Canadian Zinc is the change in perspective it will bring to the region with respect to economic growth and the possibility of financial prosperity. The Prairie Creek Mine will help Study Area residents learn the benefits of mining and, through their experiences they will be better equipped to not only manage future opportunities, but to attract them to the region as well. But more than this, Canadian Zinc wants its Project to effectively raise the quality of life of Study Area residents and to improve the sustainability of Study Area communities (see section 7.10).

A society that is resilient to outside change; that is, one that can cope with and ultimately benefit from change will be well prepared for the impacts of a major project like the Prairie Creek Mine coming to an end. In this sense, the entire mitigation strategy (summarised in Chapter 11) is a plan designed to deal with the day the Project ends. Increasing financial wealth, addressing issues of education and skills training, improving business practices, enhancing life in communities, all of these components are ultimately meant to leave the Study Area in a better position than the one they are in now.

7.7 Social Impacts

The proposed Prairie Creek Mine will affect the social performance of Study Area communities. This will occur primarily as a result of local participation; though some questions posed in the Terms of Reference ask whether the mine's existence would have an impact regardless of participation.

The previous sections have described the maximum likely participation by labour and business from the Study Area communities, the Dehcho region and the NWT as a whole. It is important that one account for the gradual increase in participation that will occur after the initial round of hiring. Resident employment will likely start at 30 to 40 individuals, and grow from there. This is a responsible economic forecast considering the current state of the human environment into which the project will enter and has important consequences for the assessment of social impacts.

7.7.1 Migration

Impact Economics' demographic model of the NWT was used to assess migration impacts from the proposed Project. It was noted earlier that the rapid economic growth that occurred in the North Slave and Tlicho regions over the past decade has not led to dramatic increases in migration despite expectations to the contrary. In addition, the planned employment at the Prairie Creek Mine is approximately 10 percent of that at Ekati, Diavik and Snap Lake when taken together. This suggests that any expectation for a change in the population of the Study Area should be low.

The modelling exercise shows a possibility of attracting up to 16 employees to the Territory in the initial years of operations. Assuming these people migrate with families, the total number of migrants could be 51 people. However, because the Project is small, it is difficult to provide adequate details regarding the results. For example, the model lacks the sophistication to describe where these people would settle. And, when the activities of the three diamond mines are added to the model, the potential impacts from the Prairie Creek Mine are overshadowed by the impacts from these larger projects.

Nevertheless, it is reasonable to believe the population base of the Study Area, Dehcho region and the NWT as a whole will be positively impacted by the proposed mine, albeit on a small scale. These impacts will materialise in three ways:

1) The rate of out-migration of Study Area residents to other NWT communities and/or other regions of Canada should dissipate.
2) As activities at other operating mines or projects slowdown or end, the number of families leaving the Territory as a result will be lessened as a result of the opportunities presented by the Prairie Creek Mine.
3) There is the possibility that former residents of the Study Area communities would return should the opportunity for employment exist.

Each of these possible migration impacts come with caveats; all of which give pause to any speculation that the impact on migration will be anything other than low.

- Countering the possibility of fewer residents migrating away from the Study Area communities because of the job prospects is the possibility that some would relocate elsewhere given the freedoms associated with their new financial wealth and the ability to retain employment regardless of the community of residency.
- The opportunity for work for those who are laid off from mining operations or those involved with the Dehcho Bridge construction will exist, but the Prairie Creek Mine will not be holding positions open until such time as this workforce becomes available. Job openings will arise through turnover, and not everyone will be in a position to wait.
- There is the possibility that some former Study Area residents would return home given the availability of work. Countering that is the fact that residency within the Study Area communities is not a requirement for employment. Therefore, such things as family, housing, and quality of life considerations would also affect the decision to relocate.

7.7.1.1 Summary of the Impact Assessment on Migration

Table 7-26 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. The proposed Prairie Creek Mine will have substantial impacts on the Study Area communities' economy and employment. This is not likely to have a similarly substantive impact on migration. Where it will affect population numbers is in slowing the rate of out migration; first from the Study Area, and later from the Territory. This impact will be positive, but at times the magnitude of change will be negligible.

Table 7-26: Impact Assessment on Migration

Impact	Direction	Range	Magnitude	Duration
Out Migration of Residents from Study Area	Positive (less out migration)	Local	Low	Long Term
Out Migration of Residents from Rest of NWT	Positive (less out migration)	Territorial	Negligible	Long Term
In Migration to the NWT	Positive (more in migration)	Territorial	Negligible	Long Term
Net Migration	Positive	Territorial	Low to Negligible	Long Term

7.7.2 Education and Life-Long Learning

Education levels in the Study Area communities are low as described in Chapter 5. Analysis of changes in education in the Tlicho and North Slave regions over the past ten years suggests that the economic growth there was a likely contributor to the improved success of students, but that improved education services offered by the Government of the NWT was also a contributor and possibly a more important contributor to the changes.

It is reasonable to assume a similar outcome can be achieved in the Dehcho region as a result of the Prairie Creek Mine. The minimum qualification for employment with the mine operator is Grade 12. The prospect of a good paying job should provide some incentive for students to remain in school and graduate and further incentive to attain additional education such as a trade or university degree. But this alone is not enough to change the education performance in the Study Area. Marked improvements will require more support from families, communities, and government.

The Project proponent has already undertaken some initiatives to improve education outcomes and to prepare the potential labour force for future employment.

- Since 2004, Canadian Zinc has sponsored students attending higher education through a scholarship program. To date, 33 scholarships have been awarded with $35,500 being handed out.
- Canadian Zinc is working with the NWT Mine Training Society to provide a number of education and training opportunities. Together with Aurora College, the Project proponent has offered an Environmental Monitor Training Program to Study Area residents.
- Canadian Zinc has worked with staff from some Study Area schools to help them understand the mining operations and work potential such that this information can be passed to students.
- Study Area residents have attended several conferences and workshops geared toward improving participation and accessing more benefits from mining. For example, several local people attended the Aboriginal Minerals Association conference on “Growing Communities in Changing Economies.”
- Canadian Zinc has employed and trained a community information representative in Fort Simpson and in Nahanni Butte.
- Canadian Zinc is and will remain very active in the communities through visits, sponsorships, promotions, and attendance at community events.

All employees of Canadian Zinc will receive a host of education and training opportunities specific to their job. Mandatory training will be provided to ensure employees are fully aware of company health, safety and environmental policies and practices and able to perform tasks in compliance with established policies and legislation. Employees will also receive training to ensure they are fully aware and trained to respond to an emergency.

Practical technical training will be provided to ensure employees attain the required skills to perform all tasks included in their job description in accordance with industry standards and regulations. Finally, employees will receive specific training in the regulatory codes, acts, regulations and industry standards as they apply to their jobs.

Training will be prioritized as mandatory and supplementary. Mandatory training courses are necessary to ensure employees perform their duties safely while promoting environmental protection, and must be undertaken before the employee can work on-site. Mandatory courses will include:

- Occupational Health and Safety;
- Safety Oriented First Aid and required levels of Mine Rescue;
- Driver Education;
- Environmental Awareness;
- Workplace Hazardous Material Information;
- Hazardous Materials Handling, Storage and Transport;
- Waste Management;
- Spill Response and Reporting - ensure employees know the site layout, and where to find safety, medical and environmental help;
- Review emergency response procedures and responsibilities;
- Make employees aware of wildlife policies, and specifically how to respond to bear encounters; and,
- Make employees aware of drug and alcohol policies, and where to find help if needed.

The Safety Coordinator will be responsible for course content, scheduling and employee participation.

In addition to the above, every employee will be encouraged to participate in supplementary orientation seminars upon arrival at the site for the first time. Seminars will include, but may not be limited, to guidance on personal financial management, and review of employee benefits packages.

The potential gains in education and life-long learning might also affect community and business leaders. Canadian Zinc is committed to working with the community and business leaders to maximize the benefits from the Project. As a part of this commitment, Canadian Zinc will offer valuable guidance in areas where it has particular expertise such as management, industrial development, and organisation.

7.7.2.1 Summary of Impact Assessment for Education and Life-Long Learning

Table 7-27 summarises the impacts according to the impact assessment criteria. The education levels of Study Area residents are expected to improve over the life of the Project. This is one of the great legacies of the Project. Employees will undertake numerous education courses while acquiring valuable on-the-job training and work experience. Local participation at the mine will make these people role models within the Study Area communities that should further encourage younger generations to remain in school. Furthermore, the experience of business in accessing contract opportunities and managing joint ventures is also a form of education that will leave residents better off than they were before the Project started.

In terms of the criteria used to judge impacts, the predicted improvements in education were deemed to be low in magnitude because the Project and its proponent can provide incentives for more and better education, but cannot affect the education system or guarantee greater attendance within the Study Area. Impacts of a greater magnitude will require action from individuals, families, communities and government. Skills and training and job experience, on the other hand, are areas of life-long learning that Canadian Zinc can and will affect through the suite of skills and on-the-job training services offered to employees of the mine.

Table 7-27: Impact Assessment for Education and Life-Long Learning

Impact	Direction	Range	Magnitude	Duration
Education	Positive	Local	Low	Indefinite
Skills and Training	Positive	Local	High	Indefinite
Job Experience	Positive	Local	High	Indefinite

7.7.3 Family

Families can be affected in several ways through participation of family members at the Prairie Creek Mine. Some of these impacts are positive, while others are negative. Canadian Zinc has little control over the impacts that come as a result of choices that employees make when at home. However, it is in the company's best interest to help its employees, their families and communities where they can in order that they receive the benefits of their participation and mitigate to the extent possible the negative impacts.

It is also reasonable to assume that challenges will arise that are unique to the individual, family and community. For this reason, Canadian Zinc is committed to working closely with its employees, their families and communities to find solutions to the challenges as they occur. The community information representative will be responsible for assisting employees and Canadian Zinc management communicate with one another when issues arise. The Human Resource Management Plan provides some of the details of Canadian Zinc's commitments in these areas. More will become a part of the Impact and Benefit Agreements and the company's commitments to monitoring and reporting to the communities.

7.7.3.1 Family Stresses, Children and Child Care

The rotation schedule means a family member will be away from their family and community for three weeks at a time, though it also means they are home and not working for an equal length of time. The time away can cause family stress on a number of fronts. It increases the workload of those who remain at home caring for children or elderly persons. It can also increase the demand for child care, with one less parent to look after the children for the time that employee is away. For the employee, the time and distance away from home can be stressful and lonely.

There is no doubt that for some employees, there will be an adjustment period. And the reality is that not everyone interested in work at the mine site will be well suited for that work. The rate of employee turnover will likely be high in the initial years of operations. For those unable or unwilling to work at the mine site, indirect employment opportunities will exist that offer alternative work schedules. A family, in particular one with young children, may have to weigh the benefits of working at the mine against those of finding work through spin-off activities. Families with older children might find that the three-week rotation offers the working parent quality time with their children and enables greater participation in the child's extracurricular activities.

But regardless of their family situation, Canadian Zinc employees will have access to a comprehensive human resources package that includes programs to help reduce the negative aspects of rotational work. Camp life will include recreational activities, religious services, and access to the Internet. The camp itself is being designed such that each employee will have their own room. Programs will be offered throughout the year such as personal financial planning and those associated with seasonal and religious holidays. Counselling services will be available as a part of the overall employee compensation package. In addition, traditional Aboriginal events and activities will be planned and country foods will be served when available.

Canadian Zinc will have guidelines that outline the circumstances under which employees can return home prior to the completion of their rotation. The company will also have a leniency policy for new employees that will outline the circumstances under which workers need some time to adjust to work life and camp life. Canadian Zinc will also sponsor community events that help improve the quality of life for those not participating directing in mine employment and those who are on their three-weeks off. As an example, Canadian Zinc is the sponsor for *Winterfest* in Nahanni Butte, which is a community festival that includes sporting events and a community supper. In February 2010 approximately 45 residents attended the event[100] that could take place on an annual basis should the Prairie Creek Mine open.

7.7.3.2 Financial Freedoms and Standard of Living

The direct or indirect participation of family members also brings with it positive financial benefits that have substantive social benefits that greatly enhances one's quality of life. Financial well-being affords families the freedom of choice. The income earned will raise the standard of living for these families, providing the opportunity to improve the quality of their homes and possessions. It affords the opportunity to make healthier life decisions such as the quality of food purchased and the extracurricular activities that children and adults can enrol in. It can afford family members the opportunity to attend college or university. Financial freedoms limit the need for additional sources of income and increase the time available to spend with one's family, relax, take a vacation, or volunteer in the community. Financial wealth also offers the opportunity for families to save.

In order for the financial gains to be considered a net benefit, it is necessary that wages be managed responsibly. Canadian Zinc will assist where it can in this regard. Alcohol will not be permitted on site under any circumstance and activities such as gambling will not be allowed. Employees will be flown back to their designated pick-up point with no exceptions. As noted earlier, money management programs will be offered to employees, and counselling services can add an additional level of support in this area. But Canadian Zinc acknowledges that it is not equipped to deal fully with addictions and will require that the entire community and responsible government and non-government agencies takes a proactive approach to helping these individuals cope with their challenges and adapt to the new economic realities.

7.7.3.3 Three-Week Rotation

Canadian Zinc currently operates a three-week in/three week out rotation schedule with its exploration and development activities at the Project site. This schedule is the preferred choice of the current employees, which has included 22 Study Area residents. Discussions on shortening or lengthening the rotation have taken place in the past, with the current schedule remaining the choice of a majority of workers.

Canadian Zinc has studied the rotation issue carefully, weighing issues of safety and costs, against alternative schedules. The Prairie Creek airstrip is a challenging strip to access. The Company wishes to maintain an adequate margin of safety by limiting use of this airstrip. Given the restricted limitations of the Prairie Creek airstrip, there could, at times, be significant weather delays. Such delays could be managed better over a longer rotation, with short rotations such as one week in/one week out becoming logistically impossible. Canadian Zinc must also assess the costs associated with the various rotation schedules. The lead-zinc mine at Prairie Creek should be operational for 14 years, but the current world price for these minerals does not offer margins that would allow for increased transportation costs of the magnitude a one week in/one week out schedule would bring. From the perspective of park users, limiting the use of airspace around Prairie Creek will reduce the visual/audio effect on Nahanni NPR integrity which includes its possible effects on wildlife and maintain the tourists experience as a wilderness park.

Canadian Zinc will continue to monitor its schedule and the impacts it may have with personnel over the life of the Project. Should circumstances change in such a manner that different rotation schedules become more feasible, such options will be discussed with the mine’s workforce.

7.7.3.4 Summary of Impact Assessment for Families

Table 7-28 summarises the impacts according to the impact assessment criteria. Families will see positive and negative impacts from their participation at the Prairie Creek Mine. It is the goal of Canadian Zinc’s to enhance those positive benefits and eliminate or at least reduce the impacts of the negative effects. It will do this through a combination of its “hire first” program, offering a comprehensive benefits package to employees, making the Prairie Creek Mine site hospitable through numerous activities, programs and services, employ a community information representative to help with communications between employees and mine management, and to remain active participants in Study Area community events.

The outcome of these initiatives will be to moderate the negative impacts for families. At the same time, the positive benefits for families through the increased financial wealth will have a positive, high and long term impact on the families of local participants.

Table 7-28: Impact Assessment for Families

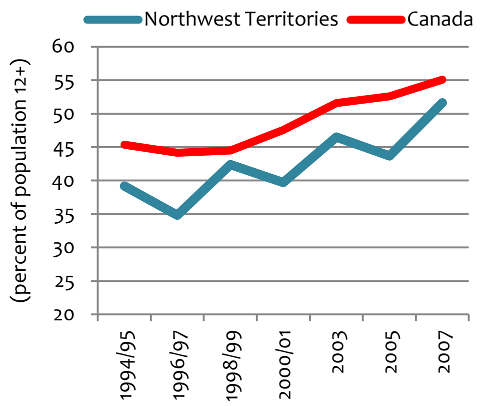
Impact	Direction	Range	Magnitude	Duration
Family Stress and Raising Children	Negative	Local	Moderate	Long Term
Financial Freedom and Standard of Living	Positive	Local	High	Long Term

7.7.4 Health

7.7.4.1 Addictions

There is a concern in the NWT that the increased income that comes with economic growth results in increased drug and alcohol usage. This is a concern for Canadian Zinc. The National Population Health Survey and Canadian Community Health Survey show that the Territory has a lower percentage of residents that drink compared to the rest of Canada, but that those who do consume alcohol have a greater tendency to drink a lot (see Figure 7-1 and Figure 7-2).[101]

Figure 7-1: Frequency of Alcohol Consumption, 1994 to 2007, NWT and Canada

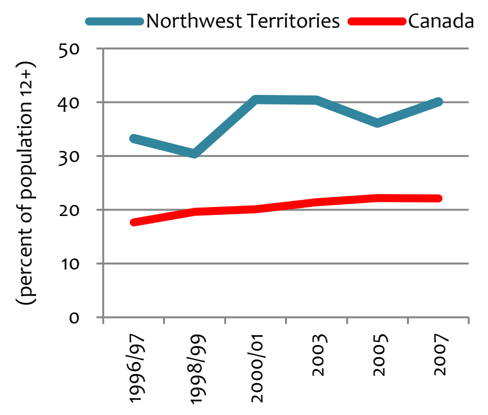


Source: National Population Health Survey and Canadian Community Health Survey, assembled by NWT Bureau of Statistics, Socio-economic Scan 2009. Note: Refers to the proportion of drinkers who drank alcohol weekly in the previous 12 months

The *2006 NWT Addictions Report* produced by the GNWT indicates that rates of drug usage in the Territory are relatively stable.[102] It is nevertheless a concern of Study Area residents and one that the Project proponent takes seriously.

Drug and alcohol counselling will be a part of employees' compensation package, though it is acknowledged that this is not sufficient to help people with addictions. At the same time, industry is not well equipped to administer programs in this field. The Human Resources Management Plan outlines the details related to alcohol and drug usage during an employee's time at Prairie Creek. In addition, the company will engage with the Study Area communities and encourage cooperation with government and non-government officials on a strategy that might limit the severity of this impact and ensure these people receive the help they need.

Figure 7-2: Frequency of Heavy Alcohol Consumption, 1994 to 2007, NWT and Canada



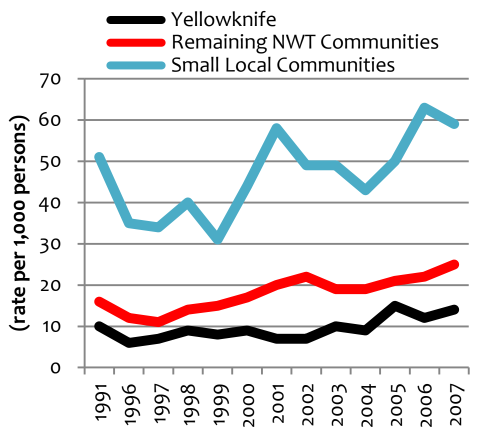
Source: National Population Health Survey and Canadian Community Health Survey, assembled by NWT Bureau of Statistics, Socio-economic Scan 2009. Note: Refers to the proportion of drinkers who drinkers who consume 5 or more drinks on one occasion at least once per month, in the past 12 months

7.7.4.2 Sexually transmitted infection rates

A marked increase in sexually transmitted infection (STI) rates took place in communities impacted by the diamond mines beginning in 1999 (see Figure 7-3).[103] Both De Beers Canada Inc. and Diavik Diamond Mines Inc. predicted this increase on the grounds that parental supervision would decrease through participation at the mine. The potential for increase access to drugs and alcohol through the increase in incomes and general disregard for safe sex were also cited as factors by the Government of the Northwest Territories in its *Communities and Diamonds* reports.

With that noted, the size and scope of the Prairie Creek Mine is approximately 10 percent of that of the diamond mines. The demographic makeup of the Study Area communities is not expected to change as a result of the project; that is, the Project is not expected to cause a significant influx of new residents. Contact between southern-based employees and local employees will be limited to the mine site. And the participation through employment is expected to grow at a gradual rate over the medium term. This suggests the magnitude of the impact will be lower. Nevertheless, the employees and their families will not be immune to mistakes, and the responsibility for controlling the spread of STIs will be a shared responsibility of the community, including individuals, families, the departments of Health and Social Services and Education and all employers operating the in Study Area.

Figure 7-3: Sexually Transmitted Infections, 1991 to 2007



Source: NWT Communicable Disease Registry, Community and Diamonds, 2008
Note: Small Local Communities refers to those impacted by the diamond mines, including Tlicho communities and Lutsel'ke. N'dilo and Detah are included with Yellowknife.

7.7.4.3 Summary of Impact Assessment for Health

Table 7-29 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. The major health concerns for Study Area residents revolve around addictions and sexually transmitted infection. Through participation at the mine, the income earned will make drugs and alcohol more affordable. The time away from home will reduce parental care that could result in youth getting into more trouble. In working with community leaders and government health and education officials, Canadian Zinc hopes to mitigate these negative outcomes. Nevertheless, it is responsible to acknowledge that the magnitude of this impact could reach moderate proportions and remain throughout the life of the Project.

The rate of STIs across the NWT was high prior to the introduction of the diamond mines (about four times the national rate), and was particularly high in the smaller communities. The impact assessment of the Prairie Creek Mine is relative to the baseline or existing conditions. From that perspective, it is believed that the Project will have a low to moderate impact on the Study Area communities. Through strong community leadership and active government programming, these impacts should be made negligible.

Over the long run, one should expect that an increase in positive role models within the communities, greater education, improved financial wealth, and an overall healthier society will ultimately result in a reduction in addictions and STI rates. Canadian Zinc believes that through its modern management practices, effective mitigation plans, and close relationships with the impacted communities, its Project will leave these communities in a position of greater resilience to the negative effects of economic and social pressures, creating stronger and healthier communities.

Table 7-29: Impact Assessment for Health

Impact	Direction	Range	Magnitude	Duration
Addictions	Negative	Local	Low to Moderate	Medium to Long Term
STI Rates	Negative	Local	Low to Moderate	Medium to Long Term

7.7.5 Community Impacts

There are some potential social impacts that can affect a community. The project is not expected to impact migration into the Study Area enough to burden community infrastructure or administration. However, those individuals and families who are benefiting from the Project either directly or indirectly will see their incomes rise in comparison to those unable or unwilling to participate. This income disparity can create stresses within the community and negatively affect relationships. A key feature of the Study Area communities is the strong social kinship that exists between its members. Income disparity will test this attribute.

There has been anecdotal evidence throughout the NWT and Nunavut that shows communities are challenged to find qualified labour to replace those who leave their jobs within the community to work for industry. At the same time, small communities offer few employment opportunities, so the movement of existing workers can also provide opportunities for younger people who have just entered the workforce.

7.7.5.1 Income Disparity

The impact assessment presented earlier for labour income revealed personal income levels could rise by more than $5 million in the Dehcho region and over the long term, assuming local participation can reach its potential, income levels could rise by over $10 million (see Table 7-30). This equates to 20 percent of the current employment income in the region. These are not just jobs, but high paying jobs. Individuals and families that are able to fully participate will see significant changes in their standard of living; something that will be quite visible in communities where poverty is a real concern. The contrast between *haves* and *have-nots* will be greater than is currently the case.

The manner in which some of this new wealth is distributed throughout the community is unclear at this point in time. Traditionally, Aboriginal cultures are ones where sharing is an important value. As the project progresses, work will be required to study if and how the transfer of wealth is taking place. Canadian Zinc is committed to monitoring and reporting the socio-economic progress of the Study Area communities during the operation of its mine. This will provide some insight on how communities are managing their wealth and how it is being distributed.

Table 7-30: Current and Potential Income Levels ($,thousands)

CURRENT	Dehcho*	Fort Liard	Fort Simpson	Fort Providence
Total Income	64,803	10,875	38,478	15,450
Employment Income	53,733	8,913	33,151	11,669
Government Transfers	8,652	1,696	3,880	3,076
POTENTIAL FOR DEHCHO*	Short Term		Long Term	
Annual Income from Prairie Creek Mine	5,488		10,976	
% of Dehcho total income	8%		17%	
% of Dehcho employment income	10%		20%	

Source: NWT Bureau of Statistics (2006 Income Statistics), Impact Economics, Canadian Zinc, Statistics Canada.
Note: * Data is limited to that from the three largest Dehcho communities. ** Short Term assumptions are 35 mining jobs and 41 additional jobs. Long Term assumptions are the maximum labour participation figures; that is, 70 mining jobs and 83 jobs with locally-impacted businesses.

7.7.5.2 Labour Shortage

When community employees take positions at the mine, the jobs they leave may remain open for several months. This is because of the current state of the labour market in these communities, where the size of the skilled and semi-skilled workforce is small.

For example, anyone working with large trucks or heavy machinery such as a water and sewage truck or snow clearing equipment will have a skill that can be used at the mine or by a mine contractor. This person might be the only one in their community able to work that equipment. After they leave, there will be a period of time when the position is empty until someone can receive the necessary training.

In other cases, recent graduates of training that was originally meant for community-based jobs, such as that for the water truck operator, boiler repair, or plumber might choose to work at the mine; taking their newly acquired skills with them. From the communities' perspective, there is a danger that its recruiting and training efforts may facilitate people accessing jobs at the mine leaving the community with little to show for their training dollars.

To complete a fair assessment of the magnitude of this impact, it is important to consider expectations for employment over the life of the project against the baseline employment and demographic scenario. In 2007, Canadian Zinc employed 22 Aboriginal people from the Study Area. Should this number grow to 30 during construction, the impact on communities' workforce will be low to moderate. Canadian Zinc wants to grow the number of local workers at the mine over time. But this growth will not likely be a straight line. Periods of more and less local employment will occur. And as shown in the potential labour force assessment, the number of eligible workers in the region will grow through the natural ageing of the population and the corresponding graduation of young people. Beyond this, any improvement in graduation rates and the number of individuals with additional training or skills development will raise the prospects for greater local participation in jobs throughout the economy, including the opportunities at the mine site, through mine contractors, and community-based employers.

7.7.5.3 Summary of Impact Assessment for Communities

Table 7-31 summarises the impacts according to the impact assessment criteria. The magnitude of impacts from proposed Prairie Creek Mine on the Study Area communities will most likely be high. This is not because of a population change that would place greater demands on government services and infrastructure, but rather because of the impacts on income levels for those participating and the gap in local labour markets that will form should too many community workers move to jobs at the mine site.

The jobs at the mine site will be high paying jobs, especially in comparison to the average employment income in the region. The financial wealth of labour force participants will rise in stark contrast to those that do not participate. Each community and the region as a whole should be aware that this will happen and prepare accordingly.

Meanwhile, some of the individuals currently employed by these communities will be attracted to work at the mine. This will leave jobs in the community open that might take several months to fill. The magnitude of this impact is reduced somewhat by the fact that these are still good jobs and will appeal to those that value community life over the higher pay at the mine.

Table 7-31: Impact Assessment for Communities				
Impact	**Direction**	**Range**	**Magnitude**	**Duration**
Income Disparity	Negative	Local	High	Long Term
Labour Shortages	Negative	Local	Moderate	Long Term

7.7.6 Impacts on Public Safety

7.7.6.1 Crime

The current crime rates in the Dehcho region are high relative to the territorial average and extremely high in comparison to the national average.

Crime occurs for many reasons. The increased employment opportunities and greater community wealth should not be viewed as an instigator of crime. Greater wealth brings with it financial security. The opportunities for employment will bring about important social changes through increased productivity throughout the Study Area society.

There will be an increase in stress levels at the family and community level as described earlier. And it must be reiterated that people who are not in a position to work at the mine site will have other opportunities. Nevertheless, the stress levels of some families will increase as a result of an absent parent. Community stresses could arise due to income disparities. But over time, through mitigation efforts and adaptation of the local population, the ability to cope with these changes will effectively lower their influence on crime.

Other stressors, such as the pressures of the modern economic world and the social changes coming about through a greater diversity of interests within the youth population and new technologies such as improved access to broad-band and the Internet will remain. Education and community-based support are needed to address these issues.

Canadian Zinc, as a part of its interest to see the Study Area communities prosper, will continue to engage with the communities and their leadership throughout the life of the Project. Sponsorship of community events and promotion of activities will improve life for community members. It believes that its role in helping to bring greater health and vibrancy to the Study Area communities is their best approach to mitigating negative social outcomes which includes the rate and severity of crime.

7.7.6.2 Ground Transportation

The successful operation of the Prairie Creek Mine depends on maintaining safe practices in all aspects of the operation. The transportation of processed minerals and supplies are a part of these operations that will take place at different times throughout the year along the various routes.

Section 6.23 of the DAR describes the transportation schedule of an operating Prairie Creek Mine. The majority of trucking on the Access Route would take place during the winter season. Historic public traffic along the existing Highway 7 in this section is low (50 vehicles/day) and the proposed mine would add approximately 12 concentrate trucks/day to this. The addition of the mine traffic is not expected to detrimentally affect the safety of the public or cause undue stress on highway infrastructure.

From a public safety perspective there are two types of roads that will be utilized by Prairie Creek traffic, public roads and the Access Road. While standard safety practices apply to both regimes such as:

- Consistent high quality maintenance of vehicles and equipment.
- Certification requirements of drivers and educated on the specific routes.
- Adherence to all highway rules and regulations.
- Truck to truck communications on a secure band.
- It is likely that Highway haulers and the Access Road haulers will be on separate, dedicated bands.
- An emergency channel will also be available.
- Each truck will be equipped with emergency provisions including a mobile satellite phone.
- A dedicated central dispatch office will be maintained either at the mine site or Fort Nelson.
- GPS trackers will be installed on all vehicles. These trackers will be active on all vehicles and will give the central dispatcher accurate data for pinpointing locations of all vehicles at any time.

Specific additional safety practices to minimize the potential for vehicle accidents could be considered along the two routes:

Public Roads (Highway #7 and #77)

- A notice of operations could be placed in the local papers
- Signage along the road could be placed at strategic locations along the route to notify drivers that trucks are active along the highway.
- The presence and tracking of public vehicles moving along the haulage route during operations could be relayed through the fleet via radio communication.
- A response program should be developed with the Department of Transport of GNWT regarding reporting road conditions, problem areas and being able to respond to and mitigate surface road issues in reasonable time during operations.

Access Road (Liard Transfer Facility to Prairie Creek Mine)

- Good maintenance of road bed is essential to safe operations.
- Strict control and monitoring of vehicle access will be maintained at the ice bridge and Grainger Gap.
- Only drivers with adequate training, knowledge of the route and protocols will be allowed to operate along the Access Road.

- Certain parts of the route will require specific driving protocols.
- Small trailers with provisions would be strategically placed along the Access Route to act as emergency shelters in the event of a breakdown or accident.

7.7.6.3 Airstrip Safety

Increased use of the existing Prairie Creek airstrip (CBH4) will increase the need for further additional safety issues to be implemented in its operation. Discussions with Transport Canada and local air carriers with regards to improving the operation of the airstrip are ongoing and will continue.

Increased air traffic at CBH4 will require some safety upgrades. Some of the improvements under consideration include:

- Strict training and certification of pilots would take place prior to pilots being qualified and permitted to operate in and out of the Prairie Creek airfield. Familiarity with local terrain and conditions is an essential part of a safe operation of the strip.
- Upgrading weather monitoring equipment at the airstrip, in particular wind monitoring intensity and directions. Consideration of a remote wind gauge on top of one of the local hills would assist in evaluating the wind conditions both in the valley and at the hilltops.
- Upgrade of weather monitoring facilities and communications along the flight paths (Fort Liard, Nahanni Butte) would improve safety.
- Installation of beacons located at strategic spots along the approach would be required.
- Strict control of any operating vehicle in the proximity of the airstrip along with regular monitoring of local wildlife.
- A shelter would be located at the airstrip and would contain emergency provisions, equipment and a spill kit.
- Regular maintenance of the airstrip including a new layer of appropriate aggregate on the surface.
- Strict procedure should be maintained for scheduling and tracking in-bound and out-bound air traffic.
- Reliable surface to air communications at the mine site.
- Improved lighting and perimeter markers could be installed.
- Clearance must be given from the Prairie Creek Site before any aircraft departs the airstrip or before any aircraft leaves an outside location and is destined for the Prairie Creek airstrip.

Provisions and contingency plans would need to be improved since the local weather conditions can often prevent airplanes from accessing the Prairie Creek airstrip.

7.7.6.4 Summary of Impact Assessment on Public Safety

Table 7-32 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. The proposed Prairie Creek Mine should not have a long-term negative impact on public safety in the Study Area. In terms of crime rates, it is reasonable to assume that the short term will see a fluctuation in the number of crimes as the population goes through an adjustment period. However, over time, similar to observations in the Tlicho and North Slave region, incidents of crime should begin to decline and ultimately improve as a result of the increase financial, social and political freedoms associated with a region experiencing strong economic growth.

Safety on the highway between the Access Road and the territorial border should not be compromised by the presence of haul trucks. These trucks will operate during the winter months when the roads are virtually empty of other traffic. These trucks will be well maintained, and drivers must be fully certified and obey all rules associated with the operation of their vehicle. Meanwhile, safety on the Access Road will be maintained through controlled access of public vehicles.

Safety associated with the airstrip at the mine site will be maintained through numerous safety provisions and strict adherence to safety regulations.

Table 7-32: Impact Assessment on Public Safety

Impact	Direction	Range	Magnitude	Duration
Crime	Negative	Local	Low	Short Term
Crime	Positive	Local	Low	Long Term
Highway Traffic	Negative	Local	Negligible	Long Term
Airstrip	Negative	Local	Negligible	Long Term

7.7.7 Impacts on Wilderness Value

Question 3.4.3.8 in the Terms of Reference asks that the developer give consideration to the potential social impacts caused by a reduction of wilderness values associated with the Nahanni NPR. Wilderness valuation is the process of considering and estimating the importance or worth of wilderness preservation.[104] In considering whether the proposed Project will alter the wilderness value of the region, we are looking to determine whether a change in the opportunities for or value of recreation, conservation, biodiversity, education, or spiritual growth will take place in the area. The proponent's assessment is that the wilderness value will not be impacted. There are several reasons for this conclusion.

First, the Prairie Creek Mine already exists. The Project proponent is not proposing to develop a new mine, but rather, operate one that has been dormant since it was built approximately 30 years ago. By bringing the mine into production, the Project offers the opportunity for economic and social gain after which the site will undergo a full reclamation. It could be argued that the mine site in its existing dormant state detracts from the region's wilderness value more so than would an operating mine in that it casts a negative perception to visitors who might inquire as to its current state.

An operating Prairie Creek Mine will have an impact on transportation volumes in the area. However, the transportation season will be limited to the winter months because of the proposed use of a winter road. The Nahanni NPR is closed to tourists during those months. Again, the mine already exists and does not appear to have been a factor influencing tourists over the past 30 years. An active mine should be no different.

Canadian Zinc will operate under a three-week rotation for its employees. Among many benefits, this schedule will reduce air traffic into Prairie Creek which will limit the exposure of wildlife and tourists to the visual and audio effects of aircraft.

Section 7.7.6 provided details regarding the rules of conduct for truck operators. Drivers will be instructed to take special care while on the Access Road should wildlife be present on or near the roadway. Because the traffic volumes are both low and seasonal, it is not expected to have an impact on wildlife.

The construction of the Access Road represents a negligible and ultimately temporary footprint. The Nahanni Butte Dene Band stand to benefit from this infrastructure as it provides access to traditional lands and creates small clearings for wildlife.

The three-week work schedule will mean the impact on air traffic in and out of the Study Area communities will be negligible and will not interfere with tourism activities, such as charter services.

7.7.7.1 Summary of Impact Assessment on Wilderness Value

Table 7-33 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. Wilderness values associated with the Nahanni NPR will not be affected by the Project or the Access Road. This property was built almost 30 years ago. It is a small project with transportation activities taking place on a seasonal basis when the Park is closed. Truck volumes are low enough that wildlife should not be adversely affected.

Table 7-33: Impact Assessment on Public Safety

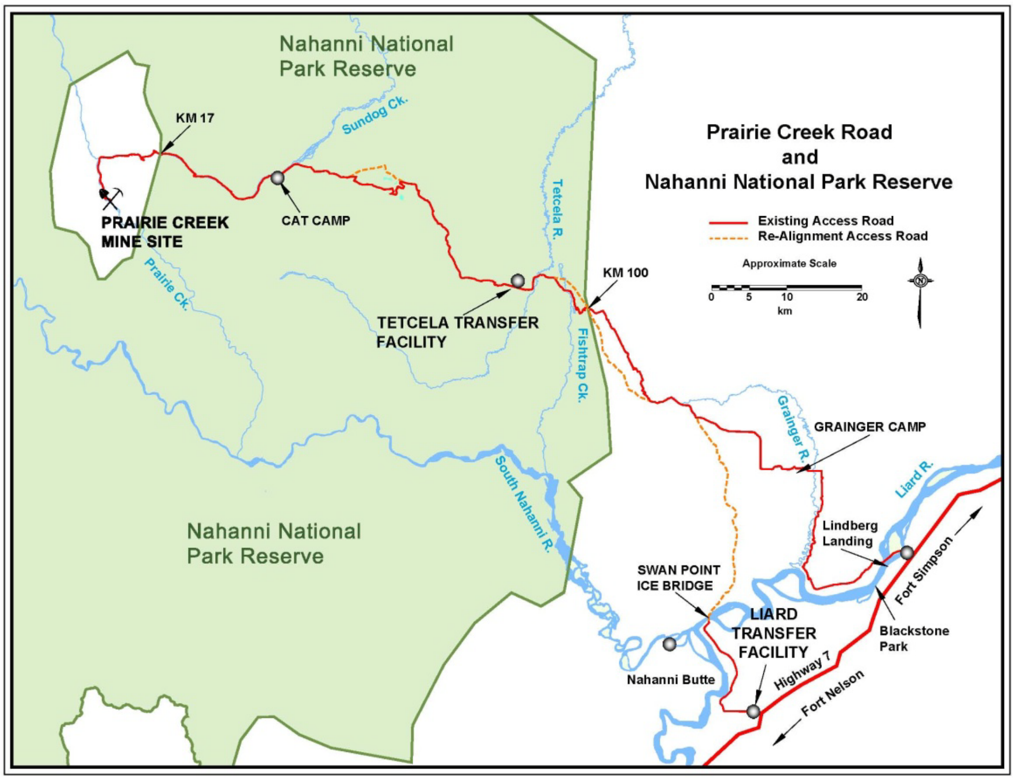
Impact	Direction	Range	Magnitude	Duration
Wilderness Value	Neutral	Local	Negligible	Long Term

7.8 Cultural Impacts

The questions raised in the Terms of Reference regarding heritage resources are dealt with in the Archaeology report and the Traditional Knowledge report. Those reports contain confidential material and cannot be presented in this report. Those reports also address questions regarding traditional land use and wildlife harvesting. Information that is not confidential in that regard is presented in this section.

Questions of harvesting activities are most relevant for the Nahanni Butte Dene Band. They have a historical and modern presence in some of the areas impacted by the proposed Project. A map of the area including the mine site, re-alignment Access Road, the Nahanni NPR, Nahanni Butte and Lindberg Landing is provided below to assist in understanding the contents of this section.

For Canadian Zinc's part, there has been no traditional use or trapping activity observed in the immediate mine site area during the duration of its activities in the area which now spans 15 years. The Nahanni Butte Dene Band has made no claims that would dispute this observation. Therefore, the primary focus of this discussion is in regards to the area surrounding the re-aligned Access Road.



7.8.1 Harvesting Activities

Some historical information regarding harvesting of the area is attached to this section. It forms a part of the Traditional Knowledge Study and has been approved for use in the DAR by the Nahanni Butte Dene Band.

> The landscape along the Prairie Creek Mine access road between Cat Camp and Second Gap (in the First Range) is quite varied but

generally open and accessible, unlike the steep and narrow valleys in lower Prairie Creek and the western section of the road. Although there is documented use of the karst plateau as a traditional trail and harvesting area, the heaviest traditional use of this portion of the road is the wetland valleys running north-south along the Tetcela River and Fishtrap Creek, and along the western side of the Nahanni Range. The plateau area to the west was utilized by Nahanni harvesters at least as early as the 1900s, likely longer given that established land use patterns are generally maintained through successive generations. It was specifically used during the winter months as a travel route to the North Nahanni River, Cli Lake, and the pass through the Nahanni Range to Little Doctor Lake, and as a trap line for beaver, lynx, marten, muskrat, wolf, wolverine, cross-fox, and mink (Dene Nation, 1975).

Tetcela River and Fishtrap Creek were used for a range of spring and winter harvesting activities as well as key travel corridors between Nahanni and Little Doctor, Cli, and Sibbeston lakes to the north, which are good fishing lakes, and Fort Simpson. The narrower wetland valley between the Silent Hills and the Nahanni (First) Range is also a spring and winter harvesting area and northerly travel route. The wetland areas have been used extensively for spring hunting given the relative abundance of beaver. Winter harvesting in the valley area included a wide range of fur species, including beaver, lynx, marten, muskrat, wolf, wolverine, cross-fox, mink, squirrel, ermine and weasel (Dene Nation, 1975) as well as moose, which appear to over-winter in this valley area.

Although fishing was not a primary purpose for people while harvesting in the valley area, except for the lower ends of Fishtrap Creek, Nahanni trappers are aware of the fish species in the main creeks in the area: Inconnu (white fish), grayling and jackfish.

The Nahanni Range itself is a harvesting area for mountain (Dall's) sheep, likely due to the presence in the area of a sheep lick. Sheep are seen all along the high country and at the Gap, particularly in summer, and calve in the area. The sheep stay on top of the mountains during the winter where snow is absent. Temporary camps have primarily been used for spring and winter harvesting activities in the wetland valleys west of the Nahanni Range, but cabins have also been established and used on the small lake just west of the Gap.

7.8.1.1 Success Rate

The re-alignment of the Access Road will move its junction with Highway #7 approximately 25 kilometres southwest of its current location which is just outside

Lindberg Landing. The new alignment gives members of the Nahanni Butte Dene Band much easier access, crossing the Liard River at Swan Point. One of the reasons for the road re-alignment was through a request by the Nahanni Butte Dene Band who saw it as an opportunity to gain easier access to hunting and trapping grounds. [105] There was also a desire to see the road avoid the Grainger lowlands, which it now does. [106]

The realignment means the Access Road will not interfere with residents of Lindberg Landing. The new route also means the road no longer travels alongside the Grainger River.

The construction and mining activities associated with the Access Road and mine site will not impact traditional harvesting activities on the South Nahanni River or the South Nahanni River Valley.

7.8.1.2 Road Access

Use of the Access Road by members of the Nahanni Butte Dene Band, residents of the Study Area, and/or non-residents to the region is a topic of ongoing discussion between the interested First Nation groups, Parks Canada, and the Government of the Northwest Territories. The discussion can be separated between that regarding the easterly portion of the Access Road that is outside the park boundaries and on crown land and that regarding the westerly portion that is a throughway to the mine site bordered by the park boundary on either side of the road.

The easterly portion of the seasonal Access Road that runs approximately 60 kilometres from the Swan Point Ice Crossing to the park boundary is on crown land and is subject to further discussions with the interested stakeholders. The principal issue at play is whether the road will be public and thus open to Aboriginal and non-Aboriginal people alike who might want to use the road for wildlife harvesting activities. The alternative is for the road to be private and thus closed to everyone.

It is important to remember that the Access Road is seasonal, open during the winter months, and only while the ice bridge is safe. The hunting season for moose and woodland caribou ends on January 31. This leaves a very short window of time for non-Aboriginal hunters to gain access to the area via the winter road. And given the distances involved, the number of non-Aboriginal hunters travelling to the area is expected to be low.

The issues associated with the more westerly portion of the road that travels through the park are less controversial since much of the activity along that portion will be governed by Parks Canada. The proposed Access Road would be a winter road, open during a time period when the park is closed to tourists. In the summer months, there will be no road and not much more than a clearing through the forest with traces of a gravel pad. One must also factor in the volume of park visitors that has averaged no more than one thousand annually, and most recently 700 visitors. Moreover, the vast majority of these tourists visit sites or participate in activities that are associated with the South Nahanni River and Virginia Falls. The number of tourists drawn to this abandoned gravel road as a means to access the park is expected to be low. Adventure tourists, such as those active in back-country hiking may be interested, though this represents a very small number of park visitors.

In Section 5.7.3 where land use is described in greater detail, information on research activities that took place in the North Nahanni karst is provided. This location is in close proximity to the Access Road. This type of tourism is expected to continue, but is unlikely to grow. The impact associated with these tourists is negligible and certainly no different than in past years. Nevertheless, Parks Canada officials will ultimately have to make a determination on whether any restrictions should be in place for these areas. There is no hunting allowed inside the Nahanni NPR, so concerns related to non-Aboriginal harvesting are not an issue for this portion of the road.[107]

7.8.2 Overall Impact on Traditional Economic Activities

There is little baseline information on harvesting in the area surrounding the re-aligned Access Road. This is in part because while it was traditionally an area used for harvesting game animals, fur bearers and fish, it is not used extensively for those purposes today. A primary reason being access by snowmobile to trapping in the area is too difficult and too costly.[108] This is especially the case as one travels further and further west toward the Prairie Creek Mine on the Access Road. Without such data, placing a dollar value on the animals that are harvested is not possible.

This region is a part of the territorial government's *Outfitter's Management Areas*, specifically, Area D/OT/02.[109] The expansion of the Nahanni NPR encompasses over half of this total area and in ten years, outfitters who are active in this management zone will be required to cease operations. Research into the topic has not uncovered any studies that show the impact on wildlife numbers as a result of these actions. Presumably the elimination of the outfitter activities will have a positive impact on the number of big game animals in the region. Again, the future value and success of harvesting in the area will depend on whether access to the seasonal road is granted to the public, and the numbers of hunters who choose to use it.

7.8.3 Access Road Management

With respect to the Access Road and whether it will be open to the public, Canadian Zinc is working with the Nahanni Butte Dene Band on a management system should public access be granted. Different options for monitoring traffic and harvest numbers are being discussed but it is likely that monitoring will be accomplished in a manner similar to that of the Tibbitt-to-Contoyto Ice Road and the Tlicho Ice Road to Wha ti, Gameti and Wekweeti. Users could be asked to report to a controller upon entering and exiting the road—probably at the Swan Point Ice Crossing. A survey of users could be conducted to determine the purpose of travel and if they are hunting, determine the location and success rate.

If the number of vehicles on the road were to increase to a point where public safety was at risk or harvesting pressures on wildlife were too great, a temporary or permanent closure to the public would be considered. Such action would take place in discussions with the Nahanni Butte Dene Band, and if necessary, officials with the Government of the Northwest Territories. These thresholds would also need to be determined through consultation with Nahanni Butte Dene Band, Parks Canada and government officials.

Should the road be closed to the public, a monitor might still be required to enforce the ruling. If necessary, a gate will be erected as a deterrent.

7.8.4 Summary of Impact Assessment on Traditional Land Use and Wildlife Harvesting

Table 7-34 summarises the impacts according to the impact assessment criteria. In their support of the proposed Project, the Nahanni Butte Dene Band has looked at the potential impacts on their harvesting activities in the areas in and around the seasonal Access Road. They are of the opinion that the Access Road has the potential to improve their harvesting activities through improved access and the positive impacts on wildlife related to the small clearing of land. This would suggest the monetary value of their harvesting activities in the area adjacent to the Access Road would improve.

Meanwhile, the expansion of the Nahanni NPR will mean big game outfitting will be phased out of the region. Therefore, it would be reasonable to assume that within the region in close proximity to the Access Road, wildlife living outside the park boundary and those closer to Highway #7 would face increased pressure from hunters compared to those living inside the park and further from the highway.

Table 7-34: Impact Assessment on Public Safety

Impact	Direction	Range	Magnitude	Duration
Traditional harvesting activities	Positive	Local	Low	Long Term
Value of harvest	Positive	Local	Low	Long Term

7.9 Distribution of Impacts between Communities

The Terms of Reference asks "How each identified potential impact may affect individual potentially-affected communities." The answer depends largely on participation levels. The First Nation groups representing Nahanni Butte, Fort Liard and Fort Simpson are in support of the mine's development and are interested in participating.[110] For the purpose of this question, however, we first assume participation will be proportional amongst the Study Area communities.

The baseline conditions of the Study Area described earlier in Chapter 5 reveal the region to be one with many social and economic challenges. The community of Fort Simpson is the best off in both regards, benefiting from its larger population, greater economies of scale, and less isolation. Education levels are better there than in the other communities; housing is better, there are more jobs, and greater economic and social diversity.[111] Meanwhile, Nahanni Butte and Wrigley are smaller communities, are more isolated, its residents are less educated, their economies are less diversified, and there are fewer economic opportunities. Fort Liard is between these extremes. One might conclude from these relative statistics that Fort Simpson will be best prepared for the opportunities and will find adaptation easier than other communities. And by the same token, the community of Nahanni Butte is the least likely to find the socio-economic changes easy to manage. In all cases, however, the Prairie Creek Mine represents a significant change in the socio-economic landscape of each community.

The other consideration is the relative proximity to the mine and the historical presence of the Aboriginal populations to that location. In this regard, residents of Nahanni Butte are the only ones truly affected. Neither the First Nation people from Fort Liard or Fort Simpson consider the Prairie Creek Mine site to be one of any traditional or cultural significance.

Physical contact with mining activities (such as the transportation of goods) will be minimal. Nahanni Butte is accessible via a 24 kilometre winter road that includes a water crossing at the Liard River. Residents who remain in town and are not working at the mine site will never have any physical contact with its activities, except through other residents' involvement. A similar situation exists for residents of Fort Liard who would only come in visual contact with haul trucks if they were to drive out to the highway which is over 4 kilometres from the town centre. And again, this chance of visual contact exists only during the winter months when the mine is hauling out concentrate. Employees of the mine will not enter the communities of Nahanni Butte or Fort Liard, but rather be flown right to site. The community information representative and company officials are exceptions to this.

Despite its isolation, or perhaps because of it, Nahanni Butte will be most influenced by the Prairie Creek Mine. It is a very small community, is relatively close to the mine, is engaged in traditional Aboriginal activities, and does have a historical presence in the general area. This proximity, the strong local support, and the lack of alternatives will likely mean the participation rate of Nahanni Butte residents will be greater than elsewhere in relative terms. This will mean a relatively-greater influx of financial wealth and relatively greater social change.

The mitigation strategy of Canadian Zinc, the suite of programs offered by the federal and territorial government, and the actions of the local population themselves will all contribute to the success of the community in conjunction with the Prairie Creek Mine. It will be important for this community to work to maintain and/or establish community-based, most-often informal networks that help residents cope with and adapt to change. By understanding the changes that will take place, the community can put itself in a position to deal with them.

For its part, Canadian Zinc has and will continue to work with the Study Area communities, paying special attention to Nahanni Butte. It already sponsors community activities, employs local workers, and promotes higher learning. The Company will monitor the progress of these communities closely once the Project is under and will address challenges as they arise.

7.9.1 Summary of the Impact Assessment Relative to Each Study Area Community

Table 7-35 summarises the impacts according to the impact assessment criteria outlined in Chapter 3. The proposed Prairie Creek Mine will have the largest impact on the community of Nahanni Butte, relative to the other Study Area communities. The Nahanni Butte Dene Bands have endorsed the project and are interested in participating. The project is in their backyard, relatively speaking; being approximately 100 kilometres away. The community is very isolated and socio-economic conditions are relatively poor. The Project will most certainly change the social and economic landscape of that community.

For Fort Liard and Fort Simpson, the relative impacts will be slightly lower. While their participation will be greater in absolute terms for employees and businesses, these communities are larger than Nahanni Butte and have other things going on, albeit on a very small scale. Fort Simpson, in particular, is far removed from the Project and the Liidlii Kué First Nation has no historical presence in the area.

Wrigley will be impacted on a smaller scale. It is a small community and might contribute to the overall employment. The Pehdzeh Ki First Nation does operate a development corporation. However, it is not clear whether it in a position to gain much access to the procurement opportunities.

With the repositioning of the Access Road, the families living at Lindberg Landing will not be impacted.

Table 7-35: Impact Assessment Relative to Each Study Area Community

Impact	Direction	Range	Magnitude	Duration
Nahanni Butte	Positive	Local	High	Long Term
Fort Liard	Positive	Local	Moderate	Long Term
Fort Simpson	Positive	Local	Moderate	Long Term
Wrigley	Positive	Local	Low	Long Term
Lindberg Landing	Neutral	Local	Negligible	Long Term

7.10 Sustainable Communities

History shows that in almost all cases, economic growth is necessary for positive social change to occur.[112] But it is not sufficient condition. In order for economic growth to have this positive influence, it must continue over a relatively long time period, it must be relatively stable, the wealth it generates needs to reach all members of society in one form or another, and the distribution of this wealth must be fair.[113] By meeting these conditions, any period of economic growth, regardless of how it is generated can have an influence far beyond a temporary rise in gross domestic product and an equally temporary change in the income levels of a minority of residents.

It is a primary objective of Canadian Zinc to ensure that its Project meets these conditions, that its Project creates real, long-term, positive change and that the region is better off when the Project ends than it was when it starts. This is, in part, what drives the company's planning around mitigation, human resources, Impact and Benefit negotiations, community involvement and local procurement. Canadian Zinc recognises the vulnerabilities of the Study Area communities to outside influences, whether economic, social, environmental or cultural. It also understands that greater resilience to these outside pressures will come slowly and over a period of many years. What the Company can do with its time in the region is ensure that its commitments to the local people and their communities is genuine, that the policies and programs it supports are implemented, and that the impacts from its actions and the actions of others are closely monitored for the purpose of making improvements over time.

While much of the improvements that Canadian Zinc hopes to influence are of a qualitative nature in terms of the improved social, economic and cultural performance, there are some already discussed in this report that are more specific. For example, the impacts on education and life-long learning were introduced earlier. Improvements in educational performance that occur over the life of the Project will be the result of many factors, the first being greater effort on the part of students, their families and communities. The Government of the Northwest Territories will also be important contributors to this change through the provision of educational services. Should broad-based improvements in education be realised, a portion could be attributed to the Project through its provision of jobs, its education and training programs, the positive role models created by mine employees, the improved financial wealth that will come from participation, and the extra-curricular activities and expenditures of Canadian Zinc in the communities.

Similarly, business and community leaders will have an opportunity to grow and learn through their experience with this mining project. For its part, Canadian Zinc is committed to working with the region's leadership to establish strong working relationship and to provide mentorship in the areas it has expertise, such as management, organisational efficiency, and productivity.

As noted earlier in this chapter, there is a concern that some quality of life variables will be negatively influenced by the Project. Areas of particular concern include some aspects of health, safety, family, and community. Canadian Zinc is and will continue to work to mitigate these potential impacts, but it also sees the potential for many positive changes in these areas over the longer term. Greater financial wealth is an important factor in influencing all aspects of one's social welfare including education, health, and safety, all of which provide for improved family and community living.

In addition to the improved social and economic performance of Study Area residents, businesses, leaders and communities, there exists the possibility of a positive infrastructure legacy. Canadian Zinc is discussing the possibilities regarding the future use of the Access Road, the Cat and Granger Camps, and the Prairie Creek Mine site with the Nahanni Butte Dene Band. The Company has planned a full reclamation of its mine site and camp facilities should there be no interest in them in the future.

Whether the Prairie Creek Mine is viewed as the primary catalyst for bringing about positive social and economic change or it is simply a contributing factor along with other environmental changes, the opportunity exists over the 16 years of mine activities to alter the lives and livelihoods of Study Area residents forever. This would make the Prairie Creek Mine a truly sustainable endeavour.

7.11 Net Cost to the Government of the Northwest Territories

The Government of the Northwest Territories is interested in what its financial position will be should the Prairie Creek Mine proceed. This question asks that the developer weigh the net benefits of the project against the net cost to the territorial government. Estimates of the tax revenues were provided earlier in the report, specifically, $39 million in territorial corporate tax, $11.5 million in personal income tax and $19.9 million in indirect taxes. However, the central issue for the territorial government when it comes to revenues generated by resource development is the revenues that it does not receive.

When combined, the claw-back and resource revenues represent a revenue opportunity of $90 million. But the portion that represents the greatest potential for the territorial government is the resource royalties that could amount to $40 million. These revenues are not a part of the Territorial Formula Financing (TFF) Agreement and therefore would not be subject to claw-back should the GNWT negotiate a resource revenue sharing agreement with the federal government. When the territorial government looks at its net cost of a resource project, its inability to capture the royalties is a central issue.

Another issue that relates specifically to the claw-back is the additional costs for such things as road maintenance that occurs as a result of resource development that is not a part of the TFF agreement. The federal government has in place the Gas Tax Fund (GTF) that provides revenues to the Northwest Territories for such things as roads and bridges; the 2009-2010 GTF was to supply the Territory with $15 million.[114] However, this program and others like it are not meant to address the costs associated with resource development specifically.

In the case of costs associated with road maintenance, the proposed Prairie Creek Mine will have a limited impact. The mine plan assumes 14 haul trucks will operate daily during the winter haul season only. Traffic on Highway 7 during the winter months is typically 50 vehicles per day. This is in stark contrast to the resource developments in the North Slave region that have put more than 10,000 trucks on the Territory's highways in a single winter season.

Other cost pressures could come from an increased demand for social services. Canadian Zinc estimates that the communities will go through an initial period of transition as individuals and families become accustomed to participation in the mine activities whether they are direct or indirect. This period of transition will be most evident in Nahanni Butte—a community of 129 people (as of 2007). Fort Liard and Fort Simpson will be impacted, but to a lesser degree than Nahanni Butte. But Canadian Zinc also believes that, like the Tlicho and North Slave communities in their involvement with the diamond mines, this period of transition will lead to a period of improved social conditions in many areas, and ultimately a greater quality of life for Study Area residents as a whole. This would mean that the net cost to government for social services would eventually become a net benefit in the latter years of the project.

Another area to investigate is the demand for services at the community level and possible pressure on community infrastructure. These impacts would occur if the population of the communities were to change. Our analysis on migration presented in section 7.7.1 reveals a low, and possibly negligible, impact on population in the Study Area communities. Without a significant change in population, there should not be a similar change in demand for community services or an increase in use of community infrastructure.

There are some questions related to the issue of net cost to the Government of the Northwest Territories that are more challenging to answer without having a detailed analysis of the cost structure of government programming and services. For instance:

- Are their productivity gaps in the provision of programs and services being offered in the Study Area communities; that is, can the programs withstand additional demand without altering their cost?
- How much additional demand is required to stimulate additional expenditures by the government?
- When viewed over the life of the Project and beyond in those cases where the impact is indefinite, what are the additional costs over time? Or are their net savings?
- How does the net present value of these costs and savings compare to the revenues generated?
- And finally, are there opportunities to share the costs with other revenue collectors (namely the federal government) or access a greater share of the total revenues generated by the Project (specifically, the resource revenues)?

Throughout Chapter 7 each potential issue has been evaluated according to the impact assessment criteria outlined in Chapter 3. These assessments are summarised in Chapter 11. The discussion in section 7.10 on sustainable communities and 10.2 on cumulative impacts on communities describe how the individual changes, which by themselves are not expected to create significant changes from the baseline conditions and thus should not represent a significant change in the demand for government services, when combined will impact communities. Canadian Zinc's mitigation strategy in response to these impacts is presented throughout this chapter and again in Chapter 10. Canadian Zinc is confident that this strategy along with its strong commitment for implementation and close monitoring of results will effectively reduce the number and size of negative impacts, which will effectively reduce the impact on government services.

8 Lindberg Landing

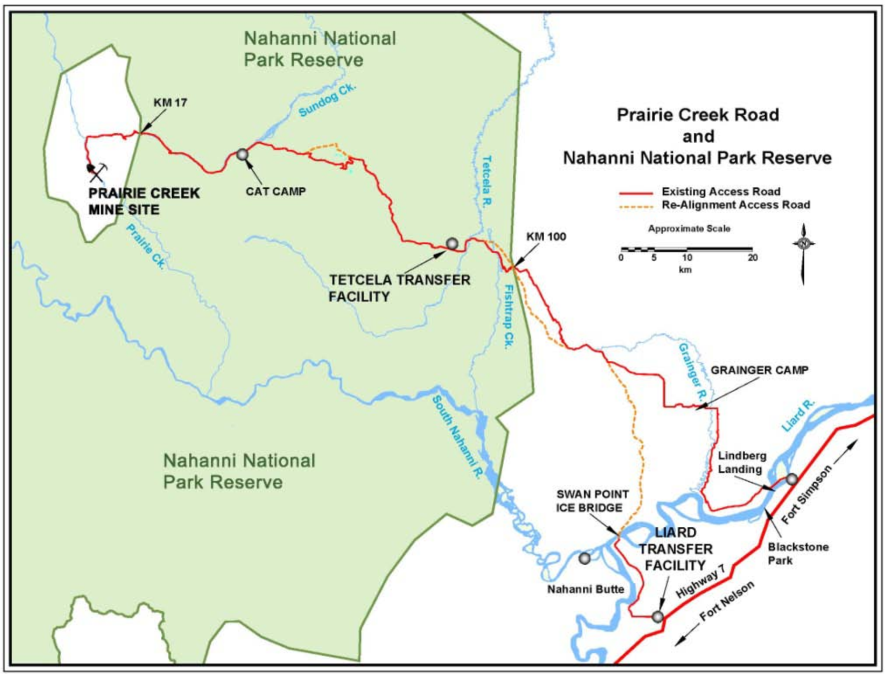
Lindberg Landing is a very small community within the Study Area. Two families live there year-round. It is the site of warehousing for the territorial government's road maintenance equipment. It is also the site of a bed and breakfast that operates on a seasonal basis out of Fort Simpson. Much of its business comes from tourists visiting the Nahanni NPR.

There are not enough people living in Lindberg Landing to justify its inclusion in statistical surveys. Information relevant to the SEIA was provided by its residents during the Environment Assessment (EA) scoping session in Nahanni Butte (September 30, 2008). The Prairie Creek Mine's potential social impacts for these residents were conveyed verbally to Canadian Zinc and by written submission to the EA's Public Registry (October 16, 2008).

The residents' principal concerns were

- the proposed location of the access road being less than 500 metres from their community,
- the proposed location of the Liard Transfer Facility 2 kilometres away,
- downstream water quality, and
- safety concerns related to nearby transportation activity.

Canadian Zinc has since changed the location of the highway access road to be 27 kilometres south of the originally permitted site (see Map below). This change of location was also requested by the Nahanni Butte Dene Band for economic benefits, monitoring access, and future improved access to their traditional lands. The changed location of the Liard Highway access should mitigate the concerns for the Lindberg Landing residents.



9 Monitoring and Management Plans

Canadian Zinc has long been engaged with the Study Area communities and has built solid relationships with the different levels of government in Nahanni Butte, Fort Liard and Fort Simpson.[115] It is now in negotiations with these communities to establish Impact and Benefit Agreements that will become a principal component of the company's mitigation strategy.

In addition to formalising the company's hiring and contracting practices, Canadian Zinc aims to establish a formal process for communications and reporting within its IBAs. These reports would be generated annually for the Study Area communities. The goal is to ensure each community understands the Project's current and future activities, its labour needs, and upcoming procurement opportunities. Canadian Zinc also hopes to include detailed feedback on the mine employment such as new hires, terminations, length of employment, training, promotions, and overall and relative payroll. It will also report on its contracts to local businesses and their total value. Traffic reports will be a regular component of these reports. It will be a matter of the IBA negotiations to determine which portions, if any, are to be withheld from the public. Otherwise, these reports will form the basis of the company's responsibilities to report to the regulators and government authorities.

Canadian Zinc is also interested in developing a system whereby the hiring practices of contractors can also be reported. This will be subject to their agreement.

Canadian Zinc views its reporting requirement as one centred on the economic activities flowing from its expenditures on labour and capital, and its management of the Access Road and mine site. It is not in the best position to produce data in macro-economic areas or in social areas. The NWT Bureau of Statistics has this mandate and produces reports that are more than adequate in helping the company and communities understand social trends. Coupled with the Canadian Census administered by Statistics Canada, which will take place in 2011, 2016 and 2021, the two statistical agencies cover most if not all relevant variables.

Canadian Zinc currently employs a community information representative. This position will continue to exist should the Project move forward. This employee will have a very important role within the company, assisting community members interact with company officials on a wide range of matters. This employee will also be able to comment on the statistical evidence produced by the NWT Bureau of Statistics and Statistics Canada.

There is a possibility that a second community information representative position will be needed. A decision on this second position has not been made and is subject to the IBA negotiations and the economic viability of the position.

The Terms of Reference asks for a description on monitoring and management plans related to wildlife harvesting and practice of traditional culture on the land. Canadian Zinc will meet this requirement, in part, by close management of the Access Road. This access is a subject of current negotiations. Should access be open, Canadian Zinc will monitor public traffic on the road. More extensive wildlife harvesting results and participation in traditional activities will require the cooperation of the First Nation groups themselves. For example, a community survey could be conducted by the community information representative, but the quality of its results would be dependent on the cooperation of the First Nation people themselves.

It is Canadian Zinc's intention to maintain its relationships with the Study Area communities throughout the life of the project. This means that management and other key personnel will continue to work closely with the communities as the Project unfolds. The proponent understands that these communities have vulnerabilities which have been described in detail in this report. They recognise that issues will arise that cannot be planned for ahead of time. Through its strong and continued relationships at the community level, its community information representative, and a real willingness to ensure the Study Area residents benefit from the Project, Canadian Zinc believes a solution can always be found. A summary of Canadian Zinc's proposed monitoring and management systems is presented in Table 9-1 below.

Table 9-1: Monitoring and Management System

Impact and Benefit Agreement Reporting	Detailed reporting to communities with Impact and Benefit Agreements. The contents of these reports are subject to ongoing negotiations.
Employment Reporting	Annual reporting on total workforce, new hires, terminations, length of employment, labour income
Procurement Reporting	Annual reporting on total expenditures for goods and services, list of goods and services required, upcoming requirements, total spending on First Nation businesses and NWT businesses
Communication Strategy	Working with the communities through the IBA negotiations, establish a communication strategy with each community
Annual Socio-Economic Report	Detailed report on mining activities, and the economic, social, cultural and socio-economic performance on the Study Area

10 Potential Cumulative Effects

At the present time, there are no large-scale economic activities taking place in the Study Area communities. Operations at the Cantung Mine and natural gas production near Fort Liard have ceased. The Nahanni National Park Reserve expansion will impart only a minor short-term economic impact on the region, with the most significant impact likely occurring in the short-term and before operations at the Prairie Creek Mine are underway.

In the Dehcho region as a whole, the Dehcho Bridge is being built outside Fort Providence and will likely be completed by 2012, barring any further delays. The timing of that project matches well with the labour demands from Prairie Creek Mine in that experienced labour from the bridge project will potentially have the opportunity to transition to the mine once that project is finished.

This leaves little to consider with respect to the cumulative effects of additional projects in the area. It nevertheless remains an important consideration for the Project proponent. Canadian Zinc has designed a mitigation strategy that will ensure the local population benefits from the construction and operation of the Prairie Creek Mine while mitigating to the extent possible any negative impacts. The proponent believes the region's people, businesses and society as a whole will be far better off having participated in the project than it would be under the status quo.

10.1 Perspectives on the Mackenzie Gas Project

Some hope remains for the possibilities associated with the proposed Mackenzie Gas Project, though prices are not currently in its favour. If and when it moves ahead, the labour and business demand for its construction phase will exceed the capacity of the entire territory, and will represent a major shock to the economic and social landscape of every region along the Mackenzie Valley.

From the perspective of Canadian Zinc, the best action it can take to mitigate the impacts of this enormous shock, should it occur, is to offer Study Area residents a stable, relatively-permanent alternative to the four-year, seasonal economic flurry from the pipeline. Canadian Zinc is confident that it will maintain its local workforce in this situation because of its offer of steady employment year round and the fact that camp life at the Prairie Creek Mine will be much more family-like (everyone will know everyone) than that of the seasonal, temporary camps established for the pipeline construction.

The Prairie Creek Mine will ultimately benefit from the Mackenzie Gas Project because it will bring an increased number of NWT residents into the workforce and provide them training. This newly-trained workforce will be eager to find work once the pipeline is built and the presence of the Prairie Creek Mine might help keep some of these recently-trained workers in the region.

For the communities, the early lessons learned in coping with and adapting to the relatively small Prairie Creek Project will be good training for those times when the pipeline construction is taking place. As much as the construction crews will be stationed at their camps and contact with residents is to be minimal, there can be no doubt that the small and isolated communities in the Dehcho region will be easily overwhelmed by the volume of economic activity the pipeline construction will bring. The best way for a community to plan for this event is to have some experience in dealing with something similar but in a much smaller, more manageable format such as the one offered by the Prairie Creek Mine.

10.2 Cumulative Impacts for Communities

This experience in managing economic growth gets at the greatest potential socio-economic impact and benefit the proposed Project will have on the Study Area communities. Through its local expenditures on labour, goods and services, the Prairie Creek Mine will alter the economic and social landscape of the region, albeit on a much smaller scale than would be the case with the pipeline. The profound and long term changes to the economy will bring a new perspective to the region in terms of its economic and financial potential. The social changes will also be profound. As shown throughout this SEIA, the Project is not likely to have a high or even moderately negative impact on most of the social and cultural areas that are of concern to the local population. There will be a period of transition to be sure, but the small size and scope of this project, the gradual increase in local participation, and the longevity of the Project will all contribute to a manageable Project from the perspective of the Study Area communities and their vulnerabilities in these individual social and cultural areas.

But the culmination of

- the entrance into the modern economy for some,
- the rise in individual wealth for many,
- the new economic, social and political freedoms for most, and
- the pressure on everyone to maintain cultural identity

will highlight existing vulnerabilities within the individual communities. The local population's ability to manage, cope and adapt to the changes and ultimately take full advantage of them should be the single greatest concern for the region. And of course, in doing so, the possibilities for positive outcomes from this Project are tremendous.

This change in their socio-economic and cultural baseline is less a function of the specific actions of Canadian Zinc and its Prairie Creek Mine, and more a function of the current vulnerabilities of a population that has not fully integrated into the wage economy due in large part to the lack of opportunity to date.

Dealing with this transition will be the responsibility of all stakeholders, starting with the individual residents, their families, communities, and community leaders. People are ultimately responsible for their own actions. To help people make good decisions are a wealth of government and non-government organisations and agencies and their respective social and economic programs. The Government of the Northwest Territories, Indian and Northern Affairs Canada and the Northern

Canadian Economic Development Agency (CanNor) offer a vast suite of programs that are more than adequate in their support of a population in transition.

Critical to these programs though is their implementation. Governments including Aboriginal governments and non-government agencies at the local level will have to assist in this implementation. Communities do not necessarily have the capacity to manage and implement a whole host of programs on their own and will need help in this area.

For its part, Canadian Zinc is already working in the Study Area communities. Industry is not the best delivery agent of public and community-based programming, but it can assist in areas where it has particular expertise. Industry is well equipped to make decisions, take action, and work efficiently toward a goal. It can provide communities and their leadership with examples of best practices in planning and management. Through its community sponsorships, education and training dollars, cooperation with local businesses, and strong community relations, Canadian Zinc will be a valuable contributor to communities' transition.

11 Proposed Mitigation Strategy

Canadian Zinc wants the Study Area communities to benefit from the economic and financial opportunities that its Project will generate. It understands that this participation will bring about changes to the socio-economic landscape of the region. But this will not deter efforts to increase participation over the life of the Project. Through a strong and flexible mitigation strategy, the proceeds generated from the Project's economic activities will leave Study Area residents with a higher and more sustainable quality of life.

The primary delivery mechanisms for this mitigation strategy are the Impact and Benefit Agreements and the Human Resource Management Plan.

11.1 Impact and Benefit Agreements

Canadian Zinc will enter into Impact and Benefit Agreements with the Study Area communities. These private agreements will outline the company's hiring and procurement practices, its reporting requirements, and much of its mitigation strategy that deals with adverse impacts as a result of the Project and of local participation. While the agreements themselves are confidential documents between the Project proponent and the community, much of the relevant details have appeared, in a general form, in this SEIA and/or in the human resources management plan included as an appendix to the DAR.

The IBAs will be the primary instrument for:

- Establishing the expected benefits
- Mitigating the social impacts
- Enhancing Canadian Zinc's involvement in the communities
- Mandating the means of implementation
- Setting up the method of dispute resolution

Canadian Zinc has been involved with the affected communities since 1994. The IBA process solidifies the ability for local community participation in the training, employment, and business partnerships associated with the development.

11.2 Human Resources Management Plan

The Human Resources Management Plan explains what workers can expect from their employment with Canadian Zinc at the Prairie Creek Mine. The Plan describes in detail the following:

- employment and training strategies;
- compensation and work schedule;
- benefits program;
- health and safety programs;
- hiring practices;
- emergency and disaster control;
- drug, alcohol and smoking policies;

- sexual and gender harassment policies;
- equal employment opportunities;
- labour relations; and,
- employee communications.

11.3 Additional Mitigation Details

Chapter 7 of this SEIA describes the impacts of the Project on the human environment within the Study Area. Each subsection describes the mitigation being proposed should it be necessary. These are summarised in Table 11-1 starting with economic impacts. In addition, each subsection concludes with a summary of the impact assessment in terms of the impact's direction, range, magnitude and duration. These are summarised in Table 11-2 on the following page.

Table 11-1: Summary of Proposed Mitigation

Economic performance from construction	Employment and income will be enhanced through local hiring and procurement
Economic performance from operations	Employment and income will be enhanced through local hiring and procurement
Impact Assessment of Local Participation during construction	Employment and income will be enhanced through local hiring and procurement, to facilitate, Canadian Zinc will pass the names of past employees onto contractors, notify Study Area communities of construction timelines, provide the names and contact information of contractors, set out a schedule of when the contractors will be hiring, and pass along applications from local labourers to contractors.
Impact Assessment of Local Participation during Operations	Employment and income will be enhanced through local hiring and procurement; Canadian Zinc believes that local employment could rise to 70 over the long run however this is dependent on improved education and mobility and is a shared responsibility between individuals, communities, governments, and Canadian Zinc. To facilitate this level of employment, Canadian Zinc will promote higher learning through a scholarship program, sponsor training in conjunction with the mine training society, take an active role in the schools and communities, and sponsor visits by school staff to site to help them understand better the environment and the possibilities for their students. Through its IBA negotiations, the Company is also working to develop a communication strategy in the communities that will include visits, promotions, sponsorships, attendance at events. Furthermore, in addition to the specific actions taking during the construction phase as it relates to contractors, Canadian Zinc will discuss the importance of local hires with Aboriginal development corporations during and after IBA negations and make northern employment a criterion for evaluating proposals.
Impact Assessment for Government Revenues from Direct Taxation and Resource Royalties	Greater participation will translate into higher tax revenues; the greatest gains to the territorial government would come from the resource royalties, however, these funds currently flow to the federal government
Impact Assessment from Induced Impacts	A stronger local economy through increased economic activity would result in greater induced impacts. No mitigation required.
Impact Assessment on Migration	Negligible impacts. No mitigation required
Impact Assessment for Education and Life-Long Learning	Canadian Zinc will offer employees an extensive array of training courses, including skills training in their area of

	employment and in safety. Canadian Zinc has a scholarship program that will continue should the Project go ahead. Students are encouraged to stay in school in order to meet the employment requirements. Local businesses will improve their knowledge through the operation and management of joint ventures and other business opportunities. Individuals, families, communities and governments have equally important roles in enhancing education and life-long learning that the Project will promote.
Impact Assessment on Families	Canadian Zinc will undertake a "hire first" program, offer a comprehensive benefits package to employees, make the Prairie Creek Mine site hospitable through numerous activities, programs and services, employ a community information representative to help with communications between employees and mine management, and to remain active participants in Study Area community events.
Impact Assessment on Health	Canadian Zinc will work with communities and its leaders to develop and implement strategies to limit negative health outcomes such as increased drug and alcohol consumption. The implementation of any strategy will mean access to government health and education programs. Canadian Zinc acknowledges that it will need the expertise of education, health, and social service workers and public programs in these areas to assist in mitigating any negative outcomes. It also requires the support of the individuals involved, their families, and their communities.
Impact Assessment on Communities	Income disparity and labour shortages will arise as a result of the labour demands of the Project. Canadian Zinc will continue to be active in the Study Area communities through sponsorship programs that will improve community life and that for those not benefiting from the Project directly. The greatest community impacts will be the cumulative impacts. But not cumulative in the sense of the impact of many projects, but rather, the impact of many changes within the community culminating in a altered social and economic landscape. Canadian Zinc's proposed mitigation is in its commitments to bring economic growth to the region that is significant and long-lasting, that produces wealth that the local population can access in a fair and equitable fashion. The Company is committed to hiring locally, working with communities in the management of their economic growth, implement rules and policies to ensure fairness, and to monitor closely the progress of communities for the purpose of making changes to its community programs should they be needed.
Impact Assessment on Public Safety	The long term impact on crime rates is positive and requires no mitigation beyond Canadian Zinc's community commitments. Safety on the highway between the Access Road and the territorial border should not be compromised. Haul trucks will operate during the winter months when the roads are virtually empty of other traffic. They will be well maintained, and drivers must be fully certified and obey all rules associated with the operation of their vehicle. Safety on the Access Road will be maintained through controlled access of public vehicles. Safety associated with the airstrip at the mine site will be maintained through numerous safety provisions and strict adherence to safety regulations.
Impact Assessment on Wilderness Value	Negligible impact. Mo mitigation required
Impact Assessment on Traditional Activities	Public use of the Access Road is to be determined. Either way, Canadian Zinc will monitor and report on road usage. Should hunting pressure escalate as a result of this new

	access, Canadian Zinc would discuss closing the road to the public with the Nahanni Butte First Nations.
Impact Assessment Relative to Each Study Area Community	Impact and Benefit Agreements will be negotiated with each Study Area community. The largest relative impact will be felt by Nahanni Butte residents. Canadian Zinc has made this community its primary focus in its communication strategy, impact and benefit agreement negotiations, and will continue this focus should the mine be approved.

Table 11-2: Summary of Impact Assessments

Impact	**Direction**	**Range**	**Magnitude**	**Duration**
Impact Assessment of Economic Performance from Construction				
GDP	Positive	Territorial	Low	Short Term
Employment	Positive	Regional	Moderate	Short Term
Labour Income	Positive	Regional	Moderate	Short Term
Indirect Taxes	Positive	Territorial	Low	Short Term
Impact Assessment of Economic Performance from Operations				
GDP	Positive	Territorial	High	Long Term
Employment	Positive	Regional	High	Long Term
Employment	Positive	Territorial	Moderate	Long Term
Labour Income	Positive	Regional	High	Long Term
Labour Income	Positive	Territorial	Moderate	Long Term
Indirect Taxes	Positive	Territorial	Moderate	Long-Term
Impact Assessment of Local Participation during Construction				
Employment	Positive	Local	Moderate	Short Term
Business Activity	Positive	Local	Moderate	Short Term
Impact Assessment of Local Participation during Operations				
Employment	Positive	Local	High	Long Term
Employment	Positive	Territorial	Low to Moderate	Long Term
Business Activity	Positive	Local	High	Long Term
Business Activity	Positive	Territorial	Low to Moderate	Long-Term
Impact Assessment for Government Revenues from Direct Taxation and Resource Royalties				
Federal Revenues	Positive	Territorial	Low	Long Term
Territorial Revenues	Positive	Territorial	Low to Moderate	Long Term
Impact Assessment from Induced Impacts				
Induced GDP	Positive	Territorial	Low	Long Term
Induced Employment	Positive	Territorial	Low	Long Term
Induced Business Activity	Positive	Territorial	Low	Long Term
Impact Assessment on Migration				
Out Migration of Residents from Study Area	Positive (less out migration)	Local	Low	Long Term
Out Migration of Residents from Rest of NWT	Positive (less out migration)	Territorial	Negligible	Long Term
In Migration to the NWT	Positive (more in migration)	Territorial	Negligible	Long Term
Net Migration	Positive	Territorial	Low to Negligible	Long Term

Impact Assessment for Education and Life-Long Learning				
Education	Positive	Local	Low	Indefinite
Skills and Training	Positive	Local	High	Indefinite
Job Experience	Positive	Local	High	Indefinite
Impact Assessment for Families				
Family Stress and Raising Children	Negative	Local	Moderate	Long Term
Financial Freedom and Standard of Living	Positive	Local	High	Long Term
Impact Assessment for Health				
Addictions	Negative	Local	Low to Moderate	Medium to Long Term
STI Rates	Negative	Local	Low to Moderate	Medium to Long Term
Impact Assessment for Communities				
Income Disparity	Negative	Local	High	Long Term
Labour Shortages	Negative	Local	Moderate to High	Long Term
Impact Assessment on Public Safety				
Crime	Negative	Local	Low	Short Term
Crime	Positive	Local	Low	Long Term
Highway Traffic	Negative	Local	Negligible	Long Term
Airstrip	Negative	Local	Negligible	Long Term
Impact Assessment on Wilderness Value				
Wilderness Value	Neutral	Local	Negligible	Long Term
Impact Assessment on Traditional Activities				
Traditional harvesting activities	Positive	Local	Low	Long Term
Value of harvest	Positive	Local	Low	Long Term
Impact Assessment Relative to Each Study Area Community				
Nahanni Butte	Positive	Local	High	Long Term
Fort Liard	Positive	Local	Moderate	Long Term
Fort Simpson	Positive	Local	Moderate	Long Term
Wrigley	Positive	Local	Low	Long Term
Lindberg Landing	Neutral	Local	Negligible	Long Term

12 SEIA Summary

The Prairie Creek Mine is a relatively small Project that is proposed for a region of the Northwest Territories that has no other confirmed economic prospects. The social conditions are bleak in comparison to what an average Canadian might experience. Low education, poor health, inadequate housing and high crime are all well-known socio-economic realities in the Study Area communities. A survey conducted in Nahanni Butte found residents share these concerns, and are particularly concerned about the future for their children.

Including construction and operations, the Project will span 16 years, employing approximately 220 people on an annual basis. Canadian Zinc will enter into Impact and Benefit Agreements with the affected communities in an effort to maximize their participation in the employment and procurement opportunities. Over time and with the right combination of improved education and skills, local employment could grow to 70 people. Direct, indirect and induced impacts will further expand the economic impact.

This project will have some negative repercussions for some participants and for some unable or unwilling to participate. Similar to what occurred in communities affected by the rise of the diamond industry, there will be a period of adjustment as people and communities integrate into the wage economy. These negative impacts will be mitigated in part through what will likely be a gradual increase in local participation, the commitment from the proponent to implement effective human resource management and socio-economic management plans, and the cooperation of communities and governments in providing the right network of support, including effective implementation of existing public programs.

The rise in financial wealth and all that it affords directly and indirectly will more than offset this initial adjustment period. For those living in the Study Area, the Prairie Creek Mine offers an opportunity for a generation of employment, leaving behind a population that is better educated, better trained and better able to cope with, adapt to and capture new opportunities in the future.

[1] Lindberg Landing is not a registered town, village or hamlet of the NWT.
[2] The Mackenzie Valley Environmental Impact Review Board, *Terms of Reference for the Environmental Assessment of the Prairie Creek Mine EA0809-002*. Available at (http://www.mveirb.nt.ca/upload/project_document/1246056009 _Final_terms_of_reference_for_the_Prairie_Creek_Mine_EA.PDF).
[3] The Project Description has been adapted from "The Prairie Creek Mine Project Description Report" produced by Canadian Zinc Corporation for submission to the Mackenzie Valley Land and Water Board in May, 2008.
[4] Canadian Zinc Corporation, "Prairie Creek Mine Project Description Report."
[5] The NWT Demographic Satellite Model was developed by Impact Economics.
[6] The NWT Economic Impact Model was developed by Impact Economics.
[7] "A Guide to Using the Input-Output Model of Statistics Canada," Eric Poole (Statistics Canada, Input-Output Division) September 1999.
[8] The financial accounting model was developed by the Government of the Northwest Territories Minerals, Oil and Gas Division within the Department of Industry, Tourism and Investment.
[9] NWT Bureau of Statistics, *Fort Liard – Statistical Profile (2008)*. Available at www.stats.gov.nt.ca.
[10] Statistics Canada. 2007. 2006 Community Profiles. 2006 Census. Statistics Canada Catalogue no. 92-591-XWE. Ottawa. Released March 13 2007. http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E
[11] Statistics Canada. 2007. 2006 Community Profiles. 2006 Census.
[12] NWT Bureau of Statistics. Fort Liard Stat Profile. 2004 Community Survey.
[13] NWT Bureau of Statistics. Fort Liard Stat Profile.
[14] Ibid.
[15] Ibid.
[16] Figures are skewed due to rounding. NWT Bureau of Statistics, *Nahanni Butte – Statistical Profile*.
[17] Statistics Canada. 2007. 2006 Community Profiles. 2006 Census.
[18] NWT Bureau of Statistics. Nahanni Butte Stat Profile. 2004 Community Survey.
[19] NWT Bureau of Statistics. Nahanni Butte Stat Profile.
[20] Ibid.
[21] Ibid.
[22] NWT Bureau of Statistics, *Fort Simpson – Statistical Profile*.
[23] Statistics Canada. 2007. 2006 Community Profiles. 2006 Census.
[24] Statistics Canada. 2007. 2006 Community Profiles. 2006 Census.
[25] NWT Bureau of Statistics. Fort Simpson Stat Profile. 2004 Community Survey.
[26] NWT Bureau of Statistics. Fort Simpson Stat Profile.
[27] Ibid.
[28] Ibid.
[29] NWT Bureau of Statistics, *Wrigley – Statistical Profile*.
[30] Statistics Canada. 2007. 2006 Community Profiles. 2006 Census.
[31] NWT Bureau of Statistics. Wrigley Stat Profile. 2004 Community Survey.
[32] NWT Bureau of Statistics. Wrigley Stat Profile.
[33] Ibid.
[34] Ibid.
[35] Acho Dene Koe First Nation letter of support for the Prairie Creek Mine, sent to the MVLWB August 8, 2008
Nahanni Butte First Nation letter of support for the Prairie Creek Mine, sent to the MVLWB December 12, 2008
Liidlii Kué First Nation letter of support for the Prairie Creek Mine, sent to the MVLWB January 9, 2009

[36] "Report for the Royal Commission on Aboriginal Peoples," Volume Two: Restructuring the Relationship, Part Two—Chapter Five: Economic Development, Section 2.1 Levers of Change—Transforming Aboriginal Economies: An Overview (Ottawa: 1996).

[37] While all the communities are accessible by road, they are a long distance from the nearest large financial centre. Ft. Simpsons is over 500 kilometres from Yellowknife, while Ft. Liard is 200 kilometres away from Ft. Nelson on a gravel road.

[38] Core need is defined in the section dealing specifically with housing.

[39] Statistics Canada, Aboriginal Population Profile, 2006 Canadian Census. http://www12.statcan.gc.ca/census-recensement/2006/dp-pd/prof/92-594/search-recherche/lst/page.cfm?Lang=E&GeoCode=61 access September 24, 2009.

[40] Human Resources and Skills Development Canada and Statistics Canada, "Building on our Competencies: Canadian Results of the International Adult Literacy and Skills Survey." Catalogue no. 89-617-XIE.

[41] The World Health Organisation, as quoted in "A Healthy, Productive Canada: A Determinant of Health Approach." The Standing Senate Committee on Social Affairs, Science and Technology: Final Report of Senate Subcommittee on Population Health. The Honourable Wilbert Joseph Keon, Chair, The Honourable Lucie Pépin, Deputy Chair. June 2009 (http://www.parl.gc.ca/40/2/parlbus/commbus/senate/com-e/popu-e/rep-e/rephealthjun09-e.pdf) accessed September 10, 2009.

[42] "A Healthy, Productive Canada: A Determinant of Health Approach." The Honourable Wilbert Joseph Keon, Chair, The Honourable Lucie Pépin, Deputy Chair.

[43] Ibid.

[44] The data presented for Nahanni Butte suggests sampling error due to the large swing from one observation to the next.

[45] NWT Bureau of Statistics. Community Profiles. http://www.stats.gov.nt.ca/Profile/*. Additional definitions regarding "core need" can be found in Appendix B of the survey document published by the NWT Bureau of Statistics in 2000. http://www.stats.gov.nt.ca/Statinfo/Generalstats/Housing%20Needs%20Survey/Housing%20Report.pdf

[46] Standard of living refers to the state of financial wealth and material well-being. This is different from more holistic references such as "quality of life" which includes all aspects of one's financial, social and environmental situation.

[47] Bruce MacLaurin, Nico Trocmé, Barbara Fallon, Lisa Pitman, Megan McCormack *Northwest Territories incidence study of reported child abuse and neglect, NWTIS-2003: Major Findings*. Calgary: University of Calgary, 2005.

[48] Ibid. Page 22.

[49] NWT Literary Council, *Multiple Literacies: Improving Our Support for Aboriginal Literacy in the NWT*. March, 2002. Available at http://www.nwt.literacy.ca/resources/aborig/mulit/Mulit.pdf accessed January 8, 2010.

[50] Government of the Northwest Territories, *Community and Diamonds, 2008*. May, 2009. Available at http://www.iti.gov.nt.ca/publications/2009/miningoilgas/Main_May_27_09.pdf.

[51] Ibid.

[52] The Traditional Knowledge Report and Archaeology Report contain further details. Some of the information in those reports is confidential however.

[53] John O'Brien, K. Mak, Meyers, Penny, Norris Ltd. *Economic Parameters for Estimating the Delivered Wood Cost in the Deh Cho Planning Area,* May, 2005. Deh Cho Land Use Planning Committtee, http://www.dehcholands.org/docs/reports/ Contractor%20Reports/Timber%20Potential%20Final%20Report%20(3)/Economic%20Parameters%20for%20Delivered%20Wood%20Cost.pdf accessed October 9, 2009.

[54] 2006 Canadian Census, Statistics Canada. (ww.statcan.gc.ca)

[55] Northern Oil and Gas Annual Report, 2007, Indian and Northern Affairs Canada. Available at (http://www.ainc-inac.gc.ca/nth/og/pubs/ann/ann2007/) accessed October 1,

[56] North American Tungsten Corporation website (www.northamericantungsten.com) accessed October 5, 2009.

[57] Natural Resources Canada, Mineral Production Report (http://mmsd.mms.nrcan.gc.ca/stat-stat/prod-prod/2008p-eng.aspx) accessed October 9, 2009.

[58] Chuck Tobin, *Mine's shutdown will have 'a big impact,' mayor says*, Whitehorse Star, June 29, 2009. (http://whitehorsestar.com/archive/story/mines-shutdown-will-have-a-big-impact-mayor-says) accessed September 25, 2009.
[59] Stornaway Diamonds Corporation, website (http://www.stornowaydiamonds.com/grassroots/southern_nwt/) accessed October 23, 2009.
[60] Technical Briefing Presentation, July 29, 2009. http://www.dot.gov.nt.ca/_live/documents/documentManagerUpload/Deh%20Cho%20Bridge%20Technical%20Update%20072809.pdf accessed November 16, 2009.
[61] Nichols Applied Management, "Aboriginal Benefits of the Deh Cho Bridge Project" submitted to the Department of Indian and Northern Affair and the Combined Council Alliance of Fort Providence, February 2003. Link available at www.dot.gov.nt.ca accessed November 17, 2009.
[62] The socio-economic research was completed by Peter Whiting, The Outspan Group Inc. for Parks Canada. (http://www. pc.gc.ca/pn-np/nt/nahanni/images/eco_e.pdf) accessed October 20, 2009.
[63] Government of the Northwest Territories, Department of Industry, Tourism and Investment. (http://www.iti.gov.nt.ca/publications/2008/tourismparks/LTORegion.pdf) accessed October 22. 2009.
[64] NWT Tourism, The Deh Cho Travel Connection, Tourism Brochure. Available at (http://www.dehchotravel.com) accessed October 22, 2009.
[65] Government of the Northwest Territories, Department of Finance, *Main Estimates 2009-2010*. Available at (http://www.fin.gov.nt.ca/documents/budgetdocuments/mains/2009-10mains.pdf) accessed October 12, 2009.
[66] 2006 NWT Business/Service Directory, (http://www.investnwt.com/businessresources/2006BusinessListingSept15_2006%20-%20FINAL.pdf).
[67] Acho Dene Koe First Nation and Fort Liard sources. http://achocampsandcatering.nt.ca/, www.fortliard.com accessed October 28, 2009.
[68] http://www.ic.gc.ca/app/ccc/srch/nvgt.do?lang=eng&prtl=1&sbPrtl=&estblmntNo=234567037277&profile=cmpltPrfl&profileId=501&app=sold accessed November 16, 2009.
[69] Mackenzie Gas Project, http://www.mackenziegasproject.com/theProject/index.html accessed November 18, 2009.
[70] Mackenzie Gas Project, http://www.mackenziegasproject.com/constructionOperations/index.html accessed November 18, 2009.
[71] Aboriginal Pipeline Group, http://www.mvapg.com/page/page/1929193.htm accessed November 18, 2009.
[72] Mackenzie Gas Project, http://www.mackenziegasproject.com/businessOpportunties/index.html accessed November 18, 2009.
[73] Joint Review Panel for the Mackenzie Gas Project, available at http://www.ngps.nt.ca/report.html accessed December 31, 2009.
[74] North American Tungsten Corporation, http://www.northamericantungsten.com/s/Cantung.asp) accessed October 30, 2009.
[75] North American Tungsten Corporation, (http://www.northamericantungsten.com/s/NewsReleases.asp?ReportID=368430&_Type=&_Title=Mactung-Project-Yukon-Environmental-And-Socio-Economic-Proposal-Accepted) accessed October 30, 2009.
[76] Selwyn Resources website http://www.selwynresources.com/selwyn_howards_pass.cfm and www.sedar.com
[77] Selwyn Resources, http://www.selwynresources.com/selwyn_economics.cfm.
[78] Northern Oil and Gas Annual Report, 2007, Indian and Northern Affairs Canada.
[79] Meyers, Penny, Norris Ltd. *Economic Parameters for Estimating the Delivered Wood Cost in the Deh Cho Planning Area*.
[80] Ibid. Page 2.
[81] Ibid. Page 7 and Appendix B.
[82] Peter Whiting, The Outspan Group Inc.
[83] These results were calculated using the information presented in the report from The Outspan Group.

[84] The Ekati and Diavik Diamond Mines were both permitted prior to the Tlicho Agreement being finalised.

[85] As shown earlier, the population in the Study Area communities equals 2,154. NWT Bureau of Statistics, Population Estimates, 2007.

[86] One can find the actual agreements and the diamond mines' monitoring reports on the GNWT's Department of Industry, Tourism and Investment website and the websites for the Ekati, Diavik and Snap Lake diamond mines.

[87] Government of the Northwest Territories, *Communities and Diamonds, 2006*. Available at (http://www.iti.gov.nt.ca/publications/2007/Diamonds/August%2007%20Com%20and%20Dia%20complete%20web.pdf) accessed October 28, 2009.

[88] Impact Economics, *NWT Diamonds Report, 2008*, for the NWT-Nunavut Chamber of Mines (http://www.miningnorth.com/) accessed October 26, 2009.

[89] The socio-economic agreements are available of the GNWT's website (http://www.iti.gov.nt.ca/miningoilgas/socioeconomicagreements.shtml). The SEIA of diamond mine owners are available from the Mackenzie Valley Environmental Impact Review Board.

[90] Government of the Northwest Territories, *Communities and Diamonds, 2006*.

[91] Gross production measures the value of all economic activities involved in producing a good or service. It counts the cost of production and the value added at each stage of production. Therefore, the gross production value will always exceed that of gross domestic product (GDP), since the latter reports only the value-added component of each step in the production process.

[92] The Snap Lake Mine in the NWT and the Meadowbank Project in Nunavut are examples where actual employment requirements were higher than was predicted.

[93] Statistics Canada, "Guide to the Income and Expenditure Accounts" Catalogue No. 13-017-X, June 2008. Available at www.statcan.ca/publications.

[94] Gross production measures the value of all economic activities involved in producing a good or service. It counts the cost of production and the value added at each stage of production. Therefore, the gross production value will always exceed that of gross domestic product (GDP), since the latter reports only the value-added component of each step in the production process.

[95] The mine's direct contribution to GDP is its value-added, which equals the sum of labour income paid to employees and its 'other operating surplus'. There are no 'indirect' impacts related to labour income or other operating surplus. Other operating surplus is the mine's return on capital. It is used to repay the capital invested in the project, pay all taxes and royalties with the remainder being profits to the owner which is the company's shareholders. Other operating surplus is therefore the sum of indirect taxes paid less subsidies received, the cost of capital depreciation and profits. Direct corporate taxes are not a part of these calculations.

[96] These figures include those from the Study Area communities.

[97] Ekati Diamond Mine and Snap Lake Diamond Mine annual socio-economic reports. See http://www.debeerscanada.com/files_2/documents/2008-Snap-Lake-Socio-economic-Annual-Report.pdf and http://www.bhpbilliton.com/bbContentRepository/docs/2007EkatiAnnualReportOnNorthernEmploymentAndSpending.pdf.

[98] Camp catering and transportation jobs are two examples where the willingness to work a rotation is required. Therefore, removing the rotation variable will add a positive bias to these results.

[99] Direct income tax revenues for provincial governments were not calculated for this report.

[100] Canadian Zinc Corporation, Deh Cho Drum, Thursday, February 18, 2010.

[101] National Population Health Survey and Canadian Community Health Survey, accessed in NWT Bureau of Statistics, *StatSup(2009)* http://www.stats.gov.nt.ca/Statinfo/Generalstats/Scan/scan.html.

[102] Government of the Northwest Territories, Department of Health and Social Services, *2006 NWT Addictions Report*. Available at http://www.hlthss.gov.nt.ca/english/publications/pubresult.asp?ID=230 accessed December 14, 2009.

[103] Government of the Northwest Territories, *Communities and Diamonds, (2006. 2007 and 2008).*
[104] Brian J. Hill, *Wilderness Valuation-Preservation*. Parks and Recreation, August 1994. Available on BNET at http://findarticles.com/p/articles/mi_m1145/is_n8_v29/ai_15769900/ accessed January 8, 2010.
[105] Bobby Vital (personal comment) January 26, 2010.
[106] Prairie Creek Mine Traditional Knowledge Report, Addendum. Included as an Appendix to the Developers' Assessment Report.
[107] The existing big-game outfitters that were affected by the park expansion have been given a 10 year moratorium after which they will have to cease operations inside the park. Non-Aboriginal hunting inside the park by other means is not allowed.
[108] Leon Konisenta (personal comment), January 27, 2010.
[109] Department of Wildlife and Natural Resources, Government of the Northwest Territories. Information on hunting zones and hunting seasons is available at http://www.enr.gov.nt.ca/ /_live/documents/documentManagerUpload/Hunting_guide.pdf accessed January 11, 2010.
[110] See the Acho Dene First Nation, Nahanni Butte Dene Band, and Liidlii Kué First Nation letters of support attached as an Appendix to the DAR.
[111] It should not be forgotten that a large disparity exists between Fort Simpson's Aboriginal and non-Aboriginal populations and that this disparity is hidden within the socio-economic data.
[112] Friedman, B. *The Moral Consequences of Economic Growth,* Knopf, 2005.
[113] Stiglitz, J. *The Ethical Economist*, Foreign Affairs, Volume 85, Number 6, November/December 2005.
[114] Government of Canada, Infrastructure Canada, Building Canada program, Available at http://www.infc.gc.ca/ip-pi/gtf-fte/gtf-fte-table-eng.ht accessed February 10, 2010.
[115] Canadian Zinc has letters of support from the Acho Dene First Nation, Nahanni Butte First Nation, Liidlii Kué First Nation and Mayor of Fort Simpson.

APPENDIX 20

February 2010

CELEBRATING 50 YEARS in 2010

CANADIAN ZINC CORPORATION

Developer's Assessment Report Prairie Creek Mine Air Quality

REPORT

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Executive Summary

This document presents the Air Quality Assessment section of the Developers Assessment Report prepared for the Prairie Creek Mine, owned by Canadian Zinc Corporation (Canadian Zinc) and situated in the southern Mackenzie Mountains of the Northwest Territories, approximately 90 km northwest of Nahanni Butte.

This Air Quality Assessment has been prepared in accordance with the Mackenzie Valley Review Board (MVRB) requirements specified in the *Terms of Reference for the Environmental Assessment of Canadian Zinc Corporation's Prairie Creek Mine EA 0809 – 002* (TOR). The objectives of this Assessment are: evaluating potential impacts of the Prairie Creek Mine project (the Project) emissions on local air quality; and proposing follow-up monitoring, mitigation and management strategies to minimize any impacts.

The evaluation of potential impacts of the Project on local air quality included an assessment of pre-development conditions associated with air quality, preparation of an air emission inventory for the construction, operation and closure phases of the Project, determination of predicted air concentrations of TSP, PM_{10}, $PM_{2.5}$, NO_2, NO_X, SO_2, CO, lead and zinc resulting from emissions during the operation phase of the Project, comparison of predicted concentrations with air quality standards, and discussion of potential impacts on other components of the ecosystem.

Air concentrations resulting from on-site (i.e., Prairie Creek Mine) emissions have been determined using the CALPUFF dispersion model, run in a dynamic (3D) mode. Concentrations resulting from off-site (i.e., access road and transfer facilities) emissions have been determined using the SCREEN3 dispersion model.

Maximum predicted concentrations of TSP, PM_{10}, $PM_{2.5}$ and lead resulting from on-site emissions are expected to exceed the respective air quality standards for receptors located within the surface lease that encompasses the Prairie Creek Mine, on the surface lease boundary and in an area extending 200 m from the surface lease boundary (referred to as the buffer zone). The number of receptors where maximum concentrations are expected to exceed the standards on the surface lease boundary and within the buffer zone is relatively small compared to the total number of receptors assessed in each of these receptor zones. Maximum predicted concentrations of TSP, PM_{10}, $PM_{2.5}$ and lead are expected to be lower than the respective air quality standards for receptors located in the outer part of the buffer zone (i.e., 200 m from the surface lease boundary) and beyond.

Maximum predicted concentrations of NO_2, SO_2 and CO resulting from on-site emissions are expected to be lower than the respective air quality standards for all receptors assessed, including those located within the surface lease. Maximum concentrations of TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO resulting from off-site emissions are expected to be lower than the respective air quality standards.

No lead or zinc emissions are expected from off-site activities, including concentrate transport on the access road.

This Air Quality Assessment indicates that the Project activities are not likely to result in significant impacts on the local air quality for receptors located 200 m from the surface lease boundary and beyond, neither for receptors located adjacent to the access road.

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List of Acronyms

Acronym	Description
ACIA	Arctic Climate Impact Assessment
CDED	Canadian Digital Elevation Data
CO	Carbon Monoxide
GHG	Greenhouse gases
GNWT	Government of the Northwest Territories
IPCC	Intergovernmental Panel on Climate Change
km	kilometre
mb	Millibar
MVRB	Mackenzie Valley Review Board
MVLWB	Mackenzie Valley Land and Water Board
MOE	Ontario Ministry of the Environment
NO_2	Nitrogen Dioxide
NO_X	Nitrogen Oxides
O3	Ozone
PM	Particulate matter
PM_{10}	Particulate matter with an aerodynamic diameter less than 10 µm
$PM_{2.5}$	Particulate matter with an aerodynamic diameter less than 2.5 µm
NCEP	National Centers for Environmental Prediction
QA/QC	Quality Assurance and Quality Control
SO_2	Sulphur Dioxide
SRES	Special Report on Emission Scenarios
TOR	Terms of Reference for the Environmental Assessment of Canadian Zinc Corporation's Prairie Creek Mine EA 0809 – 002
TSP	Total Suspended Particulate
U.S. EPA	United States Environmental Protection Agency
USGS	United States Geological Survey
UTC	Coordinated Universal Time
UTM	Universal Transverse Mercator

1.0 INTRODUCTION

The Prairie Creek Mine, owned by Canadian Zinc Corporation (Canadian Zinc), is situated in the southern Mackenzie Mountains of the Northwest Territories, approximately 90 kilometres (km) northwest of Nahanni Butte. The latitude and longitude of the Prairie Creek Mine are 61°33' N and 124°48' W, respectively.

The site currently contains significant infrastructure and facilities constructed in the early 1980's. The mine was three months from operation when the owner declared bankruptcy. The site has been on a care and maintenance basis since, with periods of advanced exploration.

In 2008, Canadian Zinc submitted permit applications to the Mackenzie Valley Land and Water Board (MVLWB) to upgrade the existing facilities and start operations at the Prairie Creek Mine. The applications were referred by the Mackenzie Valley Review Board (MVRB) for environmental assessment. As part of the environmental assessment, MVEIRB prepared the *Terms of Reference for the Environmental Assessment of Canadian Zinc Corporation's Prairie Creek Mine EA 0809 – 002* (TOR) (MVRB, 2009), which specifies the requirements of a *Developers Assessment Report* containing information about potential environmental impacts associated with these activities.

Golder Associates Ltd. (Golder) has been retained by Canadian Zinc to prepare the Air Quality Assessment section of the Developers Assessment Report.

The Air Quality Assessment presented in this document has been prepared with regard to the TOR, with the objectives of: evaluating potential impacts of the Prairie Creek Mine project (the Project) emissions on local air quality, and proposing follow-up monitoring, mitigation and management strategies to minimize any impacts.

As specified in the TOR, the following contaminants have been included in this Air Quality Assessment:

- Total Suspended Particulate (TSP);
- Particulate matter with an aerodynamic diameter less than 10 µm (PM_{10});
- Particulate matter with an aerodynamic diameter less than 2.5 µm ($PM_{2.5}$);
- Nitrogen Dioxide (NO_2);
- Nitrogen Oxides (NO_X);
- Sulphur Dioxide (SO_2);
- Carbon Monoxide (CO);
- Lead; and
- Zinc.

The Prairie Creek Mine project includes activities during construction, operation and closure phases, as presented in Table 1.

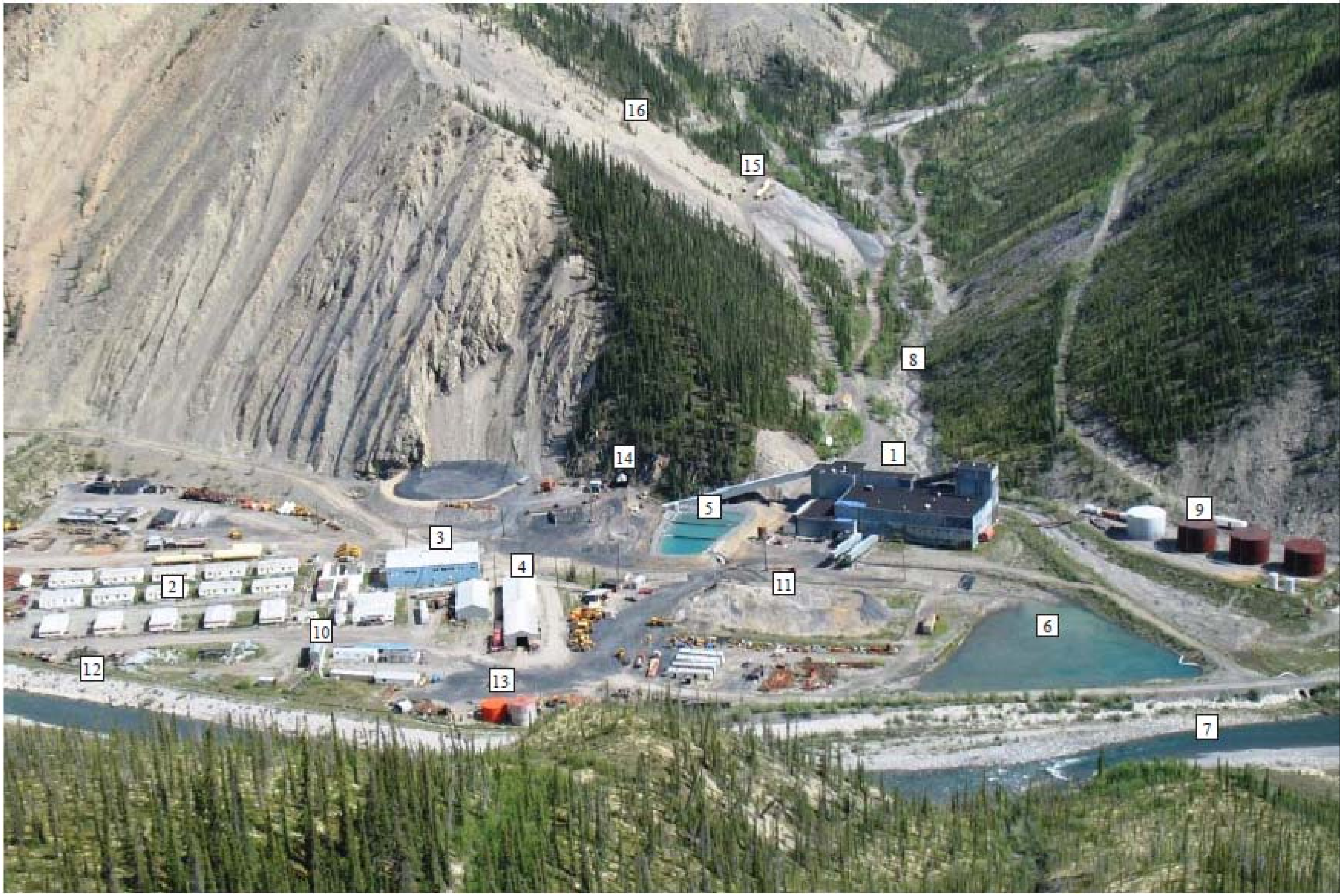
Table 1: Phases of the Prairie Creek Mine Project

Phase	Description	Expected Duration
Construction	Includes initial underground mine development, earth works, civil construction and mechanical installation activities necessary to upgrade the existing facilities.	580 days
Operation	Includes ore extraction, processing and transport, as well as other activities necessary to run the mine.	14 years with possible extensions
Closure	Includes mine decommissioning and stabilization / removal of structures from the site.	90 days

Canadian Zinc currently holds a surface lease covering the existing infra-structure and facilities at the Prairie Creek Mine (surface lease area). The surface lease area will be connected to the Liard Highway by a 180-km long access road. In addition to the surface lease area and access road, the Project will include activities at two transfer facilities. The Tetcela Transfer Facility is to be located approximately half way along the access road, and the Liard Transfer Facility is to be located at the junction of the access road and the Liard Highway.

Figure 1 presents a view showing the existing facilities at the site. Figure 2 presents a view of the proposed Prairie Creek Mine. Figure 3 presents a map showing the location of the site. Figure 4 presents the proposed facilities and structures after the construction phase. Figure 5 presents the access road corridor connecting the Prairie Creek Mine to the Liard Highway.

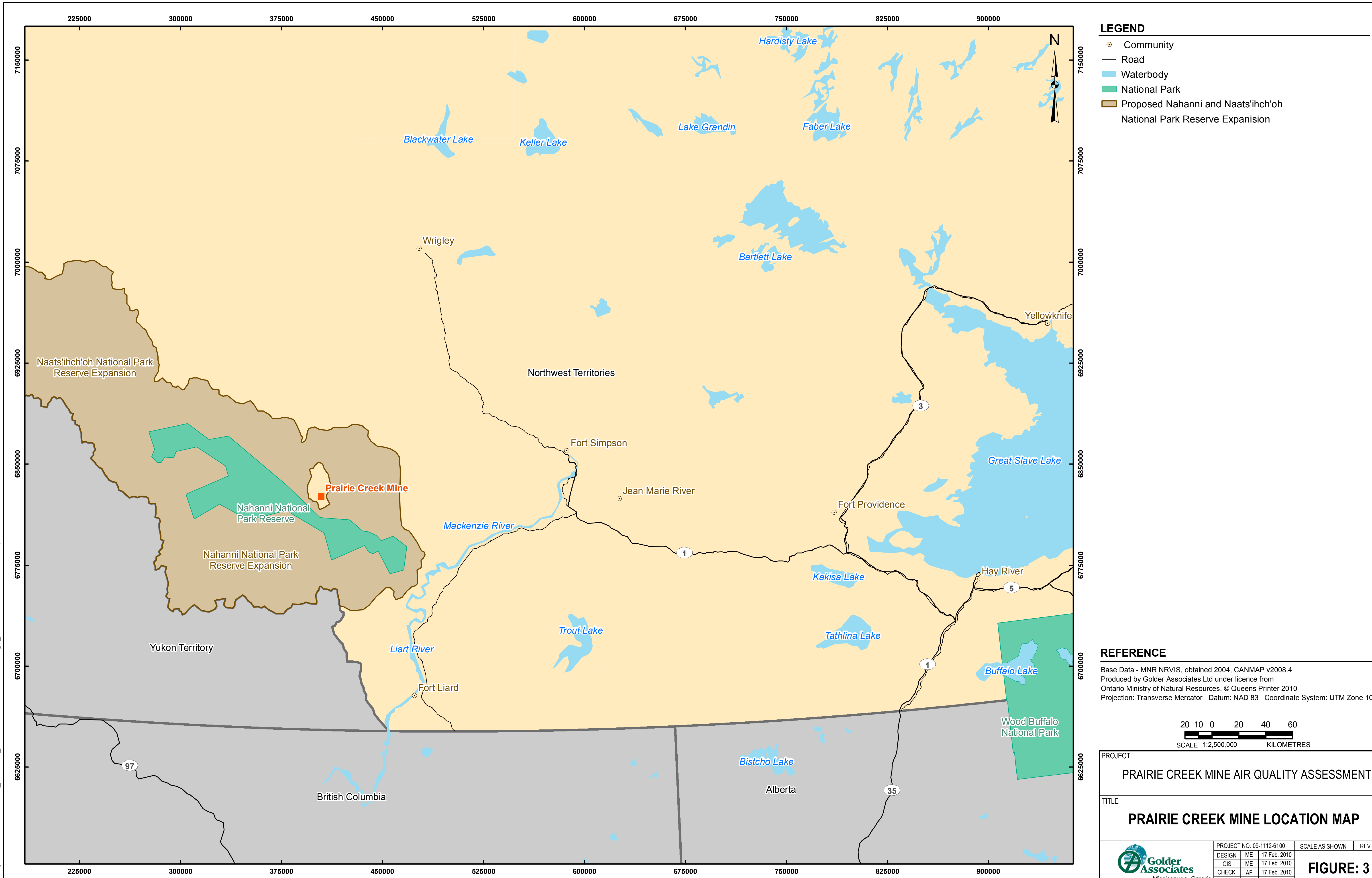
A detailed description of the Project is available in the document *Prairie Creek Mine Project Description Report* (Canadian Zinc Corporation, 2008), which has been submitted to the Mackenzie Valley Land and Water Board and is available on the Canadian Zinc website.



Prairie Creek Mine Facilities:
1 - Mill
2 - Accommodations
3 - Offices
4 - Workshops
5 - Polishing Pond
6 - Catchment Pond
7 - Prairie Creek
8 - Harrison Creek
9 - Tank Farm
10 - Sewage Treatment Plant
11 - Ore Stockpile
12 - Flood Protection Berm
13 - Parts Warehouse
14 - 870 Level Portal
15 - 930 Level Portal
16 - 970 Level Portal

Figure 1: Existing Facilities at the Prairie Creek Mine

Figure 2: View of the Prairie Creek Mine



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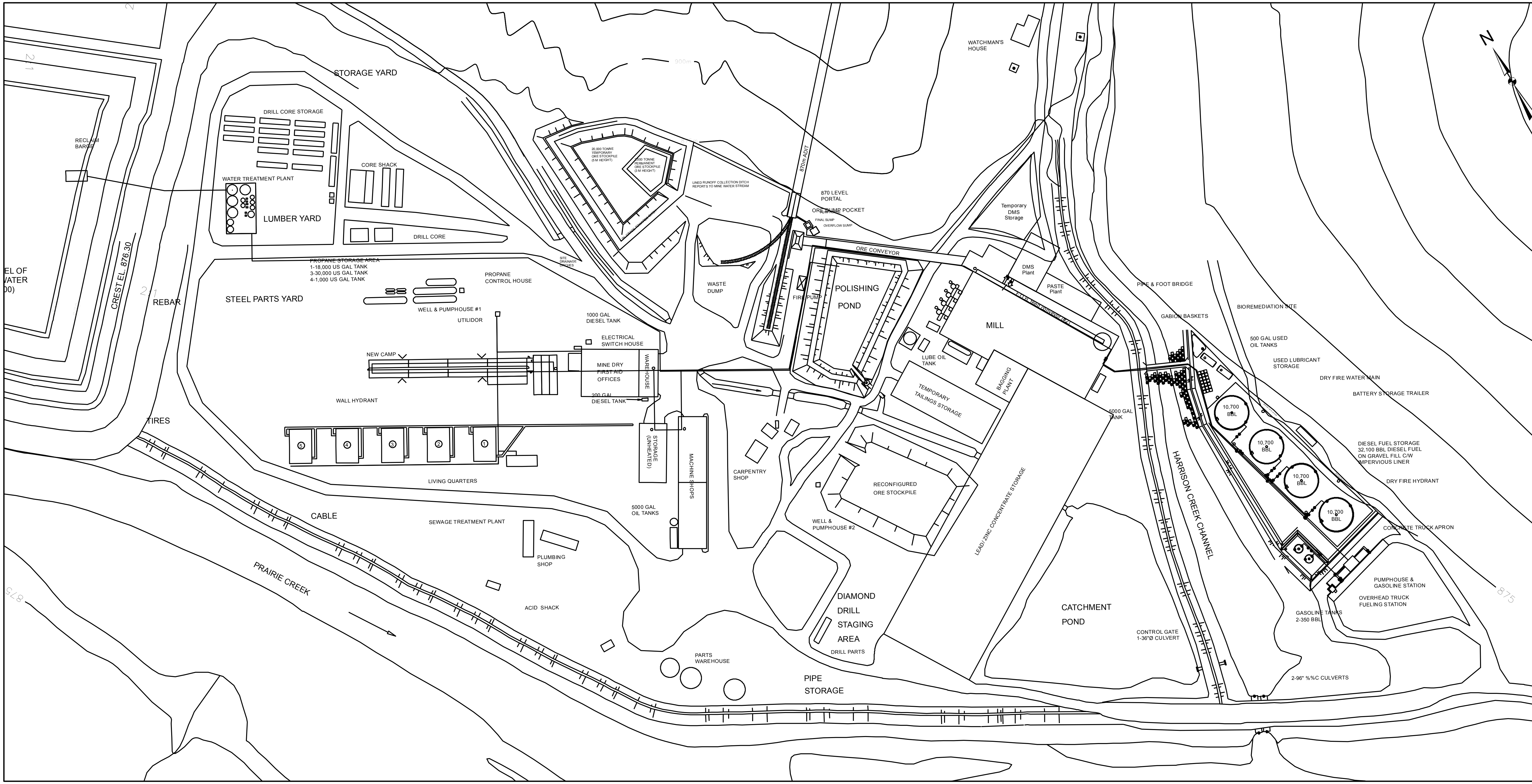

REFERENCE

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DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

20 10 0 20 40 60 80 100
SCALE 1:1,750 METRES

INDEX MAP

PROJECT
PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE
PROPOSED FACILITIES AND STRUCTURES AT THE PRAIRIE CREEK MINE

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
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GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

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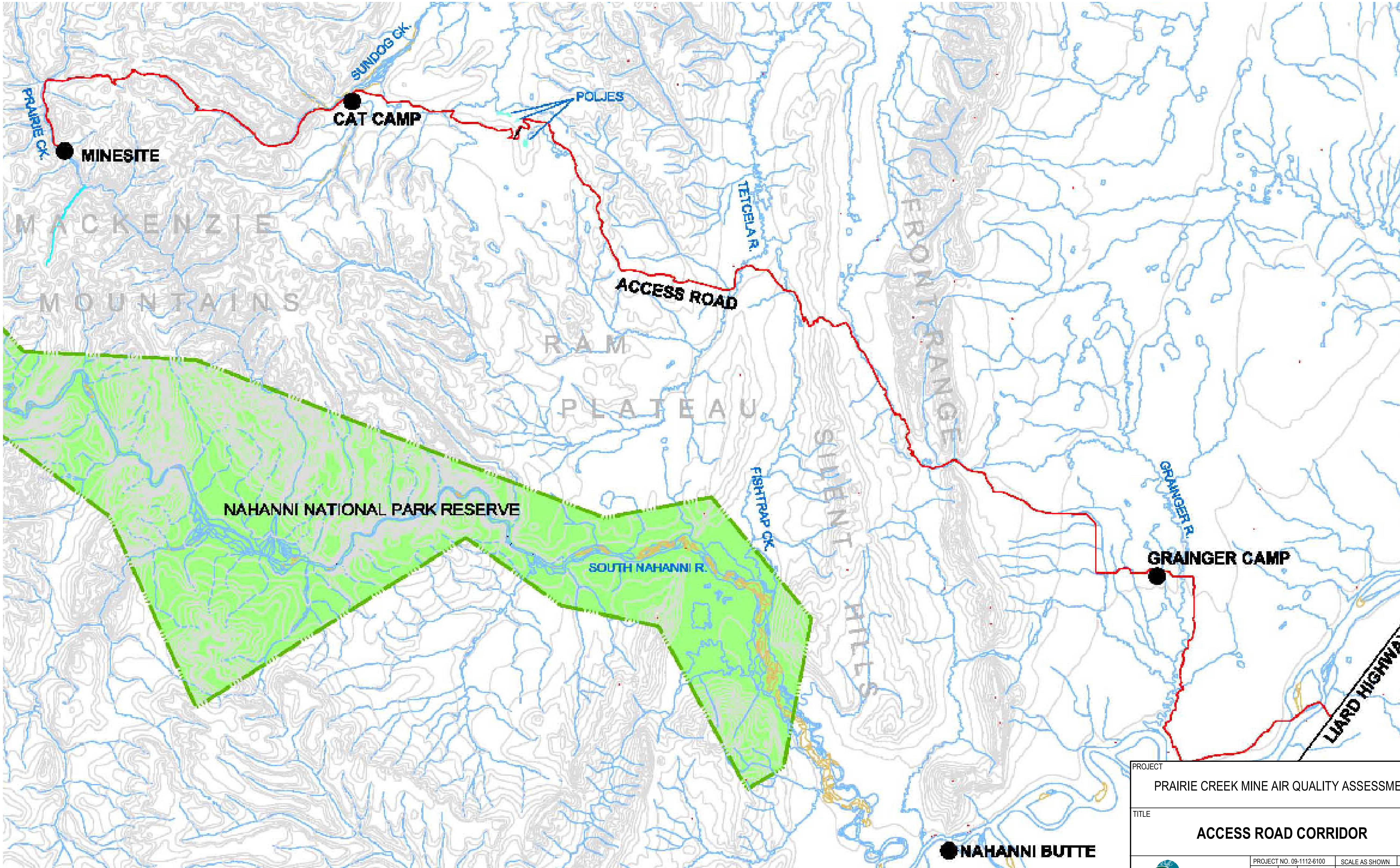

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PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT	
TITLE	
ACCESS ROAD CORRIDOR	

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	ME	17 Feb. 2010	FIGURE: 5	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		17 Feb. 2010		

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2.0 APPROACH FOR THE AIR QUALITY ASSESSMENT

The approach used in this Air Quality Assessment was based on the requirements specified in the Terms of Reference (MVEIRB, 2009), and presented to Environmental Canada and GNWT during a conference call on November 5, 2009. Environment Canada will be providing comments to the MVRB on air quality issues. The approach includes the following steps:

- Identification and evaluation of pre-development conditions of the Project relevant to air quality.
- Evaluation of potential air quality impacts from the Project, including:
  - estimating the air emissions from the Project (i.e., the emissions inventory);
  - estimating the ambient concentrations of air contaminants released from the Project using dispersion modelling; and
  - comparing the predicted ambient concentrations to available criteria and standards.
- Preparation of monitoring, mitigation and adaptive management strategies that reflect the nature of the Project, the area where the Project is situated and the predicted air impacts.

2.1 Emission Inventory

The identification of emission sources has been based on the list of Project activities presented in the TOR, on information provided by Canadian Zinc, and on previous emission inventories developed by Golder. Air emissions from the Project have been calculated using emission factors, activity data and other information according to the following documents and sources (see Appendix A for details regarding the calculation of emissions):

- U.S. EPA AP-42 Sections (U.S. EPA, 2009a: website).
- U.S. EPA NONROAD Model documents (U.S. EPA, 2009b: website).
- Information provided by Canadian Zinc.

As specified in the TOR, emissions have been estimated for TSP, PM_{10}, $PM_{2.5}$, NO_X, SO_2, CO, lead and zinc.

2.2 Dispersion Modelling

The following dispersion modelling approach has been used for this Air Quality Assessment:

- the concentrations resulting from the on-site emissions (i.e., activities within the mine surface lease) have been evaluated using the CALPUFF dispersion model, run in a dynamic (3D) mode; and
- the concentrations resulting from the off-site emissions (i.e., activities of the access road and transfer facilities) have been evaluated using SCREEN3 dispersion model.

Due the complex nature of the local terrain (see Figures 1 and 2), it is expected that the dispersion of the Project on-site emissions is better represented using the full capabilities of the CALPUFF dispersion model (i.e., run in dynamic [3D] mode with a fine resolution meteorological data set). When run in this manner, CALPUFF allows locally induced meso- and micro-meteorology such as terrain induced flow, valley and mountain breezes, or heat fluxes from snow covered ground to be modelled. In effect, the planetary boundary layer that influences dispersion can be accurately represented.

Off-site emissions resulting from the Project will consist primarily of emissions travelling along the access road and are expected to occur with much lower intensity than the on-site emissions. This means that effects will be localized. In addition, these emissions will be spread out over the length of the access road (i.e., over a length of 180 km). The localized nature of these emissions is not suited to analysis using a fully capable version of CALPUFF. Alternatively, the SCREEN3 dispersion model has been selected to evaluate off-site Project emissions. Due to built-in conservative parameters and values, SCREEN3 usually presents conservative results when compared with refined models.

Ambient concentrations have been estimated for TSP, PM_{10}, $PM_{2.5}$, NO_X, SO_2, CO, lead and zinc using the modelling approach set out above. In addition, concentrations of NO_2 have been estimated based on NO_X modelling results, using the Ozone Limiting Method (Cole and Sommerhays, 1979), in accordance with the Alberta Air Quality Model Guideline (Government of Alberta, 2009b).

2.3 Meteorological Data

In order to use the full capabilities of the CALPUFF model, a three-dimension set of meteorological data covering the area where ambient concentrations are to be calculated is required. The data file is generated using the CALMET pre-processor, and then input into CALPUFF.

The meteorological data required in CALMET includes hourly surface meteorological parameters, twice-daily values of upper air parameters, and geophysical parameters. Existing meteorological data from a station installed at the Prairie Creek Mine has been evaluated and determined to be insufficient to meet the CALMET requirements. In order to generate the meteorological data required by CALMET, MM5 modelling has been executed.

The MM5 mesoscale model has been executed for the years of 2005 to 2008, which correspond to the years that data from the on-site station was available. Data from the on-site meteorological station has been used for Quality Assurance and Quality Control (QA/QC) of the MM5 and CALMET results.

2.4 Modelling Results – Receptors

Ambient concentrations resulting from on-site emissions have been predicted at selected groups of receptors in order to provide a better understanding of the potential impacts of the Project. Considering that air quality in the external area immediately adjacent to the surface lease area possibly would be influenced by on-site Project activities, a buffer zone of 200 m beyond the surface lease area has been added for analysis purpose.

The following groups of receptors have been used in this Air Quality Assessment:

1 – Receptors within the surface lease boundary.

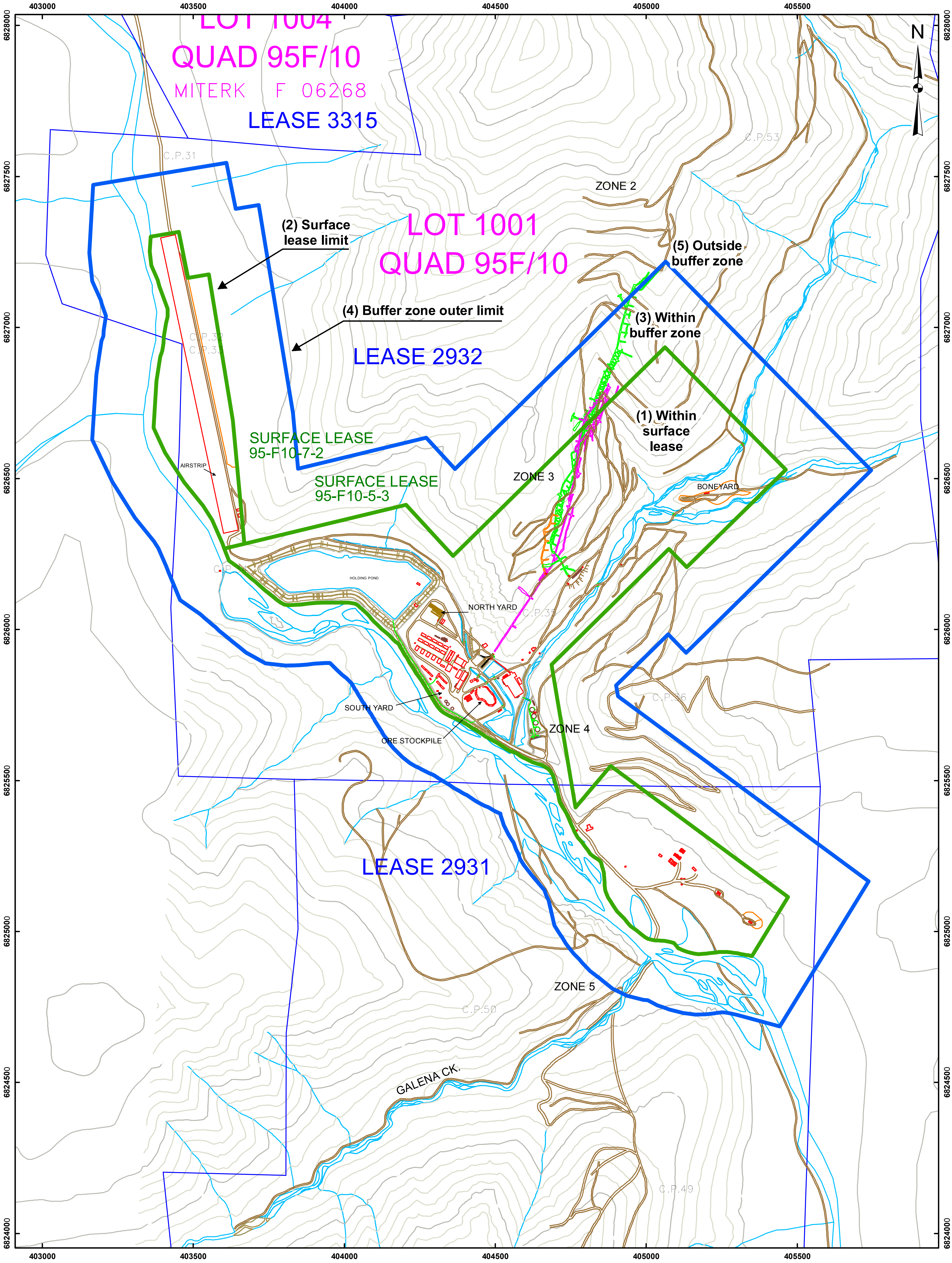
2 – Receptors on the line that delimitates the surface lease boundary.

3 – Receptors in the buffer zone. This includes receptors within the first 200 m beyond the surface lease line (2).

4 – Receptors on the line that delimitates the outer limit of the buffer zone (i.e., a line offset 200 m from the surface lease boundary [2]).

5 – Receptors located more than 200 m from the surface lease boundary (2).

Figure 6 illustrates the group of receptors used in CALPUFF modelling.



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REFERENCE

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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

GROUPS OF RECEPTORS USED IN CALPUFF

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010	FIGURE: 6	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

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2.5 Air Quality Guidelines

In order to evaluate the predicted ambient concentrations of the contaminants included in this Air Quality Assessment, the results have been compared with Air Quality Guidelines. The *Guideline for Ambient Air Quality Standards in the Northwest Territories* (GNWT, 2002) has been used as the primary reference in this Air Quality Assessment. Where GNWT standards were not available, *Alberta Ambient Air Quality Objectives and Guidelines* (Government of Alberta, 2009a) have been used as targets for air quality. Finally, the proposed Canada-Wide Standard for PM_{10} (Government of Canada, 2009: website) has been used as the target for 24-hour PM_{10} levels, as no GNWT standards or Alberta guidelines exist

Table 2 presents the air quality guidelines used for comparison purposes in this Air Quality Assessment. No air quality guidelines have been identified in the abovementioned references for NO_X and zinc.

Table 2: Air Quality Guidelines Used in the Air Quality Assessment

Contaminant	Averaging Period	GNWT(µg/m³)	Alberta Objectives and Guidelines (µg/m³)	Canada-Wide Standard (µg/m³)
TSP	24-hour	120	—	—
	Annual	60	—	—
PM_{10}	24-hour	—	—	50[(a)]
$PM_{2.5}$	1-hour	—	80	—
	24-hour	30	—	—
SO_2	1-hour	450	—	—
	24-hour	150	—	—
	Annual	30	—	—
NO_2	1-hour	—	400	—
	24-hour	—	200	—
	Annual	—	60	—
CO	1-hour	—	15,000	—
	8-hour	—	6,000	—
Lead	1-hour	—	1.5	—

Notes: (a) Proposed value for the Canada-Wide Standard for PM_{10}.

3.0 PRE-DEVELOPMENT CONDITIONS

3.1 General Topography

The Prairie Creek Mine is situated in the southern Mackenzie Mountains, on the eastern side of Prairie Creek.

The terrain around the mine site is expected to strongly influence the local meteorology. Figure 7 presents a contour plot highlighting the topography at the Project site.

3.2 Climate

The climate station of Fort Simpson, Northwest Territories, has been selected for characterizing the climate in the region of the Prairie Creek Mine.

Fort Simpson is located at 61° N Latitude and 121° W Longitude, approximately 186 km east of the Prairie Creek Mine. Fort Simpson is situated on an island at the confluence of the forks of the Mackenzie and Liard rivers, and has the most complete set of climate data in the area. Specifically, the climate has been described using the 30-year normals for the period from 1971 to 2000.

Temperatures

Table 3 presents the annual and seasonal temperature normals for the Fort Simpson Station, based on data from 1971 to 2000. The low annual temperature average, with moderate maximum temperatures in summer and very low minimum temperatures in winter, are typical for a Continental Subarctic or Boreal climate.

Table 3: Annual and Seasonal Temperatures Normals for Fort Simpson

Parameter	Annual	Spring	Summer	Fall	Winter
Daily Average (°C)	-3.2	-1.6	15.7	-3.5	-23.3
Daily Maximum (°C)	2.5	9.2	22.1	1.2	-18.5
Daily Minimum (°C)	-8.8	-9.8	9.2	-8.1	-28.1
Extreme Maximum (°C)	36.6	32.8	36.6	30.0	14.5
Extreme Minimum (°C)	-53.3	-42.2	-1.1	-27.7	-53.3
Days with Temperature above 30 °C	4.0	0.0	3.9	0.0	0.0
Days with Temperature below -10 °C	158.3	34.7	0.0	34.2	99.3

Notes: The numbers in the table above are correct, but due to rounding may not appear to add up to the yearly totals shown above.

Precipitation

Table 4 presents the annual and seasonal precipitation normals for the Fort Simpson Station based on data from 1971 to 2000. The data indicates that most of the precipitation falls in the form of rain, and occur during the summer.

Table 4: Annual and Seasonal Precipitation Normals for Fort Simpson

Parameter	Annual	Spring	Summer	Fall	Winter
Rainfall (mm)	244.0	24.6	163.7	35.4	0.2
Snowfall (cm)	170.3	39.4	0.5	62.0	68.4
Precipitation (mm)	369.0	60.1	164.2	90.2	54.6
Extreme Daily Precipitation (mm)	85.8	38.4	85.8	45.9	27.0
Days with Measurable Precipitation	123	23.9	33.6	32.9	32.6

Notes: The numbers in the table above are correct, but due to rounding may not appear to add up to the yearly totals shown above.

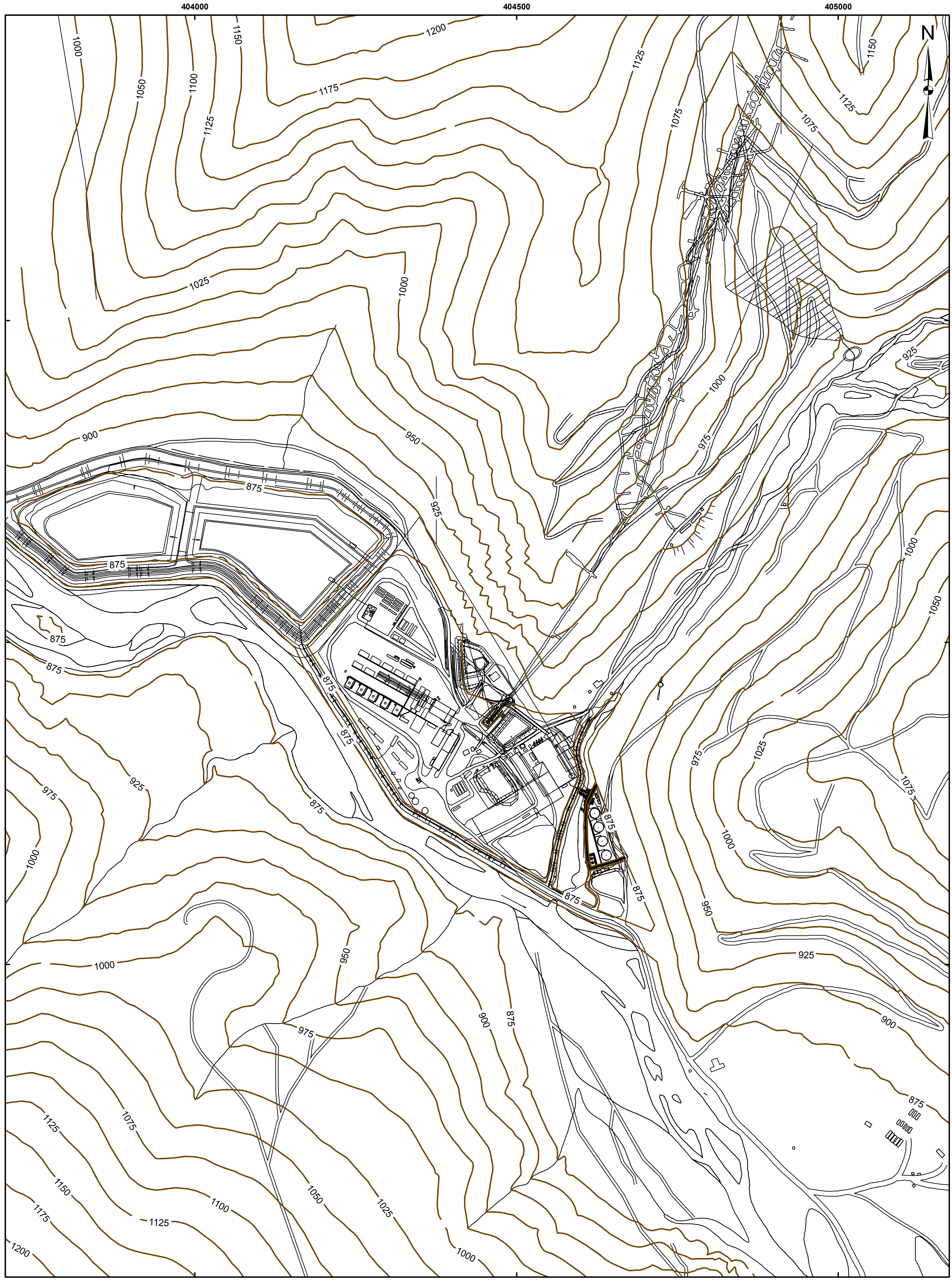
Wind

Table 5 presents the wind normals for the Fort Simpson Station based on data from 1971 to 2000. The data indicates low to moderate wind speeds. The prevalent winds are from the NW in the summer and winter, and from the E in the spring and fall. Overall, the predominant winds are from the NW.

Table 5: Annual and Seasonal Wind Normals for Fort Simpson

Parameter	Annual	Spring	Summer	Fall	Winter
Speed (km/h)	9.2	10.4	9.2	9.0	8.0
Most Prevalent Direction[a]	NW	E	NW	E	NW

Notes: (a) Direction from which the winds were blowing from.



LEGEND

— Contours

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SCALE 1:6,000 METRES

REFERENCE

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DEM - CDED
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Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

CONTOUR ELEVATIONS AT THE PRAIRIE CREEK MINE AREA

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010	**FIGURE: 7**	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

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3.3 Climate Change

It is now widely accepted that the climate is changing; therefore, consideration of these changes needs to be incorporated into environmental assessment (EA) findings.

Past climate data show clear trends in the Deh Cho region. In the Mackenzie River Basin, temperatures have increased by more than 2.0 °C since the start of the 20th century (NWT Environmental and Natural Resources, 2008).

While past trends have traditionally been used to provide guidance to the future, reliance is shifting to global climate models, which incorporate accepted understanding of climate mechanisms and standardized scenarios reflecting potential human development in the future. These Mathematical models predict that as levels of greenhouse gases (GHG) increase in the atmosphere, a greater proportion of the heat radiated from the earth will be retained in the lower atmosphere, resulting in an average warming of the Earth's surface.

A consistent feature of climate models is that they project intensified warming in the northern polar regions. Hence, the Arctic is likely the area where the first effects of global climate change will be unequivocally identified. In addition, the Arctic environment has a significant role in establishing global circulation patterns, which in turn influence both weather and climate.

3.3.1 Past Climate Observations

Recent studies completed in the Deh Cho region have shown that the temperature and precipitation in the region have been changing. Over the period from 1971 through 2000, the annual temperature has increased by 1.7 °C and the winter temperature by 4.4 °C (IORVL, 2004). The annual precipitation over that period has increased by 5 mm, corresponding to 1.3% (IORVL, 2004).

3.3.2 Future Climate Forecasts

Global climate models require extensive inputs in order to characterize the physical and social forces that could alter climate in the future. In order to represent the wide range of the inputs possible to global climate models, the Intergovernmental Panel on Climate Change (IPCC) has established a series of socio-economic scenarios that help define the future levels of global GHG emissions. The IPCC have identified four general scenarios, namely A1, B1, A2 and B2.

The A1 and A2 scenarios represent a focus on economic growth while the B1 and B2 scenarios represent a shift towards more environmentally conscious solutions to growth. Both scenarios A1 and B1 include a shift towards global solutions to reduce the impacts of climate change, while the A2 and B2 scenarios include growth based on regional models.

Figure 8 provides an illustration relating the four emission scenarios.

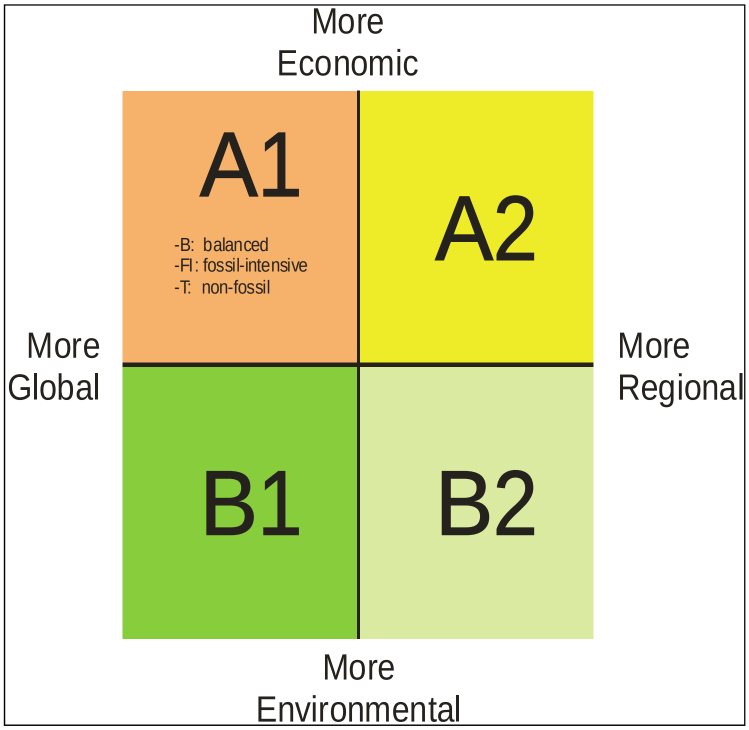


Figure 8: IPCC SRES Emission Scenarios

These four socio-economic scenarios have been described more fully by the IPCC in their Special Report on Emission Scenarios (SRES) (IPCC, 2000). Although the IPCC has not stated which of these scenarios are most likely to occur, the A2 scenario most closely reflects the current global socio-economic situation. In relation to the A2 scenario, scenarios A1, B1 and B2 result in lower long-term GHG emissions over the next century. Of the A1 scenario family, scenario A1FI yields high emissions in the first half of the 21st century due to increasing population and high dependence on fossil fuels for energy.

The Canadian Climate Centre has produced forecasts for the following three SRES emission scenarios put forward by the IPCC:

- Scenario A1B: The A1 family of scenarios describe a future world of very rapid economic growth, global population that peaks in mid-century and declines thereafter, and the rapid introduction of new and more efficient technologies. The A1 family includes three groups of scenarios that describe alternative directions in the energy system. The A1B group is distinguished by a balance across all sources of energy.
- Scenario A2: The A2 scenario family describes a world with an underlying theme of self-reliance and preservation of local identities. Fertility patterns across regions converge very slowly, which results in continuously increasing population. Economic development is regionally oriented and per capita economic growth and technological change more fragmented and slower than for other scenarios.
- Scenario B1: The B1 scenario describes a convergent world with the same global population that peaks in mid-century and declines thereafter (similar to the A1 scenarios). The B1 scenarios have rapid change in

economic structures toward a service and information economy, with reductions in material intensity and the introduction of clean and resource-efficient technologies. The emphasis is on global solutions to economic, social and environmental sustainability, including improved equity, but without additional climate initiatives.

In general terms, projections from the IPCC climate models indicate a global mean temperature increase of 1.4 ºC by the mid-21st century compared to the present climate for both the A2 and B2 scenarios (IPCC, 2007). Toward the end of the century, the global mean temperature increase is projected to be 3.5 °C and 2.5 °C for the two scenarios.

Over the Arctic, the Arctic Climate Impact Assessment (ACIA) designated models project a larger mean temperature increase: for the region north of 60º N, both emissions scenarios result in a 2.5 °C increase by the mid-21st century. By the end of the 21st century, arctic temperature increases are projected to be 7 °C and 5 °C for the A2 and B2 scenarios (Kattsov and Källén, 2009; NWT Environment and Natural Resources, 2008; NWT Federal Council, 2007).

Average autumn and winter temperatures are projected to rise by 3 to 5 °C over most arctic land areas by the end of the 21st century. By the late 21st century, projected precipitation increases in the Arctic range from about 5 to 10% and as much as 35% in certain high Arctic locations (for the B2 scenario). As for temperature, the projected increase in precipitation is generally greatest in autumn and winter and smallest in summer Kattsov and Källén, 2009; NWT Environment and Natural Resources, 2008; NWT Federal Council, 2007).

With respect to the Prairie Creek Mine, changes in climate over a shorter time frame are more likely to apply. The Mackenzie Gas Project identified that the average temperatures in the Deh Cho region would increase by between 1.0 and 2.1 °C from the current normals by the 2010 through 2039 period (IORVL, 2004). Over the same period, winter temperatures would increase by between 1.0 and 2.2 °C relative to the normals. The annual precipitation could increase by between 0.9 and 9.6% (IORVL, 2004).

3.4 Dispersion Meteorology

Dispersion meteorological data used when assessing the effects of the Prairie Creek Mine has been generated using a combination of the MM5 and CALMET models, as described in the following sub-sections.

3.4.1 MM5 Modelling

Modelling Domains

Three nested domains of 36, 12 and 4 km have been used for the MM5 modelling. The domains have been centered at 61.55° N and 124.79° W, which corresponds to the centre coordinates of the Prairie Creek Mine. The domains have been set so that each nested domain ends far enough from the edge of the next larger domain to avoid noise on the boundary of its parent domain. The meteorological fields from the 4 km domain have been prepared as an input to the CALMET model.

Terrain and Land Use

The MM5 model uses USGS v.2 global terrain and land use data as input. The data resolution used during modelling depends on the domain resolution (e.g., a 36km domain uses 10 min [~19 km] global terrain and land use data), as listed below.

The following data resolutions have been used in the MM5 modelling:

- 36 km: 10 min (~19 km) global terrain and land use;
- 12 km: 5 min (~9 km) global terrain and land use; and
- 4 km: 2 min (~4 km) global terrain and land use.

Model Initialization

The National Centers for Environmental Prediction (NCEP) FNL (Final) Operational Global Analysis data on 1°×1° grids has been used to initialize the MM5 model. The analysis data has a six hours temporal resolution. The analyses are available on the surface, at 26 mandatory (and other pressure) levels from 1,000 millibar (mb) to 10 mb, in the surface boundary layer, at some sigma layers, the tropopause and a few others. Parameters include surface pressure, sea level pressure, geopotential height, temperature, sea surface temperature, soil values, ice cover, relative humidity, u- and v-winds, vertical motion, vorticity, and ozone.

The NCEP FNL analysis data provides the MM5 model with boundary and initial condition. Since mesoscale modelling is an initial value problem, a superior boundary and initial condition has a very high impact on the accuracy of model output. The above analysis was chosen because it has higher spatial resolution compared to NCEP Re-analysis data that has 2.5° × 2.5° resolution.

Modelling Physics

The following model physics have been employed for the MM5 modelling:

- Reisner graupel (Reisner2) explicit moisture scheme: This scheme is based on a mixed-phase scheme but with the addition of graupel and ice number concentration prediction equations.
- Kain-Fritsch 2 cumulus scheme: This scheme predicts both updraft and downdraft properties and also detrains cloud and precipitation. A shallow convection is also included in this new version of the Kain-Fritsch scheme. The cumulus parameterization is not recommended for a grid size less than 5-10 km.
- Pleim-Chang planetary boundary layer scheme: This is a high resolution scheme, with 5 layers in the lowest km, and a surface layer < 100 m thick.
- RRTM longwave scheme: This scheme is combined with the cloud-radiation shortwave scheme.
- Pleim-Xiu LSM surface scheme: This scheme handles soil surface, canopy and evapotranspiration moisture fluxes from and to ground that will be used by planetary boundary layer scheme to calculate surface temperature, water vapour and surface wind.

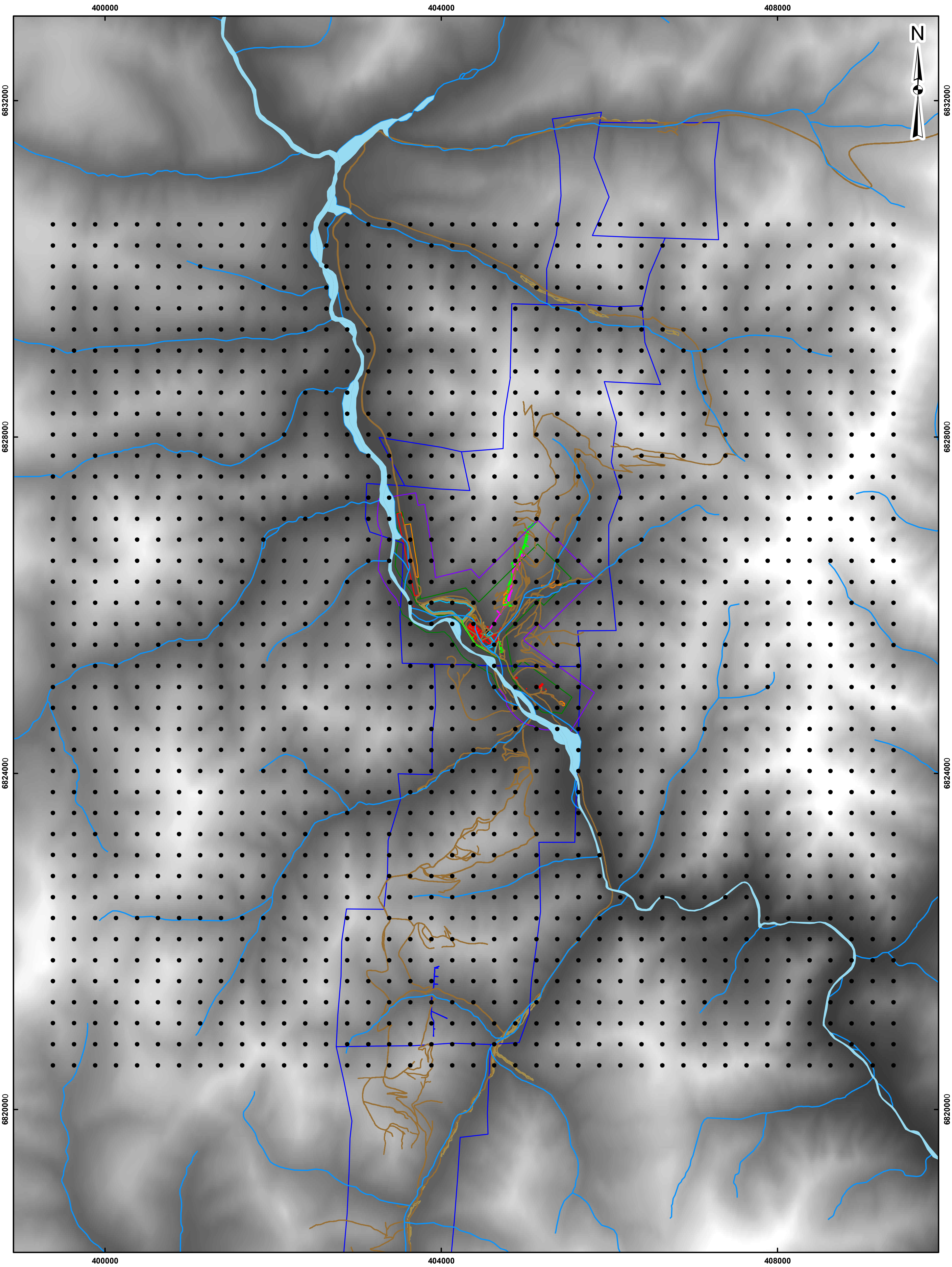
Most of the physic schemes have been applied to all three nested domains, except the cumulus scheme, which has been applied only to 36 and 12 km domains, as recommended in the MM5 model user's guide.

3.4.2 CALMET Modelling

Domain

The CALMET modelling domain has been centered at the same location as the MM5 modelling domain. The modelling domain is on a 250 m spatial resolution and an hourly temporal resolution covering an approximate 10 × 10 km area in the horizontal direction, as presented in Figure 9. In the vertical direction, the model has twelve vertical layers at 20, 40, 80, 100, 200, 300, 400, 600, 1000, 1500, 2200 and 3000 m.

Several considerations were taken into account during domain set up. Firstly, the size of the domain should be large enough to capture local wind circulations. Secondly, a fine spatial resolution was necessary considering the complexity of the terrain where the mine is located. Lastly, tight vertical layers below the height difference between the mine and surrounding hill tops (eight layers below 600 m) was set up so that it provides dispersion modelling with more accurate wind flow. Such tight layers in complex terrain are necessary especially during wind events where the local Froude number is below critical. The Froude number is a dimensionless parameter describing the ratio of inertial force of moving fluid to the gravitational force affecting the moving fluid. For example, the direction of a wind vector with an uphill component that has Froude number below a critical value will be adjusted to the tangent of the terrain. Thus, a wind vector that exceeds the critical Froude number will not be adjusted.



LEGEND

- • Grid points
- River
- Waterbody

500 250 0 500 1,000 1,500

SCALE 1:45,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

GRID USED FOR CALMET MODELLING

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010	**FIGURE: 9**	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\Fig9_ReceptorGridUsedForCalmetModelling.mxd

Terrain and Land Use

CALMET modelling uses Canadian Digital Elevation Data with 3 arc seconds (~90 m) spatial resolution which provides more than enough detail for the 250 m grid spacing. The data used in the modelling has been compiled and provided by the federal, provincial or territorial agencies.

Figure 10 presents the surrounding terrain of Prairie Creek Mine located at approximately 900 m above sea level. To the north and east of the mine there are several hill tops at approximately 1,500 m. A couple of lower hill tops are also located to the south and southwest of the mine. .

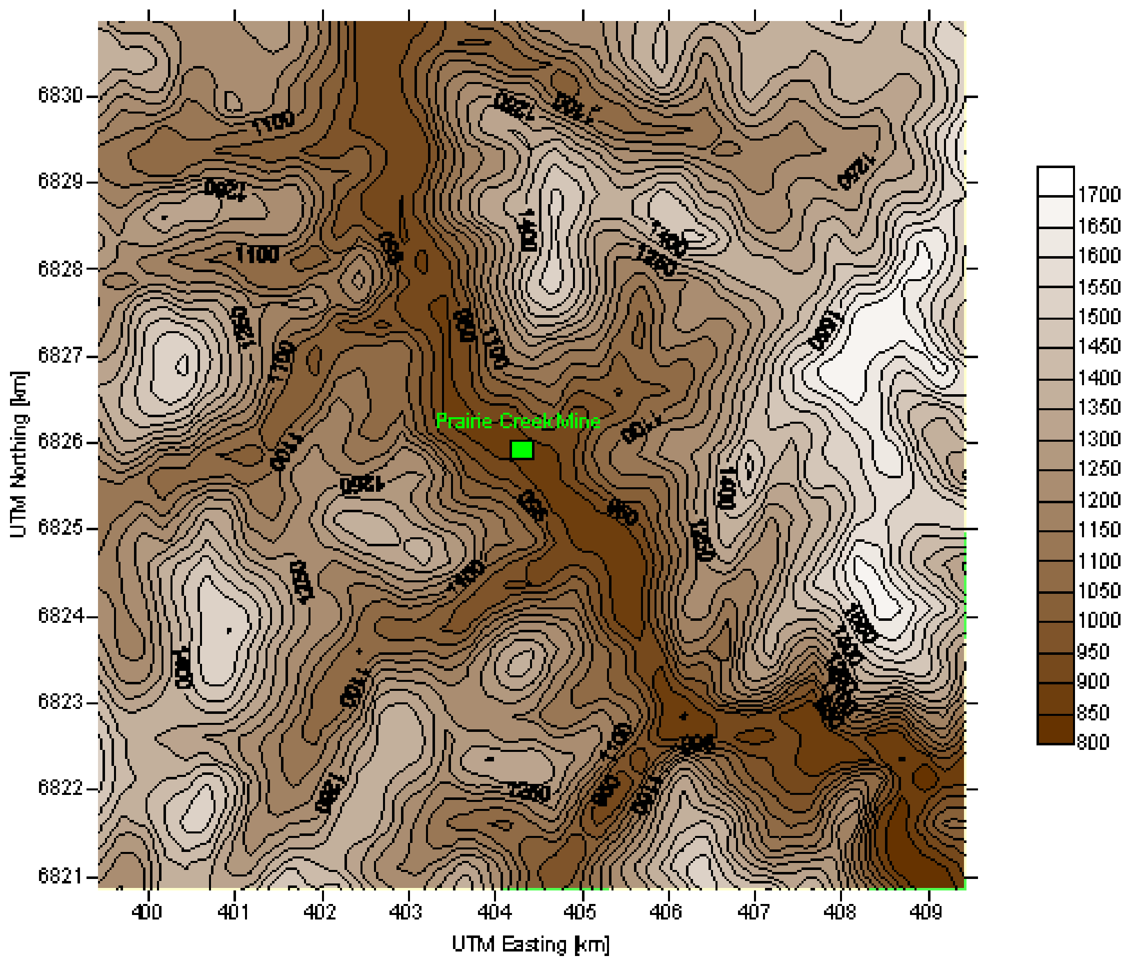


Figure 10: Prairie Creek Mine Terrain Elevation

The CALMET model also uses the global land use data from the United States Geological Survey (USGS) to determine the land cover type in the region. The land cover in the region is not as diverse as seen in Figure 11.

Based on the terrain elevation and land use profiles, it can be concluded that weather parameters affecting the dispersion modelling around the Prairie Creek Mine will be mostly dominated by the terrain.

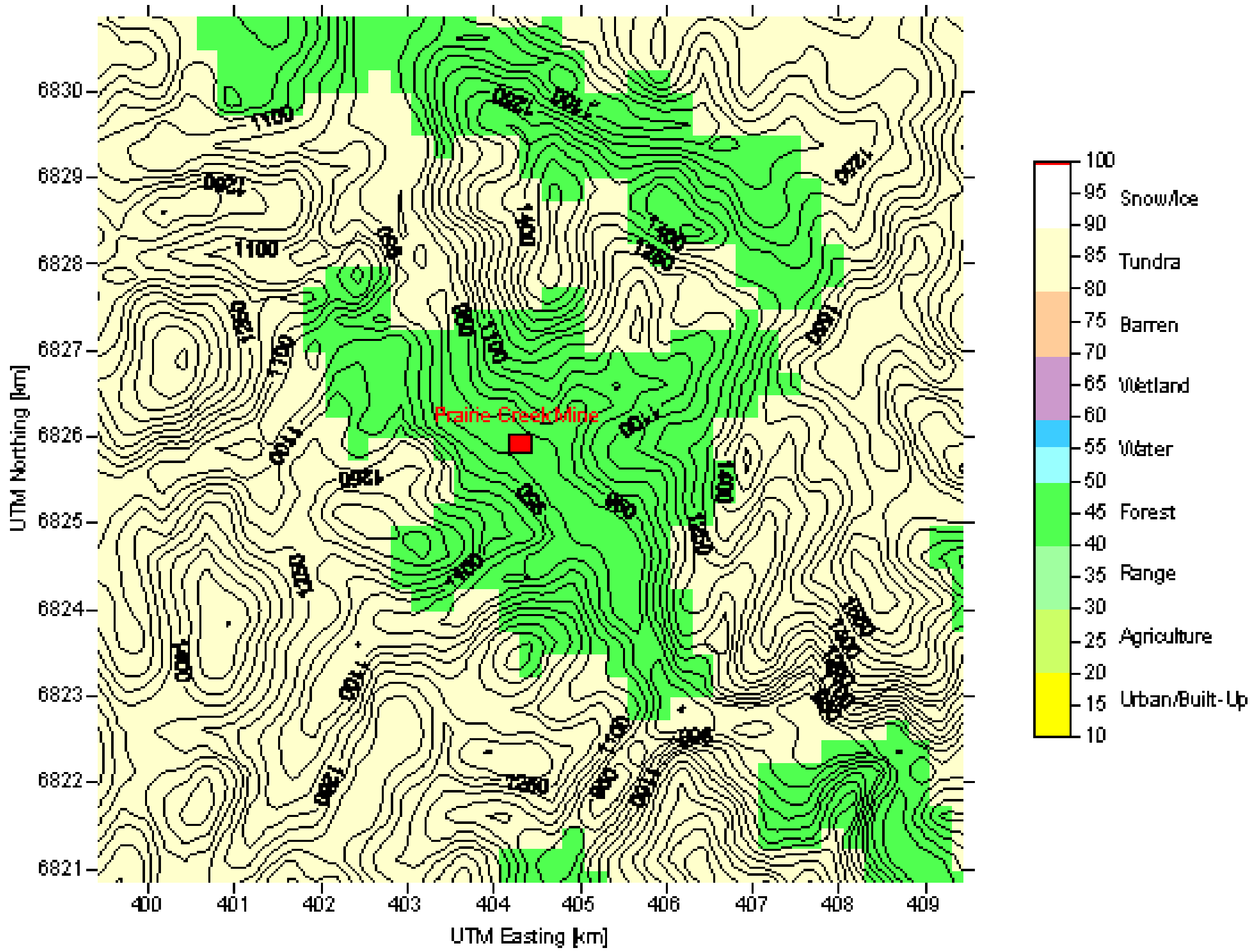


Figure 11: Land Use Around Prairie Creek Mine

Model Initialization

The CALMET model has been initialized using MM5 fields generated for the finest (i.e., 4 km) resolution domain. The MM5 output has been post-processed using CALMM5, a CALMET meteorological pre-processor.

Table 6 presents the options and flags other than defaults used in the CALMET modelling analysis.

Table 6: Listing of Non-Default CALMET Options and Flags Used in the Modelling

Variable	Description of Variable	Default Value	Description of Default Value	Values used in the modelling	Description of Alternative Value
NUSTA	Number of upper air stations	No default	N/A	0	MM5 data used
NOWSTA	Number of overwater met stations	No default	N/A	0	MM5 data used
NM3D	Number of MM4/MM5/3D.DAT files	No default	N/A	4	4 MM5 files per year
NIGF	Number of IGF-CALMET.DAT files	No default	N/A	0	MM5 data used
IBYR	Starting year	No default	N/A	2005 / 2006 / 2007 / 2008	Years included in MM5 modelling
IBMO	Starting month	No default	N/A	1	N/A
IBDY	Starting day	No default	N/A	1	N/A
IBHR	Starting hour	No default	N/A	0	N/A
IBSEC	Starting second	No default	N/A	0	N/A
ABTZ	Coordinated Universal Time (UTC) time zone	No default	N/A	UTC-0700	N/A
LCALGRD	Compute special data fields required by CALGRID (i.e., 3-D fields of W wind components and temperature) in additional to regular fields?	T	True	F	False
MREG	Test options specified to see if they conform to regulatory values?	No default	N/A	0	No checks are made
IUTMZN	Universal Transverse Mercator (UTM) zone	No default	N/A	10	Project area
RLAT0	Latitude of projection origin (decimal degrees)	No default	N/A	40 N	Project area
RLON0	Longitude of projection origin (decimal degrees)	No default	N/A	90 W	Project area
XLAT1	Matching parallel(s) of latitude (decimal degrees) for projection	No default	N/A	30 N	Project area
XLAT2	Matching parallel(s) of latitude (decimal degrees) for projection	No default	N/A	60 N	Project area
DATUM	Datum-region for output coordinates	WGS-84	Reference Ellipsoid and Geoid, Global coverage	NAR-B	Mapping projection (NAD83 for Canada)

Table 6: Listing of Non-default CALMET Options and Flags used in the Modelling (continued)

Variable	Description of Variable	Default Value	Description of Default Value	Values used in the modelling	Description of Alternative Value
NX	Number of grid cells in east-west direction	No default	N/A	41	N/A
NY	Number of grid cells in north-south direction	No default	N/A	41	N/A
DGRIDKM	Grid spacing (km)	No default	N/A	0.25	N/A
XORIGKM	Reference grid coordinate, southwest corner of cell 1,1	No default	N/A	399.3	N/A
YORIGKM	Reference grid coordinate, southwest corner of cell 1,1	No default	N/A	6820.736	N/A
NZ	Number of vertical layers	No default	N/A	12	N/A
ZFACE	Cell face heights (m)	No default	N/A	0, 20, 40, 80, 100, 200, 300, 400, 600, 1000, 1500, 2200, 3000	N/A
NOOBS	NO observation mode	0	Use surface, overwater, and upper air stations	2	No surface, overwater, or upper air observations. Use MM4/MM5/ 3D.DAT
NSSTA	Number of surface stations	No default	N/A	0	MM5 data used
NPSTA	Number of precipitation stations	No default	N/A	-1	Use MM5/3D.DAT precip data
ICLOUD	Cloud data (3 = gridded cloud cover from Prognostic Rel. Humidity at 850 mb)	0	Gridded clouds not used	4	Gridded cloud cover from Prognostic Rel. Humidity at all levels (MM5toGrads algorithm)
IEXTRP	Extrapolate surface wind observations to upper layers?	-4	Similarity theory used	1	No extrapolation is done
RMIN2	Minimum distance from nearest upper air station to surface station for which extrapolation of surface winds at surface station will be allowed	4	If there is no upper air station within 4km, wind data from	1	Do not apply since using MM5 fields

Table 6: Listing of Non-default CALMET Options and Flags used in the Modelling (continued)

Variable	Description of Variable	Default Value	Description of Default Value	Values used in the modelling	Description of Alternative Value
			surface station will be extrapolated		
IPROG	Use gridded prognostic wind field model output fields as input to the diagnostic wind field model	0	No	14	Yes, use winds from MM5/ 3D.DAT file as initial guess field
LVARY	Use varying radius of influence	F	False	T	True
RMAX1	Maximum radius of influence over land in the surface layer	No default	N/A	30	Do not apply since using MM5 fields
RMAX2	Maximum radius of influence over land aloft	No default	N/A	30	Do not apply since using MM5 fields
RMAX3	Maximum radius of influence over water	No default	N/A	50	Do not apply since using MM5 fields
TERRAD	Radius of influence of terrain features (km)	No default	N/A	12	The effect of terrain features for Step 1 wind formulation
R1	Relative weighting of the first guess field and observations in the surface layer (km)	No default	N/A	1	Do not apply since using MM5 fields
R2	Relative weighting of the first guess field and observations in the layers ALOFT (km)	No default	N/A	1	Do not apply since using MM5 fields
RPROG	Relative weighting parameter of the prognostic wind field data (km)	No default	N/A	0	Applied only if MM5 is used as Step 1 wind field
NINTR2	Maximum number of stations used in each layer for the interpolation of data to a grid point	99	N/A	5, 5, 5, 5, 5, 5, 5, 5, 5, 5	Do not apply since using MM5 fields
KBAR	Level (1 to NZ) up to which barriers apply	NZ	No. of vertical layers	12	N/A
ISURFT	Surface met. station to use for the surface temperature	-1	2-D spatially varying surface temperatures	-2	Use a domain-average prognostic surface temperatures

Table 6: Listing of Non-default CALMET Options and Flags used in the Modelling (continued)

Variable	Description of Variable	Default Value	Description of Default Value	Values used in the modelling	Description of Alternative Value
IUPT	Upper air station to use for the domain-scale lapse rate	-1	2-D spatially varying lapse rate	-2	Use a domain-average prognostic lapse rate
ZIMAX	Maximum overland mixing height	3000	N/A	2500	Limit the mixing height to the last layer
ZIMAXW	Maximum overwater mixing height	3000	N/A	2500	Limit the mixing height to the last layer
IRHPROG	3D relative humidity from observations or from prognostic data?	0	Use RH from SURF.DAT file	1	Use prognostic RH
ITPROG	3D temperature from observations or from prognostic data?	0	Use Surface and upper air stations	2	No surface or upper air observations Use MM5/3D.DAT for surface and upper air data
TRADKM	Radius of influence for temperature interpolation (km)	500	N/A	20	Do not apply since using MM5 fields
JWAT1	Beginning land use category for temperature interpolation over water	No default	N/A	55	N/A
JWAT2	Ending land use category for temperature interpolation over water	No default	N/A	55	N/A
SIGMAP	Radius of Influence – precipitation interpolation(km)	100	N/A	50	Do not apply since using MM5 fields

N/A: Not Applicable

Model Output

Figures 12 presents a wind rose generated using CALMET modelling results for 2007 for the grid cell at the middle of the 10 × 10 km modelling grid. The rose represents winds for the surface layer (i.e., height of 10 m). The dominant wind direction shown on the wind rose aligns with the direction of Prairie Creek, as is to be expected.

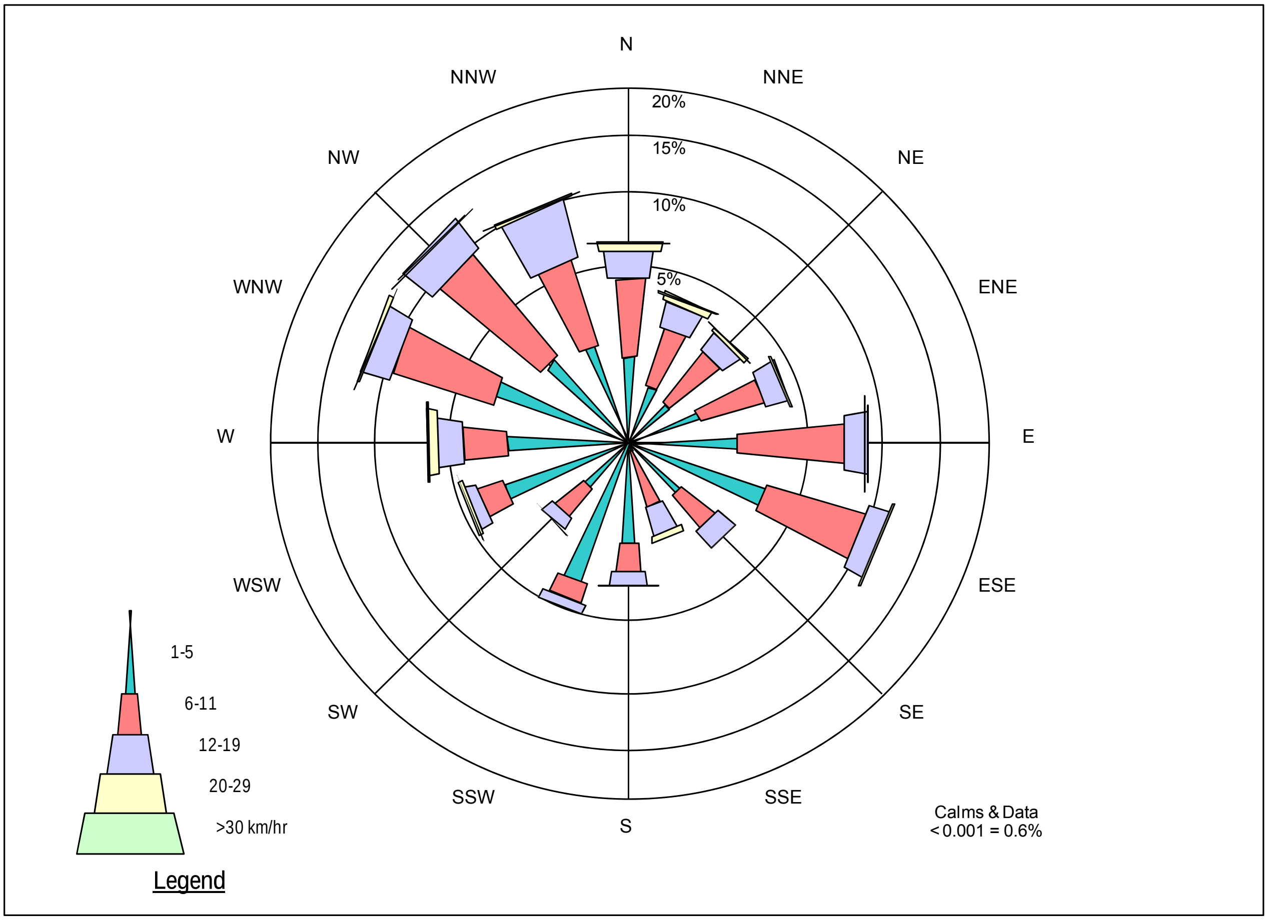


Figure 12: Wind Rose Generated using CALMET Modelling Results - Center of the Modelling Domain

Figure 13 shows wind roses for grid cells located in each corner of the modelling domain. These wind roses are based on CALMET results for 2007 and the surface layer.

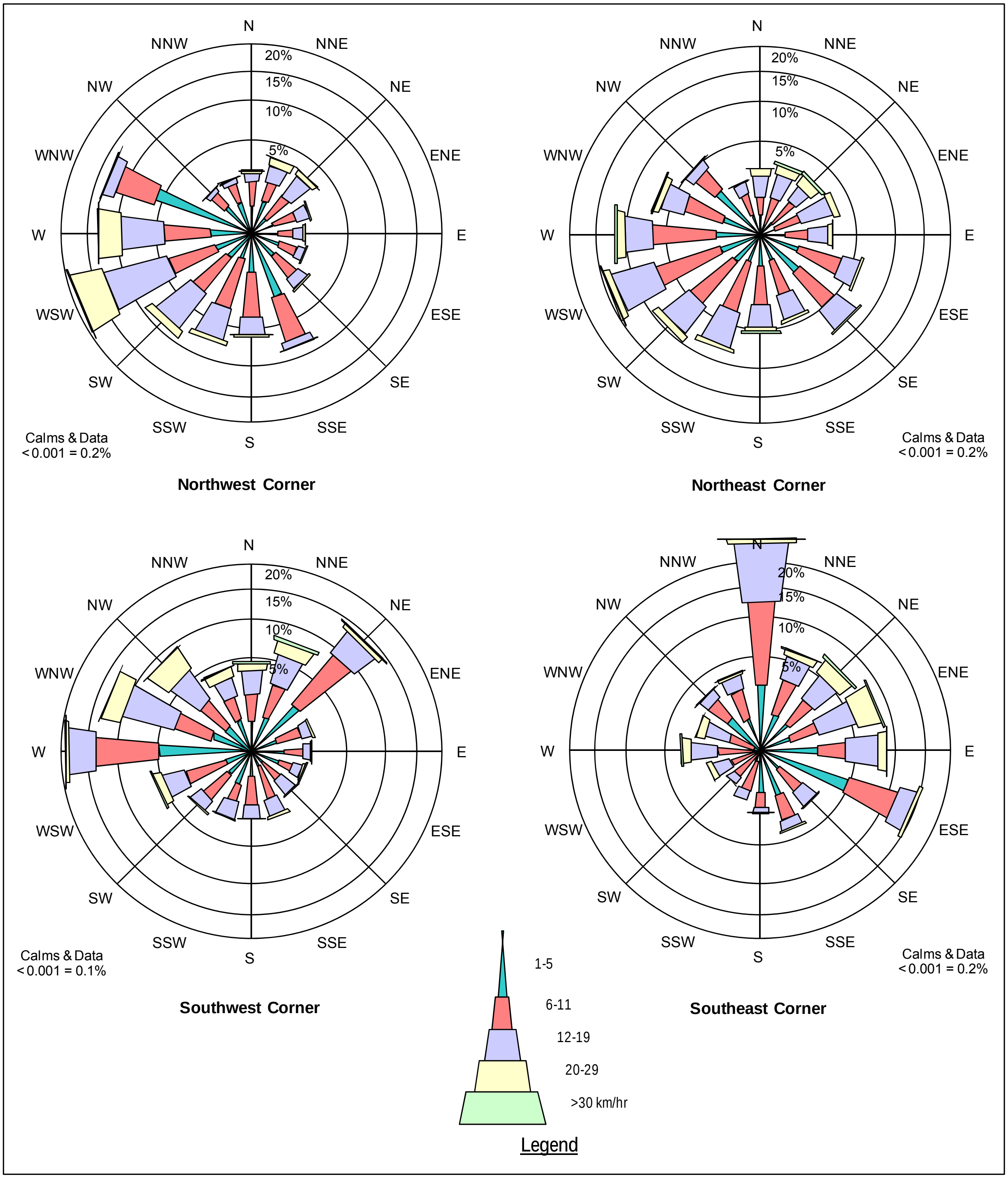


Figure 13: Wind Rose Generated Using CALMET Modelling Results – Corners of the Modelling Domain

Figure 14 presents a comparison between a wind rose generated using CALMET modelling results for the grid cell at the middle of the 10 × 10 km modelling grid and one generated using data from the on-site meteorological station. Both wind roses are based on surface layer data for 2007, which is the most recent year with the most complete data from the on-site meteorological station.

As discussed previously, the wind rose generated using CALMET results indicates the dominant wind direction aligned with the direction of Prairie Creek, as is to be expected. The wind rose generated using on-site measurements indicates a different dominant wind direction, as well as predominance of very low wind speeds, which is not to be expected at the middle of the 10 × 10 km modelling grid (i.e., area adjacent to the mill). One reason for this could be the location of the on-site meteorological station, which is situated southeast of the area adjacent to the mill. The on-site wind rose appears to reflect the influence of local features. Therefore, it is likely that the wind rose generated using CALMET results provides a better representation of the local wind at the middle of the 10 × 10 km modelling grid than that generated using on-site measurements.

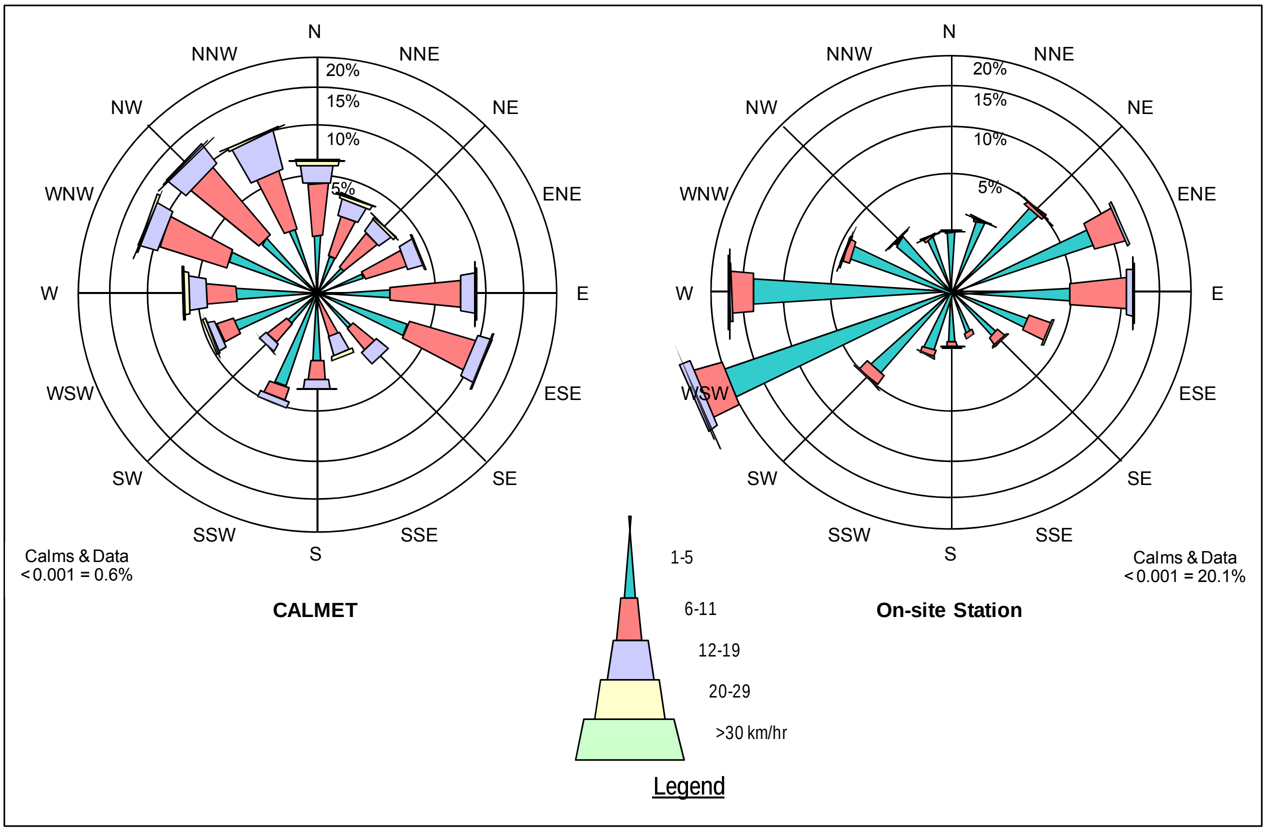


Figure 14: Comparison of Wind roses Generated Using CALMET Modelling Results and Data from the On-site Station

3.5 Baseline Air Quality

The analysis of baseline air quality was based on results of an air quality monitoring program carried out at the Prairie Creek Mine in 2009. In addition to the air quality monitoring program carried out at the site, monitoring stations run by the Northwest Territories Environment and Natural Resources have been identified as potential sources of data. However, because the stations are located in communities and are very distant from the Prairie Creek Mine, the data is not considered appropriate for the purpose of determining baseline concentrations in this Air Quality Assessment.

The air monitoring program included determination of particulate matter (i.e., TSP, PM_{10} and $PM_{2.5}$) concentrations using Hi-vol units (see Figure 15) and SO_2, Nitrogen Dioxide (NO_2) and Ozone (O_3) concentrations using passive sampler units (see figure 16). The Hi-vol units were operated continuously for discrete 24-hour periods, generating samples with total particulate matter collected over these periods and results corresponding to 24-hour average concentrations. The passive samplers were operated continuously for 30-day periods, obtaining results corresponding to monthly average concentrations.

Figure 15: Hi-vol Units Used for Determination of Baseline Concentrations of TSP, PM10 and PM2.5

Figure 16: Passive Sampler Units Used for Determination of Baseline Concentrations of NO_2, SO_2 and O_3

Figures 17 to 22 present the results of the air quality monitoring program carried out at the Prairie Creek Mine area in 2009. These results provide a reasonable estimate of baseline ambient concentrations of TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2 and O_3.

The results indicate low concentrations of particulate matter (TSP, PM_{10} and $PM_{2.5}$), compared to applicable air quality standards, as well as low NO_2, SO_2 and O_3 air concentrations, reflecting a lack of activities around the Prairie Creek Mine area. For several samplings, the concentrations were lower than the detection limit of the monitoring methods. For these samplings, the detection limits have been plotted as a conservative estimate of the concentrations.

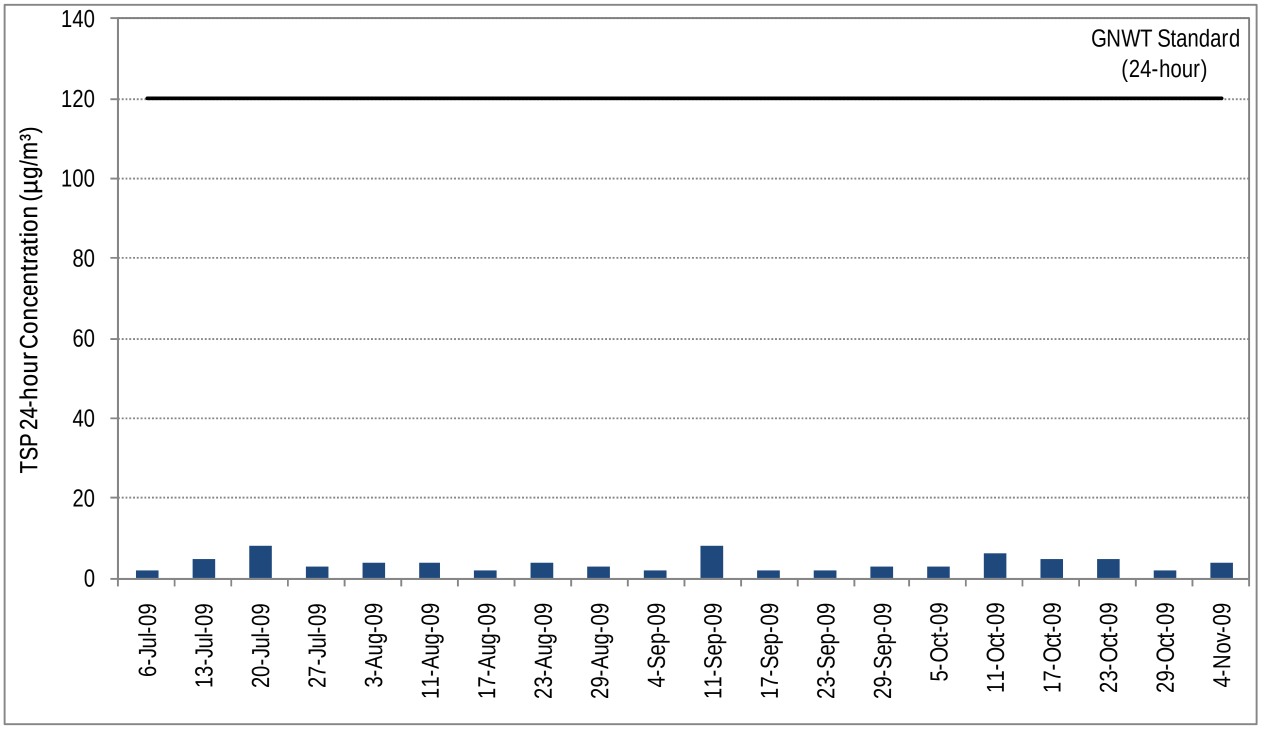


Figure 17: Baseline Concentrations of TSP

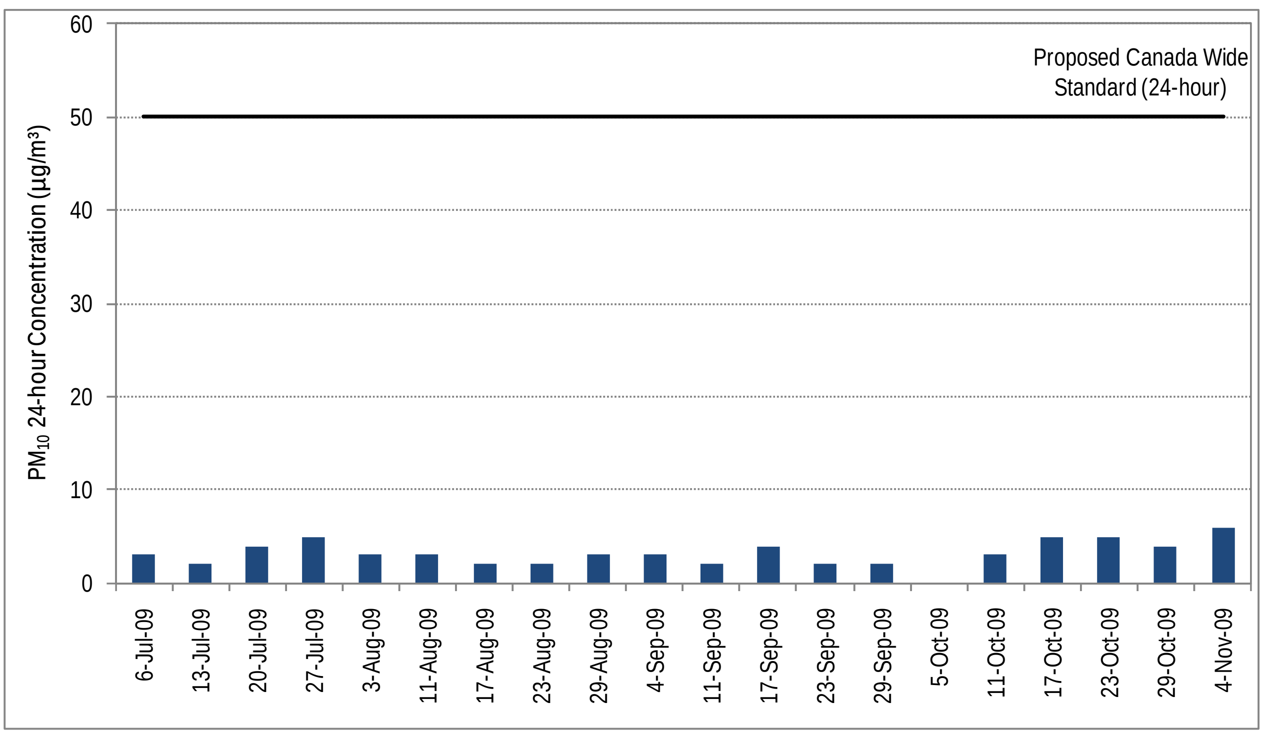


Figure 18: Baseline Concentrations of PM_{10}

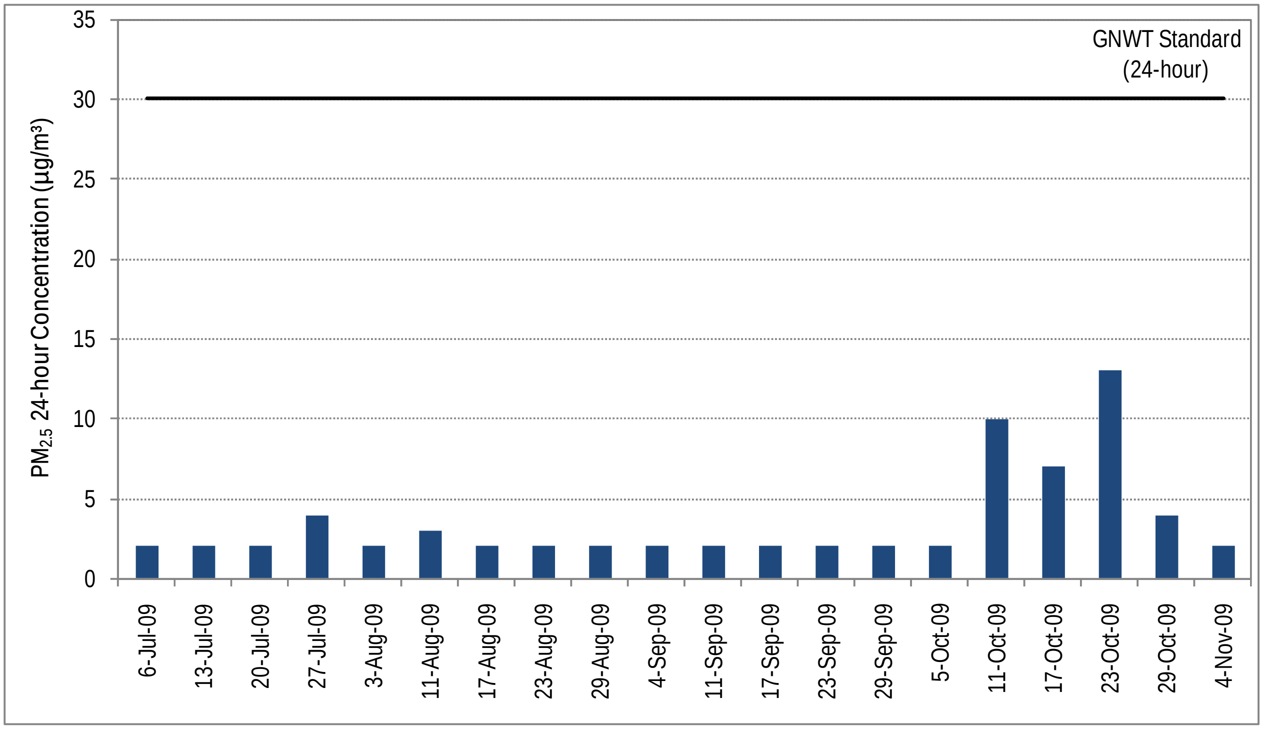


Figure 19: Baseline Concentrations of $PM_{2.5}$

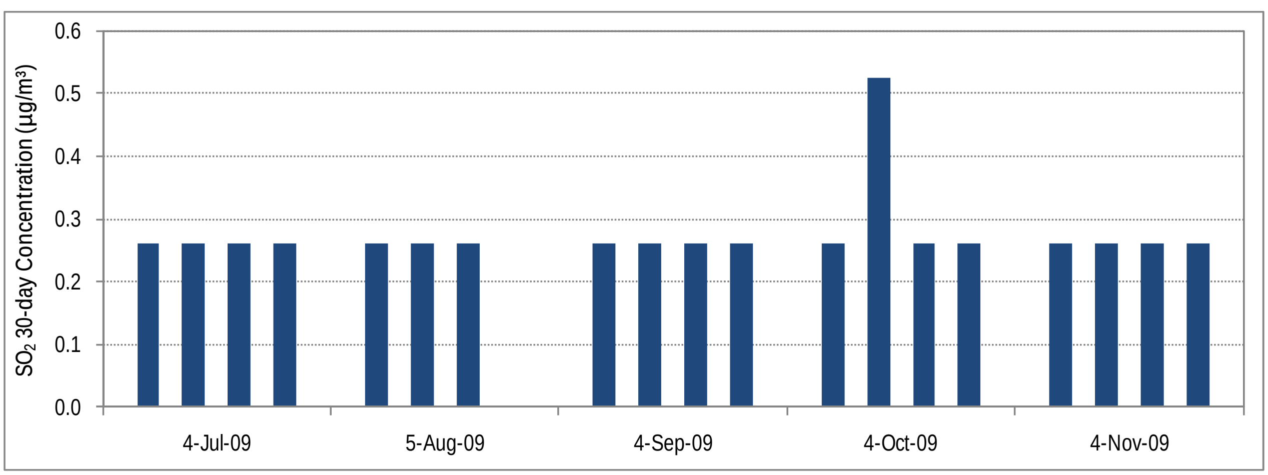


Figure 20: Baseline Concentrations of SO_2

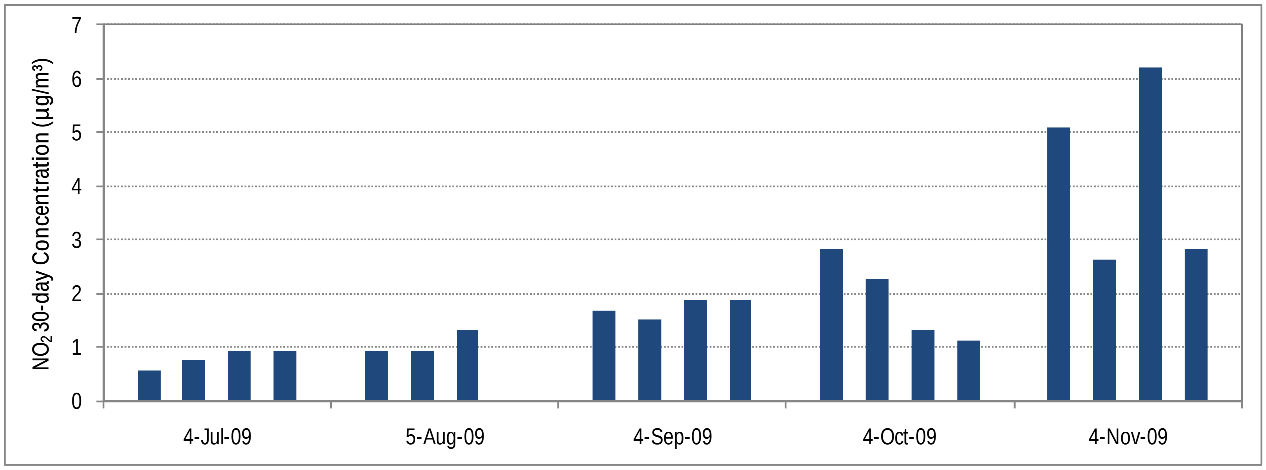


Figure 21: Baseline Concentrations of NO_2

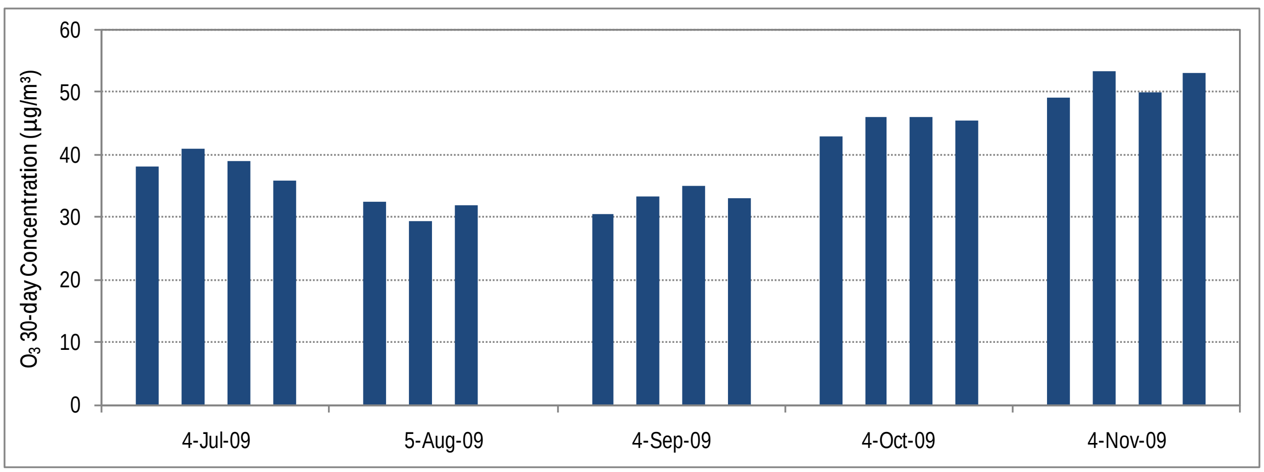


Figure 22: Baseline Concentrations of O_3

4.0 EVALUATION OF POTENTIAL IMPACTS FROM THE PROJECT

4.1 Emission Estimation

4.1.1 Identification of Sources

The first step in preparing the Project emission inventory was to identify the activities that are likely to result in air emissions. Table 2 presents the activities listed in the TOR, and an indication as to whether they are potential sources of air emissions. This table also identifies during which phase of the Project each activity will take place. Each of these activities has been assigned an identification number.

Table 8 provides a listing of the Project activities identified as sources of air emissions, grouped by the phase of the Project and activity type, as listed below:

- Construction:
  - demolition and debris removal;
  - site preparation (earth moving); and
  - general construction.
- Operation:
  - extraction;
  - ore management;
  - ore processing;
  - concentrate storage;
  - concentrate transport;
  - waste rock management;
  - backfill plant;
  - other off-site transport (people, equipment, supplies);
  - access road construction; and
  - other support activities.
- Closure:
  - demolition and debris removal; and
  - general activities.

In addition to grouping the sources, Table 8 also characterizes the activity according to the nature of the emissions using one of the following:

- Fugitive emission: This category includes the fugitive particulate emissions associated with the disturbance of granular material other than ore, including transport activities on unpaved roads. This category does not apply to activities that involve the handling or processing of ore, which are expected to contribute to the airborne release of metals. This category also includes any fugitive emissions of volatile organic compounds (VOC) from fuel storage.
- Fugitive emissions (metals): This category includes the fugitive particulate emissions associated with the disturbance of ore, including handling and transport activities. Because the ore is rich in lead and zinc, fugitive emissions associated with ore are expected to include airborne metals (i.e., lead and zinc).
- Process emissions: This category includes all of the emissions associated with the ore processing activities. As such, these activities are also expected to result in emissions of airborne metals (i.e., lead and zinc).
- Exhaust emissions: This category includes the tail pipe emissions from all of the vehicles and equipment.
- Combustion emission: This category includes the emissions from the stationary combustion sources, namely the power generators and incinerator.

Table 7: Summary of the Project Activities According to the TOR

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Mining and Materials Storage			
Use of existing and development of additional underground workings, including construction of an additional portal and decline.	Yes	Construction and Operation	1.1
Extraction and crushing of ore-bearing rock.	Yes	Operation	1.2
Transport, storage and use of explosives.	Yes	Operation	1.3
Mine dewatering.	No	N/A	1.4
Construction, transportation to and management of a waste rock pile, including water management systems.	Yes	Construction and Operation	1.5
Construction and management of a solid waste landfill within the waste rock pile; Management of dense media separation reject rock, and ore and tailings stockpiles on surface, including construction of any associated foundations, buildings, and water treatment and management systems.	Yes	Construction and Operation	1.6
Backfilling of mined out stopes using a tailings paste backfill and engineered bulkheads.	Yes	Operation	1.7
Mining equipment operation, including vehicles and materials conveyance systems.	Yes	Operation	1.8
Milling			
Construction and use of a concentrate storage shed, concentrate bagging plant, dense media separation circuit, and paste backfill plant alongside the existing mill facility.	Yes	Construction and Operation	2.1
Partial re-construction and operation of the milling complex.	Yes	Construction and Operation	2.2
Extraction, transportation, consumption, recycling, treatment and discharge to the environment of mine water and process water.	No	N/A	2.3
Storage, handling, use and disposal of milling process additives and chemicals, both at the mill and on the reagent pad south of the mill.	No	N/A	2.4
Other On-Site Facilities and Activities			
Removal of the existing coarse ore stockpile.	Yes	Operation	3.1
Replacement of existing diesel power generators and use of new power generators.	Yes	Construction and Operation	3.2

Table 7: Summary of the Project Activities According to the TOR (continued)

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Re-construction and use of the existing tailings pond as a two-cell water storage pond.	Yes	Construction	3.3
Construction and use of drainage control structures and process/waste water pipelines from mine to surface, and on surface at the Prairie Creek Mine site.	Yes	Construction	3.4
Construction of any new roads and use of all roads at the Prairie Creek Mine site.	Yes	Construction and Operation	3.5
Construction and use of a new water treatment plant.	Yes	Construction	3.6
Additional construction where necessary and use during mine operations of existing on-site water management facilities, including the sewage treatment plant, runoff collection and water discharge system (including all drainage ditches, the catchment pond and all culverts and gates at discharge points), and all flood protection dykes around the property.	Yes	Construction	3.7
Extraction of groundwater for use as potable water and for any other purposes.	No	N/A	3.8
Re-construction of portions of, and use of, the fuel storage facility on site, including water management and containment facilities and activities.	Yes	Construction and Operation	3.9
Demolition, re-construction where necessary, and use of portions of the existing support infrastructure at the Prairie Creek Mine site, including the kitchen/diner complex, and some of the accommodation trailers;	Yes	Construction	3.10
Use of existing on-site buildings and other facilities that are to be retained, including the administration/dry building, maintenance shops, bulk of accommodation trailers, equipment storage facilities in the main yard, and the inert waste storage facility (the boneyard) alongside Harrison Creek.	No	N/A	3.11
Use of vehicles and all other emissions sources at the Prairie Creek Mine site.	Yes	Construction, Operation and Closure	3.12
Replacement of existing waste incinerator with new incinerator and its use.	Yes	Construction and Operation	3.13
Support/Ancillary Facilities and Activities			
Initial upgrading (as necessary) and annual construction activities associated with the access road from the mine to Territorial Highway 7 (Liard Highway), including vehicle traffic, water use and water crossings.	Yes	Construction and Operation	4.1

Table 7: Summary of the Project Activities According to the TOR (continued)

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Re-construction and use of the existing tailings pond as a two-cell water storage pond.	Yes	Construction	3.3
Construction and use of drainage control structures and process/waste water pipelines from mine to surface, and on surface at the Prairie Creek Mine site.	Yes	Construction	3.4
Construction of any new roads and use of all roads at the Prairie Creek Mine site.	Yes	Construction and Operation	3.5
Construction and use of a new water treatment plant.	Yes	Construction	3.6
Additional construction where necessary and use during mine operations of existing on-site water management facilities, including the sewage treatment plant, runoff collection and water discharge system (including all drainage ditches, the catchment pond and all culverts and gates at discharge points), and all flood protection dykes around the property.	Yes	Construction	3.7
Extraction of groundwater for use as potable water and for any other purposes.	No	N/A	3.8
Re-construction of portions of, and use of, the fuel storage facility on site, including water management and containment facilities and activities.	Yes	Construction and Operation	3.9
Demolition, re-construction where necessary, and use of portions of the existing support infrastructure at the Prairie Creek Mine site, including the kitchen/diner complex, and some of the accommodation trailers;	Yes	Construction	3.10
Use of existing on-site buildings and other facilities that are to be retained, including the administration/dry building, maintenance shops, bulk of accommodation trailers, equipment storage facilities in the main yard, and the inert waste storage facility (the boneyard) alongside Harrison Creek.	No	N/A	3.11
Use of vehicles and all other emissions sources at the Prairie Creek Mine site.	Yes	Construction, Operation and Closure	3.12
Replacement of existing waste incinerator with new incinerator and its use.	Yes	Construction and Operation	3.13
Support/Ancillary Facilities and Activities			
Initial upgrading (as necessary) and annual construction activities associated with the access road from the mine to Territorial Highway 7 (Liard Highway), including vehicle traffic, water use and water crossings.	Yes	Construction and Operation	4.1

Table 7: Summary of the Project Activities According to the TOR (continued)

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Truck transport of concentrate from the Prairie Creek Mine site along the access road and the Liard Highway to the railhead at Fort Nelson.	Yes	Operation	4.2
Transportation activities by air and road/access road that support the Prairie Creek Mine's operation, including transportation of goods, fuel, contractors and employees in to and out of the mine, and removal and disposal of wastes or other materials, including operation of the existing airstrip at the Prairie Creek Mine site.	Yes	Operation	4.3
Construction and use of two transfer facilities, one at km 84 from the mine along the access road (Tetcela Transfer Facility), and the other near the Liard Highway east of the Liard River crossing (Liard Transfer Facility), including unloading, storage, and reloading of concentrate, hydrocarbons and other materials.	Yes	Construction and Operation	4.4
Development and use of borrow sources for aggregate production at the mine site or along the access road.	Yes	Construction and Operation	4.5
Closure and Reclamation			
Removal or stabilization of all structures and equipment.	Yes	Closure	5.1
Reclamation of water storage pond and all other site water management facilities.	Yes	Closure	5.2
Reclamation of the access road and all Prairie Creek Mine site road networks.	Yes	Closure	5.3
Reclamation of infrastructure foundations, dyking system, piping, and all built structures at the Prairie Creek Mine.	Yes	Closure	5.4
Reclamation of the Tetcela and Liard Transfer Facilities.	Yes	Closure	5.5
Reclamation of the waste rock pile, dense media separation reject rock, tailings, and ore stockpiles and any other surface materials storage locations.	Yes	Closure	5.6
Re-vegetation of areas affected by mining or support activities.	Yes	Closure	5.7
Backfilling, bulkhead installation and other capping of the underground works.	Yes	Operation and Closure	5.8
Long-term mine water outflow monitoring/management around the mine site.	No	N/A	5.9

Table 7: Summary of the Project Activities According to the TOR (continued)

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Re-construction and use of the existing tailings pond as a two-cell water storage pond.	Yes	Construction	3.3
Construction and use of drainage control structures and process/waste water pipelines from mine to surface, and on surface at the Prairie Creek Mine site.	Yes	Construction	3.4
Construction of any new roads and use of all roads at the Prairie Creek Mine site.	Yes	Construction and Operation	3.5
Construction and use of a new water treatment plant.	Yes	Construction	3.6
Additional construction where necessary and use during mine operations of existing on-site water management facilities, including the sewage treatment plant, runoff collection and water discharge system (including all drainage ditches, the catchment pond and all culverts and gates at discharge points), and all flood protection dykes around the property.	Yes	Construction	3.7
Extraction of groundwater for use as potable water and for any other purposes.	No	N/A	3.8
Re-construction of portions of, and use of, the fuel storage facility on site, including water management and containment facilities and activities.	Yes	Construction and Operation	3.9
Demolition, re-construction where necessary, and use of portions of the existing support infrastructure at the Prairie Creek Mine site, including the kitchen/diner complex, and some of the accommodation trailers;	Yes	Construction	3.10
Use of existing on-site buildings and other facilities that are to be retained, including the administration/dry building, maintenance shops, bulk of accommodation trailers, equipment storage facilities in the main yard, and the inert waste storage facility (the boneyard) alongside Harrison Creek.	No	N/A	3.11
Use of vehicles and all other emissions sources at the Prairie Creek Mine site.	Yes	Construction, Operation and Closure	3.12
Replacement of existing waste incinerator with new incinerator and its use.	Yes	Construction and Operation	3.13
Support/Ancillary Facilities and Activities			
Initial upgrading (as necessary) and annual construction activities associated with the access road from the mine to Territorial Highway 7 (Liard Highway), including vehicle traffic, water use and water crossings.	Yes	Construction and Operation	4.1

Table 7: Summary of the Project Activities According to the TOR (continued)

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Truck transport of concentrate from the Prairie Creek Mine site along the access road and the Liard Highway to the railhead at Fort Nelson.	Yes	Operation	4.2
Transportation activities by air and road/access road that support the Prairie Creek Mine's operation, including transportation of goods, fuel, contractors and employees in to and out of the mine, and removal and disposal of wastes or other materials, including operation of the existing airstrip at the Prairie Creek Mine site.	Yes	Operation	4.3
Construction and use of two transfer facilities, one at km 84 from the mine along the access road (Tetcela Transfer Facility), and the other near the Liard Highway east of the Liard River crossing (Liard Transfer Facility), including unloading, storage, and reloading of concentrate, hydrocarbons and other materials.	Yes	Construction and Operation	4.4
Development and use of borrow sources for aggregate production at the mine site or along the access road.	Yes	Construction and Operation	4.5
Closure and Reclamation			
Removal or stabilization of all structures and equipment.	Yes	Closure	5.1
Reclamation of water storage pond and all other site water management facilities.	Yes	Closure	5.2
Reclamation of the access road and all Prairie Creek Mine site road networks.	Yes	Closure	5.3
Reclamation of infrastructure foundations, dyking system, piping, and all built structures at the Prairie Creek Mine.	Yes	Closure	5.4
Reclamation of the Tetcela and Liard Transfer Facilities.	Yes	Closure	5.5
Reclamation of the waste rock pile, dense media separation reject rock, tailings, and ore stockpiles and any other surface materials storage locations.	Yes	Closure	5.6
Re-vegetation of areas affected by mining or support activities.	Yes	Closure	5.7
Backfilling, bulkhead installation and other capping of the underground works.	Yes	Operation and Closure	5.8
Long-term mine water outflow monitoring/management around the mine site.	No	N/A	5.9

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Construction	I - Demolition and Debris Removal	I.1 - Drilling	1.1	Fugitive Emissions
				Exhaust Emissions
		I.2 - Blasting	1.1	Fugitive Emissions
		I.3 - General land clearing (dozer)	3.10	Fugitive Emissions
				Exhaust Emissions
		I.4 - Loading of debris into trucks	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
		I.5 - Truck transport of debris (unpaved roads)	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
	II - Site Preparation (earth moving)	II.1 - Bulldozing	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4; 4.5	Fugitive Emissions
				Exhaust Emissions
		II.2 - Scrapers removing topsoil	1.5; 1.6; 2.1; 3.3; 3.5; 3.8; 4.4	Fugitive Emissions
		II.3 - Scrapers in travel	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 3.8; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.4 - Scrapers unloading top soil	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
		II.5 - Material handling (aggregate material, cement)	2.1; 2.2; 3.6; 3.9; 3.10; 4.4	Fugitive Emissions
		II.6 - Compacting (dozer)	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.7 - Grading	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
	III - General Construction	III.1 - Vehicular traffic	1.1; 2.1; 2.2; 3.2; 3.4; 3.6; 3.7; 3.9; 3.10; 3.12; 3.13	Fugitive Emissions
				Exhaust Emissions
		III.2 - Power Generation	-	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Operation	I - Extraction	I.1 - Drilling	1.1; 1.2	Fugitive Emissions (metals)
				Exhaust Emissions
		I.2 - Blasting	1.3	Fugitive Emissions (metals)
				Combustion Emissions
		I.3 - Ore transport (mucking and haul truck transport)	1.3; 1.8; 3.5	Fugitive Emissions
				Exhaust Emissions
	II - Ore Management	II.1 - Transfer (dump) to conveyor	1.6	Fugitive Emissions (metals)
		II.2 - Conveyor transport	1.8	Fugitive Emissions (metals)
		II.3 - Stockpiling (dump to permanent stockpile)	1.6	Fugitive Emissions (metals)
		II.4 - Recover from permanent (new) stockpile	3.1	Fugitive Emissions (metals)
		II.5 - Ore stockpile maintenance (permanent (new) stockpile)	1.6	Fugitive Emissions (metals)
				Exhaust Emissions
		II.6 - Recover from existing (reconfigured) stockpile	3.1	Fugitive Emissions (metals)
		II.7 - Ore stockpile maintenance (existing (reconfigured) stockpile)	3.1	Fugitive Emissions (metals)
				Exhaust Emissions
	III - Ore Processing	III.1 - Primary Crushing	1.2; 2.2	Process Emissions
		III.2 - Secondary Crushing	1.2; 2.2	Process Emissions
		III.3 - Dense Media Separation	2.2	N/A
		III.4 - Grinding	2.2	N/A
		III.5 - Flotation and recovery	2.1; 2.2	N/A
	IV - Concentrate Storage	IV.1 - Bagging	2.1	Fugitive Emissions (metals)
				Exhaust Emissions
		IV.2 - Storage	2.1	N/A
	V - Concentrate Transport	V.1 - Road transport (access road)	4.2	Exhaust Emissions
		V.2 - Transfer operations (at Tetcela and Liard transfer facilities)	4.4	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
	VI - Waste Rock Management	VI.1 - Waste rock dumping / recovery from Waste Dump	1.5	Fugitive Emissions
		VI.2 - Transport of waste rock to waste rock pile	1.5	Fugitive Emissions
				Exhaust Emissions
		VI.3 - Waste rock dumping on waste rock pile	1.5	Fugitive Emissions
		VI.4 - Waste rock pile maintenance	1.5	Fugitive Emissions
				Exhaust Emissions
	VII - Backfill Plant	VII.1 - Batch operations / Waste rock transfer	1.7; 2.1; 4.5; 5.8	N/A
		VII.2 - Batch operations / Cement unloading	1.7; 2.1; 5.8	Fugitive Emissions
		VII.3 - Batch operations / Mixer loading	1.7; 2.1; 5.8	Fugitive Emissions
	VIII - Other Off-site Transport (people, equipment, supplies)	VIII.1 - Road transport (access road)	1.3; 4.3	Fugitive Emissions
		VIII.2 - Air transport	4.3	Fugitive Emissions
				Exhaust Emissions
	XI - Access Road Construction	XI.1 - Access road construction	4.1	Exhaust Emissions
	X - Support Activities	X.1 - Power generation	3.2	Combustion Emissions
		X.2 - Incineration	3.13	Combustion Emissions
		X.3 - Heating	3.11	N/A
		X.4 - On-site use of support equipment and vehicles	3.5; 3.12	Fugitive Emissions
				Exhaust Emissions
		X.5 - Fuel storage	3.9	Fugitive Emissions
Closure	I - Demolition and Debris Removal	I.1 - General land clearing (dozer)	5.1; 5.2; 5.3; 5.4 5.5; 5.6	Fugitive Emissions
				Exhaust Emissions
		I.2 - Loading of debris into trucks	5.1; 5.4	Fugitive Emissions
	II - General Activities	II.1 - Vehicular traffic	3.12; 5.1; 5.7	Fugitive Emissions
				Exhaust Emissions

N/A: Not Applicable

Table 7: Summary of the Project Activities According to the TOR (continued)

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Truck transport of concentrate from the Prairie Creek Mine site along the access road and the Liard Highway to the railhead at Fort Nelson.	Yes	Operation	4.2
Transportation activities by air and road/access road that support the Prairie Creek Mine's operation, including transportation of goods, fuel, contractors and employees in to and out of the mine, and removal and disposal of wastes or other materials, including operation of the existing airstrip at the Prairie Creek Mine site.	Yes	Operation	4.3
Construction and use of two transfer facilities, one at km 84 from the mine along the access road (Tetcela Transfer Facility), and the other near the Liard Highway east of the Liard River crossing (Liard Transfer Facility), including unloading, storage, and reloading of concentrate, hydrocarbons and other materials.	Yes	Construction and Operation	4.4
Development and use of borrow sources for aggregate production at the mine site or along the access road.	Yes	Construction and Operation	4.5
Closure and Reclamation			
Removal or stabilization of all structures and equipment.	Yes	Closure	5.1
Reclamation of water storage pond and all other site water management facilities.	Yes	Closure	5.2
Reclamation of the access road and all Prairie Creek Mine site road networks.	Yes	Closure	5.3
Reclamation of infrastructure foundations, dyking system, piping, and all built structures at the Prairie Creek Mine.	Yes	Closure	5.4
Reclamation of the Tetcela and Liard Transfer Facilities.	Yes	Closure	5.5
Reclamation of the waste rock pile, dense media separation reject rock, tailings, and ore stockpiles and any other surface materials storage locations.	Yes	Closure	5.6
Re-vegetation of areas affected by mining or support activities.	Yes	Closure	5.7
Backfilling, bulkhead installation and other capping of the underground works.	Yes	Operation and Closure	5.8
Long-term mine water outflow monitoring/management around the mine site.	No	N/A	5.9

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Construction	I - Demolition and Debris Removal	I.1 - Drilling	1.1	Fugitive Emissions
				Exhaust Emissions
		I.2 - Blasting	1.1	Fugitive Emissions
		I.3 - General land clearing (dozer)	3.10	Fugitive Emissions
				Exhaust Emissions
		I.4 - Loading of debris into trucks	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
		I.5 - Truck transport of debris (unpaved roads)	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
	II - Site Preparation (earth moving)	II.1 - Bulldozing	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4; 4.5	Fugitive Emissions
				Exhaust Emissions
		II.2 - Scrapers removing topsoil	1.5; 1.6; 2.1; 3.3; 3.5; 3.8; 4.4	Fugitive Emissions
		II.3 - Scrapers in travel	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 3.8; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.4 - Scrapers unloading top soil	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
		II.5 - Material handling (aggregate material, cement)	2.1; 2.2; 3.6; 3.9; 3.10; 4.4	Fugitive Emissions
		II.6 - Compacting (dozer)	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.7 - Grading	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
	III - General Construction	III.1 - Vehicular traffic	1.1; 2.1; 2.2; 3.2; 3.4; 3.6; 3.7; 3.9; 3.10; 3.12; 3.13	Fugitive Emissions
				Exhaust Emissions
		III.2 - Power Generation	-	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Operation	I - Extraction	I.1 - Drilling	1.1; 1.2	Fugitive Emissions (metals)
				Exhaust Emissions
		I.2 - Blasting	1.3	Fugitive Emissions (metals)
				Combustion Emissions
		I.3 - Ore transport (mucking and haul truck transport)	1.3; 1.8; 3.5	Fugitive Emissions
				Exhaust Emissions
	II - Ore Management	II.1 - Transfer (dump) to conveyor	1.6	Fugitive Emissions (metals)
		II.2 - Conveyor transport	1.8	Fugitive Emissions (metals)
		II.3 - Stockpiling (dump to permanent stockpile)	1.6	Fugitive Emissions (metals)
		II.4 - Recover from permanent (new) stockpile	3.1	Fugitive Emissions (metals)
		II.5 - Ore stockpile maintenance (permanent (new) stockpile)	1.6	Fugitive Emissions (metals)
				Exhaust Emissions
		II.6 - Recover from existing (reconfigured) stockpile	3.1	Fugitive Emissions (metals)
		II.7 - Ore stockpile maintenance (existing (reconfigured) stockpile)	3.1	Fugitive Emissions (metals)
				Exhaust Emissions
	III - Ore Processing	III.1 - Primary Crushing	1.2; 2.2	Process Emissions
		III.2 - Secondary Crushing	1.2; 2.2	Process Emissions
		III.3 - Dense Media Separation	2.2	N/A
		III.4 - Grinding	2.2	N/A
		III.5 - Flotation and recovery	2.1; 2.2	N/A
	IV - Concentrate Storage	IV.1 - Bagging	2.1	Fugitive Emissions (metals)
				Exhaust Emissions
		IV.2 - Storage	2.1	N/A
	V - Concentrate Transport	V.1 - Road transport (access road)	4.2	Exhaust Emissions
		V.2 - Transfer operations (at Tetcela and Liard transfer facilities)	4.4	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
	VI - Waste Rock Management	VI.1 - Waste rock dumping / recovery from Waste Dump	1.5	Fugitive Emissions
		VI.2 - Transport of waste rock to waste rock pile	1.5	Fugitive Emissions
				Exhaust Emissions
		VI.3 - Waste rock dumping on waste rock pile	1.5	Fugitive Emissions
		VI.4 - Waste rock pile maintenance	1.5	Fugitive Emissions
				Exhaust Emissions
	VII - Backfill Plant	VII.1 - Batch operations / Waste rock transfer	1.7; 2.1; 4.5; 5.8	N/A
		VII.2 - Batch operations / Cement unloading	1.7; 2.1; 5.8	Fugitive Emissions
		VII.3 - Batch operations / Mixer loading	1.7; 2.1; 5.8	Fugitive Emissions
	VIII - Other Off-site Transport (people, equipment, supplies)	VIII.1 - Road transport (access road)	1.3; 4.3	Fugitive Emissions
		VIII.2 - Air transport	4.3	Fugitive Emissions
				Exhaust Emissions
	XI - Access Road Construction	XI.1 - Access road construction	4.1	Exhaust Emissions
	X - Support Activities	X.1 - Power generation	3.2	Combustion Emissions
		X.2 - Incineration	3.13	Combustion Emissions
		X.3 - Heating	3.11	N/A
		X.4 - On-site use of support equipment and vehicles	3.5; 3.12	Fugitive Emissions
				Exhaust Emissions
		X.5 - Fuel storage	3.9	Fugitive Emissions
Closure	I - Demolition and Debris Removal	I.1 - General land clearing (dozer)	5.1; 5.2; 5.3; 5.4 5.5; 5.6	Fugitive Emissions
				Exhaust Emissions
		I.2 - Loading of debris into trucks	5.1; 5.4	Fugitive Emissions
	II - General Activities	II.1 - Vehicular traffic	3.12; 5.1; 5.7	Fugitive Emissions
				Exhaust Emissions

N/A: Not Applicable

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Construction	I - Demolition and Debris Removal	I.1 - Drilling	1.1	Fugitive Emissions
				Exhaust Emissions
		I.2 - Blasting	1.1	Fugitive Emissions
		I.3 - General land clearing (dozer)	3.10	Fugitive Emissions
				Exhaust Emissions
		I.4 - Loading of debris into trucks	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
		I.5 - Truck transport of debris (unpaved roads)	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
	II - Site Preparation (earth moving)	II.1 - Bulldozing	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4; 4.5	Fugitive Emissions
				Exhaust Emissions
		II.2 - Scrapers removing topsoil	1.5; 1.6; 2.1; 3.3; 3.5; 3.8; 4.4	Fugitive Emissions
		II.3 - Scrapers in travel	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 3.8; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.4 - Scrapers unloading top soil	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
		II.5 - Material handling (aggregate material, cement)	2.1; 2.2; 3.6; 3.9; 3.10; 4.4	Fugitive Emissions
		II.6 - Compacting (dozer)	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.7 - Grading	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
	III - General Construction	III.1 - Vehicular traffic	1.1; 2.1; 2.2; 3.2; 3.4; 3.6; 3.7; 3.9; 3.10; 3.12; 3.13	Fugitive Emissions
				Exhaust Emissions
		III.2 - Power Generation	-	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Operation	I - Extraction	I.1 - Drilling	1.1; 1.2	Fugitive Emissions (metals)
				Exhaust Emissions
		I.2 - Blasting	1.3	Fugitive Emissions (metals)
				Combustion Emissions
		I.3 - Ore transport (mucking and haul truck transport)	1.3; 1.8; 3.5	Fugitive Emissions
				Exhaust Emissions
	II - Ore Management	II.1 - Transfer (dump) to conveyor	1.6	Fugitive Emissions (metals)
		II.2 - Conveyor transport	1.8	Fugitive Emissions (metals)
		II.3 - Stockpiling (dump to permanent stockpile)	1.6	Fugitive Emissions (metals)
		II.4 - Recover from permanent (new) stockpile	3.1	Fugitive Emissions (metals)
		II.5 - Ore stockpile maintenance (permanent (new) stockpile)	1.6	Fugitive Emissions (metals)
				Exhaust Emissions
		II.6 - Recover from existing (reconfigured) stockpile	3.1	Fugitive Emissions (metals)
		II.7 - Ore stockpile maintenance (existing (reconfigured) stockpile)	3.1	Fugitive Emissions (metals)
				Exhaust Emissions
	III - Ore Processing	III.1 - Primary Crushing	1.2; 2.2	Process Emissions
		III.2 - Secondary Crushing	1.2; 2.2	Process Emissions
		III.3 - Dense Media Separation	2.2	N/A
		III.4 - Grinding	2.2	N/A
		III.5 - Flotation and recovery	2.1; 2.2	N/A
	IV - Concentrate Storage	IV.1 - Bagging	2.1	Fugitive Emissions (metals)
				Exhaust Emissions
		IV.2 - Storage	2.1	N/A
	V - Concentrate Transport	V.1 - Road transport (access road)	4.2	Exhaust Emissions
		V.2 - Transfer operations (at Tetcela and Liard transfer facilities)	4.4	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
	VI - Waste Rock Management	VI.1 - Waste rock dumping / recovery from Waste Dump	1.5	Fugitive Emissions
		VI.2 - Transport of waste rock to waste rock pile	1.5	Fugitive Emissions Exhaust Emissions
		VI.3 - Waste rock dumping on waste rock pile	1.5	Fugitive Emissions
		VI.4 - Waste rock pile maintenance	1.5	Fugitive Emissions Exhaust Emissions
	VII - Backfill Plant	VII.1 - Batch operations / Waste rock transfer	1.7; 2.1; 4.5; 5.8	N/A
		VII.2 - Batch operations / Cement unloading	1.7; 2.1; 5.8	Fugitive Emissions
		VII.3 - Batch operations / Mixer loading	1.7; 2.1; 5.8	Fugitive Emissions
	VIII - Other Off-site Transport (people, equipment, supplies)	VIII.1 - Road transport (access road)	1.3; 4.3	Fugitive Emissions
		VIII.2 - Air transport	4.3	Fugitive Emissions Exhaust Emissions
	XI - Access Road Construction	XI.1 - Access road construction	4.1	Exhaust Emissions
	X - Support Activities	X.1 - Power generation	3.2	Combustion Emissions
		X.2 - Incineration	3.13	Combustion Emissions
		X.3 - Heating	3.11	N/A
		X.4 - On-site use of support equipment and vehicles	3.5; 3.12	Fugitive Emissions Exhaust Emissions
		X.5 - Fuel storage	3.9	Fugitive Emissions
Closure	I - Demolition and Debris Removal	I.1 - General land clearing (dozer)	5.1; 5.2; 5.3; 5.4 5.5; 5.6	Fugitive Emissions Exhaust Emissions
		I.2 - Loading of debris into trucks	5.1; 5.4	Fugitive Emissions
	II - General Activities	II.1 - Vehicular traffic	3.12; 5.1; 5.7	Fugitive Emissions Exhaust Emissions

N/A: Not Applicable

Table 7: Summary of the Project Activities According to the TOR (continued)

Terms of Reference Activities (Section 2.1 of TOR)	Potential source of air emissions?	Project Phase (Construction, Operation, Closure)	Ref.
Truck transport of concentrate from the Prairie Creek Mine site along the access road and the Liard Highway to the railhead at Fort Nelson.	Yes	Operation	4.2
Transportation activities by air and road/access road that support the Prairie Creek Mine's operation, including transportation of goods, fuel, contractors and employees in to and out of the mine, and removal and disposal of wastes or other materials, including operation of the existing airstrip at the Prairie Creek Mine site.	Yes	Operation	4.3
Construction and use of two transfer facilities, one at km 84 from the mine along the access road (Tetcela Transfer Facility), and the other near the Liard Highway east of the Liard River crossing (Liard Transfer Facility), including unloading, storage, and reloading of concentrate, hydrocarbons and other materials.	Yes	Construction and Operation	4.4
Development and use of borrow sources for aggregate production at the mine site or along the access road.	Yes	Construction and Operation	4.5
Closure and Reclamation			
Removal or stabilization of all structures and equipment.	Yes	Closure	5.1
Reclamation of water storage pond and all other site water management facilities.	Yes	Closure	5.2
Reclamation of the access road and all Prairie Creek Mine site road networks.	Yes	Closure	5.3
Reclamation of infrastructure foundations, dyking system, piping, and all built structures at the Prairie Creek Mine.	Yes	Closure	5.4
Reclamation of the Tetcela and Liard Transfer Facilities.	Yes	Closure	5.5
Reclamation of the waste rock pile, dense media separation reject rock, tailings, and ore stockpiles and any other surface materials storage locations.	Yes	Closure	5.6
Re-vegetation of areas affected by mining or support activities.	Yes	Closure	5.7
Backfilling, bulkhead installation and other capping of the underground works.	Yes	Operation and Closure	5.8
Long-term mine water outflow monitoring/management around the mine site.	No	N/A	5.9

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Construction	I - Demolition and Debris Removal	I.1 - Drilling	1.1	Fugitive Emissions
				Exhaust Emissions
		I.2 - Blasting	1.1	Fugitive Emissions
		I.3 - General land clearing (dozer)	3.10	Fugitive Emissions
				Exhaust Emissions
		I.4 - Loading of debris into trucks	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
		I.5 - Truck transport of debris (unpaved roads)	1.1; 3.10	Fugitive Emissions
				Exhaust Emissions
	II - Site Preparation (earth moving)	II.1 - Bulldozing	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4; 4.5	Fugitive Emissions
				Exhaust Emissions
		II.2 - Scrapers removing topsoil	1.5; 1.6; 2.1; 3.3; 3.5; 3.8; 4.4	Fugitive Emissions
		II.3 - Scrapers in travel	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 3.8; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.4 - Scrapers unloading top soil	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
		II.5 - Material handling (aggregate material, cement)	2.1; 2.2; 3.6; 3.9; 3.10; 4.4	Fugitive Emissions
		II.6 - Compacting (dozer)	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
		II.7 - Grading	1.5; 1.6; 2.1; 3.3; 3.5; 3.6; 4.4	Fugitive Emissions
				Exhaust Emissions
	III - General Construction	III.1 - Vehicular traffic	1.1; 2.1; 2.2; 3.2; 3.4; 3.6; 3.7; 3.9; 3.10; 3.12; 3.13	Fugitive Emissions
				Exhaust Emissions
		III.2 - Power Generation	-	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
Operation	I - Extraction	I.1 - Drilling	1.1; 1.2	Fugitive Emissions (metals)
				Exhaust Emissions
		I.2 - Blasting	1.3	Fugitive Emissions (metals)
				Combustion Emissions
		I.3 - Ore transport (mucking and haul truck transport)	1.3; 1.8; 3.5	Fugitive Emissions
				Exhaust Emissions
	II - Ore Management	II.1 - Transfer (dump) to conveyor	1.6	Fugitive Emissions (metals)
		II.2 - Conveyor transport	1.8	Fugitive Emissions (metals)
		II.3 - Stockpiling (dump to permanent stockpile)	1.6	Fugitive Emissions (metals)
		II.4 - Recover from permanent (new) stockpile	3.1	Fugitive Emissions (metals)
		II.5 - Ore stockpile maintenance (permanent (new) stockpile)	1.6	Fugitive Emissions (metals)
				Exhaust Emissions
		II.6 - Recover from existing (reconfigured) stockpile	3.1	Fugitive Emissions (metals)
		II.7 - Ore stockpile maintenance (existing (reconfigured) stockpile)	3.1	Fugitive Emissions (metals)
				Exhaust Emissions
	III - Ore Processing	III.1 - Primary Crushing	1.2; 2.2	Process Emissions
		III.2 - Secondary Crushing	1.2; 2.2	Process Emissions
		III.3 - Dense Media Separation	2.2	N/A
		III.4 - Grinding	2.2	N/A
		III.5 - Flotation and recovery	2.1; 2.2	N/A
	IV - Concentrate Storage	IV.1 - Bagging	2.1	Fugitive Emissions (metals)
				Exhaust Emissions
		IV.2 - Storage	2.1	N/A
	V - Concentrate Transport	V.1 - Road transport (access road)	4.2	Exhaust Emissions
		V.2 - Transfer operations (at Tetcela and Liard transfer facilities)	4.4	Exhaust Emissions

Table 8: Summary of Emission Sources Associated with the Prairie Creek Mine Project (continued)

Phase	Activity		TOR Ref. (see Table 7)	Air Emissions
	VI - Waste Rock Management	VI.1 - Waste rock dumping / recovery from Waste Dump	1.5	Fugitive Emissions
		VI.2 - Transport of waste rock to waste rock pile	1.5	Fugitive Emissions
				Exhaust Emissions
		VI.3 - Waste rock dumping on waste rock pile	1.5	Fugitive Emissions
		VI.4 - Waste rock pile maintenance	1.5	Fugitive Emissions
				Exhaust Emissions
	VII - Backfill Plant	VII.1 - Batch operations / Waste rock transfer	1.7; 2.1; 4.5; 5.8	N/A
		VII.2 - Batch operations / Cement unloading	1.7; 2.1; 5.8	Fugitive Emissions
		VII.3 - Batch operations / Mixer loading	1.7; 2.1; 5.8	Fugitive Emissions
	VIII - Other Off-site Transport (people, equipment, supplies)	VIII.1 - Road transport (access road)	1.3; 4.3	Fugitive Emissions
		VIII.2 - Air transport	4.3	Fugitive Emissions
				Exhaust Emissions
	XI - Access Road Construction	XI.1 - Access road construction	4.1	Exhaust Emissions
	X - Support Activities	X.1 - Power generation	3.2	Combustion Emissions
		X.2 - Incineration	3.13	Combustion Emissions
		X.3 - Heating	3.11	N/A
		X.4 - On-site use of support equipment and vehicles	3.5; 3.12	Fugitive Emissions
				Exhaust Emissions
		X.5 - Fuel storage	3.9	Fugitive Emissions
Closure	I - Demolition and Debris Removal	I.1 - General land clearing (dozer)	5.1; 5.2; 5.3; 5.4 5.5; 5.6	Fugitive Emissions
				Exhaust Emissions
		I.2 - Loading of debris into trucks	5.1; 5.4	Fugitive Emissions
	II - General Activities	II.1 - Vehicular traffic	3.12; 5.1; 5.7	Fugitive Emissions
				Exhaust Emissions

N/A: Not Applicable

The following comments apply for the information presented in Table 8:

- Operation / Ore Management / Recover from existing (reconfigured) ore stockpile: This activity is expected to take place during the initial period of the operation phase, and will continue until the material stored on the existing ore stockpile is completely processed in the mill. This activity is not representative of the total duration of the operation phase.
- Operation / Ore Management / Maintenance of existing (reconfigured) ore stockpile: Since no additional material is expected to be stored on the existing ore stockpile, the maintenance emissions correspond only to wind erosion on the pile surface. As described for the recovery activity above, wind erosion on this stockpile is expected only during a short period of the operation phase.
- Operation / Ore processing / Dense Media Separation (DMS), Grinding and Flotation: The DMS (carried out in cyclones), grinding and flotation are wet processes included in the ore processing circuit, where the ore will be in the form of pulp with a solid content of 58, 72 and 40% respectively. Due to the high moisture, these processes are not considered potential sources of particulate or metal emissions.
- Operation / Concentrate Storage / Storage: All concentrate produced in the Project will be bagged and sealed in an on-site bagging plant prior to storage. The sealed bags will be stored in a storage shed. Therefore, concentrate storage is not considered a potential source of particulate or metal emissions.
- Operation / Concentrate Transport / Road Transport (access road): concentrate will be transported from the site along the access road. Given the nature of the operations and the road surface, this activity is not expected to result in emissions of either particulate matter or airborne metals, as described below:
  - Fugitive particulate emissions (i.e., road dust): The transport of concentrate from the Project will be carried out on an access road, the surface of which will be covered with ice and snow. Therefore, this activity is not expected to generate road surface fugitive particulate emissions. This can be demonstrated numerically using *AP-42 / Section 13.2.2 - Unpaved Roads* (U.S. EPA, 2006) equations and the adjustment factor for precipitation, snow cover and frozen days according to the *Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces* (Environment Canada, 2009: website). Using the equations from these references, the resulting particulate emissions would be zero, as presented below:

$$E = VKT \times EF \times ADJ \times \left(1 - \frac{CE}{100}\right)$$

where *E* is the PM emission rate and ADJ is the adjustment factor for precipitation/snow.

$$ADJ = \frac{[working\ days - (p + snow)]}{working\ days}$$

where *p* is the estimated annual working days with precipitation exceeding 0.2 mm and *snow* is the estimated annual working days when the roads are frozen or snow covered and wet for winter.

For the access road, *working days* = *snow*. Therefore, *ADJ* = 0 and *E* = 0.

- The concentrate will be transported in sealed bags; leaks caused by damages on the bags or poor bag containment (e.g., excess material in the bags, bags not properly sealed) could cause spillage onto the road surface and thus airborne metal emissions. To minimize the potential for this happening, the bags will undergo inspection and will be promptly replaced upon detection of damages. In addition, the bagging process will promote proper bag containment. Specific monitoring and mitigation strategies and inspection procedures will be developed and applied to ensure that If any spills occur, it will be promptly cleaned up, Therefore, it is assumed that there is little chance for the concentrate to be spilled onto and remain on the road surface and thus no potential for fugitive particulate and metal emissions.

- Operation / Concentrate Transport / Transfer operations (at Tetcela and Liard transfer facilities): As discussed above, concentrate from the Project will be transported in sealed bags. In case of any damage to the bags during the transfer operation, the material will be transferred to a new bag. Therefore, fugitive particulate and metals emissions are not expected at the transfer facilities.

- Operation / Backfill Plant / Batch operations / Waste rock transfer: The waste rock used in the backfill plant will come from the DMS process, in the form of pulp with 58% of solids. Due to the high moisture content, the waste rock transfer to the backfill plant is not considered a potential source of fugitive particulate emissions.

- Operation / Other Off-site Transport / Road Transport (access road): As discussed for concentrate transport activity, no road surface fugitive particulate or metals emissions are expected from the use of the access road.

- Operation / Access Road Construction / Access Road Construction: The access road will be constructed with snow and ice from locally sourced water, delivered by water trucks. Therefore, no fugitive particulate emissions are expected from this activity.

- Operation / Support Activities / Heating: A glycol-based heat recovery system connected to the power generation units will be used to provide heated ventilation when necessary. This will occur between November and March, with the objective of maintaining a minimum temperature of 1°C. Therefore, no direct emissions from the mine and building heating system are expected.

- Operation / Extraction / Blasting and Support Activities / Fuel Storage: Combustion emissions from blasting and fugitive VOC emissions from fuel storage have been considered as marginal contributions to the overall emissions from the Project and were not included in the emission calculation.

4.1.2 Emission Calculation

Air emissions from the Project have been calculated using emission factors, activity data and other information according to the following documents and sources:

- Selected sections of AP-42 (U.S. EPA, 2009a: website).
- The U.S. EPA NONROAD Model and supporting documents (U.S. EPA, 2009b: website).
- Information provided by the power generator and incinerator suppliers.

- Information provided by Canadian Zinc.

As specified in the TOR, daily emission rates have been estimated for TSP, PM_{10}, $PM_{2.5}$, NO_X, SO_2, CO, lead and zinc.

The detailed emission calculation is presented in Appendix A, along with the specific references used in each calculation. Tables 9, 10 and 11 include emission summaries for the construction, operation and closure phases, respectively. These tables include all of the emissions from the activities detailed in Tables 7 and 8,

Table 9: Emission Summary - Construction

Activities	Emission Rates (kg/day)							
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Lead	Zinc
I - Demolition and Debris Removal	99.67	35.26	8.57	15.92	0.03	9.04	N/A	N/A
II - Site Preparation (earth moving)	217.81	83.37	23.06	33.75	0.06	20.03	N/A	N/A
III - General Construction	55.91	19.71	8.66	197.57	0.25	55.42	N/A	N/A
Total	**373.39**	**138.34**	**40.29**	**247.24**	**0.34**	**84.49**	**N/A**	**N/A**

N/A: Not applicable (i.e., emissions of lead and zinc are not expected during the construction phase)

Table 10: Emission Summary - Operation

Activities	Emission Rates (kg/day)							
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Lead	Zinc
I - Extraction	105.43	29.60	4.93	13.84	0.03	10.19	0.01	0.01
II - Ore Management	4.50	1.85	0.44	0.61	0.00	0.36	0.48	0.50
III - Ore Processing	0.51	0.20	0.00	N/A	N/A	N/A	0.06	0.06
IV - Concentrate Storage	0.96	0.96	0.93	5.94	0.01	5.38	0.0001	0.0001
IX - Access Road Construction	4.13	4.13	4.01	33.76	0.06	17.10	N/A	N/A
V - Concentrate Transport	5.90	5.90	5.72	32.31	0.06	36.11	N/A	N/A
VI - Waste Rock Management	37.86	12.42	2.02	3.06	0.01	3.06	N/A	N/A
VII - Backfill Plant	2.36	0.07	0.01	N/A	N/A	N/A	N/A	N/A
VIII - Other Off-site Transport (people, equipment, supplies)	2.53	1.34	0.95	11.05	0.02	6.79	N/A	N/A
X - Support Activities	61.00	31.01	21.34	543.99	1.08	124.67	N/A	N/A
Total	**225.19**	**87.49**	**40.37**	**644.55**	**1.26**	**203.67**	**0.54**	**0.57**

N/A: Not applicable, and indicates the activities for which emissions of the specific contaminants are not expected to occur.

Table 11: Emission Summary - Closure

Activities	Emission Rates (kg/day)							
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Lead	Zinc
I - Demolition and Debris Removal	71.99	19.59	7.61	1.56	0.03	0.46	N/A	N/A
II - General Activities	27.75	6.98	0.77	3.91	0.02	1.02	N/A	N/A
Total	**99.74**	**26.56**	**8.38**	**5.47**	**0.05**	**1.48**	**N/A**	**N/A**

N/A: Not applicable (i.e., emissions of lead and zinc are not expected during the closure phase)

Table 12 provides a summary that compares the overall emissions during the construction, operation and closure phases. The operation phase will likely cause the greatest effect to local air quality, based on the total of the emissions, considering the emission rates and duration of this phase. In addition, emissions from the operation phase are the most relevant for evaluating the effects of air quality on other environmental components, such as water quality, fish, wildlife and human health. Therefore, the evaluation of potential impacts on air quality due to the Project emissions has been focused on the emissions during the operation phase.

Table 12: Emission Summary - All Project Phases

Project Phase	Emission Rates (kg/day)							
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Lead	Zinc
Construction	373.39	138.34	40.29	247.24	0.34	84.49	N/A	N/A
Operation	225.19	87.49	40.37	644.55	1.26	203.67	0.54	0.57
Closure	99.74	26.56	8.38	5.47	0.05	1.48	N/A	N/A

N/A: Not applicable (i.e., emission of lead and zinc are not expected during either the construction or closure phases)

4.1.3 Greenhouse gases emissions from the Project

GHG emissions from the Project associated with use of fuel in vehicles, equipment and power generators have been calculated using U.S. EPA NONROAD Model documents (U.S. EPA, 2009b: website). GHG emissions from waste incinerators have been calculated based on methodologies recommended by IPCC (IPCC, 2006).

Total annual direct GHG emissions from the operation phase of the Project are estimated in 32.6 thousand tonnes of Carbon Dioxide (CO_2) equivalent per year.

The major source of GHG emissions from the Project is the use of diesel power generators. Three 1450 kW power generators are expected to operate 24 hours per day during the operation phase, accounting for approximately 86% of the total GHG emissions.

The second major contributor to the total GHG emissions is the use of diesel vehicles and equipments. The waste incinerator is expected to contribute approximately 0.25% of the total GHG emissions from the Project.

4.2 CALPUFF Dispersion Modelling

4.2.1 Model Setup

The CALPUFF modelling has been executed to generate concentrations on a 10 × 10 km receptor grid, centred at the middle of the Prairie Creek Mine area (i.e., area adjacent to the mill). The receptors were spaced at the following intervals, in accordance with the Alberta's Air Quality Model Guidelines (Government of Alberta, 2009b):

- 50 m spacing within 0.5 km from the centre of the Project area.
- 250 m spacing within 2 km from the centre of the Project area.
- 500 m spacing within 5 km from the centre of the Project area.

In addition to the points listed above, the following points have been included on the receptor grid:

- receptors with a 20 m spacing on a line that delimitates the Project surface lease boundary; and
- receptors spaced at 20 m intervals along a line delimits an area within 200 m of the limits of the surface lease boundary (i.e., referred to as the buffer zone).

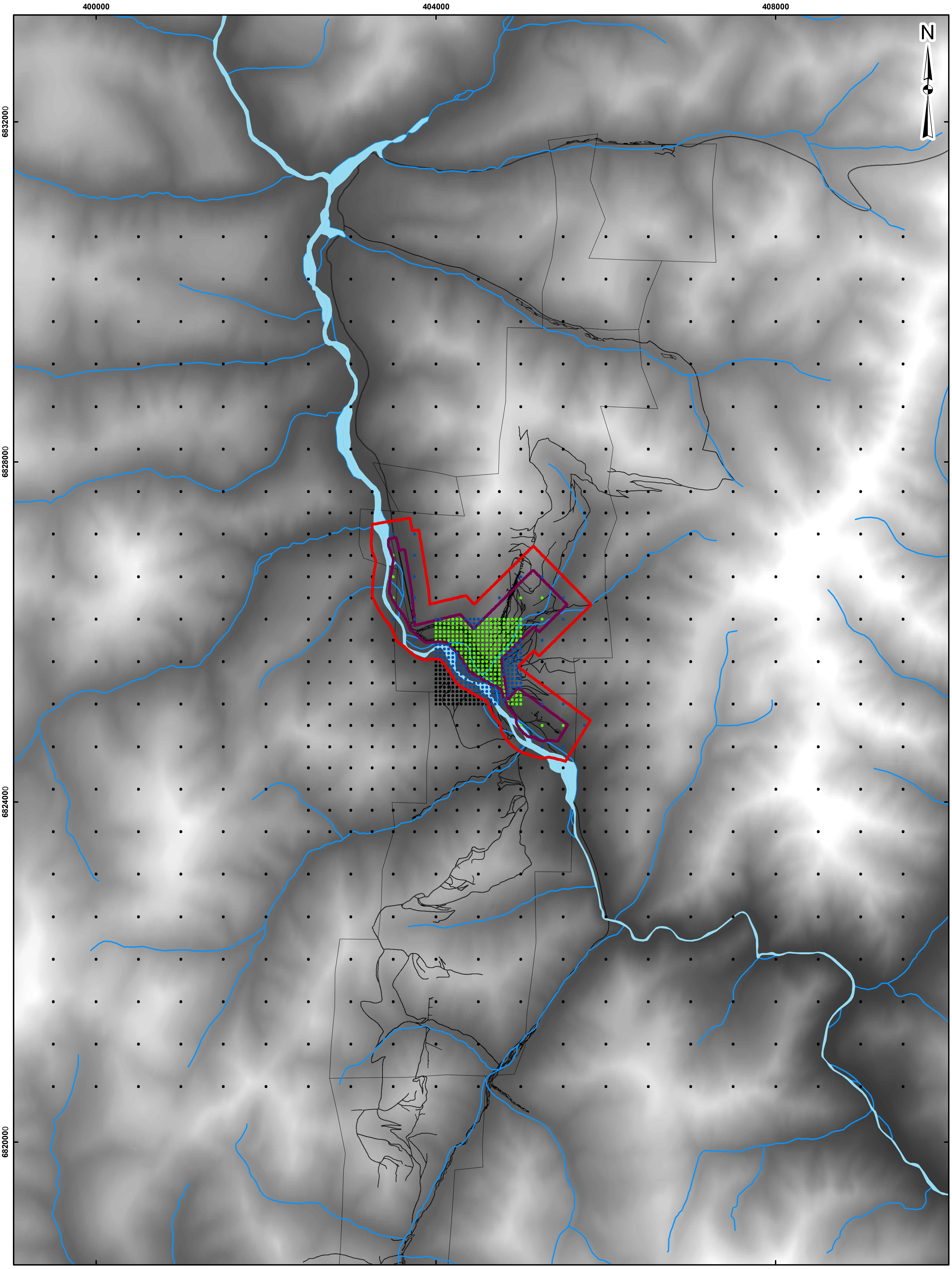
Figures 23 and 24 present the receptor grid used in the CAPUFF modelling. The first figure provides a view of the whole receptor grid and the second details of the grid at the area adjacent to the mill.

Elevations of receptor grid points have been obtained from elevation data provided by the client in the form of Autocad (CAD) contours for the area surrounding the Prairie Creek Mine. The CAD contours have been extracted and nearest neighbor analysis has been used to create a seamless digital elevation model. This data was then merged with Canadian Digital Elevation Data (CDED) where the CAD contours were not provided.

Based on the dispersion characteristics, the contaminants assessed have been grouped in the following input files:

- particulate matter (i.e., TSP, PM_{10} and $PM_{2.5}$);
- reactive compounds, as these which are expected to undergo chemical reactions in the atmosphere (i.e., NO_X and SO_2);
- carbon monoxide (CO); and
- metals (i.e., lead and zinc).

Table 13 presents the options and flags used in each type of input file. The source parameters used in the modelling are presented in Appendix B.



LEGEND

- Receptors within the surface lease
- Receptors on the surface lease boundary
- Receptors within the buffer zone
- Receptors on the buffer zone limit
- Receptors outside the buffer zone
- River
- Waterbody

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

500 250 0 500 1,000 1,500
SCALE 1:45,000 METRES

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

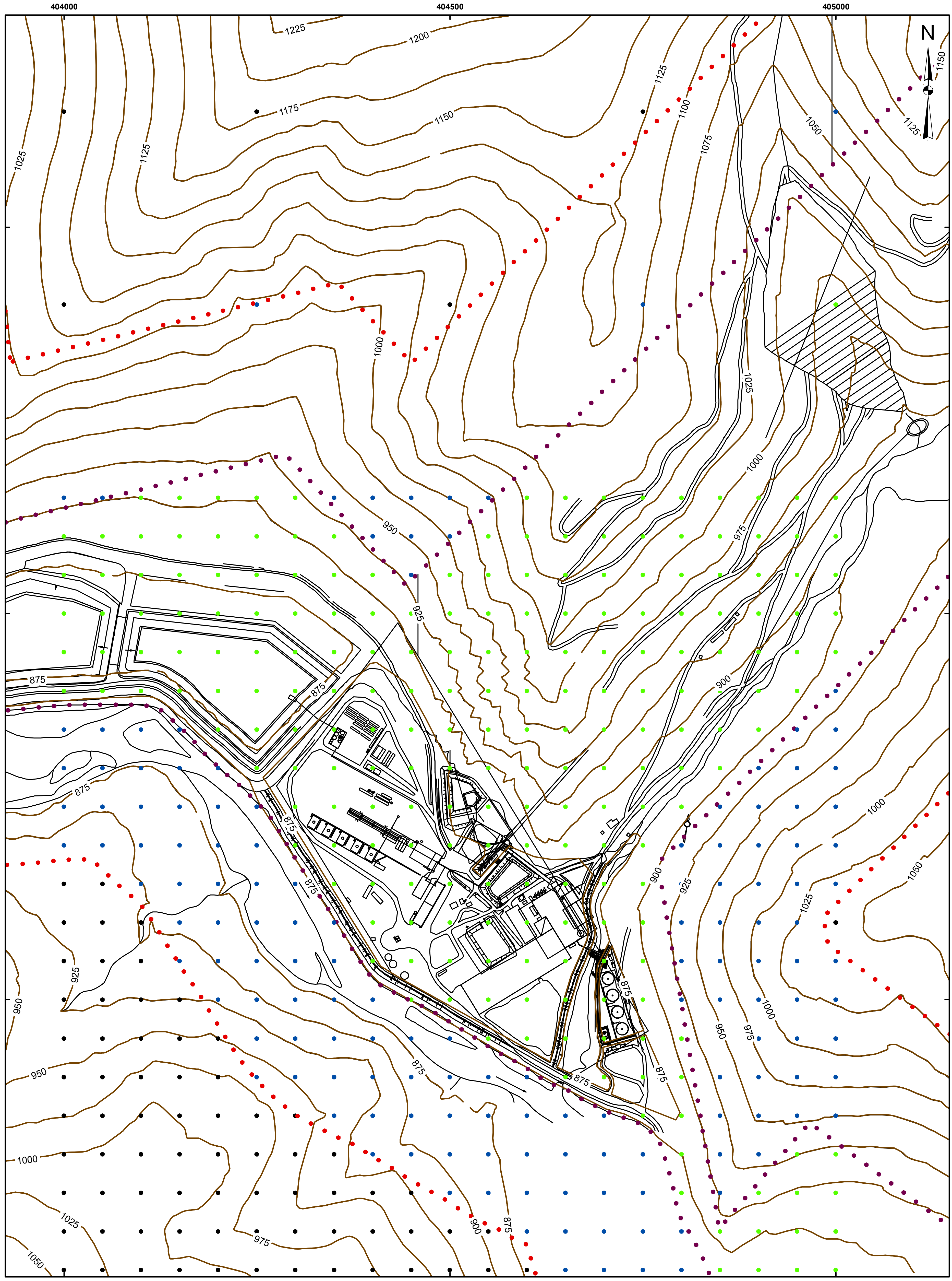
TITLE

RECEPTOR GRID USED FOR CALPUFF MODELLING

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	12 Feb. 2010	**FIGURE: 23**	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\Fig23_ReceptorGridUsedForCalpuffModelling.mxd



LEGEND

- Receptors within the surface lease
- Receptors on the surface lease boundary
- Receptors within the buffer zone
- Receptors on the buffer zone limit
- Receptors outside the buffer zone

100 50 0 100 200 300
SCALE 1:5,000 METRES

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

RECEPTOR GRID USED FOR CALPUFF MODELLING

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	14 Nov. 2008	**FIGURE: 24**	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\Fig24_ReceptorGridUsedForCalpuffModelling.mxd

Table 13: Options and Flags Used in the CALPUFF Modelling

Variable	Description of Variable	Default Value	Description of Default Value	Values used in the modelling				Description of Alternative Value
				PM	Reactive	CO	Metals	
MGAUSS	Vertical distribution used in the near field	1	Gaussian	1	1	1	1	N/A
MCTADJ	Terrain adjustment method	3	Partial plume path adjustment	3	3	3	3	N/A
MCTSG	Subgrid-scale complex terrain flag	0	Not modelled	0	0	0	0	N/A
MSLUG	Near-field puffs modelled as elongated slugs?	0	No	0	0	0	0	N/A
MTRANS	Transitional plume rise modelled?	1	Yes (i.e., transitional rise computed)	1	1	1	1	N/A
MTIP	Stack tip downwash?	1	Yes (i.e., use stack tip downwash)	1	1	1	1	N/A
MRISE	Method used to compute plume rise for point sources not subject to building downwash?	1	Briggs plume rise	T	T	T	T	Same as 1.
MBDW	Method used to simulate building downwash?	1	ISC method	2	2	2	2	2 = PRIME method
MSHEAR	Vertical wind shear modelled above stack top?	0	No (i.e., vertical wind shear not modelled)	0	0	0	0	N/A
MSPLIT	Puff splitting allowed?	0	No (i.e., puffs not split)	0	0	0	0	N/A
MCHEM	Chemical mechanism flag	1	Transformation rates computed internally (MESOPUFF II scheme)	0	1	0	0	0 = chemical transformation not modelled
MAQCHEM	Aqueous phase transformation flag	0	Aqueous phase transformation not modelled	0	0	0	0	N/A
MWET	Wet removal modelled?	1	yes	1	1	0	1	0 = no
MDRY	Dry deposition modelled?	1	yes	1	1	0	1	0 = no
MTILT	Gravitational settling (plume tilt) modelled?	0	no	0	0	0	0	N/A
MDISP	Method used to compute dispersion	3	PG dispersion coefficients for	2	2	2	2	2 = dispersion

Table 13: Options and Flags Used in the CALPUFF Modelling (continued)

Variable	Description of Variable	Default Value	Description of Default Value	Values used in the modelling				Description of Alternative Value
				PM	Reactive	CO	Metals	
	coefficients		RURAL areas (computed using the ISCST multi-segment approximation) and MP coefficients in urban areas					coefficients from internally calculated sigma v, sigma w using micrometeo-rological variables (u*, w*, L, etc.)
MTURBVW	Sigma-v/sigma-theta, sigma-w measurements used?	3	Use both sigma-(v/theta) and sigma-w from PROFILE.DAT to compute sigma-y and sigma-z (valid for METFM = 1, 2, 3, 4, 5)	3	3	3	3	N/A
MDISP2	Back-up method used to compute dispersion when measured turbulence data are missing	3	PG dispersion coefficients for RURAL areas (computed using the ISCST multi-segment approximation) and MP coefficients in urban areas	3	3	3	3	N/A
MTAULY	Method used for Lagrangian timescale for Sigma-y	0	Draxler default 617.284 (s)	0	0	0	0	N/A
MTAUAD V	Method used for Advective-Decay timescale for Turbulence	0	No turbulence advection	0	0	0	0	N/A
MCTURB	Method used to compute turbulence sigma-v & sigma-w using micrometeorological variables	1	Standard CALPUFF subroutines	1	1	1	1	N/A
MROUGH	PG sigma-y,z adj. for roughness?	0	No	0	0	0	0	N/A
MPARTL	Partial plume penetration of elevated inversion modelled for point sources?	1	Yes	1	1	1	1	N/A
MPARTLB A	Partial plume penetration of elevated inversion modelled for buoyant area sources?	1	Yes	0	0	0	0	0 = no

Table 13: Options and Flags Used in the CALPUFF Modelling (continued)

Variable	Description of Variable	Default Value	Description of Default Value	Values used in the modelling				Description of Alternative Value
				PM	Reactive	CO	Metals	
MTINV	Strength of temperature inversion provided in PROFILE.DAT extended records?	0	No (computed from measured/default gradients)	0	0	0	0	N/A
MPDF	Probability Distribution Function used for dispersion under convective conditions?	0	No	0	0	0	0	N/A
MSGTIBL	Sub-Grid TIBL module used for shore line?	0	No	0	0	0	0	N/A
MBCON	Boundary conditions (concentration) modelled?	0	No	0	0	0	0	N/A
MFOG	Configure for FOG Model output?	0	No	0	0	0	0	N/A
MREG	Test options specified to see if they conform to regulatory values?	1	Technical options must conform to U.S. EPA	0	0	0	0	0 = no checks are made

N/A: Not Applicable

4.2.2 CALPUFF Modelling Results – Concentrations

Table 14 presents maximum predicted 1-hour, 24-hour and annual concentrations for each of the five groups of receptors used in the modelling. The maximum 8-hour results for CO have been calculated using 1-hour results and conversion factors according to the Air Dispersion Modelling Guideline for Ontario (Ontario Ministry of the Environment, 2005). In addition, the NO_2 concentrations have been calculated by applying the ozone limiting method (Cole and Summerhays, 1979) in a manner consistent with the Alberta modelling guidance (Government of Alberta, 2009b).

Table 14: Predicted Maximum Ambient Concentrations based on CALPUFF Modelling

Name	Averaging Period	Standard (µg/m³)[(a)]	Concentrations (µg/m³) – Maximum values[(e)]				
			Receptors Within Surface Lease	**Receptors on Surface Lease Boundary**	**Receptors Within Buffer Zone**	**Receptors on Buffer Boundary**	**Receptors Outside Buffer Zone**
TSP	24-hour	120[(b)]	**370.9**[(f)]	**261.6**	**243.5**	66.1	51.3
	Annual	60[(b)]	**126.0**	**71.8**	**62.4**	13.3	12.8
PM_{10}	24-hour	50[(c)]	**149.9**	**94.5**	**86.9**	34.3	32.0
$PM_{2.5}$	1-hour	80[(d)]	**107.5**	79.5	67.9	47.7	47.3
	24-hour	30[(b)]	**52.6**	**38.6**	**37.4**	20.6	19.3
SO_2	1-hour	450[(b)]	2.1	2.5	1.8	1.8	1.7
	24-hour	150[(b)]	1.3	1.2	1.2	0.8	0.8
	Annual	30[(b)]	0.5	0.4	0.4	0.4	0.4
NO_2	1-hour	400[(d)]	185.6	167.7	160.8	163.2	153.9
	24-hour	200[(d)]	121.6	115.0	111.1	81.7	79.1
	Annual	60[(d)]	56.6	50.8	50.3	42.3	40.1
NO_X	1-hour	NA	1,449.5	1,270.5	1,202.1	1,225.4	1,132.5
	24-hour	NA	809.6	744.2	704.4	410.5	384.3
	Annual	NA	159.9	101.4	96.8	40.3	38.1
CO	1-hour	15,000[(d)]	513.5	399.7	356.5	253.7	264.3
	8-hour	6,000[(d)]	286.9	223.3	199.2	141.7	147.6
Lead	1-hour	1.5[(d)]	**18.11**	**1.91**	**1.69**	0.60	0.53
Zinc	1-hour	NA	18.91	2.00	1.77	0.62	0.55

Notes: (a): Air quality standards described in Section 2.5.
(b): GNWT Standard.
(c): Proposed Canada-Wide Standard.
(d): Alberta Objectives and Guidelines.
(e): The values include background levels, calculated as the average of the monitoring data.
(f): Numbers in bold correspond to concentrations higher than the air quality standards.

Appendix C presents a map with the location of the maximum predicted concentrations for each of the contaminants presented in Table 14, considering all receptor groups.

4.2.3 Comparison of Predicted Concentrations Using CALPUFF Modelling and Standards

Predicted ambient concentrations based on modelling results presented in Section 4.2.2 have been compared with the air quality guidelines presented in Section 2 (see Table 2). The conclusions from this analysis are presented below:

- TSP: maximum 24-hour and annual concentrations of TSP exceed the air quality standards for receptors located within the surface lease, on the surface lease boundary and within the buffer zone. Maximum 24-hour concentrations are expected to exceed the standard for approximately 4.9% of total number of receptors on the surface lease boundary included in this assessment (i.e., 24 out of 491 receptors) and 8.2% of the receptors located within the buffer zone (i.e.,14 out of 170 receptors). Maximum annual concentrations are expected to exceed the standard for approximately 1.6% of the receptors located on the surface lease boundary (i.e., 8 out of 491 receptors) and 0.6% of the receptors located within the buffer zone (i.e., 1 out of 170 receptors). All maximum 24-hour and annual concentrations are lower than the air quality guidelines for receptors located on the outer buffer zone boundary (i.e., 200 m from the surface lease) and outside the buffer zone.

- PM_{10}: maximum 24-hour concentrations exceed the air quality guideline for receptors located within the surface lease, on the surface lease boundary and within the buffer zone. Maximum 24-hour concentrations are expected to exceed the standard for approximately 7.7% of the receptors located on the surface lease boundary (i.e., 38 out of 491 receptors) and 10.6% of the receptors located within the buffer zone (i.e., 18 out of 170 receptors). All of the predicted concentrations are lower than the air quality guideline for receptors located on the outer buffer zone boundary and outside the buffer zone.

- $PM_{2.5}$: maximum 1-hour concentrations exceed the air quality guideline only for receptors located within the surface lease; all concentrations are lower than the guideline for receptors located on the surface lease boundary and beyond this boundary. Maximum 24-hour concentrations exceed the air quality guideline for receptors located within the surface lease, on the surface lease boundary and within the buffer zone. Maximum 24-hour concentrations are expected to exceed the standard for approximately 2.4% of the receptors located on the surface lease boundary (i.e., 12 out of 491 receptors) and 4.12% of the receptors located within the buffer zone (i.e., 7 out of 170 receptors). All predicted concentrations are lower than the air quality guideline for receptors located on the outer buffer zone boundary and outside the buffer zone.

- SO_2, NO_2 and CO: maximum 1-hour, 24-hour and annual concentrations of SO_2 and NO_2 and maximum 1-hour and 8-hour concentrations of CO are lower than the air quality guidelines for all of the receptors in the receptor grid, including areas within the mine surface lease.

- Lead: maximum 1-hour concentrations of lead exceed the Alberta air quality guideline for this parameter for receptors located within the surface lease, on the surface lease boundary and within the buffer zone. Maximum 1-hour concentrations are expected to exceed the standard for approximately 1.8% of the receptors located on the surface lease boundary (i.e., 9 out of 491 receptors) and 1.8% of the receptors located within the buffer zone (i.e., 3 out of 170 receptors). All of the predicted concentrations are lower than the air quality guideline for receptors located on the outer buffer zone boundary and outside the buffer zone. (Note: Alberta guideline adopted from Texas).

Given the nature of the Project, it was expected that fugitive emissions (TSP, PM_{10}, $PM_{2.5}$ and lead) would impact the air quality in areas close to the mining activities. Predicted concentrations exceeding air quality standards for receptors located within the surface lease, on the surface lease boundary and within the buffer zone confirm this initial assumption. Considering the proximity of where the on-site activities will take place, impacts of the Project emissions on air quality for these receptors are expected even if advanced emission control techniques were applied.

Maximum predicted concentrations of all contaminants included in this Air Quality Assessment are lower than the respective standards for receptors located 200 m away from the surface lease (i.e., outer limit of the buffer zone) and beyond.

4.2.4 CALPUFF Modelling Results – Deposition Rates

Table 15 presents predicted maximum wet, dry and total deposition rates of TSP (dust fall), estimated based on CALPUFF modelling results. Maximum total deposition rates have been calculated individually for each receptor, as the sum of maximum dry and wet deposition rates. Therefore, because maximum dry and wet depositions can occur in different locations, the maximum total values presented can be different from the sum of the maximum wet and dry deposition rates in the table.

The Alberta Ambient Air Quality and Objectives (Government of Alberta, 2009a) specifies a guideline for dust fall over a 30-day period of 158 mg/100 cm^2 for commercial and industrial areas (no guideline has been identified for the NWT [GNWT, 2002]). All predicted maximum dust fall rates presented in the table, including for receptors located within the surface lease, are lower than this guideline.

Table 15: Predicted Dust Fall Based on CALPUFF modelling (on-site emissions)

Contaminant	Deposition (1)	Deposition Rates (mg/100 cm²/30-day) – Maximum values				
		Receptors Within Surface Lease	Receptors on Surface Lease Boundary	Receptors Within Buffer Zone	Receptors on Buffer Boundary	Receptors Outside Buffer Zone
TSP	Dry	137.4	70.5	55.0	13.5	12.8
TSP	Wet	12.1	4.0	3.9	2.1	2.0
TSP	Total	138.8	71.4	55.9	14.3	13.6

Table 16 presents predicted maximum wet, dry and total deposition rates of lead and zinc, estimated based on CALPUFF modelling results. Total deposition rates have been estimated using the same approach described for dust fall. No guideline for lead and zinc deposition have been identified in references used for air quality standards in this Air Quality Assessment.

Table 16: Predicted Deposition Rates of Lead and Zinc Based on CALPUFF modelling (on-site emissions)

Contaminant	Deposition [1]	Deposition Rates ($g/m^2/year$) – Maximum values				
		Receptors Within Surface Lease	Receptors on Surface Lease Boundary	Receptors Within Buffer Zone	Receptors on Buffer Boundary	Receptors Outside Buffer Zone
Lead	Dry	1.6492	0.1087	0.0940	0.0222	0.0181
Zinc	Dry	1.7268	0.1137	0.0983	0.0232	0.0189
Lead	Wet	0.0159	0.0030	0.0028	0.0011	0.0010
Zinc	Wet	0.0167	0.0032	0.0029	0.0011	0.0010
Lead	Total	1.6620	0.1098	0.0957	0.0226	0.0184
Zinc	Total	1.7402	0.1148	0.1000	0.0236	0.0193

Appendix C presents a map with the location of the maximum predicted deposition rates of TSP (dust fall), lead and zinc presented in Tables 15 and 16, considering all receptor groups.

4.3 SCREEN3 Dispersion Modelling

Exhaust emissions from construction and traffic on the access road that connects the Project area to the Liard Highway and from equipment use at the Tetcela and Liard transfer facilities have been modelled using U.S. EPA SCREEN3 model.

In order to model exhaust emissions from construction and vehicular traffic on the access road, a road segment with length equivalent to its width has been selected as a virtual source. For construction of the access road, a worst case scenario has been assumed consisting of a piece of heavy equipment (e.g., grader) working for at least 10 minutes on this segment (based on the amount of equipment to be used, duration of the construction and length of the access road, this assumption is highly conservative). For vehicular traffic on the access road, it has been assumed that the vehicles will travel in convoy, resulting in maximum emissions in a given road segment. In addition to emissions from the virtual source, emissions from four adjacent road segments with the same dimensions as the virtual source (two on each side) have been included in the model to account for the cumulative effects of vehicles in motion (i.e., emissions from the same vehicle travelling on the five road segments have been added).

Ambient concentrations resulting from emissions on the access roads and in the transfer facilities have been estimated as a function of the distance from the sources.

SCREEN3 has been executed with rural and simple terrain options and the full built-in meteorology (i.e., all stability classes modelled). The source parameters used in the modelling are presented in Appendix B.

4.3.1 SCREEN3 Modelling Results

Ambient concentrations resulting from off-site emissions, calculated using SCREEN3, have been estimated as a function of distance from the emission source (road segment or transfer facility). Baseline concentrations presented in Section 2 and the Ozone Limiting Method have been used to predict ambient concentrations, as discussed for on-site emissions. The predicted ambient concentrations based on modelling results of off-site emissions are presented in Tables 17, 18 and 19.

The results presented in these tables have been calculated using volume sources. Because SCREEN3 does not produce modelling results for distances inside the volume sources, the predicted concentrations for the initial distances, smaller than half the width of the volume sources, correspond to the baseline concentrations, and the maximum concentrations are expected adjacent to the volume sources.

Table 17: Predicted Ambient Concentrations based on SCREEN3 Modelling (construction of the access road)

Distance from the Centre of the Source (m)		Concentrations (µg/m³) – Maximum 1-hour values[(a)]						
		TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	NO_2
10		3.8	3.3	3.5	0.0	0.3	0.0	2.0
20		33.3	32.8	32.1	241.1	0.8	122.1	64.7
30		33.4	32.9	32.1	241.6	0.8	122.3	64.8
40		31.7	31.2	30.5	227.9	0.7	115.4	63.4
50		29.5	29.0	28.3	209.6	0.7	106.1	61.6
60		27.2	26.7	26.1	190.9	0.7	96.7	59.7
70		25.0	24.6	24.1	173.4	0.6	87.8	58.0
80		23.1	22.6	22.2	157.6	0.6	79.8	56.4
90		21.4	20.9	20.5	143.4	0.6	72.6	55.0
100		19.8	19.3	19.0	130.9	0.5	66.3	53.7
200		11.5	11.0	10.9	62.7	0.4	31.8	46.9
300		8.4	7.9	7.9	37.2	0.4	18.9	39.2
400		6.9	6.4	6.4	25.0	0.3	12.6	27.0
500		6.0	5.5	5.6	18.1	0.3	9.2	20.1
600		5.5	5.0	5.1	13.8	0.3	7.0	15.8
700		5.1	4.7	4.8	11.0	0.3	5.6	13.0
800		4.9	4.4	4.5	9.1	0.3	4.6	11.1
900		4.7	4.2	4.4	7.6	0.3	3.9	9.6
1,000		4.6	4.1	4.2	6.5	0.3	3.3	8.5
Maximum Concentrations (11 m)		34.0	33.5	32.7	246.5	0.8	124.8	65.3
Standard	1-hour[(b)]	—	—	80[(c)]	—	450[(d)]	15,000[(c)]	400[(c)]
	Derived 1-hour[(e)]	292[(f)]	122[(g)]	—	—	—	—	—

Notes: (a): The values include background levels, calculated as the average of the monitoring data.

(b): Air quality standards described in Section 2.5.

(c): Alberta Objectives and Guidelines.

(d): GNWT Standard.

(e): Values derived from 24-hour standards using conversion factor as specified by the Ontario Ministry of the Environment (MOE, 2005).

(f): Derived from the GNWT standard.

(g): Derived from the Proposed Canada-Wide Standard.

Table 18: Predicted Ambient Concentrations based on SCREEN3 Modelling (traffic on the access road)

Distance from the Centre of the Source (m)		Concentrations (µg/m³) – Maximum 1-hour values[a]						
		TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	NO_2
10		3.8	3.3	3.5	0.0	0.3	0.0	2.0
20		9.7	9.2	9.1	30.0	0.4	39.3	32.0
30		9.7	9.2	9.2	30.1	0.4	39.4	32.1
40		9.4	8.9	8.8	28.4	0.3	37.1	30.4
50		8.9	8.4	8.4	26.1	0.3	34.2	28.1
60		8.4	8.0	8.0	23.8	0.3	31.1	25.8
70		8.0	7.5	7.5	21.6	0.3	28.3	23.6
80		7.6	7.2	7.2	19.6	0.3	25.7	21.6
90		7.3	6.8	6.8	17.9	0.3	23.4	19.9
100		7.0	6.5	6.5	16.3	0.3	21.3	18.3
200		5.3	4.8	4.9	7.8	0.3	10.2	9.8
300		4.7	4.2	4.3	4.6	0.3	6.1	6.6
400		4.4	3.9	4.0	3.1	0.3	4.1	5.1
500		4.2	3.8	3.9	2.3	0.3	2.9	4.3
600		4.1	3.7	3.8	1.7	0.3	2.2	3.7
700		4.1	3.6	3.7	1.4	0.3	1.8	3.4
800		4.0	3.5	3.7	1.1	0.3	1.5	3.1
900		4.0	3.5	3.6	0.9	0.3	1.2	2.9
1,000		4.0	3.5	3.6	0.8	0.3	1.1	2.8
Maximum Concentrations (11 m)		9.8	9.3	9.3	30.7	0.4	40.2	32.7
Standard	1-hour[b]	—	—	80[c]	—	450[d]	15,000[c]	400[c]
	Derived 1-hour[e]	292[f]	122[g]	—	—	—	—	—

Notes: (a): The values include background levels, calculated as the average of the monitoring data.

(b): Air quality standards described in Section 2.5.

(c): Alberta Objectives and Guidelines.

(d): GNWT Standard.

(e): Values derived from 24-hour standards using conversion factor as specified by the Ontario Ministry of the Environment (MOE, 2005).

(f): Derived from the GNWT standard.

(g): Derived from the Proposed Canada-Wide Standard.

Table 19: Predicted Ambient Concentrations based on SCREEN3 Modelling (transfer facilities)

Distance from the Centre of the Source (m)		Concentrations (µg/m³) – Maximum 1-hour values[a]						
		TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	NO_2
10		3.8[3]	3.3	3.5	0.0	0.3	0.0	2.0
20		3.8	3.3	3.5	0.0	0.3	0.0	2.0
30		41.6	41.1	40.1	234.0	0.7	188.9	64.0
40		41.5	41.0	40.0	233.5	0.7	188.5	64.0
50		41.5	41.0	40.0	233.5	0.7	188.5	64.0
60		40.9	40.4	39.4	229.7	0.7	185.4	63.6
70		40.8	40.4	39.4	229.4	0.7	185.2	63.6
80		41.0	40.5	39.5	230.3	0.7	185.9	63.6
90		40.8	40.3	39.3	229.2	0.7	185.0	63.5
100		40.4	39.9	38.9	226.6	0.7	182.9	63.3
200		32.2	31.7	31.0	176.0	0.6	142.0	58.2
300		25.0	24.5	24.0	131.0	0.5	105.8	53.7
400		20.0	19.5	19.1	100.1	0.5	80.8	50.6
500		16.5	16.1	15.8	78.9	0.4	63.7	48.5
600		14.1	13.6	13.4	63.8	0.4	51.5	47.0
700		12.5	12.1	11.9	54.1	0.4	43.7	46.0
800		11.2	10.7	10.7	46.0	0.4	37.2	45.2
900		10.2	9.7	9.7	39.7	0.4	32.1	41.7
1,000		9.5	9.0	8.9	35.0	0.4	28.3	37.0
Maximum Concentrations (26 m)		41.7	41.2	40.2	234.9	0.7	189.6	64.1
Standard	1-hour[b]	—	—	80[c]	—	450[d]	15,000[c]	400[c]
	Derived 1-hour[e]	292[f]	122[g]	—	—	—	—	—

Notes: (a): The values include background levels, calculated as the average of the monitoring data.

(b): Air quality standards described in Section 2.5.

(c): Alberta Objectives and Guidelines.

(d): GNWT Standard.

(e): Values derived from 24-hour standards using conversion factor as specified by the Ontario Ministry of the Environment (MOE, 2005).

(f): Derived from the GNWT standard.

(g): Derived from the Proposed Canada-Wide Standard.

4.3.2 Comparison of Predicted Concentrations Using SCREEN3 Modelling and Standards

Predicted air concentrations based on the modelling results presented in Section 4.3.1 have been compared with the air quality guidelines presented in Section 2 (see Table 2).

Predicted air concentrations estimated based on SCREEN3 modelling correspond to one hour results. For contaminants included in this evaluation that do not have one hour air quality guidelines (based on the sources used in this Air Quality Assessment), 24-hour standards and conversion factors specified by the Ontario Ministry of the Environment (MOE, 2005) have been used to produce derived 1-hour standards .

Using 1-hour air quality guidelines for $PM_{2.5}$, SO_2, NO_2 and CO, and derived 1-hour guidelines for TSP and PM_{10}, it has been verified that the concentrations of these contaminants are lower than the guidelines for all distances from the off-site emission sources (construction and traffic on access road and transfer facilities).

The low concentration values compared to the air quality standards are a result of the characteristics of the operations and management practices. As discussed in Section 4.1.1, the transport of mineral concentrates in sealed bags and use of the access road minimize the possibility of fugitive particulate matter emissions. Therefore, only exhaust emissions from vehicles and equipment contribute to air concentrations.

4.4 Contaminant Loading of Metals

Sources of metal (lead and zinc) emissions from the Prairie Creek Mine are presented in Table 20.

The major sources of lead and zinc emissions from the Project are the ore management activities, accounting for approximately 88% of the total emissions of these metals.

The second major contributors, with approximately 10% of the total lead and zinc emissions, are the ore crushing processes in the mill. The proposed crushing processes typically provoke great disturbance of the ore and reduction of its size, resulting in significant amount of fugitive PM emissions. The emissions from these processes in the Project will be controlled by a system including exhaustion and treatment in a bag filter. Although this type of system typically presents a high control efficiency for fugitive particulate matter (from 99 to 99.99%), some residual emissions are expected.

Extraction and bagging operations account for the remaining 2 % of the metal emissions.

No metal emissions are expected from off-site activities, including concentrate transport on the access road and transfer at the transfer facilities, due to the characteristics of the activities and controls to be implemented, as described below:

- Concentrate transport on the access road: The concentrate will be transported in sealed bags; leaks caused by damages on the bags or poor bag containment (e.g., excess material in the bags, bags not properly sealed) could cause spillage onto the road surface and thus airborne metal emissions. To minimize the potential for this happening, the bags will undergo inspection and will be promptly replaced upon detection of damages. In addition, the bagging process will promote proper bag containment. Specific monitoring and mitigation strategies and inspection procedures will be developed and applied to ensure that If any spills occur, it will be promptly cleaned up, Therefore, it is assumed that there is little chance for the concentrate to be spilled onto and remain on the road surface and thus no potential for fugitive particulate and metal emissions.

- Concentrate handling at the transfer facilities (Tetcela and Liard transfer facilities): As discussed above, concentrate from the Project will be transported in sealed bags. In case of any damage to the bags during the transfer operation, the material will be transferred to a new bag. Therefore, fugitive particulate and metals emissions are not expected at the transfer facilities.

Table 20: Sources of Lead and Zinc Emissions from the Project

Activities		Emission Category	Emission Rates (kg/day)		Contributions	
			Lead	Zinc	Lead	Zinc
I - Extraction	I.1 - Drilling	Fugitive Emissions (metals)	0.0023	0.0024	0.43%	0.43%
	I.2 - Blasting	Fugitive Emissions (metals)	0.0095	0.0099	1.74%	1.74%
II - Ore Management	II.1 - Transfer (dump) to conveyor	Fugitive Emissions (metals)	0.1441	0.1508	26.45%	26.45%
	II.2 - Conveyor transport (transfer points)	Fugitive Emissions (metals)	0.1944	0.2034	35.67%	35.67%
	II.3 - Stockpiling (dump to temporary/permanent stockpile)	Fugitive Emissions (metals)	0.0048	0.0050	0.88%	0.88%
	II.4 - Recover from temporary/permanent stockpile	Fugitive Emissions (metals)	0.0048	0.0050	0.88%	0.88%
	II.5 - Ore Stockpile Maintenance (temporary/permanent stockpile)	Fugitive Emissions (metals) - Stockpile Working (Dozer)	0.0463	0.0485	8.50%	8.50%
		Fugitive Emissions (metals) (Wind Erosion)	0.0832	0.0871	15.27%	15.27%
III - Ore Processing	III.1 - Primary Crushing	Process Emissions	0.0138	0.0145	2.54%	2.54%
	III.2 - Secondary Crushing	Process Emissions	0.0415	0.0434	7.61%	7.61%
IV - Concentrate Storage	IV.1 - Bagging	Fugitive Emissions (metals)	0.0001	0.0001	0.02%	0.02%
Total			0.5449	0.5702	100.00%	100.00%

4.5 Potential Impacts on Other Components

The approach used to evaluate potential impacts of the predicted air quality resulting from the Project emissions on other components of the ecosystem, such as water quality, fish, wildlife and human health, consisted of:

- Identification of the basis of the air quality standards used in this Air Quality Assessment, in order to verify if the values used for comparison with the predicted air concentrations are protective of human health and ecological components; and
- Identification of guidelines from the World Health organization (WHO) regarding human health protection and comparison with the predicted air concentrations.

Table 21 presents the basis for the air quality guidelines used in this air quality assessment. For GNWT standards, for which the basis was not available in the reference document (GNWT, 2002), information from the Alberta Objectives and Guidelines was used as a reference (Government of Alberta, 2009a).

The information presented in this table indicates that the standards used in this Air Quality Assessment are primarily related to effects on human health. An exception are the 24-hour and annual standards for SO_2, which are based on effects on vegetation, because this compound has adverse effects on ecological systems at concentrations far below those known to be harmful to humans (WHO, 2000). Considering that standards based on human health are conservative regarding ecological effects, and the standards based on ecological effects (i.e., SO_2 24-hour and annual) are conservative regarding human health effects, the air quality guidelines used in this Air Quality assessment are likely to represent concentrations not harmful for both human health and ecological components.

Based on the comparison with standards presented in Section 4.2.3, predicted maximum concentrations of TSP, PM_{10}, $PM_{2.5}$ and lead resulting from the on-site emissions are not likely to cause adverse effects on human health and ecological components for receptors located 200 m from the surface lease and beyond. Predicted concentrations of SO_2, NO_2 and CO resulting from on-site emissions are not expected to cause adverse effects on human health and ecological components in any of the receptors included in this assessment.

Based on the comparison with standards presented in Section 4.3.2, predicted maximum concentrations of TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2 and CO resulting from the off-site emissions (i.e., access road and transfer facilities) are not likely to cause adverse effects on human health and ecological components for any of the receptors included in this assessment.

Table 21: Basis of the Air Quality Guidelines Used in the Air Quality Assessment

Contaminant	Averaging Period	GNWT (µg/m³)		Alberta Objectives and Guidelines (µg/m³)		Canada-Wide Standard (µg/m³)	
		Standard	Basis	Standard	Basis	Standard	Basis
TSP	24-hour	**120**[a]	N/A	100	Pulmonary effects	—	
	Annual	**60**	N/A	—		—	
PM_{10}	24-hour	—	—	—	—	**50**[b]	Minimize the risks to human health and the environment.
$PM_{2.5}$	1-hour	—	—	**80**	Derived from the Canada Wide Standard	—	—
	24-hour	**30**	N/A	—	—	30	Minimize the risks to human health and the environment.
SO_2	1-hour	**450**	N/A	450	Effects on pulmonary function	—	—
	24-hour	**150**	N/A	150	Protection of Begonia, bluegrass, aspen, forests.	—	—
	Annual	**30**	N/A	30	Protection of natural forests, lichens	—	—
NO_2	1-hour	—	—	**400**	Odour perception	—	—
	24-hour	—	—	**200**	N/A	—	—
	Annual	—	—	**60**	N/A	—	—
CO	1-hour	—	—	**15,000**	Effects on oxygen carrying capacity of blood	—	—
	8-hour	—	—	**6,000**	N/A	—	—
Lead	1-hour	—	—	**1.5**	Adopted from Texas: neurological effects for children and cardiovascular and kidney effects for adults (McCarthy, 2008)	—	—

Notes: (a): Values in bold correspond to standards used in this Air Quality Assessment.

(b): Proposed value for the Canada-Wide Standards.

N/A: Not available.

Table 22 presents the guidelines regarding human health protection from the World Health Organization (WHO). Compared to the air quality standards used in this Air Quality Assessment, the WHO guidelines are more restrictive for $PM_{2.5}$ on a 24-hour basis, SO_2 on a 24-hour basis, and NO_2 on a 1-hour and annual basis. In addition, WHO presents guidelines for PM_{10}, $PM_{2.5}$ and lead on an annual basis.

Table 22: WHO Guidelines for Human Health Protection

Contaminant	Averaging Period	Guideline (µg/m³)	Reference
PM_{10}	24-hour	50	WHO, 2005
	Annual	20	WHO, 2005
$PM_{2.5}$	24-hour	25	WHO, 2005
	Annual	10	WHO, 2005
SO_2	24-hour	20	WHO, 2005
NO_2	1-hour	200	WHO, 2005
	Annual	40	WHO, 2005
CO	1-hour	30,000	WHO, 2000
	8-hour	10,000	WHO, 2000
Lead	Annual	0.5	WHO, 2000

Table 23 presents a comparison between the WHO guidelines and the predicted concentrations resulting from the Project on-site activities.

Based on the WHO guidelines, predicted PM_{10} and $PM_{2.5}$ concentrations are not likely to cause adverse effects on human health for receptors located on the buffer zone boundary (i.e., 200 m from the surface lease) and beyond. Predicted concentrations of NO_2 on an hourly basis, SO_2 and CO are not likely to cause adverse effects on human health for any of the receptors included in the assessment. Predicted concentrations of lead are not likely to cause adverse effects on human health for receptors located on the surface lease and beyond.

Although predicted concentrations of NO_2 on an annual basis are higher than the WHO guideline, there is no evidence that the predicted values are likely to result in adverse effects on human health. The WHO guideline is based on a long term and continuous exposure, usually associated with residents in a specific area. Given the remote location of the Prairie Creek Mine, it is unlikely that any human receptor will be exposed to the predicted NO_2 concentrations for periods similar to that considered by the WHO when defining the guideline.

Comparing the predicted concentrations resulting from off-site emissions, as presented in Tables 17, 18 and 19, with the existing WHO guidelines on a 1-hour basis (NO_2 and CO), there is no evidence that the off-site emissions of NO_2 and CO are likely to cause adverse effects on human health.

Table 23: Comparison of Predicted Concentrations and WHO Guidelines for Human Health Protection

Name	Averaging Period	WHO Guideline (µg/m³)	Concentrations (µg/m³) – Maximum values				
			Receptors Within Surface Lease	Receptors on Surface Lease Boundary	Receptors Within Buffer Zone	Receptors on Buffer Boundary	Receptors Outside Buffer Zone
PM_{10}	24-hour	50	**149.9**[(a)]	**94.5**	**86.9**	34.3	32.0
	Annual	20	**48.6**	**29.1**	**26.4**	8.8	8.5
$PM_{2.5}$	24-hour	25	**52.6**	**38.6**	**37.4**	20.6	19.3
	Annual	10	**20.1**	**11.0**	**10.3**	6.0	5.8
SO_2	24-hour	20	1.3	1.2	1.2	0.8	0.8
NO_2	1-hour	200	185.6	167.7	160.8	163.2	153.9
	Annual	40	**56.6**	**50.8**	**50.3**	**42.3**	**40.1**
CO	1-hour	30,000	513.5	399.7	356.5	253.7	264.3
	8-hour	10,000	286.9	223.3	199.2	141.7	147.6
Lead	Annual	0.5	**1.79**	0.12	0.10	0.02	0.02

Notes: (a): Numbers in bold correspond to concentrations higher than the WHO guidelines.

5.0 MONITORING, MITIGATION AND ADAPTIVE MANAGEMENT STRATEGIES

In this section, the predicted ambient air quality concentrations will be considered in the design of an appropriate monitoring program, and the development of mitigation and adaptive management strategies to minimize emissions for the Project and their impacts. The specific mitigation and adaptive management strategies to minimize contaminant loading by fugitive dust from the handling and transport of raw ore and concentrate, and emissions from incineration, will be described. As the Project is currently at the environmental assessment stage, the text below provides an outline of the intended management plans. Specifics are provided for the proposed monitoring program. If the Project progresses to the permitting stage, appropriate management plans will be developed and inserted here.

5.1 Monitoring Program and Mitigation and Adaptive Strategies

5.1.1 Introduction

5.1.1.1 Regulatory Review

Identification of legislation, regulatory and policy requirements which must be considered in the Monitoring Program.

5.1.1.2 Scope

Description of the scope of the Program.

5.1.1.3 Goal

Description of the goals of the Program.

5.1.2 Air Quality Monitoring Program

5.1.2.1 Introduction

5.1.2.2 Evaluation of Local Conditions and Predicted Air Concentrations

Evaluation of local conditions and predicted air concentrations that should be considered when defining the monitoring requirements.

5.1.2.3 Identification of Monitoring Requirements

Identification of requirements for the Monitoring Program, including: location of the meteorological station, parameters to be monitored, frequency and location for sampling.

Outline of the Monitoring Requirements

Table 24 presents an outline of the monitoring requirements for assessing impacts of emissions from the Project on local air quality.

Table 24: Monitoring Requirements

Parameter	Frequency	Location	Phase
Meteorological Conditions			
Wind speed	Hourly	On-site meteorological station	Construction and Operation
Wind direction	Hourly		Construction and Operation
Temperature	Hourly		Construction and Operation
Precipitation	Daily		Construction and Operation
Ambient Air Quality			
TSP	Every 6 days	On-site: one location, to be defined based maximum predicted concentrations within the surface lease; and Outside the buffer zone (i.e., more than 200 m from the surface lease boundary): on location, to be defined.	Construction and Operation
PM_{10}	Every 6 days		Construction and Operation
$PM_{2.5}$	Every 6 days		Construction and Operation
SO_2	Monthly		Operation
NO_2	Monthly		Operation
Lead	Every 30 days		Operation
Zinc	Every 30 days		Operation
Spillage on the Access Road			
Lead in the ice on the road surface	Every 30 days during the road season	Locations along the access road, to be defined based on the road plan.	Operation
Zinc in the ice on the road surface	Every 30 days during the road season		Operation

5.1.2.4 Proposed Monitoring Techniques and Equipments

Identification of monitoring techniques and equipments appropriate to meet the monitoring requirements.

5.1.2.5 Data Analysis

Description of procedures for compilation and analysis of the monitoring data.

5.1.2.6 Quality Assurance / Quality Control Procedures

Description of procedures for QA/QC the monitoring results.

5.1.2.7 Implementation of the Monitoring Program

Description of schedule and resources (including training) necessary to implement the Monitoring Program.

5.1.2.8 Recordkeeping

Description of procedures for recordkeeping the information related to the Monitoring Program, for purpose of audits and continuous improvement of the Program.

5.1.2.9 Monitoring Program Review

Description of procedures for periodic review of the Monitoring Program (continuous improvement), including stages to reduce the monitoring requirements.

5.1.3 Emission Monitoring Program

5.1.3.1 Introduction

5.1.3.2 Project Emissions

Description of the emissions from the Project.

5.1.3.3 Quantification of the Project Emissions

Description of procedures for quantification of emissions from the Project.

5.1.4 Fuel Use Summary

Description of fuel use during the development of the Project.

5.1.5 Mitigation and Adaptive Strategies

5.1.5.1 Evaluation of Predicted Impacts from the Project Emissions

Evaluation of predicted impacts from the Project emissions that must be addressed by the Mitigation and Adaptive Strategies.

5.1.5.2 Identification of Mitigation and Adaptive Strategies

Identification of Mitigation and Adaptive Strategies to minimize the impacts of the Project emissions on local air quality.

5.1.5.3 Implementation of the Mitigation and Adaptive Strategies

Description of schedule and resources necessary to implement the Mitigation and Adaptive Strategies.

5.1.5.4 Mitigation and Adaptive Strategies Review

Description of procedures for period review of the Mitigation and Adaptive Strategies (continuous improvement).

5.1.6 Response Planning

Description of strategies for responding events of significant emissions or air quality impacts.

5.1.7 Annual Report

Description of procedures for preparation of annual reports.

5.1.8 References

5.1.9 Glossary

5.2 Best Management Practices Plan to Control Fugitive Dust and Metals Emissions

5.2.1 Introduction

5.2.2 Identification of Sources of Fugitive Dust and Metal Emissions within the Facility

Description of sources of fugitive dust and metal emissions within the Facility, detailing the areas and operating procedures that result in dust emissions, along with identification of potential causes of high dust emissions from these sources.

5.2.3 Review of the Composition and Size Range of the Fugitive Dust

Review of the composition and size range of fugitive dust at the Facility based on existing data, if available.

5.2.4 Preventative Procedures and Control Measures for Control of Fugitive Dust

Description of preventative procedures and control measures to be implemented at the Prairie Creek Mine to prevent and minimize the impacts of fugitive dust emissions.

5.2.5 Preventative Procedures and Control Measures for Control of Metal Emissions

Description of additional preventative procedures and control measures to be implemented at the Prairie Creek Mine to minimize emissions of metals, including: procedures for concentrate bagging, handling (i.e., loading and unloading the bags), transport and transfer in the transfer facilities.

5.2.6 Implementation of the BMP Plan

Description of schedule and resources (including training) necessary to implement the BMP Plan.

5.2.7 Inspection and Monitoring Procedures

Description of inspection and monitoring procedures required to obtain information necessary to support the application of preventative procedures and control measures, as well as information to evaluate the effectiveness of the procedures and measures applied in minimizing the impacts of the air emissions.

5.2.8 Record Keeping

Description of procedures for recordkeeping the information related to the BMP Plan, for purpose of audits and continuous improvement of the Plan.

5.2.9 BMP Plan Review

Description of procedures for period review of the BMP Plan (continuous improvement).

5.3 Incinerator Management Plan

5.3.1 Introduction

5.3.2 Regulatory Review

Identification of legal requirements which must be considered in the Incinerator Management Plan, and performance limits applicable for the Prairie Creek Mine incinerator.

5.3.3 Identification and Evaluation of Best Practices and Technologies

Identification and evaluation of best operating practices and technologies used for waste incineration in remote industrial sites.

5.3.4 Evaluation of the Proposed Practices and Technology

Evaluation of the proposed operating practices and incineration technology with regard to the best practices and technologies, in order to identify eventual opportunities of improvement that should be considered in the plan.

5.3.5 Strategies and Procedures for Waste Incineration

Description of strategies and procedures for waste incineration to be implemented at the Prairie Creek Mine to minimize the impacts of its emissions, including: waste management practices that can affect the incinerator emissions (e.g., segregation, storage prior to incineration), waste types and quantities that can be treated by the incinerator.

5.3.6 Implementation of the Incinerator Management Plan

Description of schedule and resources (including training) necessary to implement the Incinerator Management Plan.

5.3.7 Inspection, Testing and Monitoring

Description of inspection requirements for the strategies and procedures for waste incineration, as well as testing and monitoring requirements to evaluate the effectiveness of the Incinerator Management Plan in minimizing impacts of the incinerator air emissions.

5.3.8 Record Keeping

Description of procedures for recordkeeping the information related to the Incinerator Management Plan, for purpose of audits and continuous improvement of the Plan.

5.3.9 Incinerator Management Plan Review

Description of procedures for period review of the Incinerator Management Plan (continuous improvement).

6.0 CONCLUSION

The following are the main conclusions from this Air Quality Assessment:

Pre-development conditions

- The Prairie Creek Mine is located in high north latitude, resulting in a subarctic climate with low annual temperature average. Based on climate change projections, temperatures and precipitation in the Prairie Creek Mine area are expected to increase over the 21st century.
- The complex topography in the Mine area affects significantly the local dispersion meteorology. In order to generate local meteorological data necessary for the air dispersion modelling, a combination of the MM5 and CALMET models has been used in this Air Quality Assessment.
- The analysis of baseline air quality indicated low concentrations of TSP, PM_{10}, $PM_{2.5}$, SO_2, NO_2 and O_3, reflecting the lack of activities in the Prairie Creek Mine area.

Evaluation of Potential Impacts from the Project

- The emission inventory indicated that the construction, operation and closure phases are expected to present particulate matter emissions (i.e., TSP, PM_{10} and $PM_{2.5}$) with similar order of magnitude on a daily basis, resulting from transport, material handling and earth works during the construction and closure phases, and transport, material handling, ore extraction and processing activities during the operation phase. NO_X, SO_2 and CO emissions are expected to be significantly higher during the operation phase, due to the use of on-site power generators. Lead and zinc emissions are expected only during the operation phase, resulting from ore extraction, management and processing activities.
- The transport of concentrate on the access road is not expected to generate fugitive emissions of particulate matter or airborne metals, due to the characteristics of the access road (i.e., surface covered with ice and snow) and the fact that the concentrate will be transported in sealed bags.
- Considering the type of emissions, emission rates and duration of each phase, the evaluation of potential impacts of the Project emissions on air quality has been focused on the emissions during the operation phase.
- Air concentrations resulting from on-site (i.e., Prairie Creek Mine) emissions have been determined using CALPUFF dispersion model, run in a dynamic (3D) mode to account for the effects of the complex topography on the dispersion meteorology. Concentrations resulting from off-site (i.e., access road and transfer facilities) emissions have been determined using SCREEN3 dispersion model.
- Maximum predicted concentrations of TSP, PM_{10}, $PM_{2.5}$ and lead resulting from on-site emissions are expected to exceed the respective air quality standards for receptors located within the surface lease that encompasses the Prairie Creek Mine, on the surface lease boundary and in the buffer zone area outside the surface lease. The number of receptors where maximum concentrations are expected to exceed the standards on the surface lease boundary and within the buffer zone is relatively small compared to the total number of receptors assessed in each of these receptor zones. Maximum predicted concentrations of

TSP, PM_{10}, $PM_{2.5}$ and lead are expected to be lower than the respective air quality standards for receptors located on the outer limit of the buffer zone (i.e., 200 m from the surface lease boundary) and beyond.

- Maximum predicted concentrations of NO_2, SO_2 and CO resulting from on-site emissions are expected to be lower than the respective air quality standards for all receptors assessed, including that located within the surface lease.
- Maximum concentrations of TSP, PM_{10}, $PM_{2.5}$, NO_2, SO_2 and CO resulting from off-site emissions are expected to be lower than the respective air quality standards.

This Air Quality Assessment indicates that the Project activities are not likely to result in significant impacts on the local air quality for receptors located 200 m from the surface lease boundary and beyond, neither for receptors located adjacent to the access road.

Monitoring, Mitigation and Adaptive Management Strategies

TO BE COMPLETED

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Report Signature Page

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APPENDIX A

Emission Calculation

Air Quality Assessment - Prairie Creek Mine
Summary of Emission Rates During the Construction Phase

Operations	Activities	Emission Category	Emission Rates (g/s) - 24-hour							
			TSP	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	Pb	Zn
I - Demolition and Debris Removal	I.1 - Drilling	A - Fugitive Emissions	1.84E-02	8.19E-03	1.52E-03	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	2.00E-04	2.00E-04	1.94E-04	1.69E-03	3.04E-06	1.42E-03	N/A	N/A
	I.2 - Blasting	A - Fugitive Emissions	5.09E-03	2.65E-03	1.53E-04	N/A	N/A	N/A	N/A	N/A
	I.3 - General land clearing (dozer)	A - Fugitive Emissions	2.08E-01	3.92E-02	2.18E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	4.79E-03	4.79E-03	4.65E-03	4.81E-02	9.08E-05	2.27E-02	N/A	N/A
	I.4 - Loading of debris into trucks	A - Fugitive Emissions	4.17E-01	2.17E-01	4.38E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	4.13E-03	4.13E-03	4.00E-03	2.95E-02	5.59E-05	2.26E-02	N/A	N/A
	I.5 - Truck transport of debris (unpaved roads)	A - Fugitive Emissions	4.85E-01	1.21E-01	1.21E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	1.14E-02	1.14E-02	1.10E-02	1.05E-01	1.98E-04	5.79E-02	N/A	N/A
II - Site Preparation (earth moving)	II.1 - Bulldozing	A - Fugitive Emissions	4.16E-01	7.84E-02	4.37E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	8.70E-03	8.70E-03	8.43E-03	7.34E-02	1.36E-04	5.31E-02	N/A	N/A
	II.2 - Scrapers removing top soil	A - Fugitive Emissions	6.60E-01	3.43E-01	6.93E-02	N/A	N/A	N/A	N/A	N/A
	II.3 - Scrapers in travel	A - Fugitive Emissions	4.07E-01	1.16E-01	1.16E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	7.10E-03	7.10E-03	6.88E-03	7.13E-02	1.35E-04	3.36E-02	N/A	N/A
	II.4 - Scrapers unloading topsoil	A - Fugitive Emissions	5.03E-01	2.62E-01	5.29E-02	N/A	N/A	N/A	N/A	N/A
	II.5 - Material Handling (aggregate material, cement)	A - Fugitive Emissions	4.96E-04	2.35E-04	3.55E-05	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	6.19E-03	6.19E-03	6.01E-03	4.43E-02	8.38E-05	3.27E-02	N/A	N/A
	II.6 - Compacting (dozer)	A - Fugitive Emissions	4.16E-01	7.84E-02	4.37E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	8.16E-03	8.16E-03	7.92E-03	6.80E-02	1.26E-04	4.74E-02	N/A	N/A
	II.7 - Grading	A - Fugitive Emissions	7.36E-02	4.20E-02	2.28E-03	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	1.46E-02	1.46E-02	1.42E-02	1.34E-01	2.52E-04	6.50E-02	N/A	N/A
III - General Construction	III.1 - Vehicular traffic	A - Fugitive Emissions	5.58E-01	1.39E-01	1.39E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	3.52E-02	3.52E-02	3.41E-02	2.85E-01	5.12E-04	2.51E-01	N/A	N/A
	III.2 - Power generation	C - Combustion Emissions	5.38E-02	5.38E-02	5.22E-02	2.00E+00	2.37E-03	3.90E-01	N/A	N/A
Total			**4.32E+00**	**1.60E+00**	**4.66E-01**	**2.86E+00**	**3.96E-03**	**9.78E-01**	**N/A**	**N/A**

Operations	Activities	Emission Category	Contributions							
			TSP	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	Pb	Zn
I - Demolition and Debris Removal	I.1 - Drilling	A - Fugitive Emissions	0.43%	0.51%	0.33%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.00%	0.01%	0.04%	0.06%	0.08%	0.15%	N/A	N/A
	I.2 - Blasting	A - Fugitive Emissions	0.12%	0.17%	0.03%	N/A	N/A	N/A	N/A	N/A
	I.3 - General land clearing (dozer)	A - Fugitive Emissions	4.81%	2.45%	4.68%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.11%	0.30%	1.00%	1.68%	2.29%	2.32%	N/A	N/A
	I.4 - Loading of debris into trucks	A - Fugitive Emissions	9.64%	13.53%	9.38%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.10%	0.26%	0.86%	1.03%	1.41%	2.32%	N/A	N/A
	I.5 - Truck transport of debris (unpaved roads)	A - Fugitive Emissions	11.22%	7.55%	2.59%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.26%	0.71%	2.37%	3.67%	5.00%	5.92%	N/A	N/A
II - Site Preparation (earth moving)	II.1 - Bulldozing	A - Fugitive Emissions	9.63%	4.90%	9.37%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.20%	0.54%	1.81%	2.56%	3.42%	5.43%	N/A	N/A
	II.2 - Scrapers removing top soil	A - Fugitive Emissions	15.27%	21.43%	14.85%	N/A	N/A	N/A	N/A	N/A
	II.3 - Scrapers in travel	A - Fugitive Emissions	9.41%	7.26%	2.49%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.16%	0.44%	1.48%	2.49%	3.40%	3.44%	N/A	N/A
	II.4 - Scrapers unloading topsoil	A - Fugitive Emissions	11.65%	16.35%	11.34%	N/A	N/A	N/A	N/A	N/A
	II.5 - Material Handling (aggregate material, cement)	A - Fugitive Emissions	0.01%	0.01%	0.01%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.14%	0.39%	1.29%	1.55%	2.12%	3.34%	N/A	N/A
	II.6 - Compacting (dozer)	A - Fugitive Emissions	9.63%	4.90%	9.37%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.19%	0.51%	1.70%	2.38%	3.17%	4.85%	N/A	N/A
	II.7 - Grading	A - Fugitive Emissions	1.70%	2.62%	0.49%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.34%	0.91%	3.04%	4.67%	6.37%	6.65%	N/A	N/A
III - General Construction	III.1 - Vehicular traffic	A - Fugitive Emissions	12.91%	8.69%	2.98%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	0.81%	2.20%	7.32%	9.95%	12.92%	25.68%	N/A	N/A
	III.2 - Power generation	C - Combustion Emissions	1.25%	3.36%	11.20%	69.96%	59.83%	39.91%	N/A	N/A
Total			100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	N/A	N/A

N/A: Not Applicable (i.e., emissions not expected)

Summary

Operations	Emission Rates (g/s) - 24-hour							
	TSP	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	Pb	Zn
I - Demolition and Debris Removal	1.15E+00	4.08E-01	9.92E-02	1.84E-01	3.48E-04	1.05E-01	N/A	N/A
II - Site Preparation (earth moving)	2.52E+00	9.65E-01	2.67E-01	3.91E-01	7.32E-04	2.32E-01	N/A	N/A
III - General Construction	6.47E-01	2.28E-01	1.00E-01	2.29E+00	2.88E-03	6.41E-01	N/A	N/A
Total	**4.32E+00**	**1.60E+00**	**4.66E-01**	**2.86E+00**	**3.96E-03**	**9.78E-01**	**N/A**	**N/A**

Operations	Emission Rates (kg/day) - 24-hour							
	TSP	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	Pb	Zn
I - Demolition and Debris Removal	99.67	35.26	8.57	15.92	0.03	9.04	N/A	N/A
II - Site Preparation (earth moving)	217.81	83.37	23.06	33.75	0.06	20.03	N/A	N/A
III - General Construction	55.91	19.71	8.66	197.57	0.25	55.42	N/A	N/A
Total	**373.39**	**138.34**	**40.29**	**247.24**	**0.34**	**84.49**	**N/A**	**N/A**

Operations	Contributions							
	TSP	PM_{10}	$PM_{2.5}$	NO_x	SO_2	CO	Pb	Zn
I - Demolition and Debris Removal	26.69%	25.49%	21.28%	6.44%	8.78%	10.70%	N/A	N/A
II - Site Preparation (earth moving)	58.33%	60.26%	57.22%	13.65%	18.47%	23.70%	N/A	N/A
III - General Construction	14.97%	14.25%	21.50%	79.91%	72.75%	65.59%	N/A	N/A
Total	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	N/A	N/A

N/A: Not Applicable (i.e., emissions not expected)

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

I - Demolition and Debris Removal

I.1 - Drilling

A - Fugitive Emissions

Dust Control Technique		Wet drilling

Hours of operation per day - peak	h/day	A	1.5			(a)
Number of holes	holes/day	B	9			(b)
Emission reduction efficiency	(%)	C	70	70	70	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Assuming 1 hole every 10 min.
(c) Extracted from Emission Estimation Technique Manual for Mining - Version 2.3 (Environment Australia, December 2001).

			TSP	PM_{10}	$PM_{2.5}$	
Emission factor (uncontrolled)	kg/hole	D	0.590	0.262	0.049	(a) (b) (c)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	1,593.0	708.0	131.1	
Emission rate (24-hour)	g/s	F = E/(24*3600)	1.84E-02	8.19E-03	1.52E-03	
Quality rating	-		C	-	-	

Source: (a) Emission factor for TSP extracted from AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-4 (English And Metric Units) - Uncontrolled Particulate Emission Factors for Open Dust Sources at Western Surface Coal Mines (drilling / overburden). According to recommendations in AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction Operations (reference to drilling factor in Section 11.9/Table 11.9-4).
(b) Emission factor for PM10 based on the ratio between TSP and PM10 emission factors for tertiary crushing (uncontrolled) in AP-42 / Section 11.19.2 - Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2-1 (Metric Units) - Emission Factors for Crushed Stone Processing Operations.
(c) Emission factor for PM2.5 based on the ratio between PM10 and PM2.5 emission factors for tertiary crushing (controlled) in AP-42 / Section 11.19.2 - Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004) / Table 11.19.2-1 (Metric Units) - Emission Factors for Crushed Stone Processing Operations.

Note: The document *Emission Estimation Technique Manual for Mining - Version 2.3* (Environment Australia, December 2001) presents 100% reduction efficiency on dust control for underground activities. Since the underground retention is not included in the calculation, the emission rates are representative of the initial portion of the underground workings (i.e., close to the surface). These emission rates would correspond to highly conservative estimates for underground activities.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Drill jumbo	Electric/Hydraulic	1	1.5	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	2.00E-04	2.00E-04	1.94E-04	1.69E-03	3.04E-06	1.42E-03

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

I.2 - Blasting

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day - peak	h/day	A	0.2	(a)		
Number of blasts	blasts/day	B	2	(b)		
Blast area	m^2	C	100	(c)		
Emission reduction efficiency	(%)	D	0	0	0	

Source: (a) Based on information provided by Canadia Zinc: number of hours for drilling operations during construction and ratio between number of hours for drilling and blasting operations during operation phase.
(b) Based on information provided by Canadian Zinc for the Operation phase.
(c) Assumed based on diameter of the underground tunnels.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	
Constant (a)	-	E	0.00022	-	-	(a)
Constant (b)	-	F	1.5	-	-	(a)
Scaling Factor		G	-	0.52	0.03	(a) (b)
Emission rate (uncontrolled)	kg/blast	H = E*(C^F)	0.220	0.114	0.007	(a) (c)
Emission rate (controlled)	g/day	I = H*1000*B*(1-D/100)	440.0	228.8	13.2	
Emission rate (24-hour)	g/s	J = I/(24*3600)	5.09E-03	2.65E-03	1.53E-04	
Quality rating	-		C	D	D	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (blasting). According to recommendations in AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction Operations (reference to blasting equation in Section 11.9/Table 11.9.2).
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and PM2.5.
(c) PM10 and PM2.5 calculated multiplying TSP emission rate by respective scaling factors.

Note: The document *Emission Estimation Technique Manual for Mining - Version 2.3* (Environment Australia, December 2001) presents 100% reduction efficiency on dust control for underground activities. Since the underground retention is not included in the calculation, the emission rates are representative of the initial portion of the underground workings (i.e., close to the surface). These emission rates would correspond to highly conservative estimates for underground activities.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

I.3 - General land clearing (dozer)

A - Fugitive Emissions

Dust Control Technique		No control

Number of equipment	pc	A	1	(a)
Hours of operation per day - peak	h/day	B	10	(a)
Material silt content	(%)	C	6.9	(b)
Material moisture content	(%)	D	7.9	(b)
Emission reduction efficiency	(%)	E	0	

Source: (a) Information provided by Canadia Zinc.
(b) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-3 (Metric and English Units) - Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations (values for overburden).

			TSP <= 30 um	TSP <= 15 um	PM_{10}	$PM_{2.5}$	
Constant (a)	-	F	2.6	0.45	-	-	(a)
Constant (b)	-	G	1.2	1.5	-	-	(a)
Constant (c)	-	H	1.3	1.4	-	-	(a)
Scaling Factor		I	-	-	0.75	0.105	(a) (b)
Emission rate (uncontrolled)	kg/hr/pc	J = F*(C^G)/(D^H)	1.798	0.452	0.339	0.189	(a) (c)
Emission rate (controlled)	g/hr	K = A*J*1000*(1-E/100)	1,797.5	451.7	338.7	188.7	
Emission rate	g/day	L = K*B	17,975.3	4,516.6	3,387.4	1,887.4	
Emission rate (24-hour)	g/s	M = L/(24*3600)	2.08E-01	5.23E-02	3.92E-02	2.18E-02	
Quality rating	-		B	C	D	D	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (bulldozing overburden). According to recommendations in AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction Operations (reference to dozer equation (overburden) in Section 11.9 / Table 11.9.2).
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and TSP <= 15 um to PM2.5
(c) PM10 and PM2.5 calculated multiplying TSP emission rates by respective scaling factors.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Dozer	D8H Cat	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	4.79E-03	4.79E-03	4.65E-03	4.81E-02	9.08E-05	2.27E-02

Source: See table exhaust emissions.

I.4 - Loading of debris into trucks

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day	h/day	A	10	(a)
Amount of soil removed per day	tonnes/day	B	2,000	(b)
Emission reduction efficiency	(%)	C	0	

Source: (a) Information provided by Canadia Zinc.
(b) Calculated based on information provided by Canadian Zinc (volume of crushed rock) assuming a density of 2 t/m^3.

			TSP	PM_{10}	$PM_{2.5}$	
Emission factor (uncontrolled)	kg/tonne	D	0.018	0.0094	0.0019	(a) (b) (c)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	36,000.0	18,720.0	3,780.0	
Emission rate (24-hour)	g/s	F = E/(24*3600)	4.17E-01	2.17E-01	4.38E-02	
Quality rating	-		E	-	-	

Source: (a) TSP emission factor extracted from AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9.4 - Uncontrolled Particulate Emission Factors for Open Dust Sources at Werstern Surface Coal Mine (truck loading by power shovel (batch drop) / overburden).
(b) Emission factor for PM10 based on the ratio between TSP and PM10 emission factors for blasting in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.
(c) Emission factor for PM2.5 based on the ratio between TSP and PM2.5 emission factors for bulldozing overburden in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
FEL	Cat 950	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	4.13E-03	4.13E-03	4.00E-03	2.95E-02	5.59E-05	2.26E-02

Source: See table exhaust emissions.

I.5 - Truck transport of debris (unpaved roads)

A - Fugitive Emissions

Dust Control Technique		Watering twice a day		
Hours of operation per day - peak	h/day	A	18	(a)
Surface material silt content	(%)	B	4.3	(b)
Mean vehicle weight	(tons)	C	27.98	(c)
Vehicle kilometre traveled (VKT)	km/day	D	178	(c)
Number of working days	days/year	E	350	(a)
Number of days with precipitation >= 0.2 mm	days/year	F	56	(d)
Number of days with snow cover >= 1 cm	days/year	G	194.5	(d)
Emission reduction efficiency	(%)	H	55	(e)

Source: (a) Information provided by Canadian Zinc.
(b) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (taconite mining and processing / service road).
(c) See Mean Vehicle Weight table below.
(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009).
(e) Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009).

			PM-30 (TSP)	**PM_{10}**	**$PM_{2.5}$**	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] [(b)]	1.855	0.462	0.046	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) [(c)]	235.3	58.7	5.9	
Emission rate	g/day	N = M*D	41,886.9	10,443.1	1,044.3	
Emission rate (24-hour)	g/s	O = N/(24*3600)	4.85E-01	1.21E-01	1.21E-02	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

Mean Vehicle Weight

Equipment	-		LHD Scoops	20 t Trucks	Total	
Weight - Empty	tons		12.7	20.5	-	(a)
Weight - Loaded	tons		16.3	40.5	-	(a)
Mean Weight	tons		14.5	30.5	-	(b)
Vehicle kilometer traveled (VKT)	km/day		28	150	178	(a)
Percentage of traffic	%		15.73%	84.27%	-	
Mean vehicle weight	tons		2.28	25.70	27.98	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Assuming half of the distance is travelled with the vehicle empty anf half of the distance with the vehicle loaded.
(c) Values weighted according to VKT.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
20 t Trucks	MT2010	1	18.0	(a)
LHD Scoops	2 Yard	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	1.14E-02	1.14E-02	1.10E-02	1.05E-01	1.98E-04	5.79E-02

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

II - Site Preparation (earth moving)

II.1 - Bulldozing

A - Fugitive Emissions

Dust Control Technique		No control

Number o equipment	pc	A	2	(a)
Hours of operation per day - peak	h/day	B	10	(a)
Material silt content	(%)	C	6.9	(b)
Material moisture content	(%)	D	7.9	(b)
Emission reduction efficiency	(%)	E	0	

Source: (a) Information provided by Canadia Zinc.
(b) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-3 (Metric and English Units) - Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations (values for overburden).

			TSP <= 30 um	TSP <= 15 um	PM_{10}	$PM_{2.5}$	
Constant (a)	-	F	2.6	0.45	-	-	(a)
Constant (b)	-	G	1.2	1.5	-	-	(a)
Constant (c)	-	H	1.3	1.4	-	-	(a)
Scaling Factor		I	-	-	0.75	0.105	(a) (b)
Emission rate (uncontrolled)	kg/hr	J = F*(C^G)/(D^H)	1.798	0.452	0.339	0.189	(a) (c)
Emission rate (controlled)	g/hr	K = A*J*1000*(1-E/100)	3,595.1	903.3	677.5	377.5	
Emission rate	g/day	L = K*B	35,950.7	9,033.1	6,774.8	3,774.8	
Emission rate (24-hour)	g/s	M = L/(24*3600)	4.16E-01	1.05E-01	7.84E-02	4.37E-02	
Quality rating	-		B	C	D	D	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (bulldozing overburden). According to recommendations in AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction Operations (reference to dozer equation (overburden) in Section 11.9 / Table 11.9.2).
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and TSP <= 15 um to PM2.5
(c) PM10 and PM2.5 calculated multiplying TSP emission rates by respective scaling factors.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Dozer	D8K Cat	1	10.0	(a)
Dozer	D6 Cat	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	8.70E-03	8.70E-03	8.43E-03	7.34E-02	1.36E-04	5.31E-02

Source: See table exhaust emissions.

II.2 - Scrapers removing top soil

A - Fugitive Emissions

Dust Control Technique		No control	

Hours of operation per day - peak	h/day	A	10	(a)
Vehicle kilometer traveled (VKT)	km/day	B	10	(b)
Emission reduction efficiency	(%)	C	0	

Source: (a) Information provided by Canadia Zinc.
(b) Calculated assuming an average speed of 0.5 m/h (scraping) and number of equipment provided by Canadian Zinc (2 scrappers).

			TSP	PM_{10}	$PM_{2.5}$	
Emission factor (uncontrolled)	kg/VKT	D	5.70	2.96	0.60	(a) (b) (c)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	57,000.0	29,640.0	5,985.0	
Emission rate (24-hour)	g/s	F = E/(24*3600)	6.60E-01	3.43E-01	6.93E-02	
Quality rating	-		E	E	E	

Source: (a) Emission factor for TSP extracted from AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1. Recommended Emission Factors for Construction Operations (scrapper removing topsoil).
(b) Emission factor for PM10 based on the ratio between TSP and PM10 emission factors for blasting in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.
(c) Emission factor for PM2.5 based on the ratio between TSP and PM2.5 emission factors for bulldozing overburden in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

II.3 - Scrapers in travel

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day - peak	h/day	A	10	(a)
Surface material silt content	(%)	B	8.5	(b)
Mean vehicle weight	(tons)	C	10.00	(c)
Vehicle kilometre traveled (VKT)	km/day	D	60	(c)
Number of working days	days/year	E	100	(a)
Number of days with precipitation >= 0.2 mm	days/year	F	15.3	(d)
Number of days with snow cover >= 1 cm	days/year	G	53.3	(d)
Emission reduction efficiency	(%)	H	0	(e)

Source: (a) Information provided by Canadian Zinc.
(b) AP-42 / Section 13.2.2 - Unpaved Roads / Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (construction sites/ scraper routes).
(c) See Mean Vehicle Weight table below.
(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009). Annual values were prorated
(e) Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009).

			PM-30 (TSP)	PM_{10}	$PM_{2.5}$	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] [(b)]	2.078	0.594	0.059	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) [(c)]	585.7	167.3	16.7	
Emission rate	g/day	N = M*D	35,142.6	10,041.0	1,004.1	
Emission rate (24-hour)	g/s	O = N/(24*3600)	4.07E-01	1.16E-01	1.16E-02	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

Mean Vehicle Weight

Equipment	-		Scraper	Total	
Weight - Empty	tons		10	-	(a)
Weight - Loaded	tons		10	-	(a)
Mean Weight	tons		10	-	(b)
Vehicle kilometer traveled (VKT)	km/day		60	60	(c)
Percentage of traffic	%		100.00%	-	
Mean vehicle weight	tons		10.00	10.00	(c)

Source: (a) Assumed.
(b) Assuming half of the distance is travelled with the vehicle empty anf half of the distance with the vehicle loaded.
(c) Calculated assuming an average speed of 3 km/h and number of equipment provided by Canadian Zinc (2 scrappers).
(d) Values weighted according to VKT.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Scraper	Caterpillar	2	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	7.10E-03	7.10E-03	6.88E-03	7.13E-02	1.35E-04	3.36E-02

Source: See table exhaust emissions.

II.4 - Scrapers unloading topsoil

A - Fugitive Emissions

Dust Control Technique		No control	

Hours of operation per day - peak	h/day	A	10	(a)
Amount of soil removed per day	tonnes/day	B	1,500	(b)
Emission reduction efficiency	(%)	C	0	

Source: (a) Information provided by Canadia Zinc.
(b) Calculated based on information provided by Canadian Zinc (volumes) assuming a density of 1.5 tonnes/m^3.

			TSP	PM_{10}	$PM_{2.5}$	
Emission factor (uncontrolled)	kg/tonne	D	0.029	0.01508	0.003045	(a) (b) (c)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	43,500.0	22,620.0	4,567.5	
Emission rate (24-hour)	g/s	F = E/(24*3600)	5.03E-01	2.62E-01	5.29E-02	
Quality rating	-		E	E	E	

Source: (a) TSP emission factor extracted from AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9.4 - Uncontrolled Particulate Emission Factors for Open Dust Sources at Werstern Surface Coal Mine (scrapper unloading (batch drop) topsoil). According to recommendations in AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction Operations (reference to scraper unloading factor in Section 11.9 / Table 11.9-4).
(b) Emission factor for PM10 based on the ratio between TSP and PM10 emission factors for blasting in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.
(c) Emission factor for PM2.5 based on the ratio between TSP and PM2.5 emission factors for bulldozing overburden in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.

II.5 - Material Handling (aggregate material, cement)

A - Fugitive Emissions

Dust Control Technique		No control		
Hours of operation per day - peak	h/day	A	10	(a)
Amount of material handled per day	tonnes/day	B	100	(b)
Mean wind speed - maximum daily value	m/s	C	4.422	(c)
Material moisture content	%	D	7.9	(d)
Constant (a)		E	0.0016	(e)
Constant (b)		F	1.3	(e)
Constant (c)		G	2.2	(e)
Constant (d)		H	1.4	(e)
Constant (e)		I	2	(e)
Emission reduction efficiency	(%)	J	0	

Source: (a) Information provided by Canadia Zinc.
(b) Estimated based on number of equipment.
(c) Compiled from data provided by Canadian Zinc - results from local meteorological station.
(d) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-3 (Metric and English Units) - Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations (values for overburden).
(e) AP-42 / Section 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	
Particle size multiplier	-	K	0.74	0.35	0.053	(a)
Emission factor (uncontrolled)	kg/tonne	L = K*E*((C/G)^F)/((D/I)^H)	4.29E-04	2.03E-04	3.07E-05	(a)
Emission rate (controlled) (24-hour)	g/s	M = B*L*(1-J/100)*1000/(24*3600)	4.96E-04	2.35E-04	3.55E-05	
Quality rating	-		A	A	A	

Source: (a) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Loader	Volvo	1	10.0	(a)
Backhoe	Hitachi	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	6.19E-03	6.19E-03	6.01E-03	4.43E-02	8.38E-05	3.27E-02

Source: See table exhaust emissions.

II.6 - Compacting (dozer)

A - Fugitive Emissions

Dust Control Technique		No control

Number of equipment	pc	A	2	(a)
Hours of operation per day - peak	h/day	B	10	(a)
Material silt content	(%)	C	6.9	(b)
Material moisture content	(%)	D	7.9	(b)
Emission reduction efficiency	(%)	E	0	

Source: (a) Information provided by Canadia Zinc.
(b) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-3 (Metric and English Units) - Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations (values for overburden).

			TSP <= 30 um	TSP <= 15 um	PM_{10}	$PM_{2.5}$	
Constant (a)	-	F	2.6	0.45	-	-	(a)
Constant (b)	-	G	1.2	1.5	-	-	(a)
Constant (c)	-	H	1.3	1.4	-	-	(a)
Scaling Factor		I	-	-	0.75	0.105	(a) (b)
Emission rate (uncontrolled)	kg/hr/pc	J = F*(C^G)/(D^H)	1.798	0.452	0.339	0.189	(a) (c)
Emission rate (controlled)	g/hr	K = A*J*1000*(1-E/100)	3,595.1	903.3	677.5	377.5	
Emission rate	g/day	L = K*B	35,950.7	9,033.1	6,774.8	3,774.8	
Emission rate (24-hour)	g/s	M = L/(24*3600)	4.16E-01	1.05E-01	7.84E-02	4.37E-02	
Quality rating	-		B	C	D	D	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (bulldozing overburden). According to recommendations in AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction Operations (reference to dozer equation (overburden) in Section 11.9 / Table 11.9.2).
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and TSP <= 15 um to PM2.5
(c) PM10 and PM2.5 calculated multiplying TSP emission rates by respective scaling factors.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Dozer	D8	1	10.0	(a)
Dozer	D6	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	8.16E-03	8.16E-03	7.92E-03	6.80E-02	1.26E-04	4.74E-02

Source: See table exhaust emissions.

II.7 - Grading

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day	hr/day	A	10	(a)
Mean vehicle speed	km/hr	B	3	(b)
Vehicle kilometer traveled (VKT)	VKT/day	C	120	(c)
Emission reduction efficiency	(%)	D	0	

Source: (a) Information provided by Canadia Zinc.
(b) Assumed based on similar operations.
(c) Calculated assuming an average speed of 3 km/h and number of equipment provided by Canadian Zinc (4 graders).

			TSP <= 30 um	TSP <= 15 um	PM_{10}	$PM_{2.5}$	
Constant (a)	-	E	0.0034	0.0056	-	-	(a)
Constant (b)	-	F	2.5	2	-	-	(a)
Scaling Factor		G	-	-	0.60	0.031	(a) (b)
Emission factor (uncontrolled)	kg/VKT	H = E*(B^F)	0.053	0.050	0.030	0.002	(a) (c)
Emission rate (controlled)	g/day	I = C*H*1000*(1-D/100)	6,360.1	6,048.0	3,628.8	197.2	
Emission rate (24-hour)	g/s	J = I/(24*3600)	7.36E-02	7.00E-02	4.20E-02	2.28E-03	
Quality rating	-		C	C	D	D	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (grading). According to recommendations in Section 13.2.3 Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and TSP <= 15 um to PM2.5
(c) PM10 and PM2.5 calculated multiplying TSP emission rates by respective scaling factors.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Grader	Caterpillar	2	10.0	(a)
Grader	14G Cat	1	10.0	(a)
Grader	14E Cat	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	1.46E-02	1.46E-02	1.42E-02	1.34E-01	2.52E-04	6.50E-02

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

III - General Construction

III.1 - Vehicular traffic

A - Fugitive Emissions

Dust Control Technique		Watering twice a day		
Hours of operation per day	h/day	A	10	(a)
Surface material silt content	(%)	B	4.3	(b)
Mean vehicle weight	(tons)	C	8.51	(c)
Vehicle kilometre traveled (VKT)	km/day	D	350	(c)
Number of working days	days/year	E	350	(a)
Number of days with precipitation >= 0.2 mm	days/year	F	56	(d)
Number of days with snow cover >= 1 cm	days/year	G	194.5	(d)
Emission reduction efficiency	(%)	H	55	(e)

Source: (a) Information provided by Canadian Zinc.
(b) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (taconite mining and processing / service road).
(c) See Mean Vehicle Weight table below.
(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009).
(e) Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009).

			PM-30 (TSP)	PM_{10}	$PM_{2.5}$	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] [(b)]	1.086	0.271	0.027	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) [(c)]	137.8	34.3	3.4	
Emission rate	g/day	N = M*D	48,215.9	12,021.1	1,202.1	
Emission rate (24-hour)	g/s	O = N/(24*3600)	5.58E-01	1.39E-01	1.39E-02	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

Mean Vehicle Weight

Equipment	-		Pickup Trucks	Other Trucks	Heavy Equipment	Total	
Number	-		3	13	4		
Weight - Empty	tons		3	10	10	-	(a)
Weight - Loaded	tons		4	20	10	-	(a)
Mean Weight	tons		3.5	15	10	-	(b)
Vehicle kilometer traveled (VKT)	km/day		180	130	40	350	(c)
Percentage of traffic	%		51.43%	37.14%	11.43%	-	
Mean vehicle weight	tons		1.80	5.57	1.14	8.51	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Assuming half of the distance is travelled with the vehicle empty anf half of the distance with the vehicle loaded.
(c) Values calculated assuming daily use of the vehicles, as per table Exhaust Emissions below, and average speeds over the daily use of 3 km/h for pickup trucks, 1 km/h for other trucks and heavy equipment.
(d) Values weighted according to VKT.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Crane	72 Tonne	1	10.0	(a)
Forklift		1	10.0	(a)
Manlift		2	10.0	(a)
Snowplows		2	10.0	(a)
Lowboy Trailer with Louisville Truck		1	10.0	(a)
Water Truck		1	10.0	(a)
Crewcab Truck		2	10.0	(a)
Concrete Mixing Truck		2	10.0	(a)
Fuel Truck		1	10.0	(a)
Flat Bed truck		1	10.0	(a)
Pick up Trucks		3	10.0	(a)
Sand Trucks		2	10.0	(a)
Misc. service trucks		1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	3.52E-02	3.52E-02	3.41E-02	2.85E-01	5.12E-04	2.51E-01

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Construction Phase

III.2 - Power generation

C - Combustion Emissions

Control Technique		No Control

Hours of operation per day	h/day	A	24	(a)
Sulphur content in the fuel	%	B	0.0015	(b)
Number of power generators	-	C	1	(a)
Generator power Rating	kW	D	1,450	(a)
Generator power Rating	hp	E = D*1.341022	1,944	
Peak load of the generator set	%	F	90	(a)
Emission reduction efficiency	(%)	G	0	

Source: (a) Information provided by Canadia Zinc.
(b) Based on Canada's Sulphur in Diesel Fuel Regulations for off-road diesel Fuel effective from October 1, 2010 (Environmental Canada website, accessed in December, 2009)

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	5.38E-02	5.38E-02	5.22E-02	2.00E+00	2.37E-03	3.90E-01

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Summary of Emission Rates During the Operation Phase

Operations	Activities	Emission Category	Emission Rates (g/s) - 24-hour								Contributions							
			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
I - Extraction	I.1 - Drilling	A - Fugitive Emissions	2.50E-04	1.11E-04	2.06E-05	N/A	N/A	N/A	2.70E-05	2.83E-05	0.01%	0.01%	0.00%	N/A	N/A	N/A	0.43%	0.43%
		B - Exhaust Emissions	4.63E-04	4.63E-04	4.49E-04	3.38E-03	6.07E-06	3.01E-03	N/A	N/A	0.02%	0.05%	0.10%	0.05%	0.04%	0.13%	N/A	N/A
	I.2 - Blasting	A - Fugitive Emissions	1.02E-03	5.30E-04	3.06E-05	N/A	N/A	N/A	1.10E-04	1.15E-04	0.04%	0.05%	0.01%	N/A	N/A	N/A	1.74%	1.74%
	I.3 - Ore transport (mucking and haul truck transport) (unpave	A - Fugitive Emissions	1.19E+00	3.16E-01	3.16E-02	N/A	N/A	N/A	N/A	N/A	45.76%	31.18%	6.76%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	2.58E-02	2.58E-02	2.50E-02	1.57E-01	2.96E-04	1.15E-01	N/A	N/A	0.99%	2.55%	5.36%	2.10%	2.03%	4.88%	N/A	N/A
II - Ore Management	II.1 - Transfer (dump) to conveyor	A - Fugitive Emissions	1.54E-02	7.30E-03	1.11E-03	N/A	N/A	N/A	1.67E-03	1.75E-03	0.59%	0.72%	0.24%	N/A	N/A	N/A	26.45%	26.45%
	II.2 - Conveyor transport (transfer points)	A - Fugitive Emissions	2.08E-02	7.64E-03	2.16E-03	N/A	N/A	N/A	2.25E-03	2.35E-03	0.80%	0.75%	0.46%	N/A	N/A	N/A	35.67%	35.67%
	II.3 - Stockpiling (dump to temporary/permanent stockpile)	A - Fugitive Emissions	5.15E-04	2.43E-04	3.69E-05	N/A	N/A	N/A	5.56E-05	5.82E-05	0.02%	0.02%	0.01%	N/A	N/A	N/A	0.88%	0.88%
	II.4 - Recover from temporary/permanent stockpile	A - Fugitive Emissions	5.15E-04	2.43E-04	3.69E-05	N/A	N/A	N/A	5.56E-05	5.82E-05	0.02%	0.02%	0.01%	N/A	N/A	N/A	0.88%	0.88%
	II.5 - Ore Stockpile Maintenance (temporary/permanent stock	A.1 - Fugitive PM Emissions - Stockpile Working (Dozer)	4.96E-03	5.61E-04	5.21E-04	N/A	N/A	N/A	5.36E-04	5.61E-04	0.19%	0.06%	0.11%	N/A	N/A	N/A	8.50%	8.50%
		A.2 - Fugitive PM Emissions (Wind Erosion)	8.92E-03	4.46E-03	3.34E-04	N/A	N/A	N/A	9.63E-04	1.01E-03	0.34%	0.44%	0.07%	N/A	N/A	N/A	15.27%	15.27%
		B - Exhaust Emissions	9.15E-04	9.15E-04	8.87E-04	7.05E-03	1.33E-05	4.19E-03	N/A	N/A	0.04%	0.09%	0.19%	0.09%	0.09%	0.18%	N/A	N/A
	II.6 - Recover from reconfigured stockpile	A - Fugitive Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	II.7 - Ore Stockpile Maintenance (reconfigured stockpile)	A.2 - Fugitive PM Emissions (Wind Erosion)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
III - Ore Processing	III.1 - Primary Crushing	A - Fugitive Emissions	1.48E-03	5.93E-04	1.10E-05	N/A	N/A	N/A	1.60E-04	1.67E-04	0.06%	0.06%	0.00%	N/A	N/A	N/A	2.54%	2.54%
	III.2 - Secondary Crushing	A - Fugitive Emissions	4.45E-03	1.78E-03	3.29E-05	N/A	N/A	N/A	4.80E-04	5.02E-04	0.17%	0.18%	0.01%	N/A	N/A	N/A	7.61%	7.61%
	III.3 - Dense Media Separation	A - Fugitive Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	III.4 - Grinding	A - Fugitive Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	III.5 - Flotation and recovery	A - Fugitive Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
IV - Concentrate Storage	IV.1 - Bagging	A - Fugitive Emissions	1.36E-05	6.43E-06	9.74E-07	N/A	N/A	N/A	1.47E-06	1.54E-06	0.00%	0.00%	0.00%	N/A	N/A	N/A	0.02%	0.02%
		B - Exhaust Emissions	1.11E-02	1.11E-02	1.08E-02	6.87E-02	1.26E-04	6.23E-02	N/A	N/A	0.43%	1.10%	2.31%	0.92%	0.86%	2.64%	N/A	N/A
	IV.2 - Storage	A - Fugitive Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
V - Concentrate Transport	V.1 - Road Transport	B - Exhaust Emissions	4.53E-02	4.53E-02	4.40E-02	2.32E-01	4.04E-04	3.03E-01	N/A	N/A	1.74%	4.48%	9.41%	3.11%	2.78%	12.86%	N/A	N/A
	V.2 - Transfer operations at Tetcela and Liard transfer facilitie	B - Exhaust Emissions	2.30E-02	2.30E-02	2.23E-02	1.42E-01	2.68E-04	1.15E-01	N/A	N/A	0.88%	2.27%	4.77%	1.91%	1.84%	4.87%	N/A	N/A
VI - Waste Rock Management	VI.1 - Waste Rock Dumping / Recovery from Waste Dump	A - Fugitive Emissions	4.09E-03	1.93E-03	2.93E-04	N/A	N/A	N/A	N/A	N/A	0.16%	0.19%	0.06%	N/A	N/A	N/A	N/A	N/A
	VI.2 - Transport of Waste Rock to Waste Rock Pile	A - Fugitive Emissions	2.51E-01	6.65E-02	6.65E-03	N/A	N/A	N/A	N/A	N/A	9.64%	6.57%	1.42%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	2.15E-03	2.15E-03	2.08E-03	1.26E-02	2.36E-05	7.22E-03	N/A	N/A	0.08%	0.21%	0.45%	0.17%	0.16%	0.31%	N/A	N/A
	VI.3 - Waste Rock Dumping on Waste Rock Stockpile	A - Fugitive Emissions	3.25E-03	1.54E-03	2.33E-04	N/A	N/A	N/A	N/A	N/A	0.12%	0.15%	0.05%	N/A	N/A	N/A	N/A	N/A
	VI.4 - Waste Rock Pile Maintenance	A.1 - Fugitive PM Emissions - Stockpile Working (Dozer)	4.96E-02	5.61E-03	5.21E-03	N/A	N/A	N/A	N/A	N/A	1.90%	0.55%	1.12%	N/A	N/A	N/A	N/A	N/A
		A.2 - Fugitive PM Emissions (wind erosion)	1.23E-01	6.16E-02	4.62E-03	N/A	N/A	N/A	N/A	N/A	4.73%	6.09%	0.99%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	4.38E-03	4.38E-03	4.25E-03	2.29E-02	4.04E-05	2.82E-02	N/A	N/A	0.17%	0.43%	0.91%	0.31%	0.28%	1.20%	N/A	N/A
VII - Backfill Plant	VII.1.1 - Batch Operations/Waste Rock Transfer	A - Fugitive Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	VII.1.2 - Batch Operations/Cement Unloading	A - Fugitive Emissions	1.56E-04	5.31E-05	9.54E-06	N/A	N/A	N/A	N/A	N/A	0.01%	0.01%	0.00%	N/A	N/A	N/A	N/A	N/A
	VII.1.3 - Batch Operations/Mixer Loading	A - Fugitive Emissions	2.72E-02	7.49E-04	1.35E-04	N/A	N/A	N/A	N/A	N/A	1.04%	0.07%	0.03%	N/A	N/A	N/A	N/A	N/A
VIII - Other Off-site Transport (people, equipment, supplies)	VIII.1 - Road Transport	B - Exhaust Emissions	7.55E-03	7.55E-03	7.33E-03	3.86E-02	6.73E-05	5.05E-02	N/A	N/A	0.29%	0.75%	1.57%	0.52%	0.46%	2.14%	N/A	N/A
	VIII.2 - Air Transport	A - Fugitive Emissions	1.84E-02	4.59E-03	4.59E-04	N/A	N/A	N/A	N/A	N/A	0.71%	0.45%	0.10%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	3.37E-03	3.37E-03	3.27E-03	8.92E-02	1.12E-04	2.80E-02	N/A	N/A	0.13%	0.33%	0.70%	1.20%	0.77%	1.19%	N/A	N/A
IX - Winter Road Construction	IX.1 - Winter Road Construction	B - Exhaust Emissions	4.78E-02	4.78E-02	4.64E-02	3.91E-01	7.35E-04	1.98E-01	N/A	N/A	1.84%	4.73%	9.93%	5.24%	5.05%	8.39%	N/A	N/A
X - Support Activities	X.1 - Power Generation	C - Combustion Emissions	1.98E-01	1.98E-01	1.92E-01	6.03E+00	7.11E-03	1.22E+00	N/A	N/A	7.59%	19.54%	41.07%	80.80%	48.89%	51.58%	N/A	N/A
	X.2 - Incineration	C - Combustion Emissions	1.46E-02	1.20E-02	1.00E-02	1.11E-02	4.88E-03	1.58E-03	N/A	N/A	0.56%	1.18%	2.14%	0.15%	33.56%	0.07%	N/A	N/A
	X.3 - Heating	C - Combustion Emissions	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
	X.4 - On-site use of support equipment and vehicles	A - Fugitive Emissions	4.59E-01	1.14E-01	1.14E-02	N/A	N/A	N/A	N/A	N/A	17.61%	11.30%	2.45%	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	3.47E-02	3.47E-02	3.37E-02	2.57E-01	4.62E-04	2.26E-01	N/A	N/A	1.33%	3.43%	7.20%	3.45%	3.18%	9.57%	N/A	N/A
Total			**2.61E+00**	**1.01E+00**	**4.67E-01**	**7.46E+00**	**1.45E-02**	**2.36E+00**	**6.31E-03**	**6.60E-03**	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

N/A: Not Applicable (i.e., emissions not expected)

Summary

Operations	Emission Rates (g/s) - 24-hour								Emission Rates (kg/day) - 24-hour								Contributions							
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
I - Extraction	1.22E+00	3.43E-01	5.71E-02	1.60E-01	3.02E-04	1.18E-01	1.37E-04	1.43E-04	105.43	29.60	4.93	13.84	0.03	10.19	0.01	0.01	46.82%	33.83%	12.22%	2.15%	2.07%	5.00%	2.17%	2.17%
II - Ore Management	5.21E-02	2.14E-02	5.08E-03	7.05E-03	1.33E-05	4.19E-03	5.53E-03	5.78E-03	4.50	1.85	0.44	0.61	0.00	0.36	0.48	0.50	2.00%	2.11%	1.09%	0.09%	0.09%	0.18%	87.65%	87.65%
III - Ore Processing	5.93E-03	2.37E-03	4.39E-05	N/A	N/A	N/A	6.40E-04	6.70E-04	0.51	0.20	0.00	N/A	N/A	N/A	0.06	0.06	0.23%	0.23%	0.01%	N/A	N/A	N/A	10.15%	10.15%
IV - Concentrate Storage	1.12E-02	1.12E-02	1.08E-02	6.87E-02	1.26E-04	6.23E-02	1.47E-06	1.54E-06	0.96	0.96	0.93	5.94	0.01	5.38	0.0001	0.0001	0.43%	1.10%	2.31%	0.92%	0.86%	2.64%	0.02%	0.02%
IX - Winter Road Construction	4.78E-02	4.78E-02	4.64E-02	3.91E-01	7.35E-04	1.98E-01	N/A	N/A	4.13	4.13	4.01	33.76	0.06	17.10	N/A	N/A	1.84%	4.73%	9.93%	5.24%	5.05%	8.39%	N/A	N/A
V - Concentrate Transport	6.83E-02	6.83E-02	6.62E-02	3.74E-01	6.72E-04	4.18E-01	N/A	N/A	5.90	5.90	5.72	32.31	0.06	36.11	N/A	N/A	2.62%	6.74%	14.17%	5.01%	4.62%	17.73%	N/A	N/A
VI - Waste Rock Management	4.38E-01	1.44E-01	2.33E-02	3.55E-02	6.40E-05	3.55E-02	N/A	N/A	37.86	12.42	2.02	3.06	0.01	3.06	N/A	N/A	16.81%	14.20%	5.00%	0.48%	0.44%	1.50%	N/A	N/A
VII - Backfill Plant	2.73E-02	8.02E-04	1.44E-04	N/A	N/A	N/A	N/A	N/A	2.36	0.07	0.01	N/A	N/A	N/A	N/A	N/A	1.05%	0.08%	0.03%	N/A	N/A	N/A	N/A	N/A
VIII - Other Off-site Transport (people, equipment, supplies)	2.93E-02	1.55E-02	1.11E-02	1.28E-01	1.80E-04	7.85E-02	N/A	N/A	2.53	1.34	0.95	11.05	0.02	6.79	N/A	N/A	1.12%	1.53%	2.37%	1.71%	1.23%	3.33%	N/A	N/A
X - Support Activities	7.06E-01	3.59E-01	2.47E-01	6.30E+00	1.25E-02	1.44E+00	N/A	N/A	61.00	31.01	21.34	543.99	1.08	124.67	N/A	N/A	27.09%	35.44%	52.87%	84.40%	85.62%	61.21%	N/A	N/A
Total	**2.61E+00**	**1.01E+00**	**4.67E-01**	**7.46E+00**	**1.45E-02**	**2.36E+00**	**6.31E-03**	**6.60E-03**	**225.19**	**87.49**	**40.37**	**644.55**	**1.26**	**203.67**	**0.54**	**0.57**	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%

N/A: Not Applicable (i.e., emissions not expected)

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

I - Extraction

I.1 - Drilling

A - Fugitive Emissions

Dust Control Technique		(i) Wet Drilling (ii) Retention - underground mine

Hours of operation per day - maximum	h/day	A	15			(a)
Material throughput (ore extracted)	tonnes/day	B	1200			(a)
Emission reduction efficiency	(%)	C	80	80	80	(b)

Source: (a) Information provided by Canadia Zinc.
(b) Underground retention. Conservative estimate based on the document Emission Estimation Technique Manual for Mining - Version 2.3 (Environment Australia, December 2001), which presents 100% reduction efficiency for underground activities.

			TSP	PM_{10}	$PM_{2.5}$	Pb	Zn	
Emission factor (controlled - wet drilling)	kg/tonne	D	9.00E-05	4.00E-05	7.41E-06	-	-	(a) (b) (c)
Emission rate (controlled - wet drilling and retention)	g/day	E = B*D*1000*(1-C/100)	21.6	9.6	1.8	-	-	
Emission rate (24-hour)	g/s	F = E/(24*3600)	2.50E-04	1.11E-04	2.06E-05	2.70E-05	2.83E-05	(d)
Quality rating	-		C	-	-	-	-	

Source: (a) Emission factor for TSP extracted from in AP-42 / 11.19.2 - Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2.1 (value for Wet Drilling - Unfragmented Stone).
(b) Emission factor for PM10 based on the ratio between TSP and PM10 emission factors for tertiary crushing (uncontrolled) in AP-42 / 11.19.2 - Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2.1.
(c) Emission factor for PM2.5 based on the ratio between PM10 and PM2.5 emission factors for tertiary crushing (controlled) in AP-42 / 11.19.2 - Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2.1.
(d) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Drll Jumbos	Electric/ Hydra	2	1.5	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	4.63E-04	4.63E-04	4.49E-04	3.38E-03	6.07E-06	3.01E-03

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

I.2 - Blasting

A - Fugitive Emissions

Dust Control Technique		Deposition - underground mine

Hours of operation per day - maximum	h/day	A	2			(a)
Number of blasts	blasts/day	B	2			(a)
Blast area	m^2	C	100			(b)
Emission reduction efficiency	(%)	D	80	80	80	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Assumed based on diameter of the underground tunnels.
(c) Underground deposition. Conservative estimate based on the document Emission Estimation Technique Manual for Mining - Version 2.3 (Environment Australia, December 2001), which presents 100% reduction efficiency for underground activities.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	Pb	Zn	
Constant (a)	-	E	0.00022	-	-	-	-	(a)
Constant (b)	-	F	1.5	-	-	-	-	(a)
Scaling Factor		G	-	0.52	0.03	-	-	(a) (b)
Emission rate (uncontrolled)	kg/blast	H = E*(C^F)	0.220	0.114	0.007	-	-	(a) (c)
Emission rate (controlled)	g/hr	I = H*1000*B*(1-D/100)	88.0	45.8	2.6	-	-	
Emission rate (24-hour)	g/s	J = I/(24*3600)	1.02E-03	5.30E-04	3.06E-05	1.10E-04	1.15E-04	(d)
Quality rating	-		C	D	D	-	-	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998)/ Table 11.9-2 - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (blasting).
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and PM2.5.
(c) PM10 and PM2.5 calculated multiplying TSP emission rate by respective scaling factors.
(d) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

I.3 - Ore transport (mucking and haul truck transport) (unpaved roads)

A - Fugitive Emissions

Dust Control Technique		(i) Watering twice a day and (ii) Deposition - undergorund mine				
Hours of operation per day - maximum	h/day	A	16			(a)
Surface material silt content	(%)	B	5.8			(b)
Mean vehicle weight	(tons)	C	24.39			(c)
Vehicle kilometre traveled (VKT)	km/day	D	537			(c)
Number of working days	days/year	E	350			(a)
Number of days with precipitation >= 0.2 mm	days/year	F	0			(d)
Number of days with snow cover >= 1 cm	days/year	G	0			(d)
Emission reduction efficiency	(%)	H	91.0	91.0	91.0	(e) (f)

Source: (a) Information provided by Canadian Zinc.
(b) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (taconite mining and processing / haul road to/from pit).
(c) See Mean Vehicle Weight table below.
(d) Underground mine.
(e) Includes control efficiency of 55% from watering twice a day extracted from Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009) and control efficiency of 80% related to underground deposition (see note (f)).
(f) Underground deposition. Conservative estimate based on the document Emission Estimation Technique Manual for Mining - Version 2.3 (Environment Australia, December 2001), which presents 100% reduction efficiency for underground activities.

			PM-30 (TSP)	PM_{10}	$PM_{2.5}$	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] [(b)]	7.564	2.002	0.200	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) [(c)]	191.9	50.8	5.1	
Emission rate	g/day	N = M*D	103,047.5	27,276.1	2,727.6	
Emission rate (24-hour)	g/s	O = N/(24*3600)	1.19E+00	3.16E-01	3.16E-02	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

Note: Maximum 1 hour and 24 hours emisssion rates are assumed to occur in periods without snow cover on roads and without precipitation > 0.254 mm.

Mean Vehicle Weight

Equipment	-		LHD Scoops	20 t Trucks	Total	
Weight - Empty	tons		12.7	20.5	-	(a)
Weight - Loaded	tons		16.3	40.5	-	(a)
Mean Weight	tons		14.5	30.5	-	(b)
Vehicle kilometer traveled (VKT)	km/day		205	332	537	(c)
Percentage of traffic	%		38.18%	61.82%	-	
Mean vehicle weight	tons		5.54	18.86	24.39	(d)

Source: (a) Information provided by Canadia Zinc.
(b) Assuming half of the distance is travelled with the vehicle empty and half of the distance with the vehicle loaded.
(c) VKT for LHD scoops provided by Canadian Zinc. VKT for 20 t trucks calculated according to the table VKT below.
(d) Values weighted according to VKT.

VKT			20 t Trucks	
Truck capacity	tonnes		14.51	(a)
Amout of material transported daily	tonnes/day		1,200	(b)
Requires trips per day	trips/day		83	(c)
Transport distance (both ways)	km/trip		4.0	(d)
Vehicle kilometer traveled (VKT)	km/day		332	(c)

Source: (a) Based on truck capacity information provided by Canadia Zinc, assuming it carries of 80% of its capacity on average.
(b) Information provided by Canadia Zinc.
(c) Calculated
(d) Estimated based on information provided by Canadian Zinc, considering the longest distances in the underground mine.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Lhd Scoops	2 Yard	3	16.0	(a)
20T Trucks	MT 2010	2	15.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	2.58E-02	2.58E-02	2.50E-02	1.57E-01	2.96E-04	1.15E-01

Source: See table exhaust emissions.
Note: 80% of the exhaust emissions from the 20T Trucks were attributed to haul transport; the remaining 20% were attributed to waste rock transport, based on daily production rates

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

II - Ore Management

II.1 - Transfer (dump) to conveyor

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material handled per day	tonnes/day	B	1,200	(b)
Mean wind speed - maximum daily value	m/s	C	4.422	(c)
Material moisture content	%	D	4	(a)
Constant (a)		E	0.0016	(d)
Constant (b)		F	1.3	(d)
Constant (c)		G	2.2	(d)
Constant (d)		H	1.4	(d)
Constant (e)		I	2	(d)
Emission reduction efficiency	(%)	J	0	

Source: (a) Information provided by Canadia Zinc.
(b) Estimated assuming 2/3 of the ore is dumped to the conveyor and 1/3 is dumped to the stockpile.
(c) Compiled from data provided by Canadian Zinc - results from local meteorological station.
(d) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	Pb	Zn	
Particle size multiplier	-	K	0.74	0.35	0.053	-	-	(a)
Emission factor (uncontrolled)	kg/tonne	L = K*E*((C/G)^F)/((D/I)^H)	1.11E-03	5.26E-04	7.96E-05	-	-	(a)
Emission rate (controlled) (24-hour)	g/s	M = B*L*(1-J/100)*1000/(24*3600)	1.54E-02	7.30E-03	1.11E-03	1.67E-03	1.75E-03	(b)
Quality rating	-		A	A	A	-	-	

Source: (a) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.
(b) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

II.2 - Conveyor transport (transfer points)

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material transferred	tonnes/day	B	1,200	(a)
Emission reduction efficiency	(%)	C	0	

Source: (a) Based on information provided by Canadia Zinc for "Transfer (dump) to conveyor".

			TSP	PM_{10}	$PM_{2.5}$	Pb	Zn	
Emission factor (controlled)	kg/tonne	D	0.0015	0.00055	1.55E-04	-	-	(a) (b)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	1,800.0	660.0	186.5	-	-	
Emission rate (24-hour)	g/s	F = E/(24*3600)	2.08E-02	7.64E-03	2.16E-03	2.25E-03	2.35E-03	(c)
Quality rating	-		E	D	E	-	-	

Source: (a) AP-42 / 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2-1 (Metric Units) - Emission factors for crushed stone processing operations (value for conveyor transfer point - uncontrolled)
(b) Emission factor for PM2.5 based on the ratio between PM10 and PM2.5 emission factors for conveyor transfer points controlled in AP-42 / 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2.1.
(c) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

II.3 - Stockpiling (dump to temporary/permanent stockpile)

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material handled per day	tonnes/day	B	40	(b)
Mean wind speed - maximum daily value	m/s	C	4.422	(c)
Material moisture content	%	D	4	(a)
Constant (a)		E	0.0016	(d)
Constant (b)		F	1.3	(d)
Constant (c)		G	2.2	(d)
Constant (d)		H	1.4	(d)
Constant (e)		I	2	(d)
Emission reduction efficiency	(%)	J	0	

Source: (a) Information provided by Canadia Zinc.
(b) Estimated assuming 2/3 of the ore is dumped to the conveyor and 1/3 is dumped to the stockpile.
(c) Compiled from data provided by Canadian Zinc - results from local meteorological station.
(d) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

			TSP <= 30 um	**PM_{10}**	**$PM_{2.5}$**	**Pb**	**Zn**	
Particle size multiplier	-	K	0.74	0.35	0.053	-	-	(a)
Emission factor (uncontrolled)	kg/tonne	L = K*E*((C/G)^F)/((D/I)^H)	1.11E-03	5.26E-04	7.96E-05	-	-	(a)
Emission rate (controlled) (24-hour)	g/s	M = B*L*(1-J/100)*1000/(24*3600)	5.15E-04	2.43E-04	3.69E-05	5.56E-05	5.82E-05	(b)
Quality rating	-		A	A	A	-	-	

Source: (a) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.
(b) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

II.4 - Recover from temporary/permanent stockpile

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material removed per day	tonnes/day	B	40	(b)
Mean wind speed - maximum daily value	m/s	C	4.422	(c)
Material moisture content	%	D	4	(a)
Constant (a)		E	0.0016	(d)
Constant (b)		F	1.3	(d)
Constant (c)		G	2.2	(d)
Constant (d)		H	1.4	(d)
Constant (e)		I	2	(d)
Emission reduction efficiency	(%)	J	0	

Source: (a) Information provided by Canadia Zinc.
(b) Estimated assuming 2/3 of the ore is dumped to the conveyor and 1/3 is dumped to the stockpile.
(c) Compiled from data provided by Canadian Zinc - results from local meteorological station.
(d) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	Pb	Zn	
Particle size multiplier	-	K	0.74	0.35	0.053	-	-	(a)
Emission factor (uncontrolled)	kg/tonne	L = K*E*((C/G)^F)/((D/I)^H)	1.11E-03	5.26E-04	7.96E-05	-	-	(a)
Emission rate (controlled) (24-hour)	g/s	M = B*L*(1-J/100)*1000/(24*3600)	5.15E-04	2.43E-04	3.69E-05	5.56E-05	5.82E-05	(b)
Quality rating	-		A	A	A	-	-	

Source: (a) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.
(b) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

II.5 - Ore Stockpile Maintenance (temporary/permanent stockpile)

A.1 - Fugitive PM Emissions - Stockpile Working (Dozer)

Dust Control Technique		No control

Number o equipment	pc	A	1	(a)
Hours of operation per day - maximum	h/day	B	1	(a)
Material silt content	(%)	C	1	(b)
Material moisture content	(%)	D	4	(a)
Emission reduction efficiency	(%)	E	0	

Source: (a) Information provided by Canadia Zinc.

(b) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ Table 13.2.4-1. Typical silt and moisture contents of materials at various industries (value for limestone).

			TSP <= 30 um	TSP <= 15 um	PM_{10}	$PM_{2.5}$	Pb	Zn	
Constant (a)	-	F	2.6	0.45	-	-	-	-	(a)
Constant (b)	-	G	1.2	1.5	-	-	-	-	(a)
Constant (c)	-	H	1.3	1.4	-	-	-	-	(a)
Scaling Factor		I	-	-	0.75	0.105	-	-	(a) (b)
Emission rate (uncontrolled)	kg/hr/pc	J = F*(C^G)/(D^H)	0.429	0.065	0.048	0.045	-	-	(a) (c)
Emission rate (controlled)	g/hr	K = A*J*1000*(1-E/100)	428.8	64.6	48.5	45.0	-	-	
Emission rate	g/day	L = K*B	428.8	64.6	48.5	45.0	-	-	
Emission rate (24-hour)	g/s	M = L/(24*3600)	4.96E-03	7.48E-04	5.61E-04	5.21E-04	5.36E-04	5.61E-04	(d)
Quality rating	-		B	C	D	D	-	-	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (bulldozing overburden).
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and TSP <= 15 um to PM2.5
(c) PM10 and PM2.5 calculated multiplying TSP emission rates by respective scaling factors.
(d) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

A.2 - Fugitive PM Emissions (Wind Erosion)

Dust Control Technique		No control

Pile surface area	ha	A	0.304	(a)
Mean wind speed - maximum daily value	%	B	29.167	(b)
Material silt content	%	C	1	(c)
Number of days with precipitation >= 0.2 mm	days/year	D	123	(d)
Constant (a)		E	1.9	(e)
Constant (b)		F	1.5	(e)
Constant (c)		G	365	(e)
Constant (d)		H	235	(e)
Constant (e)		I	15	(e)
Emission reduction efficiency	(%)	J	0	

Source: (a) Estimated based on site plan provided by Canadia Zinc.
(b) Compiled from data provided by Canadian Zinc - results from local meteorological station.

(c) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ Table 13.2.4-1. Typical silt and moisture contents of materials at various industries (value for limestone).
(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009).
(e) Control of Open Fugitive Dust Source (USEPA, September 1988) / Equation (4-9)

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	Pb	Zn	
Scaling factors	-	K	-	0.5	0.075	-	-	(a)
Emission factor (uncontrolled)	kg/d/ha	L = E*(C/F)*((G-D)/H)*(B/I)	2.54E+00	1.27E+00	9.51E-02	-	-	(b) (c)
Emission rate (controlled) (24-hour)	g/s	M = L*A*1000*(1-J/100)/(24*3600)	8.92E-03	4.46E-03	3.34E-04	9.63E-04	1.01E-03	(d)
Quality rating	-		A	A	A	-	-	

Source: (a) AP-42/Section 13.2.5 - Industrial Wind Erosion.
(b) TSP calculated according to Control of Open Fugitive Dust Source (USEPA, September 1988) / Equation (4-9)
(c) PM10 and PM2.5 calculated multiplying TSP emission rate by respective scaling factors.
(d) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Dozer	D8H Cat	1	1.0	(a)
Loader	Cat 966	1	1.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	9.15E-04	9.15E-04	8.87E-04	7.05E-03	1.33E-05	4.19E-03

Source: See table exhaust emissions.

II.6 - Recover from reconfigured stockpile

A - Fugitive Emissions

This activity is expected to take place during the initial period of the operation phase, and will continue until the material stored on the existing ore stockpile is completely processed in the mill. This activity is not representative of the total duration of the operation phase.

II.7 - Ore Stockpile Maintenance (reconfigured stockpile)

A.2 - Fugitive PM Emissions (Wind Erosion)

This activity is expected to take place during the initial period of the operation phase, and will continue until the material stored on the existing ore stockpile is completely processed in the mill. This activity is not representative of the total duration of the operation phase.

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Calculation of Emissions During the Operation Phase

III - Ore Processing

III.1 - Primary Crushing

A - Fugitive Emissions

Dust Control Technique		Bag house with suction heads at the end of each transfer point

Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material processed per day	tonnes/day	B	1,280	(b)
Emission reduction efficiency	(%)	C	99	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Calculated based on information provided by Canadian Zinc: hours of operation per day and hourly processing rate.
(c) Bag filter efficiecy based on AP-42 / 11.24 - Metallic Minerals Processing (USEPA, August 1982).

			TSP	PM_{10}	$PM_{2.5}$	Pb	Zn	
Emission factor (uncontrolled)	kg/tonne	D	0.01	0.004	0.00007	-	-	(a) (b)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	128.0	51.2	0.9	-	-	
Emission rate (24-hour)	g/s	F = E/(24*3600)	1.48E-03	5.93E-04	1.10E-05	1.60E-04	1.67E-04	(c)
Quality rating	-		C	C	-	-	-	

Source: (a) AP-42 / 11.24 - Metallic Minerals Processing (USEPA, August 1982)/ Table 11.24-1 (Metric Units). Emission factors for metallic minerals processing (value for high moisture ore / primary crushing; high moisture ore defined as >= 4% in weight).
(b) Emission factor for PM2.5 based on the ratio between PM10 and PM2.5 emission factors for tertiary crushing (controlled) in AP-42 / 11.19.2 Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2.1.
(c) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

III.2 - Secondary Crushing

A - Fugitive Emissions

Dust Control Technique		Bag house with suction heads at the end of each transfer point

Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material processed per day	tonnes/day	B	1,280	(b)
Emission reduction efficiency	(%)	C	99	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Calculated based on information provided by Canadian Zinc: hours of operation per day and hourly processing rate.
(c) Bag filter efficiecy based on AP-42 / 11.24 - Metallic Minerals Processing (USEPA, August 1982).

			TSP	PM_{10}	$PM_{2.5}$	Pb	Zn	
Emission factor (uncontrolled)	kg/tonne	D	0.03	0.012	0.00022	-	-	(a) (b)(c)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	384.1	153.7	2.8	-	-	
Emission rate (24-hour)	g/s	F = E/(24*3600)	4.45E-03	1.78E-03	3.29E-05	4.80E-04	5.02E-04	(d)
Quality rating	-		C	-	-	-	-	

Source: (a) AP-42 / 11.24 - Metallic Minerals Processing (USEPA, August 1982)/ Table 11.24-1 (Metric Units). Emission factors for metallic minerals processing (value for high moisture ore / secondary crushing; high moisture ore defined as >= 4% in weight).
(b) Emission factor for tertiary crushing in AP-42 / 11.24 - Metallic Minerals Processing (USEPA, August 1982)/ Table 11.24.1 was used for PM10.
(c) Emission factor for PM2.5 based on the ratio between PM10 and PM2.5 emission factors for tertiary crushing (controlled) in AP-42 / 11.19.2 - Crushed Stone Processing and Pulverized Mineral Processing (USEPA, August 2004)/ Table 11.19.2.1.
(d) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

III.3 - Dense Media Separation

A - Fugitive Emissions

Fugitive particulate matter emissions: no significant. Wet process (cyclone) with ore in the form of a pulp with 58% of solids.

III.4 - Grinding

A - Fugitive Emissions

Fugitive particulate matter emissions: no significant. Wet process with ore in the form of a pulp with 72% of solids.

III.5 - Flotation and recovery

A - Fugitive Emissions

Fugitive particulate matter emissions: no significant. Wet process with ore in the form of a pulp with 40% of solids.

IV - Concentrate Storage

IV.1 - Bagging

A - Fugitive Emissions

Dust Control Technique		Bag house with suction heads at the end of each transfer point	

Hours of operation per day - maximum	h/day	A	24	(a)
Amount of material handled per day	tonnes/day	B	329	(b)
Mean wind speed - maximum daily value	m/s	C	4.422	(c)
Material moisture content	%	D	9	(a)
Constant (a)		E	0.0016	(d)
Constant (b)		F	1.3	(d)
Constant (c)		G	2.2	(d)
Constant (d)		H	1.4	(d)
Constant (e)		I	2	(d)
Emission reduction efficiency	(%)	J	99	(e)

Source: (a) Information provided by Canadia Zinc.
(b) Based on information provided by Canadian Zinc: hours of operation per day and material rate.
(c) Compiled from data provided by Canadian Zinc - results from local meteorological station.
(d) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.
(c) Bag filter efficiecy based on AP-42 / 11.24 - Metallic Minerals Processing (USEPA, August 1982).

Note: Bagging operations will take place inside a building. Wind speeds used in the calculation correspond to outdoor measurements. Therefore, the emission rates correspond to conservative estimates.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	Pb	Zn	
Particle size multiplier	-	K	0.74	0.35	0.053	-	-	(a)
Emission factor (uncontrolled)	kg/tonne	L = K*E*((C/G)^F)/((D/I)^H)	3.57E-04	1.69E-04	2.56E-05	-	-	(a)
Emission rate (controlled) (24-hour)	g/s	M = B*L*(1-J/100)*1000/(24*3600)	1.36E-05	6.43E-06	9.74E-07	1.47E-06	1.54E-06	(b)
Quality rating	-		A	A	A	-	-	

Source: (a) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.
(b) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Crane	72 Tonne	1	24.0	(a)
Forklift		1	24.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	1.11E-02	1.11E-02	1.08E-02	6.87E-02	1.26E-04	6.23E-02

Source: See table exhaust emissions.

IV.2 - Storage

A - Fugitive Emissions

Fugitive particulate matter emissions: no significant. Material is stored in sealed bags inside a shed.

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V - Concentrate Transport

V.1 - Road Transport

A - Fugitive Emissions

- Road surface fugitive particulate matter emissions: not significant. The transport of concentrate from the Project will be carried out on an access road, the surface of which will be covered with ice and snow. Therefore, this activity is not expected to generate road surface fugitive particulate emissions. This can be demonstrated numerically using AP-42 / Section 13.2.2 - Unpaved Roads (U.S. EPA, 2006) equations and the adjustment factor for precipitation, snow cover and frozen days according to the Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, 2009; website). Using the equations from these references, the resulting particulate emissions would be zero, as presented below:

E = VKT*EF*ADJ*(1-CE/100)

where E is the PM emission rate and ADJ is the adjustment factor for precipitation/snow.

ADJ = {[working days - (p + snow)]/working days}

where p is the estimated annual working days with precipitation exceeding 0.2 mm and snow is the estimated annual working days when the roads are frozen or snow covered and wet for winter.

For the access road working days = snow. Therefore, ADJ = 0 and E = 0.

- Fugitive particulate matter emissions resulting from material leaks / drops: not significant. The concentrate will be transported in sealed bags; leaks caused by damages on the bags or poor bag containment (e.g., excess material in the bags, bags not properly sealed) could cause spillage onto the road surface and thus airborne metal emissions. To minimize the potential for this happening, the bags will undergo inspection and will be promptly replaced upon detection of damages. In addition, the bagging process will promote proper bag containment. Specific monitoring and mitigation strategies and inspection procedures will be developed and applied to ensure that If any spills occur, it will be promptly cleaned up, Therefore, it is assumed that there is little chance for the concentrate to be spilled onto and remain on the road surface and thus no potential for fugitive particulate and metal emissions.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Flat Bed truck		6	24.0	(a)

Source: (a) Information provided by Canadia Zinc.
(b) Number of trucks estimated based on a maximum daily traffic of 37 trucks/day, road length of 170 km (both information provided by Canadia Zinc) and average speed of 50 km/h (assumed): (37 trucks/day * 170 km) / (50 km/h * 24 h/day) = 5.24 trucks; rounded up to 6 trucks.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	4.53E-02	4.53E-02	4.40E-02	2.32E-01	4.04E-04	3.03E-01

Source: See table exhaust emissions.

V.2 - Transfer operations at Tetcela and Liard transfer facilities

A - Fugitive Emissions

- Fugitive particulate matter emissions: no significant. As discussed above, concentrate from the Project will be transported in sealed bags. In case of any damage to the bags during the transfer operation, the material will be transferred to a new bag. Therefore, fugitive particulate and metals emissions are not expected at the transfer facilities.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Loader	Volvo	1	24.0	(a)
FEL	Cat 950	1	24.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NOx	SO2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	2.30E-02	2.30E-02	2.23E-02	1.42E-01	2.68E-04	1.15E-01

Source: See table exhaust emissions.

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VI - Waste Rock Management

VI.1 - Waste Rock Dumping / Recovery from Waste Dump

A - Fugitive Emissions

Dust Control Technique		No control		
Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material handled per day	tonnes/day	B	318	(b)
Mean wind speed - maximum daily value	m/s	C	4.422	(c)
Material moisture content	%	D	4	(a)
Constant (a)		E	0.0016	(d)
Constant (b)		F	1.3	(d)
Constant (c)		G	2.2	(d)
Constant (d)		H	1.4	(d)
Constant (e)		I	2	(d)
Emission reduction efficiency	(%)	J	0	

Source: (a) Based on information provided by Canadia Zinc for "Transfer (dump) to conveyor".
(b) Based on information provided by Canadian Zinc for totals over years 0 - 14, as presented in the table daily rates below. Assuming the material will be handled twice: dumping and recovery.
(c) Compiled from data provided by Canadian Zinc - results from local meteorological station.
(d) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	
Particle size multiplier	-	K	0.74	0.35	0.053	(a)
Emission factor (uncontrolled)	kg/tonne	L = K*E*((C/G)^F)/((D/I)^H)	1.11E-03	5.26E-04	7.96E-05	(a)
Emission rate (controlled) (24-hour)	g/s	M = B*L*(1-J/100)*1000/(24*3600)	4.09E-03	1.93E-03	2.93E-04	
Quality rating	-		A	A	A	

Source: (a) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.
(b) Lead and zinc emission rates caculated based on TSP emission rates, assuming that the particulate material will present the same composition as the ore: 10.8% Pb and 11.3% Zn.

Daily rates

Material	-		Mill Feed	Development waste rock	
Total years 0 - 14	m3			276,470	(a)
Wet density of Density Backfill	tonnes/m3			2.24	(a)
Total years 0 - 14	tonnes		4,995,000	619,293	(a) (b)
Ratio to mill feed	%		100.00%	12.40%	
Daily rate	tonne/day		1,280	159	(c) (d)

Source: (a) Prairie Creek Mine Project Description Report (Canadian Zinc Corporation, May 2008)
(b) Waste rock calculated based on volume and density.
(c) Mill feed: information provided by Canadian Zinc.
(d) Waste rock calculated based on ratio to mill feed.

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Calculation of Emissions During the Operation Phase

VI.2 - Transport of Waste Rock to Waste Rock Pile

A - Fugitive Emissions

Dust Control Technique		Watering twice a day		
Hours of operation per day - maximum	h/day	A	16	(a)
Surface material silt content	(%)	B	5.8	(b)
Mean vehicle weight	(tons)	C	30.50	(c)
Vehicle kilometre traveled (VKT)	km/day	D	72	(c)
Number of working days	days/year	E	350	(a)
Number of days with precipitation >= 0.2 mm	days/year	F	56	(d)
Number of days with snow cover >= 1 cm	days/year	G	194.5	(d)
Emission reduction efficiency	(%)	H	55	(e)

Source: (a) Based on information provided by Canadia Zinc for "Transfer (dump) to conveyor".
(b) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (taconite mining and processing / haul road to/from pit).
(c) See Mean Vehicle Weight table below.
(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009).
(e) Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009).

			PM-30 (TSP)	PM_{10}	$PM_{2.5}$	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] (b)	2.378	0.629	0.063	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) (c)	301.6	79.8	8.0	
Emission rate	g/day	N = M*D	21,716.7	5,748.3	574.8	
Emission rate (24-hour)	g/s	O = N/(24*3600)	2.51E-01	6.65E-02	6.65E-03	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

Mean Vehicle Weight

Equipment	-		20 t Trucks	Total	
Weight - Empty	tons		20.5	-	(a)
Weight - Loaded	tons		40.5	-	(a)
Mean Weight	tons		30.5	-	(b)
Vehicle kilometer traveled (VKT)	km/day		72	72	(c)
Percentage of traffic	%		100.00%	-	
Mean vehicle weight	tons		30.50	30.50	(d)

Source: (a) Information provided by Canadia Zinc.
(b) Assuming half of the distance is travelled with the vehicle empty anf half of the distance with the vehicle loaded.
(c) See tables daily rates and VKT below.
(d) Values weighted according to VKT.

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Calculation of Emissions During the Operation Phase

Daily rates

Material	-		Mill Feed	Total to Waste Rock Pile	
Total years 0 - 14	m3			439,699	(a)
Wet density of Density Backfill	tonnes/m3			2.24	(a)
Total years 0 - 14	tonnes		4,995,000	984,926	(a) (b)
Ratio to mill feed	%		100.00%	19.72%	
Daily rate	tonne/day		1,280	252	(c) (d)

Source: (a) Prairie Creek Mine Project Description Report (Canadian Zinc Corporation, May 2008)
(b) Waste rock calculated based on volume and density.
(c) Mill feed: information provided by Canadian Zinc.
(d) Waste rock calculated based on ratio to mill feed.

VKT

Truck capacity	tonnes		14.51	(a)
Requires trips per day	trips/day		18	(b)
Distance to waste rock pile (both ways)	km/trip		4	(c)
Vehicle kilometer traveled (VKT)	km/day		72	(b)

Source: (a) Based on truck capacity information provided by Canadia Zinc, assuming it carries of 80% of its capacity on average.
(b) Calculated
(c) Estimated based on information provided by Canadian Zinc.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
20T Trucks	MT 2010	2	15.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	2.15E-03	2.15E-03	2.08E-03	1.26E-02	2.36E-05	7.22E-03

Source: See table exhaust emissions.
Note: 80% of the exhaust emissions from the 20T Trucks were attributed to haul transport; the remaining 20% were attributed to waste rock transport, based on daily production rates.

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Calculation of Emissions During the Operation Phase

VI.3 - Waste Rock Dumping on Waste Rock Stockpile

A - Fugitive Emissions

Dust Control Technique		No control	

Hours of operation per day - maximum	h/day	A	16	(a)
Amount of material handled per day	tonnes/day	B	252	(b)
Mean wind speed - maximum daily value	m/s	C	4.422	(c)
Material moisture content	%	D	4	(a)
Constant (a)		E	0.0016	(d)
Constant (b)		F	1.3	(d)
Constant (c)		G	2.2	(d)
Constant (d)		H	1.4	(d)
Constant (e)		I	2	(d)
Emission reduction efficiency	(%)	J	0	

Source: (a) Based on information provided by Canadia Zinc for "Transfer (dump) to conveyor".
(b) Based on information provided by Canadian Zinc for totals over years 0 - 14, as presented in the table daily rates below.
(c) Compiled from data provided by Canadian Zinc - results from local meteorological station.
(d) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	
Particle size multiplier	-	K	0.74	0.35	0.053	(a)
Emission factor (uncontrolled)	kg/tonne	L = K*E*((C/G)^F)/((D/I)^H)	1.11E-03	5.26E-04	7.96E-05	(a)
Emission rate (controlled) (24-hour)	g/s	M = B*L*(1-J/100)*1000/(24*3600)	3.25E-03	1.54E-03	2.33E-04	
Quality rating	-		A	A	A	

Source: (a) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ equation 1 - emission factor for drop operation.

Daily rates

Material	-		Mill Feed	Total to Waste Rock Pile	
Total years 0 - 14	m3			439,699	(a)
Wet density of Density Backfill	tonnes/m3			2.24	(a)
Total years 0 - 14	tonnes		4,995,000	984,926	(a) (b)
Ratio to mill feed	%		100.00%	19.72%	
Daily rate	tonne/day		1,280	252	(c) (d)

Source: (a) Prairie Creek Mine Project Description Report (Canadian Zinc Corporation, May 2008)
(b) Waste rock calculated based on volume and density.
(c) Mill feed: information provided by Canadian Zinc.
(d) Waste rock calculated based on ratio to mill feed.

VI.4 - Waste Rock Pile Maintenance

A.1 - Fugitive PM Emissions - Stockpile Working (Dozer)

Dust Control Technique		No control

Number of equipment	pc	A	1	(a)
Hours of operation per day - maximum	h/day	B	10	(a)
Material silt content	(%)	C	1	(b)
Material moisture content	(%)	D	4	(a)
Emission reduction efficiency	(%)	E	0	

Source: (a) Information provided by Canadia Zinc.

(b) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ Table 13.2.4-1. Typical silt and moisture contents of materials at various industries (value for limestone).

			TSP <= 30 um	TSP <= 15 um	PM_{10}	$PM_{2.5}$	
Constant (a)	-	F	2.6	0.45	-	-	(a)
Constant (b)	-	G	1.2	1.5	-	-	(a)
Constant (c)	-	H	1.3	1.4	-	-	(a)
Scaling Factor		I	-	-	0.75	0.105	(a) (b)
Emission rate (uncontrolled)	kg/hr/pc	J = F*(C^G)/(D^H)	0.429	0.065	0.048	0.045	(a) (c)
Emission rate (controlled)	g/hr	K = A*J*1000*(1-E/100)	428.8	64.6	48.5	45.0	
Emission rate	g/day	L = K*B	4,288.4	646.1	484.6	450.3	
Emission rate (24-hour)	g/s	M = L/(24*3600)	4.96E-02	7.48E-03	5.61E-03	5.21E-03	
Quality rating	-		B	C	D	D	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (bulldozing overburden).

(b) Scaling factor to convert TSP <= 30 um to PM2.5 and TSP <= 15 um to PM2.5

(c) PM10 and PM2.5 calculated multiplying TSP emission rates by respective scaling factors.

A.2 - Fugitive PM Emissions (wind erosion)

Dust Control Technique		No control

Pile surface area	ha	A	4.200	(a)
Mean wind speed - maximum daily value	%	B	29.167	(b)
Material silt content	%	C	1	(c)
Number of days with precipitation >= 0.2 mm	days/year	D	123	(d)
Constant (a)		E	1.9	(e)
Constant (b)		F	1.5	(e)
Constant (c)		G	365	(e)
Constant (d)		H	235	(e)
Constant (e)		I	15	(e)
Emission reduction efficiency	(%)	J	0	

Source: (a) Estimated based on site plan provided by Canadia Zinc.

(b) Compiled from data provided by Canadian Zinc - results from local meteorological station.

(c) AP-42 / 13.2.4 - Aggregate Handling And Storage Piles (USEPA, November 2006)/ Table 13.2.4-1. Typical silt and moisture contents of materials at various industries (value for limestone).

(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009).

(e) Control of Open Fugitive Dust Source (USEPA, September 1988) / Equation (4-9)

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

			TSP <= 30 um	PM_{10}	$PM_{2.5}$	
Scaling factors	-	K	-	0.5	0.075	(a)
Emission factor (uncontrolled)	kg/d/ha	L = E*(C/F)*((G-D)/H)*(B/I)	2.54E+00	1.27E+00	9.51E-02	(b) (c)
Emission rate (controlled) (24-hour)	g/s	M = L*A*1000*(1-J/100)/(24*3600)	1.23E-01	6.16E-02	4.62E-03	
Quality rating	-		A	A	A	

Source: (a) AP-42/Section 13.2.5 - Industrial Wind Erosion.
(b) TSP calculated according to Control of Open Fugitive Dust Source (USEPA, September 1988) / Equation (4-9)
(c) PM10 and PM2.5 calculated multiplying TSP emission rate by respective scaling factors.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Dozer	D6 Cat	1	10.0	(a)
Grader	14G Cat	1	2.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	4.38E-03	4.38E-03	4.25E-03	2.29E-02	4.04E-05	2.82E-02

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

VII - Backfill Plant

VII.1 - Batch Operations

VII.1.1 - Batch Operations/Waste Rock Transfer

A - Fugitive Emissions

Fugitive PM emissions: no significant. Wet material with 41.6% moisture.

VII.1.2 - Batch Operations/Cement Unloading

A - Fugitive Emissions

Dust Control Technique		Bag house

Hours of operation per day	h/day	A	16	(a)
Amount of material processed	tonnes/day	B	27	(b)
Emission reduction efficiency	(%)	C	N/A	

Source: (a) Information provided by Canadia Zinc.
(b) See table daily rates below.
Notes N/A: Not Available

			TSP	PM_{10}	$PM_{2.5}$	
Emission factor (controlled)	kg/tonne	D	0.0005	0.00017	3.06E-05	(a) (b)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	13.5	4.6	0.8	
Emission rate (24-hour)	g/s	F = E/(24*3600)	1.56E-04	5.31E-05	9.54E-06	
Quality rating	-		E	D	E	

Source: (a) AP-42 / 11.12 - Concrete Batching (USEPA, June 2006)/ Table 11.12-1 (Metric Units) - Emission Factors for Concrete Batching (value for cement unloading to elevated storage silo - controlled)
(b) Emission factor for PM2.5 based on the ratio between PM10 and PM2.5 emission factors for uncontrolled operations in AP-42 / 11.12 - Concrete Batching / Table 11.12-3. Equation Parameters for Truck Mix Operations.

Daily rates

Material	-		Mill Feed	Placed Backfill (DMS+FT)	Cement binder	
% cement in the backfill			-	-	3%	(a)
Total years 0 - 14	tonnes		4,995,000	3,401,470	105,200	(a) (b)
Ratio to mill feed	%		100.00%	68.10%	2.11%	
Daily rate	tonne/day		1,280	872	27	(c) (d)

Source: (a) Prairie Creek Mine Project Description Report (Canadian Zinc Corporation, May 2008)
(b) Cement binder calculated based backfill amount and cement binder %.
(c) Mill feed: information provided by Canadian Zinc.
(d) Backfill and cement calculated based on ratio to mill feed.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

VII.1.3 - Batch Operations/Mixer Loading

A - Fugitive Emissions

Dust Control Technique		Bag house	

Hours of operation per day	h/day	A	16	(a)
Amount of material processed	tonnes/day	B	27	(b)
Emission reduction efficiency	(%)	C	N/A	

Source: (a) Information provided by Canadia Zinc.
(b) See table daily rates below.

Notes N/A: Not Available

			TSP	PM_{10}	$PM_{2.5}$	
Emission factor (controlled)	kg/tonne	D	0.087	0.0024	4.32E-04	(a) (b)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	2,346.2	64.7	11.6	
Emission rate (24-hour)	g/s	F = E/(24*3600)	2.72E-02	7.49E-04	1.35E-04	
Quality rating	-		E	D	E	

Source: (a) AP-42 / 11.12 - Concrete Batching (USEPA, June 2006)/ Table 11.12-1 (Metric Units) - Emission Factors for Concrete Batching (value for mixer loading (central mix) - controlled)
(b) Emission factor for PM2.5 based on the ratio between PM10 and PM2.5 emission factors for uncontrolled operations in AP-42 / 11.12 - Concrete Batching / Table 11.12-3. Equation Parameters for Truck Mix Operations.

Daily rates

Material	-		Mill Feed	Placed Backfill (DMS+FT)	Cement binder	
% cement in the backfill			-	-	3%	(a)
Total years 0 - 14	tonnes		4,995,000	3,401,470	105,200	(a) (b)
Ratio to mill feed	%		100.00%	68.10%	2.11%	
Daily rate	tonne/day		1,280	872	27	(c) (d)

Source: (a) Prairie Creek Mine Project Description Report (Canadian Zinc Corporation, May 2008).
(b) Cement binder calculated based backfill amount and cement binder %.
(c) Mill feed: information provided by Canadian Zinc.
(d) Backfill and cement calculated based on ratio to mill feed.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

VIII - Other Off-site Transport (people, equipment, supplies)

VIII.1 - Road Transport

A - Fugitive Emissions

- Road surface fugitive PM emissions: not significant. The transport of concentrate from the Project will be carried out on an access road, the surface of which will be covered with ice and snow. Therefore, this activity is not expected to generate road surface fugitive particulate emissions. This can be demonstrated numerically using AP-42 / Section 13.2.2 - Unpaved Roads (U.S. EPA, 2006) equations and the adjustment factor for precipitation, snow cover and frozen days according to the Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, 2009; website). Using the equations from these references, the resulting particulate emissions would be zero, as presented below:

E = VKT*EF*ADJ*(1-CE/100)

where E is the PM emission rate and ADJ is the adjustment factor for precipitation/snow.

ADJ = {[working days - (p + snow)]/working days}

where p is the estimated annual working days with precipitation exceeding 0.2 mm and snow is the estimated annual working days when the roads are frozen or snow covered and wet for winter.

For the access road working days = snow. Therefore, ADJ = 0 and E = 0.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Lowboy Trailer with Louisville Truck		1	24.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	7.55E-03	7.55E-03	7.33E-03	3.86E-02	6.73E-05	5.05E-02

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

VIII.2 - Air Transport

A - Fugitive Emissions

Dust Control Technique		No Control

Hours of operation per day	h/day	A	1	(a)
Surface material silt content	(%)	B	4.3	(c)
Mean vehicle weight	(tons)	C	20.00	(d)
Vehicle kilometre traveled (VKT)	km/day	D	3.2	(e)
Number of working days	days/year	E	156	(f)
Number of days with precipitation >= 0.2 mm	days/year	F	23.9	(g)
Number of days with snow cover >= 1 cm	days/year	G	83.1	(g)
Emission reduction efficiency	(%)	H	0	(h)

Source: (a) Assumed based on maximum of one landing and one takeoff per day.
(b) Considering activities 52 per year and 3 landings/takeoffs per day.
(c) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (taconite mining and processing / service road).
(d) Maximum takeoff weight.
(e) Assumed based on maximum of one landing and one takeoff per day, each one covering two times the length of the air strip (approximatelly 800 m).
(f) Calculated based on information provided by Canadia Zinc (3 flights per week) and 52 weeks per year.
(g) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009). Annual values were prorated based on the number of working days per year.
(h) Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009).

			PM-30 (TSP)	PM_{10}	$PM_{2.5}$	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] (b)	1.762	0.439	0.044	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) (c)	496.7	123.8	12.4	
Emission rate	g/day	N = M*D	1,589.5	396.3	39.6	
Emission rate (24-hour)	g/s	O = N/(24*3600)	0.0184	0.0046	0.0005	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Airplane	Dash 7	1	1	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	3.37E-03	3.37E-03	3.27E-03	8.92E-02	1.12E-04	2.80E-02

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

IX - Winter Road Construction

IX.1 - Winter Road Construction

A - Fugitive Emissions

- Road surface / material handling fugitive PM emissions: not significant. Winter roads will be constructed with snow and ice from locally sourced water delivered by water trucks.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Grader	Caterpillar	2	19.0	(a)
Grader	14G Cat	1	19.0	(a)
Grader	14E Cat	1	19.0	(a)
Scraper	Caterpillar	2	19.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	4.78E-02	4.78E-02	4.64E-02	3.91E-01	7.35E-04	1.98E-01

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

X - Support Activities

X.1 - Power Generation

C - Combustion Emissions

Control Technique		No Control

Hours of operation per day	h/day	A	24	(a)
Sulphur content in the fuel	%	B	0.0015	(b)
Number of power generators	-	C	3	(a)
Generator power Rating	kW	D	1,450	(a)
Generator power Rating	hp	E = D*1.341022	1,944	
Peak load of the generator set	%	F	90	(a)
Emission reduction efficiency	(%)	G	0	

Source: (a) Information provided by Canadia Zinc.
(b)Based on Canada's Sulphur in Diesel Fuel Regulations for off-road diesel Fuel effective from October 1, 2010 (Environmental Canada website, accessed in December, 2009)

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	1.98E-01	1.98E-01	1.92E-01	6.03E+00	7.11E-03	1.22E+00

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

X.2 - Incineration

C - Combustion Emissions

Control Technique		No Control

Hours of operation per day	h/day	A	2	(a)
Number of Incinerators	-	B	1	(a)
Total exhaust flow rate	Nm3/s	C	1.65	(b)
Emission reduction efficiency	(%)	D	0	

Source: (a) Information provided by Canadia Zinc.
(b) Data for CY-2050-FA "D" incinerator provided by the manufacter (Westland Environmental Services Inc.).

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	
Concentrations at the exaust stack (source testing results)	mg/Nm3	E	1.06E+02	8.71E+01	7.28E+01	8.10E+01	3.55E+01	1.15E+01	(a) (b) (c)
Emission rate (24-hour)	g/s	F = A*B*C*E*(1-D/100)/(1000*24)	1.46E-02	1.20E-02	1.00E-02	1.11E-02	4.88E-03	1.58E-03	
Quality rating	-		A	E	E	A	A	-	

Source: (a) TSP, NOx and SO2: Source testing results provided by Canadian Zinc (typical stack emissions on Westland incinerators: memorandum from Inproheat to SNC Lavalin submitted on February 14, 2007).
(b) PM10 and PM2.5: based on the ratio between Total Particulate and PM10 / PM2.5 emission factors based on fuel inputs presented in AP-42 / 3.4 - Large Stationary Diesel And All Stationary Dual-fuel Engines (USEPA, October 2006)/ Table 3.4-2 - Particulate and particle-sizing emission factors for large uncontrolled stationary diesel engines.
(c) CO: Value provided by Westland Incinerators, as worst case scenario for waste incinerators produced by this company.

X.3 - Heating

C - Combustion Emissions

No significant emissions. A glycol-based heat recovery system connected to the power generation units will be used to provide heated ventilation when necessary, during November through March to a minimum temperature

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Operation Phase

X.4 - On-site use of support equipment and vehicles

A - Fugitive Emissions

Dust Control Technique		Watering twice a day	

Hours of operation per day	h/day	A	12	(a)
Surface material silt content	(%)	B	4.3	(b)
Mean vehicle weight	(tons)	C	7.77	(c)
Vehicle kilometre traveled (VKT)	km/day	D	300	(c)
Number of working days	days/year	E	350	(a)
Number of days with precipitation >= 0.2 mm	days/year	F	56	(d)
Number of days with snow cover >= 1 cm	days/year	G	194.5	(d)
Emission reduction efficiency	(%)	H	55	(e)

Source: (a) Information provided by Canadian Zinc.
(b) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (taconite mining and processing / service road).
(c) See Mean Vehicle Weight table below.
(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009).

(e) Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009).

			PM-30 (TSP)	PM_{10}	$PM_{2.5}$	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] [(b)]	1.042	0.260	0.026	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) [(c)]	132.2	33.0	3.3	
Emission rate	g/day	N = M*D	39,653.5	9,886.3	988.6	
Emission rate (24-hour)	g/s	O = N/(24*3600)	4.59E-01	1.14E-01	1.14E-02	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

Mean Vehicle Weight

Equipment	-		Pickup Trucks	Other Trucks	Heavy Equipment	Total	
Number	-		3	10	2		
Weight - Empty	tons		3	10	10	-	(a)
Weight - Loaded	tons		4	20	10	-	(a)
Mean Weight	tons		3.5	15	10	-	(b)
Vehicle kilometer traveled (VKT)	km/day		180	100	20	300	(c)
Percentage of traffic	%		60.00%	33.33%	6.67%	-	
Mean vehicle weight	tons		2.10	5.00	0.67	7.77	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Assuming half of the distance is travelled with the vehicle empty anf half of the distance with the vehicle loaded.
(c) Values calculated assuming daily use of the vehicles, as per table Exhaust Emissions below, and average speeds over the daily use of 3 km/h for pickup trucks, 1 km/h for other trucks and heavy equipment.
(d) Values weighted according to VKT.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Manlift		2	12.0	(a)
Snowplows		2	12.0	(a)
Water Truck		1	12.0	(a)
Crewcab Truck		2	12.0	(a)
Concrete Mixing Truck		2	12.0	(a)
Fuel Truck		1	12.0	(a)
Pick up Trucks		3	12.0	(a)
Sand Trucks		2	12.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	3.47E-02	3.47E-02	3.37E-02	2.57E-01	4.62E-04	2.26E-01

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Summary of Emission Rates During the Closure Phase

Operations	Activities	Emission Category	Emission Rates (g/s) - 24-hour							
			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
I - Demolition and Debris Removal	I.1 - General land clearing (dozer)	A - Fugitive Emissions	6.24E-01	1.18E-01	6.55E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	6.29E-04	6.29E-04	6.10E-04	1.53E-02	2.70E-04	4.46E-03	N/A	N/A
	I.2 - Loading of debris into trucks	A - Fugitive Emissions	2.08E-01	1.08E-01	2.19E-02	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	1.11E-04	1.11E-04	1.07E-04	2.69E-03	4.74E-05	8.78E-04	N/A	N/A
II - General Activities	II.1 - Vehicular traffic	A - Fugitive Emissions	3.20E-01	7.99E-02	7.99E-03	N/A	N/A	N/A	N/A	N/A
		B - Exhaust Emissions	9.05E-04	9.05E-04	8.77E-04	4.53E-02	2.88E-04	1.18E-02	N/A	N/A
Total			**1.15E+00**	**3.07E-01**	**9.70E-02**	**6.33E-02**	**6.05E-04**	**1.72E-02**	**N/A**	**N/A**

N/A: Not Applicable (i.e., emissions not expected)

Contributions							
TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
54.07%	38.26%	67.57%	N/A	N/A	N/A	N/A	N/A
0.05%	0.20%	0.63%	24.21%	44.58%	25.98%	N/A	N/A
18.05%	35.24%	22.55%	N/A	N/A	N/A	N/A	N/A
0.01%	0.04%	0.11%	4.26%	7.84%	5.11%	N/A	N/A
27.74%	25.97%	8.23%	N/A	N/A	N/A	N/A	N/A
0.08%	0.29%	0.90%	71.53%	47.58%	68.91%	N/A	N/A
100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	N/A	N/A

Summary

Operations	Emission Rates (g/s) - 24-hour								Emission Rates (kg/day) - 24-hour							
	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn	TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
I - Demolition and Debris Removal	8.33E-01	2.27E-01	8.81E-02	1.80E-02	3.17E-04	5.34E-03	N/A	N/A	71.99	19.59	7.61	1.56	0.03	0.46	N/A	N/A
II - General Activities	3.21E-01	8.08E-02	8.86E-03	4.53E-02	2.88E-04	1.18E-02	N/A	N/A	27.75	6.98	0.77	3.91	0.02	1.02	N/A	N/A
Total	**1.15E+00**	**3.07E-01**	**9.70E-02**	**6.33E-02**	**6.05E-04**	**1.72E-02**	**N/A**	**N/A**	**99.74**	**26.56**	**8.38**	**5.47**	**0.05**	**1.48**	**N/A**	**N/A**

N/A: Not Applicable (i.e., emissions not expected)

Contributions							
TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
72.18%	73.73%	90.86%	28.47%	52.42%	31.09%	N/A	N/A
27.82%	26.27%	9.14%	71.53%	47.58%	68.91%	N/A	N/A
100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	N/A	N/A

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Closure Phase

I - Demolition and Debris Removal

I.1 - General land clearing (dozer)

A - Fugitive Emissions

Dust Control Technique		No control

Number of equipment	pc	A	3	(a)
Hours of operation per day - peak	h/day	B	10	(a)
Material silt content	(%)	C	6.9	(b)
Material moisture content	(%)	D	7.9	(b)
Emission reduction efficiency	(%)	E	0	

Source: (a) Information provided by Canadia Zinc.
(b) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-3 (Metric and English Units) - Typical Values for Correction Factors Applicable to the Predictive Emission Factor Equations (values for overburden).

			TSP <= 30 um	TSP <= 15 um	PM_{10}	$PM_{2.5}$	
Constant (a)	-	F	2.6	0.45	-	-	(a)
Constant (b)	-	G	1.2	1.5	-	-	(a)
Constant (c)	-	H	1.3	1.4	-	-	(a)
Scaling Factor		I	-	-	0.75	0.105	(a) (b)
Emission rate (uncontrolled)	kg/hr/pc	J = F*(C^G)/(D^H)	1.798	0.452	0.339	0.189	(a) (c)
Emission rate (controlled)	g/hr	K = A*J*1000*(1-E/100)	5,392.6	1,355.0	1,016.2	566.2	
Emission rate	g/day	L = K*B	53,926.0	13,549.7	10,162.3	5,662.2	
Emission rate (24-hour)	g/s	M = L/(24*3600)	6.24E-01	1.57E-01	1.18E-01	6.55E-02	
Quality rating	-		B	C	D	D	

Source: (a) AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines (bulldozing overburden). According to recommendations in AP-42 / Section 13.2.3 - Heavy Construction Operations (USEPA, January 1995) / Table 13.2.3-1 - Recommended Emission Factors for Construction Operations (reference to dozer equation (overburden) in Section 11.9 / Table 11.9.2).
(b) Scaling factor to convert TSP <= 30 um to PM2.5 and TSP <= 15 um to PM2.5
(c) PM10 and PM2.5 calculated multiplying TSP emission rates by respective scaling factors.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Dozer	D8H Cat	1	10.0	(a)
Dozer	D8H Cat	1	10.0	(a)
Dozer	D8H Cat	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	6.29E-04	6.29E-04	6.10E-04	1.53E-02	2.70E-04	4.46E-03

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Closure Phase

I.2 - Loading of debris into trucks

A - Fugitive Emissions

Dust Control Technique		No control

Hours of operation per day	h/day	A	10	(a)
Amount of soil removed per day	tonnes/day	B	1,000	(b)
Emission reduction efficiency	(%)	C	0	

Source: (a) Information provided by Canadia Zinc.
(b) Calculated based on information provided by Canadian Zinc (volume of crushed rock) assuming a density of 2 t/m^3.

			TSP	PM_{10}	$PM_{2.5}$	
Emission factor (uncontrolled)	kg/tonne	D	0.018	0.0094	0.0019	(a) (b) (c)
Emission rate (controlled)	g/day	E = B*D*1000*(1-C/100)	18,000.0	9,360.0	1,890.0	
Emission rate (24-hour)	g/s	F = E/(24*3600)	2.08E-01	1.08E-01	2.19E-02	
Quality rating	-		E	-	-	

Source: (a) TSP emission factor extracted from AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9.4 - Uncontrolled Particulate Emission Factors for Open Dust Sources at Werstern Surface Coal Mine (truck loading by power shovel (batch drop) / overburden).
(b) Emission factor for PM10 based on the ratio between TSP and PM10 emission factors for blasting in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.
(c) Emission factor for PM2.5 based on the ratio between TSP and PM2.5 emission factors for bulldozing overburden in AP-42 / Section 11.9 - Western Surface Coal Mining (USEPA, October 1998) / Table 11.9-2 (Metric Units) - Emission Factor Equations for Uncontrolled Open Dust Sources at Western Surface Coal Mines.

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
FEL	Cat 950	1	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	1.11E-04	1.11E-04	1.07E-04	2.69E-03	4.74E-05	8.78E-04

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Closure Phase

II - General Activities

II.1 - Vehicular traffic

A - Fugitive Emissions

Dust Control Technique		Watering twice a day	

Hours of operation per day	h/day	A	10	(a)
Surface material silt content	(%)	B	4.3	(b)
Mean vehicle weight	(tons)	C	7.71	(c)
Vehicle kilometre traveled (VKT)	km/day	D	210	(c)
Number of working days	days/year	E	350	(a)
Number of days with precipitation >= 0.2 mm	days/year	F	56	(d)
Number of days with snow cover >= 1 cm	days/year	G	194.5	(d)
Emission reduction efficiency	(%)	H	55	(e)

Source: (a) Information provided by Canadian Zinc.
(b) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Table 13.2.2-1 - Typical Silt Content Values of Surface Materials on Industrial Unpaved Roads (taconite mining and processing / service road).
(c) See Mean Vehicle Weight table below.
(d) Data for Fort Simpson A station (closest meteorological station to the site with data available) (Environment Canada website, accessed in December 2009).
(e) Unpaved Industrial Road Dust Calculator (Environment Canada website, accessed in December 2009).

			PM-30 (TSP)	PM_{10}	$PM_{2.5}$	
Constant (k)	-	I	4.9	1.5	0.15	(a)
Constant (a)	-	J	0.7	0.9	0.9	(a)
Constant (b)	-	K	0.45	0.45	0.45	(a)
Emission factor (uncontrolled)	lb/VMT	L = I*((B/12)^J)*((C/3)^K)*[(E-(F+G))/E] [(b)]	1.039	0.259	0.026	(a)
Emission factor (controlled)	g/VKT	M = L*281.9*(1-H/100) [(c)]	131.8	32.9	3.3	
Emission rate	g/day	N = M*D	27,673.1	6,899.4	689.9	
Emission rate (24-hour)	g/s	O = N/(24*3600)	3.20E-01	7.99E-02	7.99E-03	
Quality rating	-		B	B	B	

Source: (a) AP-42 / Section 13.2.2 - Unpaved Roads (USEPA, November 2006)/ Equation (1a) - unpaved surfaces at industrial sites and Table 13.2.2-2.
(b) Adjustment factor for precipitation, snow cover and frozen days (E, F and G variables) according to Guidance on Estimating Road Dust Emissions from Industrial Unpaved Surfaces (Environment Canada website, accessed in December 2009).
(c) 281.9: constant to convert lb/VMT (pounds per vehicle mile travelled) to g/VKT (grams per vehicle kilometre travelled).

Mean Vehicle Weight

Equipment	-		Pickup Trucks	Other Trucks	Heavy Equipment	Total	
Number	-		2	6	3		
Weight - Empty	tons		3	10	10	-	(a)
Weight - Loaded	tons		4	20	10	-	(a)
Mean Weight	tons		3.5	15	10	-	(b)
Vehicle kilometer traveled (VKT)	km/day		120	60	30	210	(c)
Percentage of traffic	%		57.14%	28.57%	14.29%	-	
Mean vehicle weight	tons		2.00	4.29	1.43	7.71	(c)

Source: (a) Information provided by Canadia Zinc.
(b) Assuming half of the distance is travelled with the vehicle empty anf half of the distance with the vehicle loaded.
(c) Values calculated assuming daily use of the vehicles, as per table Exhaust Emissions below, and average speeds over the daily use of 3 km/h for pickup trucks, 1 km/h for other trucks and heavy equipment.
(d) Values weighted according to VKT.

Air Quality Assessment - Prairie Creek Mine
Calculation of Emissions During the Closure Phase

B - Exhaust Emissions

Equipment / Vehicle	Model	Number of Equipment / Vehicle	Daily Use (hours)	
Crane	72 Tonne	1	10.0	(a)
Forklift		1	10.0	(a)
Manlift		1	10.0	(a)
Snowplows		1	10.0	(a)
Lowboy Trailer with Louisville Truck		1	10.0	(a)
Water Truck		1	10.0	(a)
Crewcab Truck		1	10.0	(a)
Fuel Truck		1	10.0	(a)
Flat Bed truck		1	10.0	(a)
Pick up Trucks		2	10.0	(a)

Source: (a) Information provided by Canadia Zinc.

			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO
Emission rate (24-hour)	g/s	(see Exhaust Emissions Table)	9.05E-04	9.05E-04	8.77E-04	4.53E-02	2.88E-04	1.18E-02

Source: See table exhaust emissions.

Air Quality Assessment - Prairie Creek Mine
Calculation of Exhaust Emissions During the Construction, Operation and Closure Phases

Ref.	Equipment / Vehicle	Model	Type of Vehicle or Equipment	Number of Equipment / Vehicle	Daily Use (hours)	Engine Horse-power (hp)	Horsepower Category (hp)	Engine Year	Engine Technology Category	Load Factor Assignment	Suggested Cycle Load Factor	Fraction of useful life already expended (%)	Alternate Cycle Load Factor	Type of Fuel Used	Fuel Sulphur (% weight)	THC Adjustment Factor	PM Adjustment Factor	Zero-hour emission factor (g/Hp-hr); [(lb/Hp-hr) for fuel]					Deterioration factor				Transient Adjustment factor				
																		Fuel*	NO_x	CO	THC	PM	NO_x	CO	THC	PM	Fuel*	NO_x	CO	THC	PM
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S1	S2	S3	S4	S5	T1	T2	T3	T4	U1	U2	U3	U4	U5
1 - Construction																															
I.1	Drill jumbo	Electric/Hydraulic	Construction Equipment Bore/Drill Rigs	1	1.5	75	75-100	2009	Tier 3B	Avg 7-cycle	0.43	50%	0.43	Diesel	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
I.3	Dozer	D8H Cat	Construction Equipment Crawler Dozer	1	10.0	270	175-300	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
I.4	FEL	Cat 950	Construction Equipment Tractors/Loaders/Backho	1	10.0	400	300-600	2009	Tier 3	Lo LF	0.21	50%	0.21	ULSD	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.004	1.076	1.014	1.237	1.180	1.210	2.570	2.290	2.370
I.5	LHD Scoops	2 Yard	Construction Equipment Tractors/Loaders/Backho	1	10.0	117	100-175	2009	Tier 3	Lo LF	0.21	50%	0.21	Diesel	0.0015	1	0.0346	0.367	2.500	0.867	0.184	0.220	1.004	1.076	1.014	1.237	1.180	1.210	2.570	2.290	2.370
I.5	20 t Trucks	MT2010	Construction Equipment Off-highway Trucks	1	18.0	300	300-600	2009	Tier 3	Hi LF	0.59	50%	0.59	Diesel	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.1	Dozer	D8K Cat	Construction Equipment Crawler Dozer	1	10.0	300	300-600	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.1	Dozer	D6 Cat	Construction Equipment Crawler Dozer	1	10.0	93	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.3	Scraper	Caterpillar	Construction Equipment Scrapers	2	10.0	200	175-300	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.5	Loader	Volvo	Construction Equipment Tractors/Loaders/Backho	1	10.0	400	300-600	2009	Tier 3	Lo LF	0.21	50%	0.21	ULSD	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.004	1.076	1.014	1.237	1.180	1.210	2.570	2.290	2.370
II.5	Backhoe	Hitachi	Construction Equipment Tractors/Loaders/Backho	1	10.0	200	175-300	2009	Tier 3	Lo LF	0.21	50%	0.21	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.004	1.076	1.014	1.237	1.180	1.210	2.570	2.290	2.370
II.6	Dozer	D8	Construction Equipment Crawler Dozer	1	10.0	270	175-300	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.6	Dozer	D6	Construction Equipment Crawler Dozer	1	10.0	93	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.7	Grader	Caterpillar	Construction Equipment Graders	2	10.0	200	175-300	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.7	Grader	14G Cat	Construction Equipment Graders	1	10.0	200	175-300	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
II.7	Grader	14E Cat	Construction Equipment Graders	1	10.0	150	100-175	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.867	0.184	0.220	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Crane	72 Tonne	Construction Equipment Cranes	1	10.0	100	100-175	2009	Tier 3	Avg 7-cycle	0.43	50%	0.43	ULSD	0.0015	1	0.0346	0.367	2.500	0.867	0.184	0.220	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
III.1	Forklift		Construction Equipment Rough Terrain Forklifts	1	10.0	75	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Manlift		Industrial Equipment Aerial Lifts	2	10.0	20	16-25	2009	Tier 4A	Lo LF	0.21	50%	0.21	ULSD	0.0015	1.016260163	0.0346	0.408	4.440	2.161	0.445	0.280	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
III.1	Snowplows		Construction Equipment Off-highway Trucks	2	10.0	200	175-300	2009	Tier 3	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Lowboy Trailer with Louisville Truck		Construction Equipment Off-highway Trucks	1	10.0	75	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Water Truck		Construction Equipment Off-highway Trucks	1	10.0	75	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Crewcab Truck		Construction Equipment Off-highway Trucks	2	10.0	50	50-75	2009	Tier 4A	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0346	0.408	3.000	2.366	0.187	0.200	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
III.1	Concrete Mixing Truck		Construction Equipment Cement & Mortar Mixers	2	10.0	75	75-100	2009	Tier 3B	Avg 7-cycle	0.43	50%	0.43	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
III.1	Fuel Truck		Construction Equipment Off-highway Trucks	1	10.0	75	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Flat Bed truck		Construction Equipment Off-highway Trucks	1	10.0	75	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Pick up Trucks		Construction Equipment Off-highway Trucks	3	10.0	50	50-75	2009	Tier 4A	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0346	0.408	3.000	2.366	0.187	0.200	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
III.1	Sand Trucks		Construction Equipment Off-highway Trucks	2	10.0	75	75-100	2009	Tier 3B	Hi LF	0.59	50%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.004	1.076	1.014	1.237	1.010	1.040	1.530	1.050	1.470
III.1	Misc. service trucks		Construction Equipment Off-highway Trucks	1	10.0	50	50-75	2009	Tier 4A	Hi LF	0.59	50%	0.59	Diesel	0.0015	1.016260163	0.0346	0.408	3.000	2.366	0.187	0.200	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
III.2	Generators		Light Commercial Generator Sets	1	24	1,944	>1200	2009	Tier 2	Avg 7-cycle	0.43	50%	0.90	Diesel	0.0015	1	0.1416	0.367	4.100	0.764	0.167	0.132	1.005	1.051	1.017	1.237	1.000	1.000	1.000	1.000	1.000
2 - Operation																															
I.1	Drll Jumbos	Electric/ Hydraulic	Construction Equipment Bore/Drill Rigs	2	1.5	75	75-100	2009	Tier 3B	Avg 7-cycle	0.43	90%	0.43	Diesel	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.000	1.000	1.000	1.000	1.000
I.3	Lhd Scoops	2 Yard	Construction Equipment Tractors/Loaders/Backho	3	16.0	300	300-600	2009	Tier 3	Lo LF	0.21	90%	0.21	Diesel	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.007	1.136	1.024	1.426	1.180	1.210	2.570	2.290	2.370
I.3	20T Trucks	MT 2010	Construction Equipment Off-highway Trucks	2	15.0	117	100-175	2009	Tier 3	Hi LF	0.59	90%	0.59	Diesel	0.0015	1	0.0346	0.367	2.500	0.867	0.184	0.220	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
II.5	Dozer	D8H Cat	Construction Equipment Crawler Dozer	1	1.0	270	175-300	2009	Tier 3	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
II.5	Loader	Cat 966	Construction Equipment Tractors/Loaders/Backho	1	1.0	300	300-600	2009	Tier 3	Lo LF	0.21	90%	0.21	ULSD	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.007	1.136	1.024	1.426	1.180	1.210	2.570	2.290	2.370
IV.1	Crane	72 Tonne	Construction Equipment Cranes	1	24.0	100	100-175	2009	Tier 3	Avg 7-cycle	0.43	90%	0.43	ULSD	0.0015	1	0.0346	0.367	2.500	0.867	0.184	0.220	1.007	1.136	1.024	1.426	1.000	1.000	1.000	1.000	1.000
IV.1	Forklift		Construction Equipment Rough Terrain Forklifts	1	24.0	75	75-100	2009	Tier 3B	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
V.1	Flat Bed truck		Construction Equipment Off-highway Trucks	6	24.0	75	75-100	2009	Tier 3B	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
V.2	Loader	Volvo	Construction Equipment Tractors/Loaders/Backho	1	24.0	400	300-600	2009	Tier 3	Lo LF	0.21	90%	0.21	ULSD	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.007	1.136	1.024	1.426	1.180	1.210	2.570	2.290	2.370
V.2	FEL	Cat 950	Construction Equipment Tractors/Loaders/Backho	1	24.0	400	300-600	2009	Tier 3	Lo LF	0.21	90%	0.21	ULSD	0.0015	1	0.0346	0.367	2.500	0.843	0.167	0.150	1.007	1.136	1.024	1.426	1.180	1.210	2.570	2.290	2.370
VI.4	Dozer	D6 Cat	Construction Equipment Crawler Dozer	1	10.0	93	75-100	2009	Tier 3B	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
VI.4	Grader	14G Cat	Construction Equipment Tractors/Loaders/Backho	1	2.0	200	175-300	2009	Tier 3	Lo LF	0.21	90%	0.21	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.007	1.136	1.024	1.426	1.180	1.210	2.570	2.290	2.370
VIII.1	Lowboy Trailer with Louisville Truck		Construction Equipment Off-highway Trucks	1	24.0	75	75-100	2009	Tier 3B	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
VIII.2	Airplane	Dash 7	Airport Service Equipment Airport Support Equipm	1	1	3,340	>1200	2009	Tier 2	Hi LF	0.59	50%	0.59	Av. Gas	0.0015	1	0.1416	0.367	4.100	0.764	0.167	0.132	1.005	1.051	1.017	1.237	1.010	0.950	1.530	1.050	1.230
IX.1	Grader	Caterpillar	Construction Equipment Graders	2	19.0	200	175-300	2009	Tier 3	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
IX.1	Grader	14G Cat	Construction Equipment Graders	1	19.0	200	175-300	2009	Tier 3	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
IX.1	Grader	14E Cat	Construction Equipment Graders	1	19.0	150	100-175	2009	Tier 3	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.867	0.184	0.220	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
IX.1	Scraper	Caterpillar	Construction Equipment Scrapers	2	19.0	200	175-300	2009	Tier 3	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
X.1	Generators		Light Commercial Generator Sets	3	24	1,944	>1200	2009	Tier 2	Avg 7-cycle	0.43	90%	0.90	Diesel	0.0015	1	0.1416	0.367	4.100	0.764	0.167	0.132	1.008	1.091	1.031	1.426	1.000	1.000	1.000	1.000	1.000
X.4	Manlift		Industrial Equipment Aerial Lifts	2	12.0	20	16-25	2009	Tier 4A	Lo LF	0.21	90%	0.21	ULSD	0.0015	1.016260163	0.0346	0.408	4.440	2.161	0.445	0.280	1.007	1.136	1.024	1.426	1.000	1.000	1.000	1.000	1.000
X.4	Snowplows		Construction Equipment Off-highway Trucks	2	12.0	200	175-300	2009	Tier 3	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.367	2.500	0.748	0.184	0.150	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
X.4	Water Truck		Construction Equipment Off-highway Trucks	1	12.0	75	75-100	2009	Tier 3B	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
X.4	Crewcab Truck		Construction Equipment Off-highway Trucks	2	12.0	50	50-75	2009	Tier 4A	Hi LF	0.59	90%	0.59	ULSD	0.0015	1.016260163	0.0346	0.408	3.000	2.366	0.187	0.200	1.007	1.136	1.024	1.426	1.000	1.000	1.000	1.000	1.000
X.4	Concrete Mixing Truck		Construction Equipment Cement & Mortar Mixers	2	12.0	75	75-100	2009	Tier 3B	Avg 7-cycle	0.43	90%	0.43	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.000	1.000	1.000	1.000	1.000
X.4	Fuel Truck		Construction Equipment Off-highway Trucks	1	12.0	75	75-100	2009	Tier 3B	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
X.4	Pick up Trucks		Construction Equipment Off-highway Trucks	3	12.0	50	50-75	2009	Tier 4A	Hi LF	0.59	90%	0.59	ULSD	0.0015	1.016260163	0.0346	0.408	3.000	2.366	0.187	0.200	1.007	1.136	1.024	1.426	1.000	1.000	1.000	1.000	1.000
X.4	Sand Trucks		Construction Equipment Off-highway Trucks	2	12.0	75	75-100	2009	Tier 3B	Hi LF	0.59	90%	0.59	ULSD	0.0015	1	0.0346	0.408	3.000	2.366	0.184	0.300	1.007	1.136	1.024	1.426	1.010	1.040	1.530	1.050	1.470
3 - Closure																															
I.1	Dozer	D8H Cat	Construction Equipment Crawler Dozer	1	10	270	175-300	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.367	0.276	0.075	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
I.1	Dozer	D8K Cat	Construction Equipment Crawler Dozer	1	10	300	300-600	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.367	0.276	0.084	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
I.1	Dozer	D6 Cat	Construction Equipment Crawler Dozer	1	10	93	75-100	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	0.276	0.237	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
I.2	FEL	Cat 950	Construction Equipment Tractors/Loaders/Backho	1	10	400	300-600	2020	Tier 4N	Lo LF	0.21	50%	0.21	ULSD	0.0015	1.016260163	0.0000	0.367	0.276	0.084	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Crane	72 Tonne	Construction Equipment Cranes	1	10	100	100-175	2020	Tier 4N	Avg 7-cycle	0.43	50%	0.43	ULSD	0.0015	1.016260163	0.0000	0.367	0.276	0.087	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Forklift		Construction Equipment Rough Terrain Forklifts	1	10	75	75-100	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	0.276	0.237	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Manlift		Industrial Equipment Aerial Lifts	1	10	20	16-25	2020	Tier 4B	Lo LF	0.21	50%	0.21	ULSD	0.0015	1.016260163	0.0000	0.408	4.440	2.161	0.445	0.280	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Snowplows		Construction Equipment Off-highway Trucks	1	10	200	175-300	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.367	0.276	0.075	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Lowboy Trailer with Louisville Truck		Construction Equipment Off-highway Trucks	1	10	75	75-100	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	0.276	0.237	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Water Truck		Construction Equipment Off-highway Trucks	1	10	75	75-100	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	0.276	0.237	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Crewcab Truck		Construction Equipment Off-highway Trucks	1	10	50	50-75	2020	Tier 4	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	3.000	0.237	0.134	0.018	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Fuel Truck		Construction Equipment Off-highway Trucks	1	10	75	75-100	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	0.276	0.237	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Flat Bed truck		Construction Equipment Off-highway Trucks	1	10	75	75-100	2020	Tier 4N	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	0.276	0.237	0.134	0.009	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000
II.1	Pick up Trucks		Construction Equipment Off-highway Trucks	2	10	50	50-75	2020	Tier 4	Hi LF	0.59	50%	0.59	ULSD	0.0015	1.016260163	0.0000	0.408	3.000	0.237	0.134	0.018	1.004	1.076	1.014	1.237	1.000	1.000	1.000	1.000	1.000

Notes: 1 - See description of the calculation on page 3/3.

2 - For diesel engines, all PM emissions are assumed to be PM_{10} (source: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004) - paga 23).

Air Quality Assessment - Prairie Creek Mine
Calculation of Exhaust Emissions During the C

Ref.	Equipment / Vehicle	Model	Adjusted exhaust emission factor (g/Hp×hr); [(lb/Hp-hr) for fuel]						Exhaust emission rate (g/h); [(lb/h) for fuel]						Exhaust emission rate (g/s) - Daily					
			Fuel*	NO_X	CO	THC	PM	SO_2	Fuel*	NO_X	CO	THC	PM	SO_2	NO_X	CO	THC	PM_{10}	$PM_{2.5}$	SO_2
A	B	C	V1	V2	V3	V4	V5	V6	W1	W2	W3	W4	W5	W6	X1	X2	X3	X4	X5	X6
1 - Construction																				
I.1	Drill jumbo	Electric/Hydraulic	0.408	3.0	2.544	0.186	0.357	0.005	13.2	97.1	82.0	6.0	11.5	0.2	1.7E-03	1.4E-03	1.0E-04	2.0E-04	1.9E-04	3.0E-06
I.3	Dozer	D8H Cat	0.371	2.6	1.230	0.195	0.260	0.005	59.0	415.8	195.9	31.1	41.4	0.8	4.8E-02	2.3E-02	3.6E-03	4.8E-03	4.6E-03	9.1E-05
I.4	FEL	Cat 950	0.433	3.0	2.329	0.387	0.425	0.006	36.4	255.1	195.6	32.5	35.7	0.5	3.0E-02	2.3E-02	3.8E-03	4.1E-03	4.0E-03	5.6E-05
I.5	LHD Scoops	2 Yard	0.433	3.0	2.396	0.426	0.630	0.006	10.6	74.6	58.9	10.5	15.5	0.1	8.6E-03	6.8E-03	1.2E-03	1.8E-03	1.7E-03	1.6E-05
I.5	20 t Trucks	MT2010	0.371	2.6	1.386	0.178	0.260	0.005	65.6	462.0	245.4	31.4	46.0	0.9	9.6E-02	5.1E-02	6.5E-03	9.6E-03	9.3E-03	1.8E-04
II.1	Dozer	D8K Cat	0.371	2.6	1.386	0.178	0.260	0.005	65.6	462.0	245.4	31.4	46.0	0.9	5.3E-02	2.8E-02	3.6E-03	5.3E-03	5.2E-03	1.0E-04
II.1	Dozer	D6 Cat	0.412	3.1	3.892	0.195	0.531	0.005	22.6	171.9	213.6	10.7	29.1	0.3	2.0E-02	2.5E-02	1.2E-03	3.4E-03	3.3E-03	3.5E-05
II.3	Scraper	Caterpillar	0.371	2.6	1.230	0.195	0.260	0.005	87.5	616.1	290.3	46.1	61.3	1.2	7.1E-02	3.4E-02	5.3E-03	7.1E-03	6.9E-03	1.3E-04
II.5	Loader	Volvo	0.433	3.0	2.329	0.387	0.425	0.006	36.4	255.1	195.6	32.5	35.7	0.5	3.0E-02	2.3E-02	3.8E-03	4.1E-03	4.0E-03	5.6E-05
II.5	Backhoe	Hitachi	0.433	3.0	2.066	0.426	0.425	0.006	18.2	127.6	86.8	17.9	17.8	0.2	1.5E-02	1.0E-02	2.1E-03	2.1E-03	2.0E-03	2.8E-05
II.6	Dozer	D8	0.371	2.6	1.230	0.195	0.260	0.005	59.0	415.8	195.9	31.1	41.4	0.8	4.8E-02	2.3E-02	3.6E-03	4.8E-03	4.6E-03	9.1E-05
II.6	Dozer	D6	0.412	3.1	3.892	0.195	0.531	0.005	22.6	171.9	213.6	10.7	29.1	0.3	2.0E-02	2.5E-02	1.2E-03	3.4E-03	3.3E-03	3.5E-05
II.7	Grader	Caterpillar	0.371	2.6	1.230	0.195	0.260	0.005	87.5	616.1	290.3	46.1	61.3	1.2	7.1E-02	3.4E-02	5.3E-03	7.1E-03	6.9E-03	1.3E-04
II.7	Grader	14G Cat	0.371	2.6	1.230	0.195	0.260	0.005	43.7	308.0	145.1	23.1	30.7	0.6	3.6E-02	1.7E-02	2.7E-03	3.5E-03	3.4E-03	6.7E-05
II.7	Grader	14E Cat	0.371	2.6	1.426	0.195	0.387	0.005	32.8	231.0	126.2	17.3	34.3	0.4	2.7E-02	1.5E-02	2.0E-03	4.0E-03	3.8E-03	5.0E-05
III.1	Crane	72 Tonne	0.367	2.5	0.932	0.186	0.259	0.005	15.8	107.9	40.1	8.0	11.2	0.2	1.2E-02	4.6E-03	9.3E-04	1.3E-03	1.3E-03	2.4E-05
III.1	Forklift		0.412	3.1	3.892	0.195	0.531	0.005	18.2	138.6	172.2	8.6	23.5	0.2	1.6E-02	2.0E-02	1.0E-03	2.7E-03	2.6E-03	2.8E-05
III.1	Manlift		0.408	4.5	2.324	0.451	0.332	0.005	3.4	37.4	19.5	3.8	2.8	0.0	4.3E-03	2.3E-03	4.4E-04	3.2E-04	3.1E-04	5.3E-06
III.1	Snowplows		0.371	2.6	1.230	0.195	0.260	0.005	87.5	616.1	290.3	46.1	61.3	1.2	7.1E-02	3.4E-02	5.3E-03	7.1E-03	6.9E-03	1.3E-04
III.1	Lowboy Trailer with Louisville Truck		0.412	3.1	3.892	0.195	0.531	0.005	18.2	138.6	172.2	8.6	23.5	0.2	1.6E-02	2.0E-02	1.0E-03	2.7E-03	2.6E-03	2.8E-05
III.1	Water Truck		0.412	3.1	3.892	0.195	0.531	0.005	18.2	138.6	172.2	8.6	23.5	0.2	1.6E-02	2.0E-02	1.0E-03	2.7E-03	2.6E-03	2.8E-05
III.1	Crewcab Truck		0.408	3.0	2.544	0.189	0.233	0.005	24.1	177.7	150.1	11.2	13.8	0.3	2.1E-02	1.7E-02	1.3E-03	1.6E-03	1.5E-03	3.7E-05
III.1	Concrete Mixing Truck		0.408	3.0	2.544	0.186	0.357	0.005	26.3	194.3	164.1	12.0	23.0	0.3	2.2E-02	1.9E-02	1.4E-03	2.7E-03	2.6E-03	4.0E-05
III.1	Fuel Truck		0.412	3.1	3.892	0.195	0.531	0.005	18.2	138.6	172.2	8.6	23.5	0.2	1.6E-02	2.0E-02	1.0E-03	2.7E-03	2.6E-03	2.8E-05
III.1	Flat Bed truck		0.412	3.1	3.892	0.195	0.531	0.005	18.2	138.6	172.2	8.6	23.5	0.2	1.6E-02	2.0E-02	1.0E-03	2.7E-03	2.6E-03	2.8E-05
III.1	Pick up Trucks		0.408	3.0	2.544	0.189	0.233	0.005	36.1	266.6	225.2	16.7	20.6	0.5	3.1E-02	2.6E-02	1.9E-03	2.4E-03	2.3E-03	5.6E-05
III.1	Sand Trucks		0.412	3.1	3.892	0.195	0.531	0.005	36.5	277.2	344.5	17.3	47.0	0.5	3.2E-02	4.0E-02	2.0E-03	5.4E-03	5.3E-03	5.6E-05
III.1	Misc. service trucks		0.408	3.0	2.544	0.189	0.233	0.005	12.0	88.9	75.1	5.6	6.9	0.2	1.0E-02	8.7E-03	6.5E-04	8.0E-04	7.7E-04	1.9E-05
III.2	Generators		0.367	4.1	0.803	0.170	0.111	0.005	642.3	7,207.4	1,404.9	297.0	193.8	8.5	2.0E+00	3.9E-01	8.3E-02	5.4E-02	5.2E-02	2.4E-03
2 - Operation																				
I.1	Drll Jumbos	Electric/ Hydraulic	0.408	3.0	2.687	0.188	0.414	0.005	26.3	194.9	173.3	12.1	26.7	0.3	3.4E-03	3.0E-03	2.1E-04	4.6E-04	4.5E-04	6.1E-06
I.3	Lhd Scoops	2 Yard	0.433	3.0	2.459	0.391	0.492	0.006	81.8	575.8	464.8	74.0	93.0	1.1	1.1E-01	8.6E-02	1.4E-02	1.7E-02	1.7E-02	2.0E-04
I.3	20T Trucks	MT 2010	0.371	2.6	1.506	0.197	0.448	0.005	51.2	361.5	208.0	27.3	61.9	0.7	6.3E-02	3.6E-02	4.7E-03	1.1E-02	1.0E-02	1.2E-04
II.5	Dozer	D8H Cat	0.371	2.6	1.299	0.197	0.302	0.005	59.0	417.2	206.9	31.5	48.0	0.8	4.8E-03	2.4E-03	3.6E-04	5.6E-04	5.4E-04	9.1E-06
II.5	Loader	Cat 966	0.433	3.0	2.459	0.391	0.492	0.006	27.3	191.9	154.9	24.7	31.0	0.4	2.2E-03	1.8E-03	2.9E-04	3.6E-04	3.5E-04	4.2E-06
IV.1	Crane	72 Tonne	0.367	2.5	0.984	0.188	0.301	0.005	15.8	108.3	42.3	8.1	12.9	0.2	3.0E-02	1.2E-02	2.2E-03	3.6E-03	3.5E-03	5.8E-05
IV.1	Forklift		0.412	3.1	4.111	0.197	0.614	0.005	18.2	139.1	181.9	8.7	27.2	0.2	3.9E-02	5.1E-02	2.4E-03	7.6E-03	7.3E-03	6.7E-05
V.1	Flat Bed truck		0.412	3.1	4.111	0.197	0.614	0.005	109.4	834.3	1,091.5	52.4	163.1	1.5	2.3E-01	3.0E-01	1.5E-02	4.5E-02	4.4E-02	4.0E-04
V.2	Loader	Volvo	0.433	3.0	2.459	0.391	0.492	0.006	36.4	255.9	206.6	32.9	41.3	0.5	7.1E-02	5.7E-02	9.1E-03	1.1E-02	1.1E-02	1.3E-04
V.2	FEL	Cat 950	0.433	3.0	2.459	0.391	0.492	0.006	36.4	255.9	206.6	32.9	41.3	0.5	7.1E-02	5.7E-02	9.1E-03	1.1E-02	1.1E-02	1.3E-04
VI.4	Dozer	D6 Cat	0.412	3.1	4.111	0.197	0.614	0.005	22.6	172.4	225.6	10.8	33.7	0.3	2.0E-02	2.6E-02	1.3E-03	3.9E-03	3.8E-03	3.5E-05
VI.4	Grader	14G Cat	0.433	3.0	2.182	0.431	0.492	0.006	18.2	128.0	91.7	18.1	20.7	0.2	3.0E-03	2.1E-03	4.2E-04	4.8E-04	4.6E-04	5.6E-06
VIII.1	Lowboy Trailer with Louisville Truck		0.412	3.1	4.111	0.197	0.614	0.005	18.2	139.1	181.9	8.7	27.2	0.2	3.9E-02	5.1E-02	2.4E-03	7.6E-03	7.3E-03	6.7E-05
VIII.2	Airplane	Dash 7	0.371	3.9	1.228	0.178	0.148	0.005	730.4	7,710.0	2,420.4	351.2	291.0	9.7	8.9E-02	2.8E-02	4.1E-03	3.4E-03	3.3E-03	1.1E-04
IX.1	Grader	Caterpillar	0.371	2.6	1.299	0.197	0.302	0.005	87.5	618.0	306.6	46.6	71.2	1.2	1.4E-01	6.7E-02	1.0E-02	1.6E-02	1.5E-02	2.6E-04
IX.1	Grader	14G Cat	0.371	2.6	1.299	0.197	0.302	0.005	43.7	309.0	153.3	23.3	35.6	0.6	6.8E-02	3.4E-02	5.1E-03	7.8E-03	7.6E-03	1.3E-04
IX.1	Grader	14E Cat	0.371	2.6	1.506	0.197	0.448	0.005	32.8	231.8	133.3	17.5	39.7	0.4	5.1E-02	2.9E-02	3.8E-03	8.7E-03	8.5E-03	9.6E-05
IX.1	Scraper	Caterpillar	0.371	2.6	1.299	0.197	0.302	0.005	87.5	618.0	306.6	46.6	71.2	1.2	1.4E-01	6.7E-02	1.0E-02	1.6E-02	1.5E-02	2.6E-04
X.1	Generators		0.367	4.1	0.834	0.172	0.136	0.005	1,926.8	21,699.8	4,376.8	903.1	712.2	25.6	6.0E+00	1.2E+00	2.5E-01	2.0E-01	1.9E-01	7.1E-03
X.4	Manlift		0.408	4.5	2.455	0.456	0.385	0.005	3.4	37.6	20.6	3.8	3.2	0.0	5.2E-03	2.9E-03	5.3E-04	4.5E-04	4.4E-04	6.3E-06
X.4	Snowplows		0.371	2.6	1.299	0.197	0.302	0.005	87.5	618.0	306.6	46.6	71.2	1.2	8.6E-02	4.3E-02	6.5E-03	9.9E-03	9.6E-03	1.6E-04
X.4	Water Truck		0.412	3.1	4.111	0.197	0.614	0.005	18.2	139.1	181.9	8.7	27.2	0.2	1.9E-02	2.5E-02	1.2E-03	3.8E-03	3.7E-03	3.4E-05
X.4	Crewcab Truck		0.408	3.0	2.687	0.191	0.271	0.005	24.1	178.3	158.5	11.3	16.0	0.3	2.5E-02	2.2E-02	1.6E-03	2.2E-03	2.2E-03	4.4E-05
X.4	Concrete Mixing Truck		0.408	3.0	2.687	0.188	0.414	0.005	26.3	194.9	173.3	12.1	26.7	0.3	2.7E-02	2.4E-02	1.7E-03	3.7E-03	3.6E-03	4.9E-05
X.4	Fuel Truck		0.412	3.1	4.111	0.197	0.614	0.005	18.2	139.1	181.9	8.7	27.2	0.2	1.9E-02	2.5E-02	1.2E-03	3.8E-03	3.7E-03	3.4E-05
X.4	Pick up Trucks		0.408	3.0	2.687	0.191	0.271	0.005	36.1	267.4	237.8	16.9	24.0	0.5	3.7E-02	3.3E-02	2.3E-03	3.3E-03	3.2E-03	6.7E-05
X.4	Sand Trucks		0.412	3.1	4.111	0.197	0.614	0.005	36.5	278.1	363.8	17.5	54.4	0.5	3.9E-02	5.1E-02	2.4E-03	7.6E-03	7.3E-03	6.7E-05
3 - Closure																				
I.1	Dozer	D8H Cat	0.367	0.3	0.081	0.135	0.011	0.005	58.5	44.1	12.8	21.6	1.8	0.8	5.1E-03	1.5E-03	2.5E-03	2.1E-04	2.0E-04	9.0E-05
I.1	Dozer	D8K Cat	0.367	0.3	0.090	0.135	0.011	0.005	65.0	49.0	16.0	24.0	2.0	0.9	5.7E-03	1.9E-03	2.8E-03	2.3E-04	2.3E-04	1.0E-04
I.1	Dozer	D6 Cat	0.408	0.3	0.255	0.135	0.011	0.005	22.4	15.2	14.0	7.4	0.6	0.3	1.8E-03	1.6E-03	8.6E-04	7.2E-05	7.0E-05	3.4E-05
I.2	FEL	Cat 950	0.367	0.3	0.090	0.135	0.011	0.005	30.8	23.3	7.6	11.4	1.0	0.4	2.7E-03	8.8E-04	1.3E-03	1.1E-04	1.1E-04	4.7E-05
II.1	Crane	72 Tonne	0.367	0.3	0.094	0.135	0.011	0.005	15.8	11.9	4.0	5.8	0.5	0.2	1.4E-03	4.7E-04	6.7E-04	5.7E-05	5.5E-05	2.4E-05
II.1	Forklift		0.408	0.3	0.255	0.135	0.011	0.005	18.1	12.3	11.3	6.0	0.5	0.2	1.4E-03	1.3E-03	6.9E-04	5.8E-05	5.7E-05	2.8E-05
II.1	Manlift		0.408	4.5	2.324	0.451	0.346	0.005	1.7	18.7	9.8	1.9	1.5	0.0	2.2E-03	1.1E-03	2.2E-04	1.7E-04	1.6E-04	2.6E-06
II.1	Snowplows		0.367	0.3	0.081	0.135	0.011	0.005	43.3	32.7	9.5	16.0	1.3	0.6	3.8E-03	1.1E-03	1.8E-03	1.6E-04	1.5E-04	6.7E-05
II.1	Lowboy Trailer with Louisville Truck		0.408	0.3	0.255	0.135	0.011	0.005	18.1	12.3	11.3	6.0	0.5	0.2	1.4E-03	1.3E-03	6.9E-04	5.8E-05	5.7E-05	2.8E-05
II.1	Water Truck		0.408	0.3	0.255	0.135	0.011	0.005	18.1	12.3	11.3	6.0	0.5	0.2	1.4E-03	1.3E-03	6.9E-04	5.8E-05	5.7E-05	2.8E-05
II.1	Crewcab Truck		0.408	3.0	0.255	0.135	0.023	0.005	12.0	88.9	7.5	4.0	0.7	0.2	1.0E-02	8.7E-04	4.6E-04	7.8E-05	7.5E-05	1.9E-05
II.1	Fuel Truck		0.408	0.3	0.255	0.135	0.011	0.005	18.1	12.3	11.3	6.0	0.5	0.2	1.4E-03	1.3E-03	6.9E-04	5.8E-05	5.7E-05	2.8E-05
II.1	Flat Bed truck		0.408	0.3	0.255	0.135	0.011	0.005	18.1	12.3	11.3	6.0	0.5	0.2	1.4E-03	1.3E-03	6.9E-04	5.8E-05	5.7E-05	2.8E-05
II.1	Pick up Trucks		0.408	3.0	0.255	0.135	0.023	0.005	24.1	177.7	15.0	8.0	1.3	0.3	2.1E-02	1.7E-03	9.2E-04	1.6E-04	1.5E-04	3.7E-05

Air Quality Assessment - Prairie Creek Mine

Description of the Calculation of Exhaust Emissions During the Construction, Operation and Closure Phases

A	Reference to the results presented in the calculation of emissions during construction, operation and closure phases.
B	Input. Information provided by Canadian Zinc.
C	Input. Information provided by Canadian Zinc.
D	Input. Based on: Median Life, Annual Activity, and Load Factor Values for Nonroad EngineEmissions Modeling (EPA, April 2004) / Table 10. CI Load Factor Assignments by Equipment Type.
E	Input. Information provided by Canadian Zinc.
F	Input. Information provided by Canadian Zinc.
G	Input. Information provided by Canadian Zinc. In cases where the information was not available, the engine horsepower was estimated based on fuel consumption and type of equipment provided by Canadian Zinc.
H	Input. Based on: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-Compression-Ignition (EPA, 2004) / Table A2. Zero-Hour, Steady-State Emission Factors for Nonroad CI Engines.
I	Input. Estimated based on information provided by Canadian Zinc.
J	Input. Extracted from: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-Compression-Ignition (EPA, 2004) / Table 1 - Nonroad CI Engine Emission Standards and Table 2 - Default Certification Diesel Fuel Sulfur Content for Tier 3 and Tier 4 Engines.
K	Extracted from: Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (EPA, April 2004) / Table 10. CI Load Factor Assignments by Equipment Type .
L	Load factor indicates the average proportion of rated power used. Extracted from: Median Life, Annual Activity, and Load Factor Values for Nonroad EngineEmissions Modeling (EPA, April 2004) / Table 9 - Compression-Ignition Load Factors.
M	Input. Conservative values have been used in the calculation, resulting in higher emissions.
N	Input. Load factor indicates the average proportion of rated power used. If site specific load factor for this type of equipment was available, it was used in the calculation. Otherwise, the value presented in L was used.
O	Input. Information provided by Canadian Zinc.
P	Input. Extracted from: Sulphur in Liquid Fuels (Environment Canada, 2006).
Q	Factor to account for Tier 4 level as NMHC to THC for consistency, based on NRC-002c (EPA, December 2005).
R	Sulfur Adjustment for PM emissions to account for variation in fuel sulphur content in comparison to default values. SPM adj = BSFC * 453.6 * 7.0 * soxcnv * 0.01 * (soxbas - soxdsl) [Equation 5] SPM adj = PM sulfur adjustment (g/hp-hr) BSFC = in-use adjusted brake-specific fuel consumption (lb fuel/hp-hr) 453.6 = conversion from lb to grams 7.0 = grams PM sulfate/grams PM sulfur soxcnv = grams PM sulfur/grams fuel sulfur consumed (extracted from: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition (EPA, April 2004) / Table A4 - Deterioration Factors for Nonroad Diesel Engines) 0.01= conversion from percent to fraction soxbas = default certification fuel sulfur weight percent (extracted from: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition (EPA, April 2004) / Table A4 - Deterioration Factors for Nonroad Diesel Engines) soxdsl = episodic fuel sulfur weight percent (specified by the user) Note: The value calculated in this column does not include the variable BSFC. This variable is included later in the calculation of final PM emission factor. Source: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004).
S1; S2; S3; S4; S5	Extracted from: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-Compression-Ignition (EPA, 2004) / Table A2. Zero-Hour, Steady-State Emission Factors for Nonroad CI Engines.
T1; T2; T3; T4	DF = 1 + A * (Age Factor)b [Equation 4] Age Factor = fraction of median life expended A = constant for a given pollutant/technology type (extracted from: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling - Compression-Ignition (EPA, April 2004) / Table A4 - Deterioration Factors for Nonroad Diesel Engines) b = constant for a given pollutant/technology type (b = 1 for diesel nonroad engines) Source: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004).
U1; U2; U3; U4; U5	Extracted from: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004) / Table A3 - Transient Adjustment Factors by Equipment Type for Nonroad CI Equipment.
V1	EFadj(BSFC) = EFss × TAF [Equation 3] EFadj = final emission factor used in model, after adjustments to account for transient operation and deterioration (g/hp-hr) EFss = zero-hour, steady-state emission factor (g/hp-hr) TAF = transient adjustment factor (unitless) Source: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004).
V2; V3; V4	EFadj(HC, CO, NOx) = EFss × TAF × DF [Equation 1] EFadj = final emission factor used in model, after adjustments to account for transient operation and deterioration (g/hp-hr) EFss = zero-hour, steady-state emission factor (g/hp-hr) TAF = transient adjustment factor (unitless) DF = deterioration factor (unitless) Source: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004)
V5	EFadj(PM) = EFss × TAF × DF – SPMadj [Equation 2] EFadj = final emission factor used in model, after adjustments to account for transient operation and deterioration (g/hp-hr) EFss = zero-hour, steady-state emission factor (g/hp-hr) TAF = transient adjustment factor (unitless) DF = deterioration factor (unitless) SPM adj = adjustment to PM emission factor to account for variations in fuel sulfur content (g/hp-hr) Source: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004)
V6	SO2 = (BSFC * 453.6* (1 - soxcnv) - HC) * 0.01 * soxdsl * 2 [Equation 7] SO2 is in g/hp-hr BSFC is the in-use adjusted fuel consumption in lb/hp-hr 453.6 is the conversion factor from pounds to grams soxcnv is the fraction of fuel sulfur converted to direct PM HC is the in-use adjusted hydrocarbon emissions in g/hp-hr 0.01 is the conversion factor from weight percent to weight fraction soxdsl is the episodic weight percent of sulfur in nonroad diesel fuel 2 is the grams of SO2 formed from a gram of sulfur Source: Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004)
W1; W2; W3; W4; W5; W6	Emissions = Pop x Power x LF x A x EF Pop= Engine Population Power= Average Power (hp) LF= Load Factor (fraction of available power) A= Activity (hrs/yr) EF= Emission Factor (g/hp-hr) Source: Median Life, Annual Activity, and Load Factor Values for Nonroad EngineEmissions Modeling (EPA, April 2004
X1; X2; X3; X4; X6	ER_daily = ER*HD/(24*3600) ER_daily: daily emission rate ER: exhaust emission rate HD: hours of operation per day (24*3600): to convert days to seconds.
X5	ER = 0.97*ER_PM10 All PM emissions are assumed to be smaller than 10 microns (PM10) and 97% of the PM is assumed to be smaller than 2.5 microns (PM2.5) as presented in the document Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling-- Compression-Ignition (EPA, April 2004).

APPENDIX B

Source Parameters Used in the Modelling

Air Quality Assessment - Prairie Creek Mine
Source Parameters Used in the Modelling

1 - Source Summary

Operation	Source Description	Air Emissions	Included in the Model?	Model ID	Model Description	Rationale
I - Extraction	I.1 - Drilling	A - Fugitive Emissions	Yes	UMVENT	Underground mine ventilation at 930 m portal	—
		B - Exhaust Emissions	Yes	UMVENT	Underground mine ventilation at 930 m portal	—
	I.2 - Blasting	A - Fugitive Emissions	Yes	UMVENT	Underground mine ventilation at 930 m portal	—
	I.3 - Ore transport (mucking and haul truck transport) (unpaved roads)	A - Fugitive Emissions	Yes	UMVENT	Underground mine ventilation at 930 m portal	—
		B - Exhaust Emissions	Yes	UMVENT	Underground mine ventilation at 930 m portal	—
II - Ore Management	II.1 - Transfer (dump) to conveyor	A - Fugitive Emissions	Yes	ODUMP	Ore dump pocket	—
	II.2 - Conveyor transport (transfer points)	A - Fugitive Emissions	Yes	OCONV	End point of the ore conveyor	—
	II.3 - Stockpiling (dump to temporary/permanent stockpile)	A - Fugitive Emissions	Yes	OSTOCKPILE	Ore stockpile	—
	II.4 - Recover from temporary/permanent stockpile	A - Fugitive Emissions	Yes	OSTOCKPILE	Ore stockpile	—
	II.5 - Ore Stockpile Maintenance (temporary/permanent stockpile)	A.1 - Fugitive PM Emissions - Stockpile Working (Dozer)	Yes	OSTOCKPILE	Ore stockpile	—
		A.2 - Fugitive PM Emissions (Wind Erosion)	Yes	OSTOCKPILE	Ore stockpile	—
		B - Exhaust Emissions	Yes	OSTOCKPILE	Ore stockpile	—
	II.6 - Recover from reconfigured stockpile	A - Fugitive Emissions	No	—	—	Not representative of the operation phase
	II.7 - Ore Stockpile Maintenance (reconfigured stockpile)	A.2 - Fugitive PM Emissions (Wind Erosion)	No	—	—	Not representative of the operation phase
III - Ore Processing	III.1 - Primary Crushing	A - Fugitive Emissions	Yes	MILL	Mill	—
	III.2 - Secondary Crushing	A - Fugitive Emissions	Yes	MILL	Mill	—
	III.3 - Dense Media Separation	A - Fugitive Emissions	No	—	—	Wet process
	III.4 - Grinding	A - Fugitive Emissions	No	—	—	Wet process
	III.5 - Flotation and recovery	A - Fugitive Emissions	No	—	—	Wet process.
IV - Concentrate Stor	IV.1 - Bagging	A - Fugitive Emissions	Yes	BAGPLANT	Bagging plant	—
		B - Exhaust Emissions	Yes	BAGPLANT	Bagging plant	—
	IV.2 - Storage	A - Fugitive Emissions	No	—	—	Sealed bags and storage shed
V - Concentrate Tran	V.1 - Road Transport	B - Exhaust Emissions	Yes	WINTROAD_TRANS	Transport on winter road	—
	V.2 - Transfer operations at Tetcela and Liard transfer facilities	B - Exhaust Emissions	Yes	OTRANSFER	Tetcela / Liard transfer facilities	—
VI - Waste Rock Man	VI.1 - Waste Rock Dumping / Recovery from Waste Dump	A - Fugitive Emissions	Yes	WDUMP	Waste dump	—
	VI.2 - Transport of Waste Rock to Waste Rock Pile	A - Fugitive Emissions	Yes	LOCROAD	Local roads	—
		B - Exhaust Emissions	Yes	LOCROAD	Local roads	—
	VI.3 - Waste Rock Dumping on Waste Rock Stockpile	A - Fugitive Emissions	Yes	WSTOCKPILE	Waste rock stockpile	—
	VI.4 - Waste Rock Pile Maintenance	A.1 - Fugitive PM Emissions - Stockpile Working (Dozer)	Yes	WSTOCKPILE	Waste rock stockpile	—
		A.2 - Fugitive PM Emissions (wind erosion)	Yes	WSTOCKPILE	Waste rock stockpile	—
		B - Exhaust Emissions	Yes	WSTOCKPILE	Waste rock stockpile	—
VII - Backfill Plant	VII.1.1 - Batch Operations/Waste Rock Transfer	A - Fugitive Emissions	No	—	—	Sealed bags
	VII.1.2 - Batch Operations/Cement Unloading	A - Fugitive Emissions	Yes	BACKPLANT	Backfill plant	—
	VII.1.3 - Batch Operations/Mixer Loading	A - Fugitive Emissions	Yes	BACKPLANT	Backfill plant	—
VIII - Other Off-site T	VIII.1 - Road Transport	B - Exhaust Emissions	Yes	WINTROAD_TRANS	Transport on winter road	—
	VIII.2 - Air Transport	A - Fugitive Emissions	Yes	AIRSTRIP	Air strip	—
		B - Exhaust Emissions	Yes	AIRSTRIP	Air strip	—
IX - Winter Road Con	IX.1 - Winter Road Construction	B - Exhaust Emissions	Yes	WINTROAD_CONS	Construction of winter roads	—
X - Support Activities	X.1 - Power Generation	C - Combustion Emissions	Yes	GENSTACK	Power generator stacks	—
	X.2 - Incineration	C - Combustion Emissions	Yes	INCINSTACK	Incinerator stack	—
	X.3 - Heating	C - Combustion Emissions	No	—	—	Heat recovering system
	X.4 - On-site use of support equipment and vehicles	A - Fugitive Emissions	Yes	LOCROAD	Local roads	—
		B - Exhaust Emissions	Yes	LOCROAD	Local roads	—

Air Quality Assessment - Prairie Creek Mine
Source Parameters Used in the Modelling

2 - Emission Rates Summary

Model ID	Model ID Description	Emission Rates (g/s) - 24-hour							
		TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
UMVENT	Underground mine ventilation at 930 m portal	1.22E+00	3.43E-01	5.71E-02	1.60E-01	3.02E-04	1.18E-01	1.37E-04	1.43E-04
ODUMP	Ore dump pocket	1.54E-02	7.30E-03	1.11E-03	0.00E+00	0.00E+00	0.00E+00	1.67E-03	1.75E-03
OCONV	End point of the ore conveyor	2.08E-02	7.64E-03	2.16E-03	0.00E+00	0.00E+00	0.00E+00	2.25E-03	2.35E-03
OSTOCKPILE	Ore stockpile	1.58E-02	6.42E-03	1.82E-03	7.05E-03	1.33E-05	4.19E-03	1.61E-03	1.68E-03
MILL	Mill	5.93E-03	2.37E-03	4.39E-05	0.00E+00	0.00E+00	0.00E+00	6.40E-04	6.70E-04
BAGPLANT	Bagging plant	1.12E-02	1.12E-02	1.08E-02	6.87E-02	1.26E-04	6.23E-02	1.47E-06	1.54E-06
WINTROAD_TRANS	Transport on winter road	5.29E-02	5.29E-02	5.13E-02	2.70E-01	4.71E-04	3.54E-01	0.00E+00	0.00E+00
OTRANSFER	Tetcela / Liard transfer facilities	2.30E-02	2.30E-02	2.23E-02	1.42E-01	2.68E-04	1.15E-01	0.00E+00	0.00E+00
WDUMP	Waste dump	4.09E-03	1.93E-03	2.93E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LOCROAD	Local roads	7.47E-01	2.18E-01	5.38E-02	2.70E-01	4.86E-04	2.33E-01	0.00E+00	0.00E+00
WSTOCKPILE	Waste rock stockpile	1.81E-01	7.32E-02	1.43E-02	2.29E-02	4.04E-05	2.82E-02	0.00E+00	0.00E+00
BACKPLANT	Backfill plant	2.73E-02	8.02E-04	1.44E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AIRSTRIP	Air strip	2.18E-02	7.95E-03	3.73E-03	8.92E-02	1.12E-04	2.80E-02	0.00E+00	0.00E+00
WINTROAD_CONS	Construction of winter roads	4.78E-02	4.78E-02	4.64E-02	3.91E-01	7.35E-04	1.98E-01	0.00E+00	0.00E+00
GENSTACK	Power generator stacks	1.98E-01	1.98E-01	1.92E-01	6.03E+00	7.11E-03	1.22E+00	0.00E+00	0.00E+00
INCINSTACK	Incinerator stack	1.46E-02	1.20E-02	1.00E-02	1.11E-02	4.88E-03	1.58E-03	0.00E+00	0.00E+00
Total		2.61E+00	1.01E+00	4.67E-01	7.46E+00	1.45E-02	2.36E+00	6.31E-03	6.60E-03

3 - Emission Rates for the Modelling

Model ID	Source Type	Unit	Emission Rates - 24-hour							
			TSP	PM_{10}	$PM_{2.5}$	NO_X	SO_2	CO	Pb	Zn
A - CALPUFF										
UMVENT	Point	g/s	1.22E+00	3.43E-01	5.71E-02	1.60E-01	3.02E-04	1.18E-01	1.37E-04	1.43E-04
ODUMP	Volume	g/s	1.54E-02	7.30E-03	1.11E-03	0.00E+00	0.00E+00	0.00E+00	1.67E-03	1.75E-03
OCONV	Volume	g/s	2.08E-02	7.64E-03	2.16E-03	0.00E+00	0.00E+00	0.00E+00	2.25E-03	2.35E-03
OSTOCKPILE	Volume	g/s	1.58E-02	6.42E-03	1.82E-03	7.05E-03	1.33E-05	4.19E-03	1.61E-03	1.68E-03
MILL	Volume	g/s	5.93E-03	2.37E-03	4.39E-05	0.00E+00	0.00E+00	0.00E+00	6.40E-04	6.70E-04
BAGPLANT	Volume	g/s	1.12E-02	1.12E-02	1.08E-02	6.87E-02	1.26E-04	6.23E-02	1.47E-06	1.54E-06
WDUMP	Volume	g/s	4.09E-03	1.93E-03	2.93E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
LOCROAD	Area	$g/s\text{-}m^2$	5.96E-06	1.74E-06	4.30E-07	2.15E-06	3.87E-09	1.86E-06	0.00E+00	0.00E+00
WSTOCKPILE_1	Area	$g/s\text{-}m^2$	5.21E-06	2.11E-06	4.13E-07	6.62E-07	1.17E-09	8.15E-07	0.00E+00	0.00E+00
WSTOCKPILE_2	Area	$g/s\text{-}m^2$	5.21E-06	2.11E-06	4.13E-07	6.62E-07	1.17E-09	8.15E-07	0.00E+00	0.00E+00
BACKPLANT	Volume	g/s	2.73E-02	8.02E-04	1.44E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
AIRSTRIP	Area	$g/s\text{-}m^2$	4.35E-07	1.59E-07	7.45E-08	1.78E-06	2.25E-09	5.60E-07	0.00E+00	0.00E+00
GENSTACK_1	Point	g/s	6.59E-02	6.59E-02	6.40E-02	2.01E+00	2.37E-03	4.05E-01	0.00E+00	0.00E+00
GENSTACK_2	Point	g/s	6.59E-02	6.59E-02	6.40E-02	2.01E+00	2.37E-03	4.05E-01	0.00E+00	0.00E+00
GENSTACK_3	Point	g/s	6.59E-02	6.59E-02	6.40E-02	2.01E+00	2.37E-03	4.05E-01	0.00E+00	0.00E+00
GENSTACK_4	Point	g/s	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
INCINSTACK	Point	g/s	1.46E-02	1.20E-02	1.00E-02	1.11E-02	4.88E-03	1.58E-03	0.00E+00	0.00E+00
B - SCREEN3										
WINTROAD_TRANS	Volume	g/s	5.29E-02	5.29E-02	5.13E-02	2.70E-01	4.71E-04	3.54E-01	0.00E+00	0.00E+00
WINTROAD_CONS	Volume	g/s	7.97E-03	7.97E-03	7.74E-03	6.51E-02	1.22E-04	3.30E-02	0.00E+00	0.00E+00
OTRANSFER	Volume	g/s	1.15E-02	1.15E-02	1.11E-02	7.11E-02	1.34E-04	5.74E-02	0.00E+00	0.00E+00

Air Quality Assessment - Prairie Creek Mine
Source Parameters Used in the Modelling

4 - Model Parameters

Model ID	Source Type	Source Coordinates		Base Elevation [m]	Point Sources				Volume Sources					Area Sources			Stack Parameters		
		X [m]	Y [m]		Stkhgt - Stack Height Above Ground [m]	Stktmp - Stack Exit Gas Temperature [°C]	Stkvel - Stack Exit Gas Velocity [m/s]	Stkdia - Stack Inner Diameter [m]	Actual Lateral Dimension [m]	Actual Vertical Dimension [m]	Relhgt - Release Height [m]	Syinit - Initial Lateral Dimension [m]	Szinit - Initial Vertical Dimension [m]	Number of vertices [(a)]	Szinit - initial vertical dimension of the plume [m]	Area [m2]	Rain Protection	Volumetric Flow Rate [m³/s]	
A - CALPUFF																			
UMVENT	Point	404,741.00	6,826,178.00	930.0	5.0	1.0	13.35	3.00	NA	NA	NA	NA	NA	NA	NA	NA	No	94.39	(b)
ODUMP	Volume	404,486.67	6,825,904.51	870.0	NA	NA	NA	NA	9.00	3.00	1.50	2.09	1.40	NA	NA	NA	NA	NA	
OCONV	Volume	404,552.67	6,825,855.69	870.0	NA	NA	NA	NA	15.00	5.00	2.50	3.49	2.33	NA	NA	NA	NA	NA	
OSTOCKPILE	Volume	404,432.77	6,825,970.73	870.0	NA	NA	NA	NA	49.00	5.00	2.50	11.40	2.33	NA	NA	NA	NA	NA	
MILL	Volume	404,555.73	6,825,811.35	870.0	NA	NA	NA	NA	74.00	12.00	6.00	17.21	5.58	NA	NA	NA	NA	NA	
BAGPLANT	Volume	404,537.42	6,825,802.57	870.0	NA	NA	NA	NA	18.00	6.00	3.00	4.19	2.79	NA	NA	NA	NA	NA	
WDUMP	Volume	404,453.19	6,825,909.99	870.0	NA	NA	NA	NA	48.00	5.00	2.50	11.16	2.33	NA	NA	NA	NA	NA	
LOCROAD	Area	404,348.72	6,826,194.91	870.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	5	0.0	125,336.9	NA	NA	
WSTOCKPILE_1	Area	404,840.01	6,826,760.18	1014.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	4	0.0	16,397.6	NA	NA	
WSTOCKPILE_2	Area	404,824.60	6,826,552.11	1009.7	NA	NA	NA	NA	NA	NA	NA	NA	NA	4	0.0	18,237.9	NA	NA	(c)
BACKPLANT	Volume	404,582.43	6,825,818.71	870.0	NA	NA	NA	NA	29.00	6.00	3.00	6.74	2.79	NA	NA	NA	NA	NA	
AIRSTRIP	Area	403,440.53	6,827,307.25	898.0	NA	NA	NA	NA	NA	NA	NA	NA	NA	4	0.0	49,994.7	NA	NA	
GENSTACK_1	Point	404,530.97	6,825,811.19	870.0	20.0	433.1	50.69	0.305	NA	NA	NA	NA	NA	NA	NA	NA	No	3.70	(d)
GENSTACK_2	Point	404,532.05	6,825,811.86	870.0	20.0	433.1	50.69	0.305	NA	NA	NA	NA	NA	NA	NA	NA	No	3.70	(d)
GENSTACK_3	Point	404,533.12	6,825,812.63	870.0	20.0	433.1	50.69	0.305	NA	NA	NA	NA	NA	NA	NA	NA	No	3.70	(d)
GENSTACK_4	Point	404,534.10	6,825,813.09	870.0	20.0	433.1	50.69	0.305	NA	NA	NA	NA	NA	NA	NA	NA	No	3.70	(d)
INCINSTACK	Point	404,867.88	6,826,746.53	1021.0	7.0	1,100.0	14.55	0.380	NA	NA	NA	NA	NA	NA	NA	NA	Rain cap	1.65	(e)
B - SCREEN3																			
WINTROAD_TRANS	Volume	NA	NA	NA	NA	NA	NA	NA	20.00	3.00	3.00	4.65	0.70	NA	NA	NA	NA	NA	
WINTROAD_CONS	Volume	NA	NA	NA	NA	NA	NA	NA	20.00	3.00	3.00	4.65	0.70	NA	NA	NA	NA	NA	
OTRANSFER	Volume	NA	NA	NA	NA	NA	NA	NA	50.00	8.00	4.00	11.63	1.86	NA	NA	NA	NA	NA	

Notes: (a) Coordinates and elevations of the vertices:

Model ID	Vertices	Coordinates		Base Elevation [m]
		X (m)	Y (m)	
LOCROAD	1	404,348.72	6,826,194.91	870
	2	404,673.34	6,825,666.99	870
	3	404,571.33	6,825,604.27	870
	4	404,346.58	6,825,732.19	870
	5	404,191.72	6,825,983.97	870
WSTOCKPILE_1	1	404,840.01	6,826,760.18	1013.995178
	2	404,866.01	6,826,769.09	1012.045227
	3	404,970.71	6,826,653.08	1017.440674
	4	404,824.60	6,826,552.11	1009.663696
WSTOCKPILE_2	1	404,824.60	6,826,552.11	1009.663696
	2	404,970.71	6,826,653.08	1017.440674
	3	405,011.72	6,826,474.59	928.036987
	4	404,972.84	6,826,457.27	931.292297
AIRSTRIP	1	403,440.64	6,827,307.24	898
	2	403,648.89	6,826,329.28	898
	3	403,599.99	6,826,318.86	898
	4	403,391.63	6,827,296.83	898

(b) - Volumetric flow rate of 200.000 cfm extracted from: Prairie Creek Mine Project Description Report (Canadian Zinc Corporation, May 2008).
- Stack diameter assumed as the approximate diameter of the portal.
- Gas velocity calculated based on stack diameter and volumetric flow rate.
- Temperature: minimum during winter with heated ventilation.

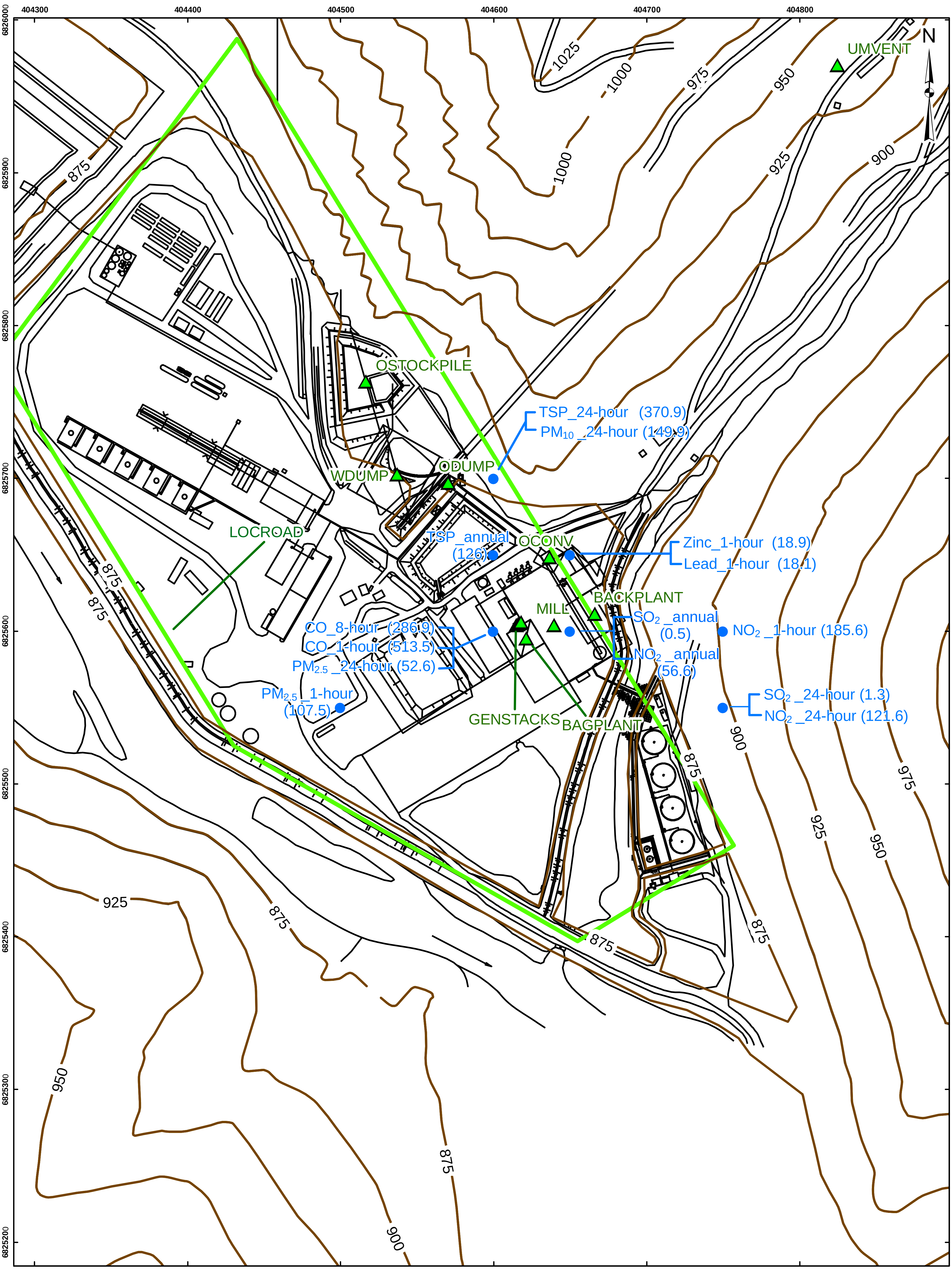
(c) - Base elevation from 925 to 1010 m.

(d) - Stack diameter and temperature extracted from the document "Gen Set Package Performance Data [516DE2A]" corresponding to 70% load.
- Gas velocity calculated based on stack diameter and flow rate extracted from the same document.
- Stack height assumed based on best engineering practices and height of adjacent buildings.

(e) - Volumetric flow rate and gas temperature for CY100CA-D-O incinerator spec provided by the supplier (Westland Environmental Services Inc.).
- Stack height and diameter extracted from CY-2050-FA "D" incinerator spec (Westland Environmental Services Inc.).
- Gas velocity calculated based on stack diameter and volumetric flow rate.

APPENDIX C

Location of Maximum Concentrations and Deposition Rates Based on CALPUFF Modelling



LEGEND

- ● Maximum Concentrations (µg/m³)
- ▲ Emission Sources (Point or Volume Sources)
- ▭ Emission Sources (Area Sources)
- — Contours

Source	Description	Source	Description
ODUMP	Ore dump pocket	LOCROAD	Local roads
OCONV	End point of the ore conveyor	WSTOCKPILE	Waste rock stockpile
OSTOCKPILE	Ore stockpile	BACKPLANT	Backfill plant
MILL	Mill	AIRSTRIP	Air strip
BAGPLANT	Bagging plant	GENSTACKS	Power generator stacks
WDUMP	Waste dump	INCINSTACK	Incinerator stack
UMVENT	Underground mine ventilation at 930 m portal		

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

50 25 0 50 100 150

SCALE 1:2,500 METRES

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

LOCATION OF MAXIMUM CONCENTRATIONS BASED ON CALPUFF MODELLING

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	14 Nov. 2008	FIGURE: C.1	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

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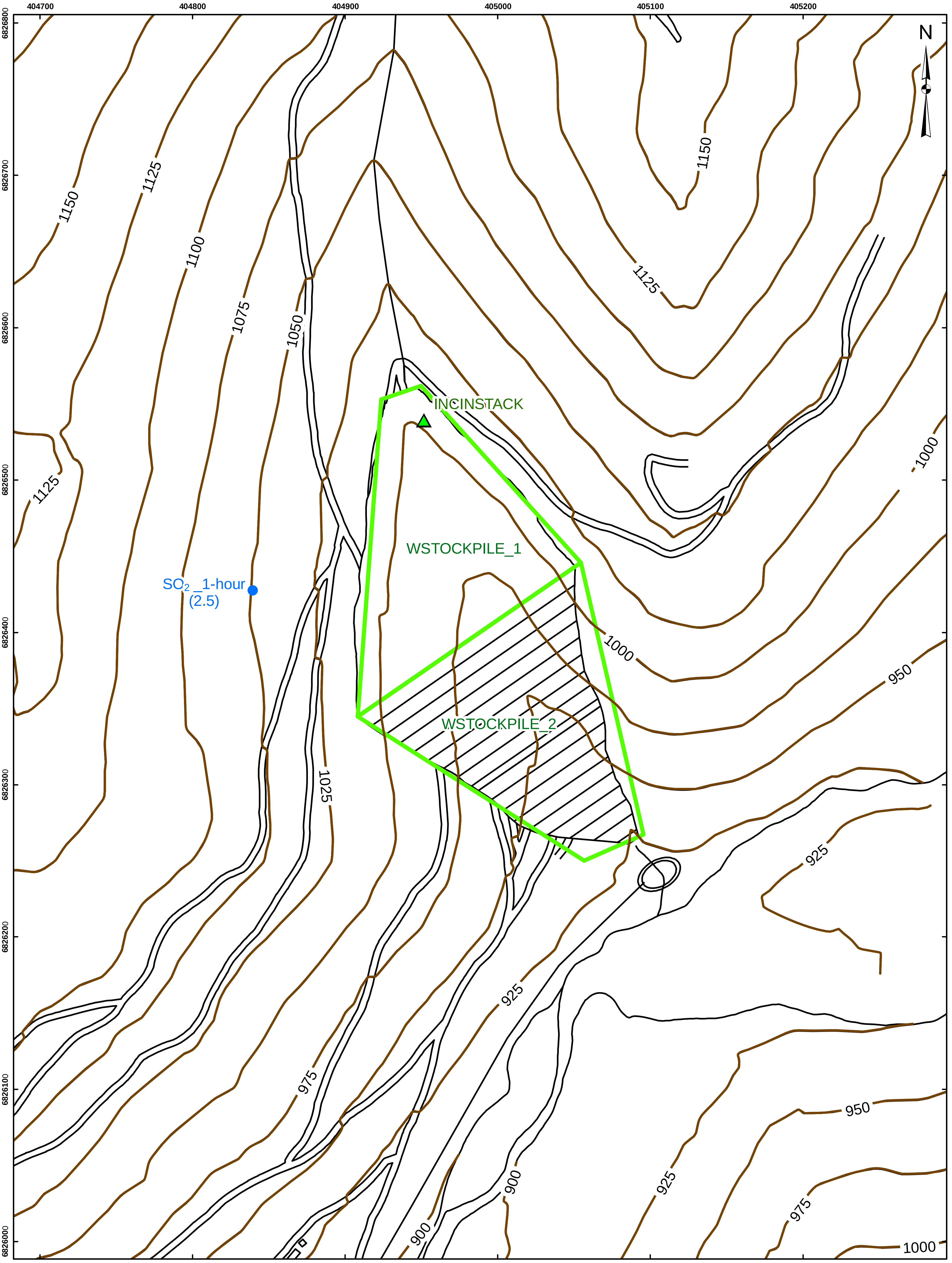

LEGEND

- Maximum Concentrations (µg/m³)
- Emission Sources (Point or Volume Sources)
- Emission Sources (Area Sources)

Source	Description	Source	Description
ODUMP	Ore dump pocket	LOCROAD	Local roads
OCONV	End point of the ore conveyor	WSTOCKPILE	Waste rock stockpile
OSTOCKPILE	Ore stockpile	BACKPLANT	Backfill plant
MILL	Mill	AIRSTRIP	Air strip
BAGPLANT	Bagging plant	GENSTACKS	Power generator stacks
WDUMP	Waste dump	INCINSTACK	Incinerator stack
UMVENT	Underground mine ventilation at 930 m portal		

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
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Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

50 25 0 50 100 150
SCALE 1:2,500 METRES

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

LOCATION OF MAXIMUM CONCENTRATIONS BASED ON CALPUFF MODELLING

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	14 Nov. 2008	FIGURE: C.2	
GIS	PP	22 Feb. 2010		
CHECK	AF	22 Feb. 2010		
REVIEW		22 Feb. 2010		

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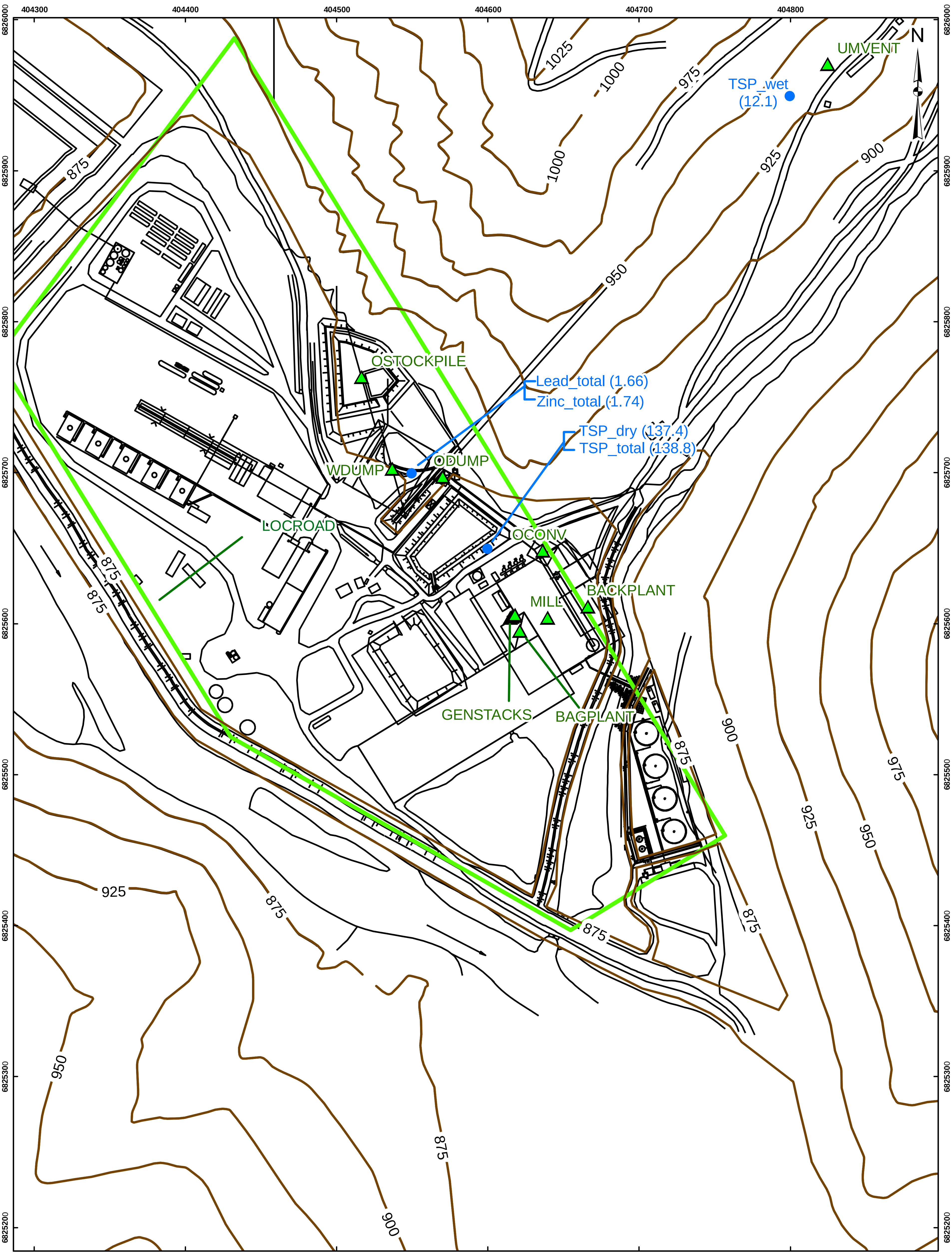

LEGEND

- ● Maximum Deposition Rates*
- ▲ Emission Sources (Point or Volume Sources)
- Emission Sources (Area Sources)
- Contours

Source	Description	Source	Description
ODUMP	Ore dump pocket	LOCROAD	Local roads
OCONV	End point of the ore conveyor	WSTOCKPILE	Waste rock stockpile
OSTOCKPILE	Ore stockpile	BACKPLANT	Backfill plant
MILL	Mill	AIRSTRIP	Air strip
BAGPLANT	Bagging plant	GENSTACKS	Power generator stacks
WDUMP	Waste dump	INCINSTACK	Incinerator stack
UMVENT	Underground mine ventilation at 930 m portal		

* mg/100 cm²/30-day for TSP; g/m²/year for lead or zinc

REFERENCE

Base Data - MNR NRVIS, obtained 2004, CANMAP v2008.4
DEM - CDED
Produced by Golder Associates Ltd under licence from
Ontario Ministry of Natural Resources, © Queens Printer 2010
Projection: Transverse Mercator Datum: NAD 83 Coordinate System: UTM Zone 10

50 25 0 50 100 150
SCALE 1:2,500 METRES

PROJECT

PRAIRIE CREEK MINE AIR QUALITY ASSESSMENT

TITLE

LOCATION OF MAXIMUM DEPOSITION RATES BASED ON CALPUFF MODELLING

Golder Associates
Mississauga, Ontario

PROJECT NO. 09-1112-6100			SCALE AS SHOWN	REV.
DESIGN	PP	14 Nov. 2008	FIGURE: C.3	
GIS	PP	19 Feb. 2010		
CHECK	AF	19 Feb. 2010		
REVIEW		19 Feb. 2010		

G:\Projects\2009\09-1112-6100_Canadian_Zinc\GIS\MXDs\Draft\Report\FigC3_LocationOfMaximumDepositionRatesBasedOnCalpuffModelling.mxd

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Golder Associates

APPENDIX 21

PRAIRIE CREEK MINE ACCESS ROAD
ARCHAEOLOGICAL INVESTIGATIONS, 2009

(NWT Permit 2009-023)
(Parks Canada Permit NAH-2009-3917)

Prepared for:
CANADIAN ZINC CORPORATION
Suite 1710, 650 West Georgia Street
Vancouver, B. C.

Prepared By:
POINTS WEST HERITAGE CONSULTING LTD.
23531 – 8th Avenue
Langley, B. C.

Gabriella Prager
December 16, 2009

EXECUTIVE SUMMARY

In September, 2009, on behalf of Canadian Zinc Corporation and at the request of the Nahanni Butte Dene Band, Points West Heritage Consulting Ltd. completed an archaeological assessment of selected portions of an access road between the Liard Highway near Nahanni Butte and the Prairie Creek Mine. The project area is in the South Mackenzie Mountains and extends into the southeastern portion of the expanded Nahanni National Park Reserve. The road will essentially follow a cutline prepared in 1980 by a previous owner of the mine.

The study assessed three sections of possible heritage concern that had been identified during a Nahanni Butte Dene traditional knowledge study:

1. The easternmost landscape feature is a pass known as Second or Grainger Gap.
2. The next pass of interest to the west is called Wolverine or Silent Hills Pass.
3. The westernmost area of the three identified is the crossing of the Tetcela River which is situated within the newly expanded Nahanni National Park Reserve.

The initial step of the study was for the archaeologist to meet with the Band members who were available to ask about the past uses of these particular areas. No previously recorded archaeological sites were found to occur within or in close proximity to the proposed road corridor.

Following the interviews, a team comprising the project archaeologist, a Canadian Zinc representative and two Elders proceeded to overfly the areas of interest. The cutline was still readily visible in most areas; therefore, the route was easily followed. Ground reconnaissance was completed of the entire length of the Second Gap pass and both banks of the main Tetcela River crossing. A brief stop was made at the second Tetcela (tributary) crossing for visual assessment. The Wolverine Pass area was very carefully visually assessed from the helicopter by repeated low and slow passes and circles. Shovel testing was conducted on both sides of the Tetcela River crossing as well as along a well defined terrace in Second Gap, in the vicinity of some camp remains.

All shovel tests were negative and visual surface inspection revealed no archaeological remains in any of the areas examined. The camp remains found in Second Gap suggest that the site probably dates no earlier than the cutline, that is, the 1980s. Therefore, it was not recorded as an archaeological site. No other cultural evidence was observed within or in close proximity to the specific portions of the project footprint assessed during this investigation.

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LIST OF PHOTOGRAPHS

1.0 INTRODUCTION

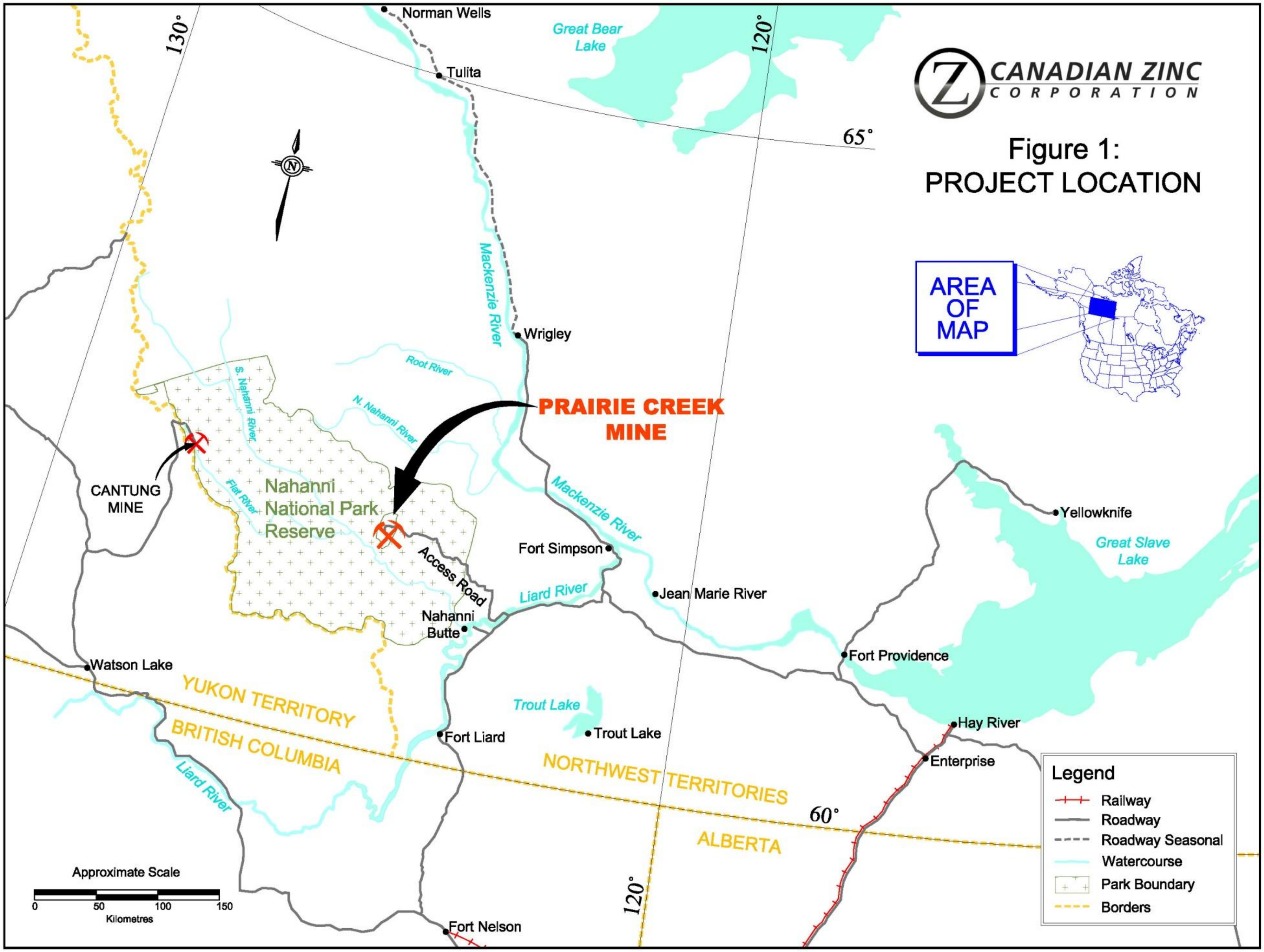
In September, 2009, Canadian Zinc Corporation (Canadian Zinc) requested that Points West Heritage Consulting Ltd. (Points West) complete an archaeological assessment of selected portions of their access road between the Liard Highway and the Prairie Creek Mine. This investigation was conducted at the request of the Nahanni Butte Dene Band. Field work was completed over two days in September, 2009 and was directed by archaeologist Gabriella Prager of Points West under Northwest Territories Archaeologist Permit 2009-023A and Parks Canada Research Permit NAH-2009-3917. Local members of the field team were Wilbert Antoine from Fort Simpson, and Leon Konisenta, Raymond Vital and Tom Betsaka, all from Nahanni Butte.

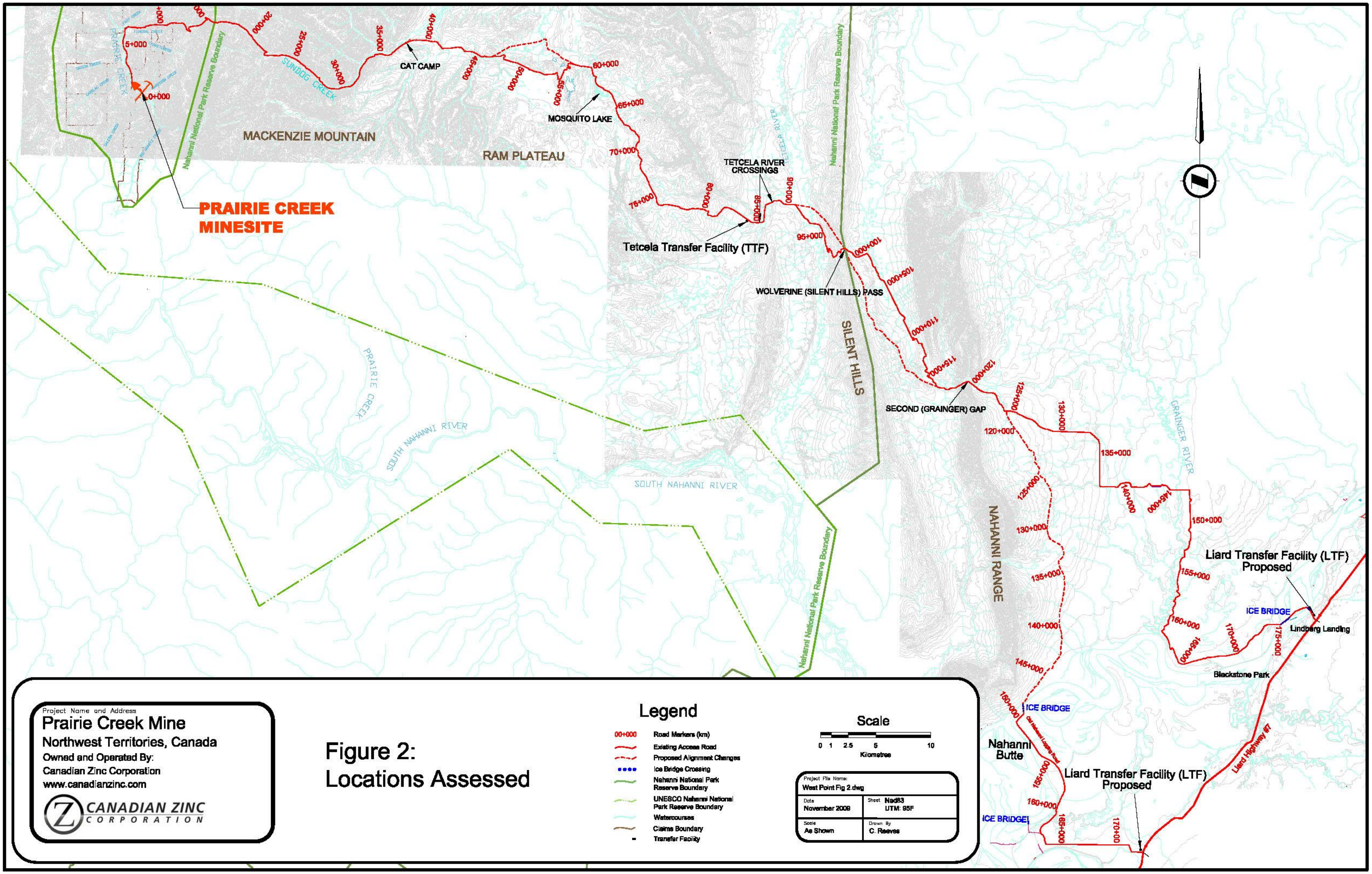
1.1 Project Background

The Prairie Creek Mine is in the South Mackenzie Mountains approximately 150 km west of Fort Simpson and almost 1500 km northeast of Vancouver (Figure 1). The project area extends into the southeastern portion of the expanded Nahanni National Park Reserve. The access road is approximately 170 km long and is intended for use during the winter season. It essentially follows a cutline that was prepared in 1980 by previous owners of the mine. It was used to transport equipment and supplies for two winters.

Three sections of possible heritage concern were identified during a Nahanni Butte Dene traditional knowledge study (Figure 2). The easternmost feature of interest is a pass known as Second or Grainger Gap. The next pass of concern to the west is called Wolverine or Silent Hills Pass. The westernmost area of the three identified is the crossing of the Tetcela River which is situated within the newly expanded Nahanni National Park Reserve, thereby necessitating a Parks research permit. Points West was only asked to examine these three areas of interest to the Nahanni Butte Dene Band; consequently, no formal assessment of any other part of the road was conducted.

It should be clarified that the purpose of this study was to search for archaeological remains which are the physical signs of past human activities. In order for remains to be considered archaeological in the Northwest Territories, they must be more than 50 years old. Although traditional knowledge studies are related and certainly important from a cultural perspective, archaeological studies are, by definition, not concerned with traditional or cultural uses of the study area for which no physical evidence is present.


CANADIAN ZINC CORPORATION
Figure 1:
PROJECT LOCATION
AREA OF MAP
Norman Wells
Tulita
Great Bear Lake
130°
120°
65°
Mackenzie River
Wrigley
Root River
S. Nahanni River
N. Nahanni River
PRAIRIE CREEK MINE
CANTUNG MINE
Flat River
Nahanni National Park Reserve
Access Road
Mackenzie River
Fort Simpson
Liard River
Jean Marie River
Nahanni Butte
Yellowknife
Great Slave Lake
Fort Providence
Watson Lake
YUKON TERRITORY
BRITISH COLUMBIA
Trout Lake
Trout Lake
Fort Liard
Hay River
Enterprise
NORTHWEST TERRITORIES
60°
ALBERTA
Liard River
Approximate Scale
0
50
100
150
Kilometres
Fort Nelson
Legend
Railway
Roadway
Roadway Seasonal
Watercourse
Park Boundary
Borders


PRAIRIE CREEK MINESITE
MACKENZIE MOUNTAIN
RAM PLATEAU
CAT CAMP
MOSQUITO LAKE
TETCELA RIVER CROSSINGS
Tetcela Transfer Facility (TTF)
WOLVERINE (SILENT HILLS) PASS
SILENT HILLS
SECOND (GRAINGER) GAP
NAHANNI RANGE
SOUTH NAHANNI RIVER
PRAIRIE CREEK
GRAINGER RIVER
Liard Transfer Facility (LTF) Proposed
ICE BRIDGE
Lindberg Landing
Blackstone Park
Nahanni Butte
Liard Transfer Facility (LTF) Proposed
Project Name and Address
Prairie Creek Mine
Northwest Territories, Canada
Owned and Operated By:
Canadian Zinc Corporation
www.canadianzinc.com
CANADIAN ZINC CORPORATION
Figure 2:
Locations Assessed
Legend
Road Markers (km)
Existing Access Road
Proposed Alignment Changes
Ice Bridge Crossing
Nahanni National Park Reserve Boundary
UNESCO Nahanni National Park Reserve Boundary
Watercourses
Claims Boundary
Transfer Facility
Scale
Kilometres
West Point Fig 2.dwg
November 2009
Nad83 UTM: 95F
As Shown
C. Reeves

1.2 Setting

The study area is located within the South Mackenzie Mountains. The topography and vegetation vary from broad, low lying muskeg through boreal forest to mountain tundra. The main drainages within the project area are the Grainger River, part of the Liard River system, and the Tetcela River that flows north into the North Nahanni River. There is still debate as to whether the Nahanni region was glaciated during the last ice age, but it was certainly ice free by 12,000 years ago.

Major big game to be found on the eastern slopes include moose, woodland caribou, grizzly and black bear, Dall sheep and mountain goat. Beaver also occur frequently. Fish are found in all streams and lakes in the region and comprise trout, whitefish, northern pike and inconnu.

Due to significant elevation variations, a number of different ecozones associated with this boreal forest region are included in the study area. Consequently, a wide variety of plants grow throughout the region. Forests comprise varying percentages of spruce, aspen, willow and cottonwood. Edible berries include rosehips, blueberries, saskatoons, strawberries, and raspberries.

Human History

Research of documentary sources is required in order to design appropriate field programs as well as to place study findings in proper context. It is probable that there was no permanent human population residing in the study area (other than at Nahanni Butte) in the recent past, and no evidence has yet been found to suggest that occurred in the more distant past either. This is likely because this region is fairly resource poor compared to adjacent areas. During the late prehistoric/protohistoric periods, the Nahanni region appears to have been used periodically by several neighbouring aboriginal populations (Amsden 1977:21) of Northern Athapaskan speakers. The most likely people to have used the study region most frequently were two groups identified by early ethnographers as Slavey Indians and Mountain Indians. The Mountain Indians exploited the eastern slopes of the Mackenzie Mountains (Gillespie 1981:326), that is, the northern part of the study area. The Slavey occupied much of the Mackenzie drainage system, including the vicinity of the Liard River and the lower South Nahanni River (Asch 1981:338). The following summary draws heavily from an ethnography by James Van Stone (1974) and an ethnographic review by A. McFadyen Clark (1974), both describing lifeways of northern Athapaskans in general.

Typical subsistence patterns and techniques were similar for all Athapaskan groups in this region. They were semi-nomadic hunters and fishers, exploiting all possible resources available; consequently, they travelled a great deal throughout the region. They had intimate knowledge of the seasonal patterns of the main animal resources, such as elevational movement patterns of the primary big game animals and seasonal schedules of fish spawning. Although the large mammals were of key importance, it was the combination of fish, small mammals and birds that often staved off starvation. In spring, family groups travelled to where they could snare or shoot muskrats or other small game animals or where spring fishing was most reliable. The main fish utilized were trout, whitefish and pike. This was also the time to collect bark for canoes, baskets and shelter covers; birchbark was favoured, but spruce and cottonwood were also harvested. Whitefish were caught in traps made of thin strips of spruce tied with spruce root; weirs were also used. In late spring, migratory waterfowl were hunted with bows and arrows. Bears were killed as they came out of hibernation.

The summer season was spent gathering and drying as many food resources as possible in order to prepare for the inevitable difficult winter period. Summer camps were set up on larger rivers and lakes for intensive fishing. Traps or willow nets were used. Fish were generally dried on racks or lines. Moose was the most important game animal for the Slavey. They were hunted using large snares or bows and arrows. Bears were sometimes captured using snares in berry patches. Mountain goats and sheep were also hunted occasionally.

In early autumn, people moved to camps focused more on hunting, although fishing continued. Throughout the winter, moose were hunted whenever possible and wherever found using bows and arrows or snares. Bears were killed in their dens. Beaver were hunted at all times of the year. Small mammals such as hares were captured in deadfalls and snares. Birds such as grouse were hunted using bows and arrows or snares. Fishing continued through the ice using spears, lures and bone hooks as well as traps and nets.

Travel in winter was generally by snowshoes largely made of wood products. Winter houses were often domed tents with a framework of long, curved poles stuck into the ground and covered by moose hides. Spring and summer shelters were made of poles, brush and moose skins, or skin tents were used. A great variety of snares made of plant materials were used to capture animals of all sizes. Birchbark baskets were used for storing food as well as for boiling. Food was cached by burying in baskets or hanging in trees or was placed on elevated platforms.

<u>Previous Archaeological Research</u>

There have been no previous archaeological investigations within the specific project study area. The South Nahanni drainage system saw several archaeological studies from the 1970s on, aimed at documenting cultural remains in Nahanni National Park (Amsden 1977, 1978; Arthurs 2001). The closest prehistoric site concentrations south of the project area occur at the South Nahanni-Liard confluence and Yohin Lake within the Park Reserve (Amsden 1977). Further south, a long sequence of human occupation has been discovered at Fisherman Lake, just northwest of Fort Liard (Fedirchuk 1970). Those sites have been used to develop a culture history for the region. To the north, the Mackenzie Basin Corridor Survey (Millar 1972) recorded an impressive number of sites, both prehistoric and historic, on lakes draining into the lower reaches of the Tetcela River drainage system. On Cli Lake, eight sites were recorded, three of which were prehistoric and two of those may have buried components. Six sites were recorded on Little Doctor Lake, all prehistoric. At

Sibbeston Lake, 12 prehistoric sites were recorded, at least three of which contain possible diagnostic artifacts and one may contain multiple buried components. The interesting consistent feature of the use of these lakes is that the vast majority of the sites are situated at creek mouths, and the largest sites are at the lake outlets in all three cases (Millar 1972:13).

Culture History

The following brief culture history summary has been prepared based on the previous studies in surrounding areas noted above. It is thought that the Nahanni area was ice free for at least the past 12,000 years, if not longer. The earliest dated cultural evidence comes from Fisherman Lake. This is called Sandy Lake or Stemmed Point complex and has been dated to around 8,700 years ago. Associated artifacts are large spear points and scrapers, and burins. Between 8,000 and 6,000 years ago, various complexes appear in the region that are characterized by large to medium sized lanceolate spear points. These have been called northern Plano and are thought to represent a focus on big game hunting. Between 6,000 and 3,000 years ago, two complexes were dominant at Fisherman Lake: Pointed Mountain and Julian. These are characterized by microblades, burins and gravers indicative of bone and antler working as well as axes, gouges, scrapers and wedges associated with wood working. One of the sites at Yohin Lake in Nahanni Park revealed artifacts suggestive of the Julian complex (Amsden 1978:105).

Dated to about 2200 to 1500 years ago, the Mackenzie Complex has been recognized at Fisherman Lake to the south and Sibbeston Lake to the north of the study area. Characteristic artifacts include straight based bifaces, medium sized lanceolate and stemmed points, and the first appearance of large stone hide scrapers known as chi-thos, all made from coarse materials such as quartzite and sandstone. From about 1500 to 150 years ago, a complex known as Spence River is considered to be ancestral Dene. Artifacts are small, triangular and leaf shaped points, small end scrapers and gravers, coarse lithics such as chi-thos and cobble choppers, and an elaborate bone and antler technology comprising such tools as metapodial fleshers and bone awls.

Summary

Results of past archaeological studies together with ethnographic documentation of human history suggest that the specific project area is situated between two human use focal points: the South Nahanni/Liard and the North Nahanni/Mackenzie drainage systems. Traditionally, the region was used mostly by Slavey Indians from the Liard area to the south and the Mountains Indians from the north. Focal points for use were larger lakes and rivers with main river valleys providing travel routes. However, people may have travelled anywhere in the study area that the most important food resources - moose and fish - could be found. A large proportion of the tool inventory was made of wood, plant materials, and/or bone or antler but, because of the rapid deterioration rates in this forest environment, these tools are unlikely to be found. It is primarily the tools and tool components made of stone that can be expected.

2.0 METHODS

The initial step of the study was to conduct a site file search for previously recorded sites. This not only identifies any known sites within the project footprint but also provides information on the types of sites and locations that may be important in the study area. No previously recorded archaeological sites were found to occur within or in close proximity to the proposed road corridor. A small scale map and coordinates of the three areas of concern were provided by Canadian Zinc. Topographic maps at scales of 1:250,000 and 1:50,000 were used for field reference.

2.1 Consultations

Since the Nahanni Butte Dene Band had raised the concerns about these three areas, it was considered essential by the project archaeologist to first discuss with them the importance of these locations. Consequently, at the start of field work, the archaeologist visited the Band office to try to meet with Band members who were knowledgeable about the past uses of these particular areas. Unfortunately, the two people who were most familiar with the areas were unavailable during the field program period. The members who were available confirmed the importance of Second Gap as a use area for Nahanni Butte people for a considerable length of time. However, they had no specific knowledge of the use of either Wolverine Pass or the Tetcela River. The Tetcela River was simply identified as a possible north-south travel route.

An addendum document addressing Traditional Knowledge relative to the Prairie Creek Project (Nahá Dehé Dene Band 2009) was provided to the archaeologist for planning purposes during the field investigations. This provided additional mapped information used to assess the two areas for which the band members on the field crew had no specific details.

Wilbert Antoine, Canadian Zinc’s northern development manager, capably handled logistics and participated in both days of the field work. Also present on both days was Leon Konisenta, a member of the Nahanni Butte Band and an employee of Canadian Zinc. On the first day assistance was provided by Raymond Vital, a Nahanni Butte band member, and on the second day, Tom Betsaka, also from Nahanni Butte, joined the field crew.

2.2 Field Methods

Standard archaeological techniques were utilized for the ground reconnaissance. The initial preliminary assessment of potential was based on visual examination and assessment of specific landforms using low level aerial reconnaissance. The inventory and assessment portion of the archaeological field study involved on-foot traverses and close visual inspection of the specific areas of interest. Pedestrian traverses were focused within the cutline and immediately adjacent landform edges (Photo 1). Field team members were positioned at regular intervals, depending on visibility. The team members looked for any features or remains that appeared humanly modified. The visual

Photo 1. Surveying in Grainger Gap.

Photo 2. Shovel testing at Tetcela River.

Photo 3. Backfilled unit.

Photo 4. Cutline through Grainger Gap.

survey was supplemented by examination of ground exposures and subsurface shovel tests, where judged necessary. The spacing and number of tests depended on the size of the landform, amount of exposure and degree of soil deposition, and the potential for archaeological resources. Tests were generally 40 cm by 40 cm, although occasionally they were larger or smaller, depending on local vegetation and soil conditions (Photo 2). Depth varied from area to area, but tests were dug to sterile subsurface wherever possible. In this study area, because of extensive gravel deposits, maximum depths of subsurface tests ranged from 20 cm to 50 cm below surface. All soil removed was carefully sorted through by hand and closely examined. Matrix composition was described. Pits were carefully inspected for any stratigraphic changes. All subsurface tests were filled in (Photo 3) and the ground surface was restored as much as possible to its original state.

Field investigations began with low level helicopter overflights of all three areas of interest. The original cutline was readily apparent (Photo 4); therefore, the areas of interest could easily be identified from the air. Several low and slow passes were made to view the terrain from all possible angles. Then, two of the areas were examined by ground reconnaissance. The third, Wolverine Pass, was eliminated from further consideration partly due to the lack of visible landscape features with good potential for archaeological resources (Photo 5). Furthermore, on the basis of comparison of the existing cutline location to a specific past use locality identified in the traditional knowledge addendum on the east side of the pass, it was concluded that there appears to be a sufficient distance separation. The road cut likely crosses traditional trails on both sides of that pass and there was undoubtedly occasional travel through the pass. However, based on the visible terrain features and the traditional knowledge mapped information, it appears unlikely that there was a high or consistent degree of use of the pass itself as a camp location.

At the Tetcela River crossing, there appeared to be two former cutlines (Photo 6). The full width of both cutlines on the east side was thoroughly examined by pedestrian transects, and the surface exposures on the lowest and second river terrace were closely inspected. Six shovel tests were dug across the width of the cutline on the second terrace. These extended to between 30 and 50 cm below surface, with one corner of the deepest test being extended to 60 cm below surface. On the west side, there appeared to be just one line (Photo 7) and essentially one terrace level. Visible sections of the one metre high cutbank were examined. Surface exposures were limited, and two shovel tests were completed to depths of 35 cm and 50 cm below surface.

A brief stop was made at a second Tetcela River crossing, which is actually a small tributary of the main river. The traditional knowledge study had identified a possible use area on a height of land around which the river curves (Figure 2). This visit was simply meant as a visual assessment of archaeological potential since it had not been identified as a specific area of concern.

Ground reconnaissance completed at Second Gap involved pedestrian traverses conducted through the full length of the pass and extending to the headwaters lake just west of the pass, between the north bank of the Grainger River which flows through the southern portion of the pass to the northern limit of the existing cutline. An attempt was made to walk around the lake, but the south side is very wet, including the cutline, making it essentially impassable. All ground exposures were closely examined. Subsurface testing was completed in the western portion of the pass, where the cutline is closest to the river bank and some cultural features were identified. Nine subsurface tests were dug in the vicinity. These test pits extended to between 5 cm and 30 cm below surface. Two of the shallower tests uncovered a larger surface area, approximately 75 cm square. A rough sketch map was completed of the camp remains and they were photographed.

Photo 5. Cutline through Wolverine Pass (west).

Photo 6. Tetcela Crossing (view west).

Photo 7. View across to west bank of Tetcela River.

3.0 RESULTS

The original cutline was still readily visible in most areas; therefore, the route was easily followed. Ground reconnaissance was completed of the road corridor through the entire length of the Second Gap pass and on both sides of the main Tetcela River crossing. A brief stop was made at the west Tetcela tributary crossing for visual assessment. At that location, archaeological potential is not particularly good (Photo 8), and the landform height that was tentatively identified as a possible cultural area is a considerable distance from the cutline; therefore, it is considered unlikely that archaeological remains will be encountered at that crossing location.

Ground traverses were completed on the east side of the main Tetcela River. The east side is characterized by fairly open forest of mature spruce and tamarack with young aspen in disturbed sections. A number of spruce trees were observed with bark peeling from the bottom (Photo 9). Close examination of several such trees revealed no visible cut marks and the appearance is not typical of known human uses of trees. It was decided that this is a most probably natural phenomenon, likely caused by disease, animal or micro-environmental conditions. Ground surface is cobble deposits with considerable amounts of exposure on the two terraces with about one half metre elevation difference (Photo 10). Very careful inspection of the exposed ground on both the lower and second terraces was conducted. Six shovel tests were completed across the width of the cutlines. All shovel tests contained sand, gravel and cobble deposits as deep as we could dig, down to 50 cm to 60 cm (Photo 11). No cultural remains were found nor was there any physical evidence of past unnatural soil substrate disturbances.

On the west side, the Tetcela River terrace is characterized by much thicker young aspen growth and irregular ground surface indicative of past flood episodes (Photo 12). Because the ground surface was obscured, the primary visual inspection comprised examination of the one metre high cutbank exposure. The profile confirmed flood deposition action. This was further confirmed when one of the two shovel tests revealed a 10 cm diameter log buried at about 50 cm below surface. The other test was halted at 35 cm upon encountering thick tree roots. No cultural evidence was observed.

Both the east and west ends of Grainger (Second) Gap are characterized by broad cobble and boulder floodplains of seasonal drainages coming from the north and running into the Grainger River (Photo 13). There are no terraces associated with those drainages. The central portion of the pass is slightly more elevated, dry and level. The bank of the Grainger River becomes more defined toward the central and western part of the pass but then flattens out again at the west end, near the headwaters lake and becomes very diffuse, spreading out over the broad cobble floodplain. Traverses along the cutline through the pass (Photo 14) did not reveal any cultural remains except a comparatively recent camp near the west end of the pass, immediately adjacent to the cutline.

Shovel testing and visual surface inspection along the section of well defined terrace along the Grainger River in Second Gap in the vicinity of the camp revealed no archaeological remains. The

Photo 8. West Tetcela tributary (view east).

Photo 9. Peeling bark.

Photo 10. Second terrace east side Tetcela River.

Photo 11. Test pit east side Tetcela River.

Photo 12. Cutline west side Tetcela River.

Photo 13. East side of Grainger Gap.

Photo 14. Traversing cutline, west side, Grainger Gap.

Photo 15. Camp, cut brush in foreground.

Photo 16. Hearth at camp, Grainger Gap.

Photo 17. Tent frame at Grainger Gap camp.

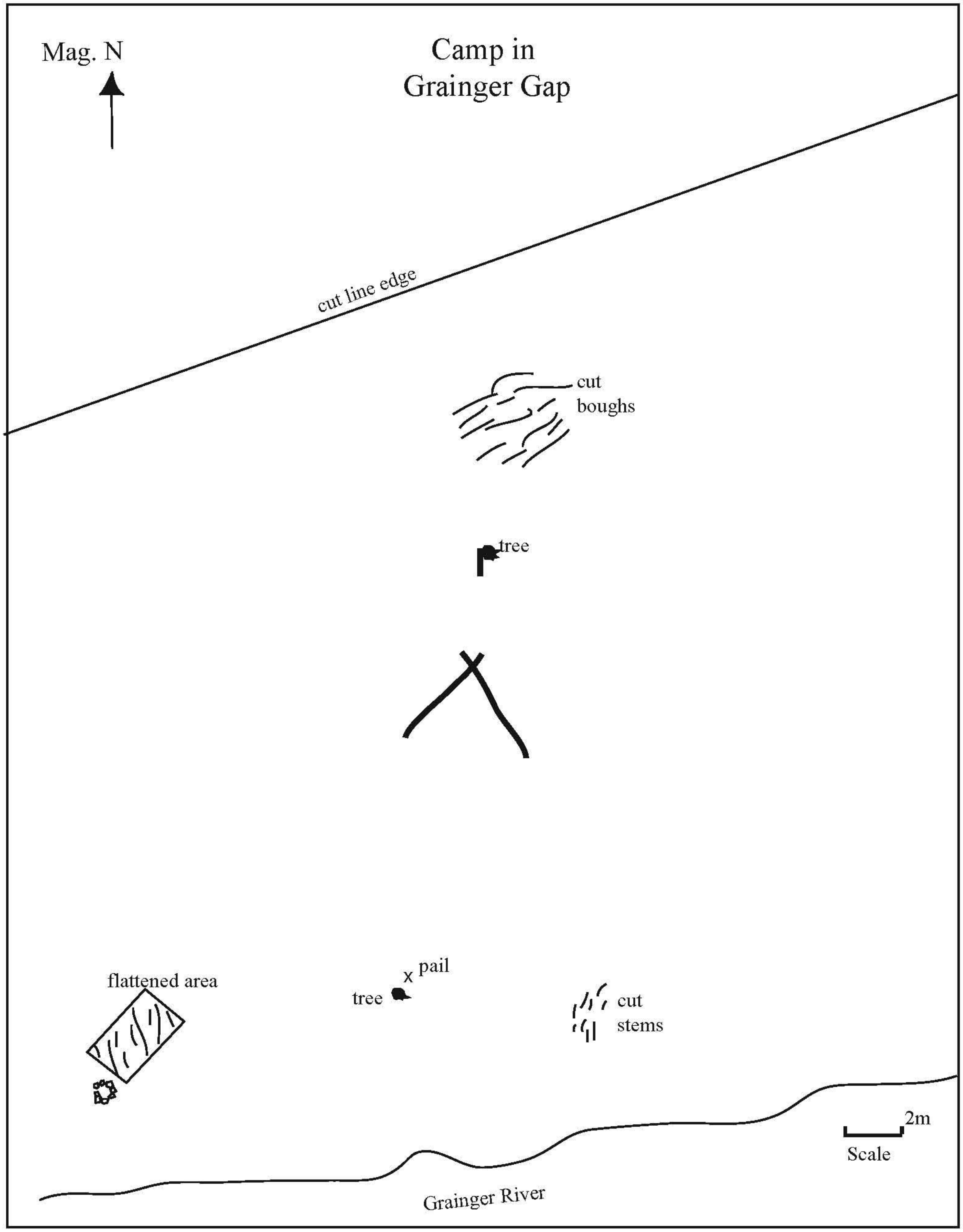
camp (Figure 3) contained portions of a wooden tent frame, some cut brush (Photo 15), a pail, glass jar, and a circle of rocks likely representing a hearth (Photo 16). The tent frame was apparently constructed by nailing 2x4 lumber using wire nails to a tree for the ridge pole, and attaching a tripod of young tree stems for the other end of the tent (Photo 17). A tripod of tree stems that likely served as a cache was observed on the other side of the river (Photo 18). Due to its proximity to the cutline and the types of remains found, the camp probably dates no earlier than the cutline, that is, the 1980s. Therefore, it was not recorded as an archaeological site.

Shovel tests were placed along the Grainger River bank between these camp remains and two rock clusters a short distance east. These clusters appeared somewhat circular, so two subsurface tests were completed at each – one inside and one outside. These tests were a larger size but quite shallow due to the large rocks encountered just below the surface, obviously part of the rock clusters. Because of the lack of cultural remains, it was decided that these clusters probably represent rock piles created during cutline or road preparation or by unusually large flood events.

Five other shovel tests were completed along the river bank. Four of these were halted at 20 cm below surface and one extended to 30 cm. All encountered heavy concentrations of pebbles and cobbles in a sandy matrix. No cultural evidence nor stratigraphic changes were observed.

The north side of the headwaters lake appears to have been the focal use point in this pass area at least in the recent past. The ground is considerably elevated forming a rim around that side of the lake. We observed an old cabin as well as a cabin that Raymond Vital currently uses in that area. As noted previously, the south lake edge is low and wet and therefore was likely not used. Some distance south, there is a terrain rise that could represent an old lake edge and likely has better potential. That terrain feature is well away from the current cutline; therefore, no impacts are anticipated.

Photo 18. Tripod on other side of Grainger River.


Mag. N
Camp in
Grainger Gap
cut line edge
cut
boughs
tree
pail
tree
flattened area
cut
stems
2m
Scale
Grainger River

4.0 CONCLUSIONS AND RECOMMENDATIONS

No archaeological remains were observed during this investigation. As long as the access road follows the existing cutline and it remains a winter use road, it is considered unlikely that there will be conflicts with archaeological deposits in the three areas assessed during this investigation. However, if there are deviations from the existing cutline in the vicinities of the three areas of concern to this study, there may be some increased potential for encountering cultural remains.

It may be possible that some deeply buried deposits exist on the west side of the Tetcela River crossing where there has been flood deposition, but this is not considered a major concern in the case of a winter road which typically involves comparatively little ground disturbance. Since this crossing is simply at a mid-stream point and not near a typical focal point such as a confluence, the chances of archaeological remains being present at this location are considered low.

In the absence of specific knowledge concerning use of the Wolverine (Silent Hills) Pass, terrain assessment coupled with traditional knowledge mapped information suggests there is low potential for encountering archaeological resources along the existing cutline.

In the vicinity of the headwaters lake on the west side of Grainger (Second) Gap, conflicts with archaeological resources are considered unlikely along the existing cutline. Due to the known levels of use in the past, any revisions of the alignment in this section, particularly to higher ground south and west of the headwaters lake, would increase potential for archaeological resources and additional investigation may be required.

This study involved only a small portion of the Prairie Creek Mine access road and does not represent a full impact assessment of the entire road. Further, the assessment was based on use as a winter road. In the event that the alignment changes or there is a change in the status of the road, for example, to an all season use, further archaeological inventory and impact assessments likely would be required.

It is always possible for a small archaeological site to be present in unexpected locations. In the event of an unanticipated cultural find during any project related activity, all activities in that vicinity must cease and the Territorial Archaeologist of the Government of the Northwest Territories must be contacted.

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Nahá Dehé Dene Band

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APPENDIX 22

O'Kane Consultants Inc.
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Telephone: (306) 955-0702 Facsimile: (306) 955-1596

MEMORANDUM

To: David Harpley – VP Environment, Canadian Zinc Corporation

From: Mike O'Kane – O'Kane Consultants Inc.

cc: Dave Christensen – O'Kane Consultants Inc.

Date: February 24, 2010

Re: **Results of Preliminary Numerical Modelling Program of WRP Cover System Alternatives at Prairie Creek**

O'Kane Consultants Inc. (OKC) was retained by Canadian Zinc Corp. to complete a preliminary evaluation of potential cover systems for the Prairie Creek waste rock pile (WRP). OKC's discussion with David Harpley (Canadian Zinc) and Dave Caughill (Golder Associates – Edmonton) provided a good understanding of the WRP design, the constraints associated with the WRP, and the scope of Prairie Creek's needs and concerns about the WRP at this pre-construction design stage. This memorandum provides a summary of the material and climatic inputs used in the numerical modelling of cover system alternatives, analysis of the predicted performance of alternatives, as well as suggested courses of action to improve surface water management within the WRP catchment.

Executive Summary

The purpose of the preliminary numerical modelling program was to evaluate various cover scenarios with respect to limiting net percolation to the underlying waste rock material. Two (2) different cover scenarios were completed for four-year continuous one-dimensional (1D) simulations. The options included a monolithic 2.0 m non-compacted granular till store-and-release cover system. Option 2 was a barrier cover system with a 50 cm compacted clayey till underlying a 1.5 m non-compacted granular till protective layer. The cover alternatives were evaluated under two, four-year climate cycles including a site-specific climate database (annual precipitation = 508 mm).

The results of the numerical simulations with the two cover alternatives and site-specific climate database are summarized below in Table 1. The annual average net percolation (in mm) is presented along with the improvement in performance compared to the estimated bare waste rock condition. The performance of each cover system alternative calculated as a percentage of average annual precipitation is also provided. Modelling results are provided in Table 1 for two surface conditions; the first where predicted runoff (snowmelt or rainfall) rate > infiltration rate to runoff (i.e. representative of a sloping surface and thus removed from the model); and the second where water is allowed to pond (i.e. representative of a relatively horizontal surface) and is available for subsequent infiltration. The WRP will have 2H:1V slopes and the upper plateau will be graded to ensure good drainage. Therefore, provided no ponding of water occurs, 20% is the most reasonable percolation rate modelled for the granular till cover system. If ponding did occur on the WRP, the percolation rate would increase, but not to 29% for the whole pile because approximately half of the WRP area is the 2H:1V slope.

Table 1
Summary of predicted net percolation for two cover system scenarios evaluated with site-specific database.
(in mm and % of annual precipitation).

Cover System Alternative	Surface Runoff Scenario		Surface Ponding Scenario	
	Net Percolation (mm)	**Net Percolation (% Precip.)**	**Net Percolation (mm)**	**Net Percolation (% Precip.)**
Bare Waste Rock	180 mm	36%	221 mm	43%
Option 1 – Granular Till	100 mm	20%	145 mm	29%
Option 2 – Clayey Till	93 mm	18%	141 mm	28%

The numerical modelling program found there was little difference in the performance of the monolithic granular till and compacted clayey till barrier cover systems. This result might be surprising as the compacted clay layer has lower k_{sat} to prevent water from percolating to the underlying waste rock material. However, the low potential evaporation (PE) rates predicted for the site prevent the barrier layer from operating efficiently.

In general, a barrier cover system improves the storage capacity of the overlying non-compacted material by preventing rapid percolation of water during high infiltration periods like spring snow melt and summer storm events. The barrier layer keeps water within the upper area of the profile, within the zone of evaporation and vegetation rooting systems, so it is readily available for actual evapotranspiration (AET) during subsequent dry periods. Due to the northern location of the Prairie Creek site, there is insufficient PE available to take advantage of the readily available water, AET rates are already at a maximum, and hence there is not a substantial increase in AET. Under the flow gradients created by the infiltration events, the k_{sat} of the clayey till barrier layer (5×10^{-7} cm/s) was still high enough to allow percolation similar to the granular till store-and-release cover system.

The preliminary design of the WRP produces several constraints that will greatly influence the design of the WRP cover system for closure from both a hydraulic performance and constructability perspective. Based on discussions to date, OKC identifies the following constraints to the WRP cover system design:

1) The 2H:1V slope of the WRP is constrained by the toe of the WRP, the topography of the natural catchment area, the required capacity of the facility, and the operational consideration of limiting the final WRP height; and
2) The elevation of the WRP toe is constrained by the immediate downslope location of the seepage collection pond above Harrison Creek.

A few cover system alternatives will not be acceptable on the 2H:1V slope area of the WRP. For example, it is extremely challenging to place and compact a clayey material on a 2H:1V slope and therefore its application would be limited to the 1% slope plateau area of the WSRF. Due to the preliminary nature of this modelling program, this cover option was evaluated and considered for recommendation.

Recommendations:

The preliminary modelling program showed a wide range of performance from approximately 15% - 30% of average annual precipitation for cover systems constructed of natural borrow materials.

If net percolation control provided by the natural borrow materials is sufficient, OKC provides the following recommendations.

1) Placement of 1 – 2 m non-compacted granular till on the 2H:1V slope of the WRP. Final thickness of the sloping cover system would be dependent on available borrow material and final detailed cover system design. Preliminary modelling suggests that 1 m thickness provides sufficient water holding capacity to support vegetation.
2) Stability of the non-compacted granular till material on the 2H:1V slope should be investigated both from a slope stability and erosion control perspective. It is anticipated that some component of infiltrating water will move laterally down the slope within the cover system and upper waste rock profile producing increased pore-water pressures and decreasing stability.
3) Placement of 1 – 2 m non compacted granular till on the upper plateau area of the WRP. OKC does not recommend the use of a compacted clayey till barrier cover system as the small improvement in cover performance does not warrant the increased complexity of cover design, cover construction, and cover maintenance associated with a compacted barrier layer.
4) Development of the WRP landform to ensure incident precipitation is conveyed off the landform with minimal erosion to improve cover system performance. The performance of the granular till cover system ranged from 16% to 20% of average annual precipitation if runoff was removed.

Surface Water Management:

Development of a surface water management plan to ensure “clean” surface runoff and lateral flow water is conveyed from the landform to Harrison Creek without further contamination or excessive erosion will be a key aspect for closure of the WRP. Robust drainage systems will be required to ensure water is routed off the WRP in a safe and stable manner. In addition, in developing the surface water management plan, the long-term viability of drainage channels and diversion ditches must be addressed from a closure perspective, not just an operational perspective.

Additional Recommendations:

At the preliminary design stage of the WRP a large amount of information required for detailed numerical modelling was unavailable. The following suggested courses of action are intended to be minor tasks that can be completed during mine operations to allow further cover design stages at Prairie Creek:

1) Geotechnical laboratory tests including saturated hydraulic conductivity and moisture retention characteristics of the borrow and waste materials;
2) Construction of a long-term (30 – 50 year) climate database representative of the Prairie Creek site;
3) Installation of a net radiometer to characterize annual potential evaporation at the site; and
4) Completion of annual snow surveys prior to spring melt to provide snow water equivalent estimations to the existing site rainfall data.

Soil-Atmosphere Numerical Modelling Program

The numerical modelling program utilized VADOSE/W, a coupled mass and heat transport model which is fully coupled to the atmosphere, to examine several cover system alternatives for the WRP. The program evaluated a range of cover system alternatives from a simple cover system such as a monolithic, 2.0 m thick non-compacted granular till cover system to a more complex system incorporating compacted clay layer beneath a non-compacted growth medium. Inputs required in the numerical model included material properties and climate data, which are discussed first followed by a summary of the modelling results and sensitivity analysis.

Modelling Inputs

Key inputs and assumptions to the VADOSE/W model include hydraulic properties of the simulated materials, climate data, and characteristics of the climax vegetation. Each of these is reviewed in detail below.

Material Properties

Three materials (3) materials were selected for the WRP cover evaluation based on details provided by Canadian Zinc and Golder Associates personnel including granular till, clayey till, and waste rock. The moisture retention curves (MRCs) used in the VADOSE/W modelling are shown in Figure 1. MRCs define the storage capacity of the cover material and are used to determine the saturation levels within the unsaturated cover system during the numerical model simulation. The air entry value (AEV – the matric suction at which the soil begins to de-saturate) and the storage capacity are two important features of the MRC. Storage capacity is defined by the difference between the field capacity (10 kPa for coarse-textured materials and 33 kPa for finer-textured materials) and the plant wilting point (assumed to be 1,500 kPa). Storage capacity measures a soils ability to hold water within its matrix for subsequent release to the atmosphere through evaporation or plant transpiration or deep percolation by gravity flow. For example, the storage capacity of the waste rock material is approximately 110 mm/m (10 kPa = 0.15, 1,500 kPa = 0.04 Capacity / m = (0.15 – 0.04) * 1000 mm).

The waste rock MRC reflects a relatively coarse material with a low AEV and a relatively low moisture storage capacity. The AEV of the granular till is approximately 10 kPa. The increased fines content within the granular till material results in the increased AEV value and greater storage capacity (approximately 130 mm/m) compared to the waste rock material. The clayey till MRC is typical of a material with a high fines content indicated by the AEV in the range of 100 – 200 kPa and high storage capacity (200 mm/m).

The functions selected for each material were generated from OKC's material database by matching the particle size distribution of the Prairie Creek granular and clayey till materials to the database. The waste rock function was based on a waste rock material from a similar site in northern BC.

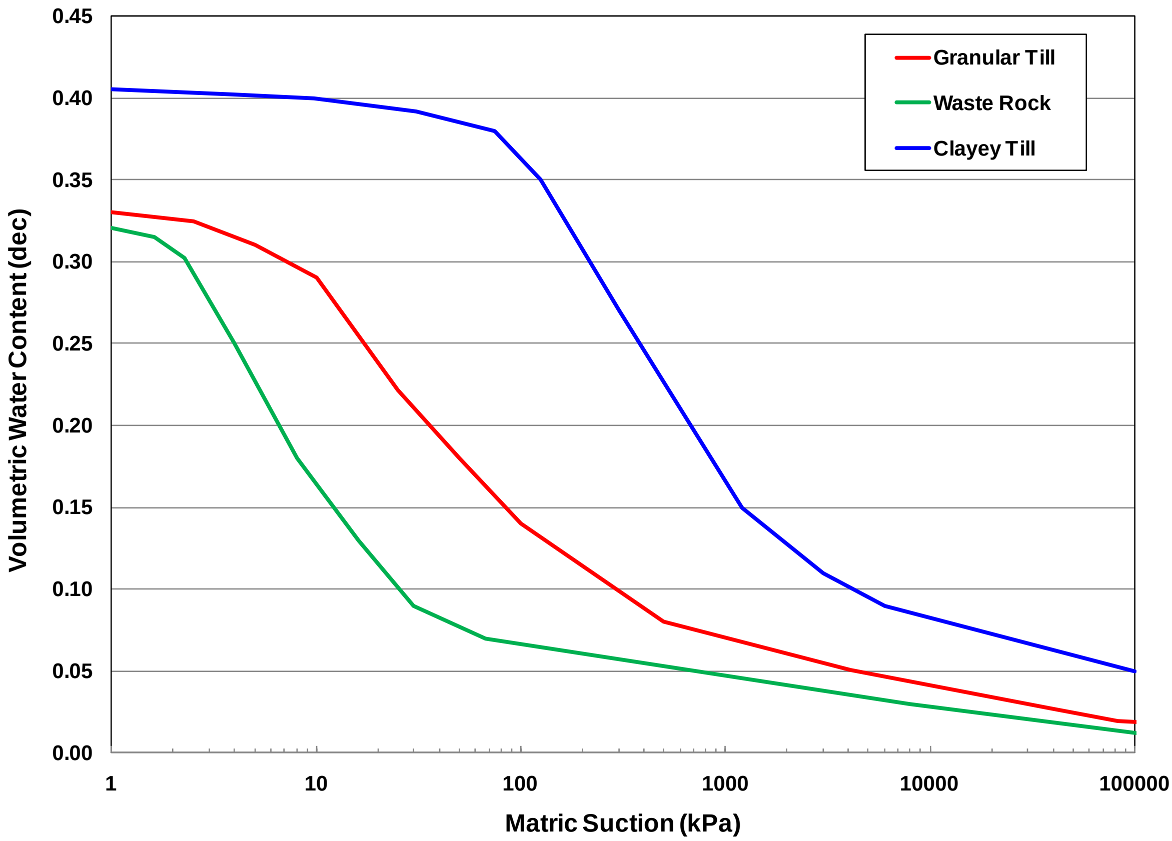


Figure 1 Moisture retention curves used in the numerical modelling program.

Figure 2 presents the hydraulic conductivity functions (k-function) used in the modelling program. The saturated hydraulic conductivity of each material was selected based on the particle size distribution and OKC's experience with similar materials. The shape of the conductivity functions was generated within the VADOSE/W model subroutine based on the shape of the MRCs. The granular till function is bi-modal with an increased k_{sat} to reflect the presence of macropores or soil structure development at low suction values and a k_{sat} of 1 x 10^{-5} cm/s for the matrix component of the material. OKC anticipates that the fines content of the granular till could potentially lead to substantial freeze-thaw cracking and heaving for the near-surface materials. Therefore the k-function ranges up to 3 x 10^{-4} cm/s at low suctions to simulate allowing water to quickly enter the material profile through cracks. The k_{sat} of the clayey till material was assumed to be 5 x 10^{-7} cm/s while the waste rock was 5 x 10^{-4} cm/s.

Climate Data

Climate data required for VADOSE/W simulations include daily maximum and minimum air temperature, daily maximum and minimum relative humidity, daily rainfall, and average daily wind speed. The user has the option of inputting daily potential evaporation or net radiation values, or VADOSE/W will estimate potential evaporation based on the latitude of the site and other available climate data.

Site-specific climate data is available for the site from 2005 to 2008, and from Environment Canada weather stations at Ft. Liard and Ft. Simpson. The climate data collected on site from May 25, 2005 to August 15, 2008 included daily rainfall and daily maximum and minimum temperature and average daily wind speed. Figure 3 compares the average monthly rainfall measured at the site, Ft. Liard, and Ft. Simpson from 2004-08.

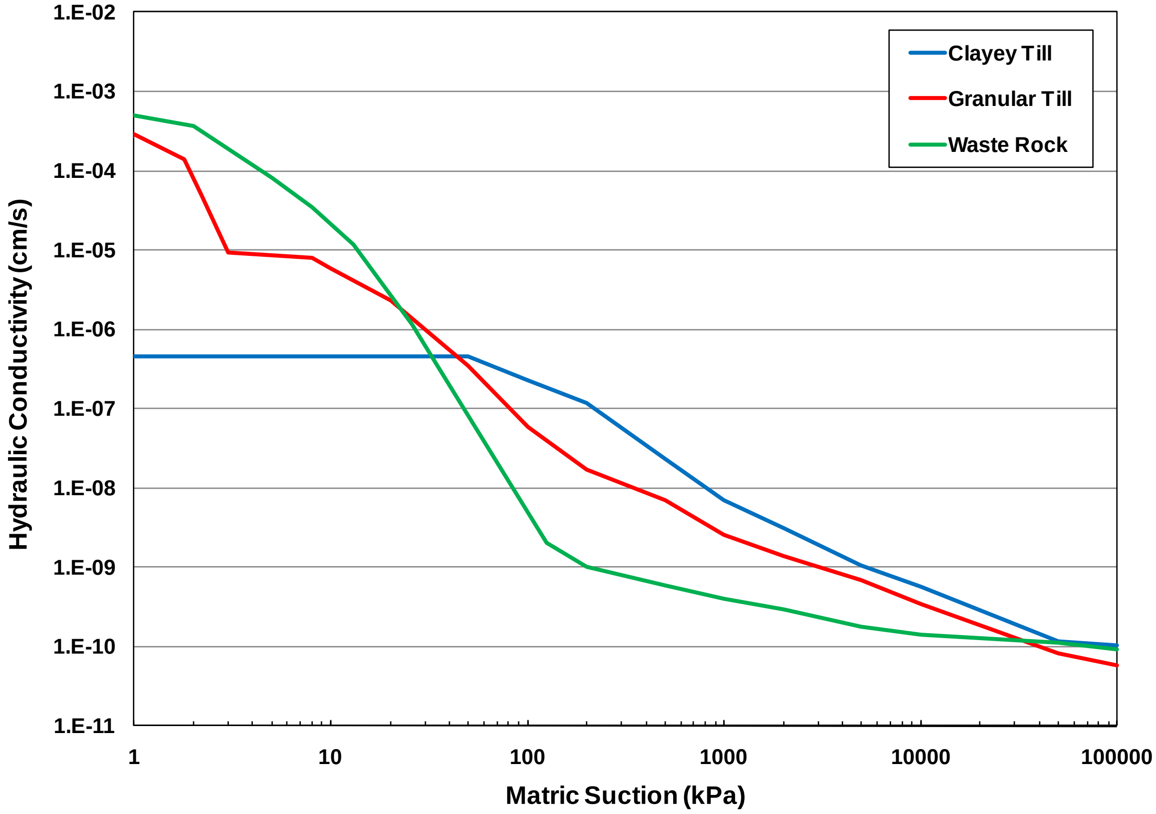


Figure 2 Hydraulic conductivity functions generated for the modelling program.

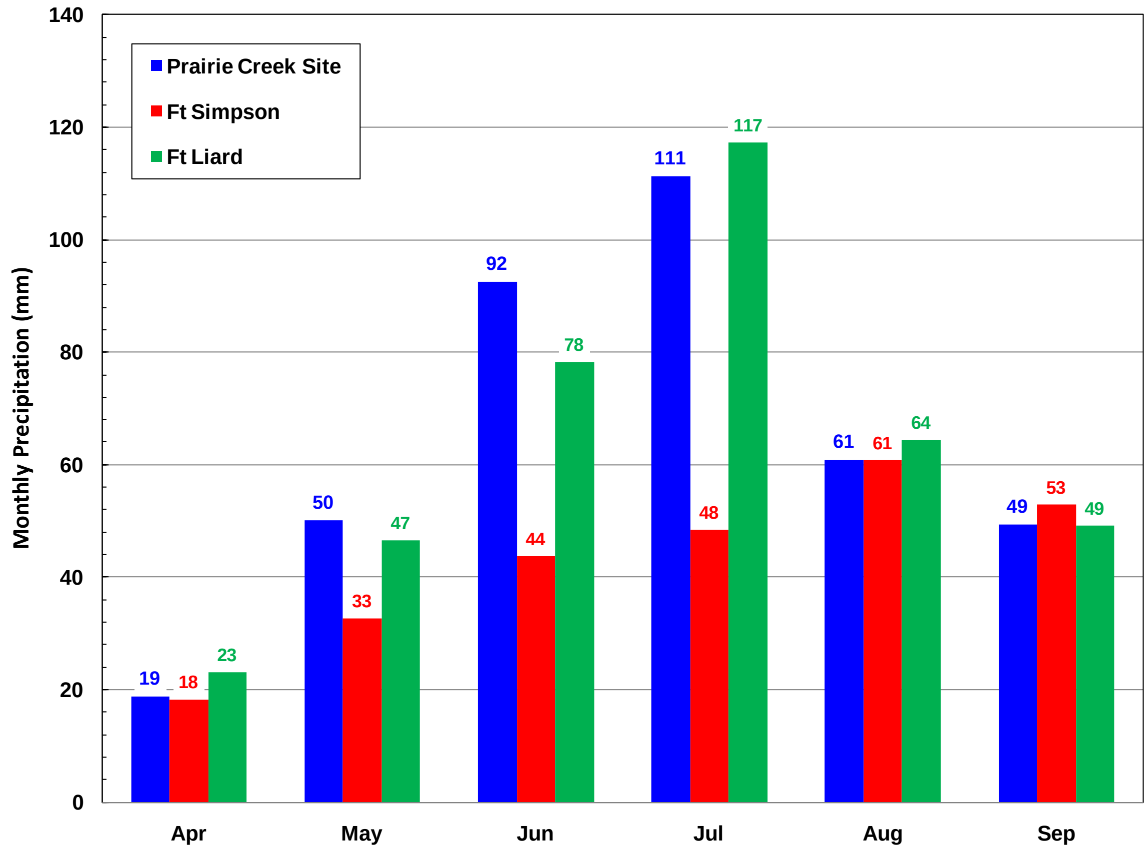


Figure 3 Summary of the average monthly rainfall measured from 2004-08.

Rainfall measured at Ft. Liard is similar to values measured at the site over the same period, therefore daily measurements from Ft. Liard such as daily relative humidity and snowfall data were used to fill in the required data in the modelling program database. The Environment Canada station at Ft. Liard records both snowfall and a measurement of snow on the ground allowing estimation of the snowpack at the Prairie Creek site. Within the numerical model, snowpack was assumed to develop without drifting and sublimation was allowed to occur. Simulations were completed from October – September to allow a snowpack to build throughout the winter season.

Net radiation was estimated based on the latitude of the site, air temperature, relative humidity and the albedo of the surface. More information regarding the net radiation calculation is available on the Food and Agriculture Organization of the United Nations (FAO) website (FAO, 2009).

It should be noted that there were several gaps in the Ft. Liard database beginning in 2007 and continuing into 2008. Data from the Ft. Simpson station, factored to be representative of Ft. Liard, were inserted to complete the climate database. The four-year (October 2004 – September 2008) climate database used in the modelling program is an amalgam of data from three stations; however, it is assumed to be adequate for the preliminary nature of the modelling program. Table 2 provides climate averages for the four-year database, annual precipitation from 2004-05 to 2007-08 was 500 mm, 493 mm, 643 mm, and 394 mm, respectively.

Table 2
Summary of key annual climate characteristics for the four-year site-specific climate database.

Climate Parameter	Value
Mean Annual Precipitation	508 mm
Mean Annual Rainfall	375 mm
Average Daily Maximum Temperature	1.5°C
Average Daily Minimum Temperature	-9.5°C
Average Daily Maximum Relative Humidity	88%
Average Daily Minimum Relative Humidity	57%
Average Daily Wind Speed	1.6 m/s

The 508 mm annual precipitation assumed for the site is similar to the 494 mm annual average for the same period at the Ft. Liard station and greater than the 450 mm long-term average (1971-2007) for Ft. Liard station. It is OKC's opinion that the four-year climate database is suitable for the preliminary nature of the modeling program, however, a second climate database was prepared with factored precipitation to produce a four-year 450 mm average annual precipitation. This will provide precipitation conditions that might be more consistent with long-term average conditions at the Prairie Creek site.

Vegetation

Vegetation properties required for VADOSE/W modelling include leaf area index (LAI), root depth, growing season, and plant moisture limiting function (PMLF). Based on OKC experience with sites in northern Canada, vegetated-surface simulations completed with VADOSE/W assumed a surface coverage of 50%. This scenario is associated with a leaf area index (LAI) of 1.0. The rooting depth was limited to 0.5 m below surface and the growing season was assumed to be June 1st to September 15th.

Modelling Methodology

The purpose of the preliminary numerical modelling was to evaluate various cover scenarios with respect to limiting net percolation to the underlying waste rock material. Two (2) different cover scenarios were completed for four-year continuous 1D simulations. The cover alternatives are presented in Figure 4. All cover options were placed over 6 m of waste rock.

The options included a simple monolithic 2.0 m non-compacted granular till store-and-release cover system. Option 2 was a barrier cover system with a 50 cm compacted clayey till underlying a 1.5 m non-compacted granular till protective layer. The cover alternatives were evaluated under both the site-specific four-year climate database (annual precipitation = 508 mm) and the Ft. Liard average database (450 mm).

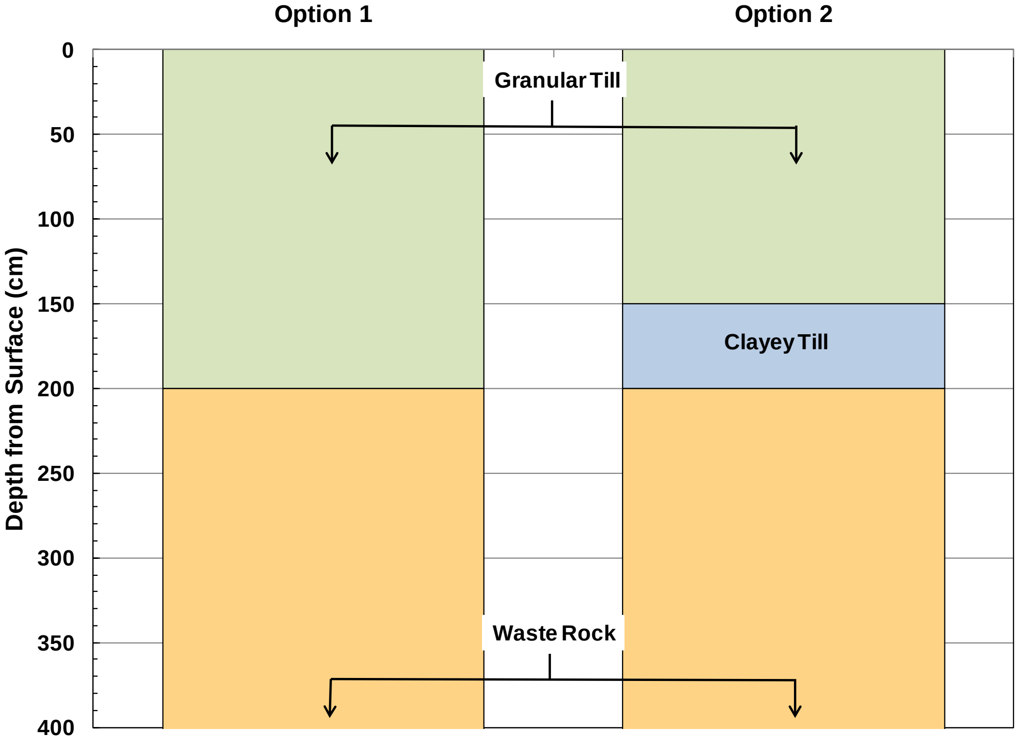


Figure 4 Cover scenarios selected for 1D modelling.

Simulations were completed to evaluate the distinctly different areas of the current WRP design that potentially require a cover system. The current WRP design will be constructed on the existing 3.5H:1V natural slope and will feature a 2H:1V slope that is approximately 190 m long. The upper plateau of the WRP will be back-sloped at a 1% grade toward the natural slope and will be approximately 140 m in length. The surface water conditions will differ greatly on these areas, runoff will be much greater on the 2H:1V slope. VADOSE/W provides the option to allow excess rainfall and snowmelt to runoff from the 1D model or allow it to pond until it infiltrates into the surface or evaporates. The cover alternatives were simulated with both conditions, runoff and ponding. The runoff simulation will be representative of the sloping 2H:1V surface and the upper plateau if a well drained, even slope is created on the latter. The ponding simulation will represent any part of the upper plateau area where positive runoff does not occur

The initial *in situ* temperature and suction conditions used for each simulation were determined from running the four-year climate cycle repeatedly to produce a “steady-state” set of sub-surface conditions representative of site conditions.

Preliminary Modelling Results

The 2.0 m granular till store-and-release cover system was selected as the base case cover system during the modelling program. Figure 5 shows the water balance parameters for each year of the four-year simulation and the average values. Precipitation is substantially greater than potential evaporation (PE) during each year of the four-year simulation. Average precipitation during the four-year period is 508 mm compared to 375 mm of PE. In OKC's experience, it is difficult to achieve low net percolation rates (<10% precipitation) in humid areas (annual precipitation greater than PE) without the use of high quality barrier materials such as compacted clay and robust surface water and interflow water drainage systems to remove water from the cover system profile. In humid areas, net percolation rates will be higher with store-and-release cover systems due to the reduced amount of evaporation energy available to remove water during dry periods.

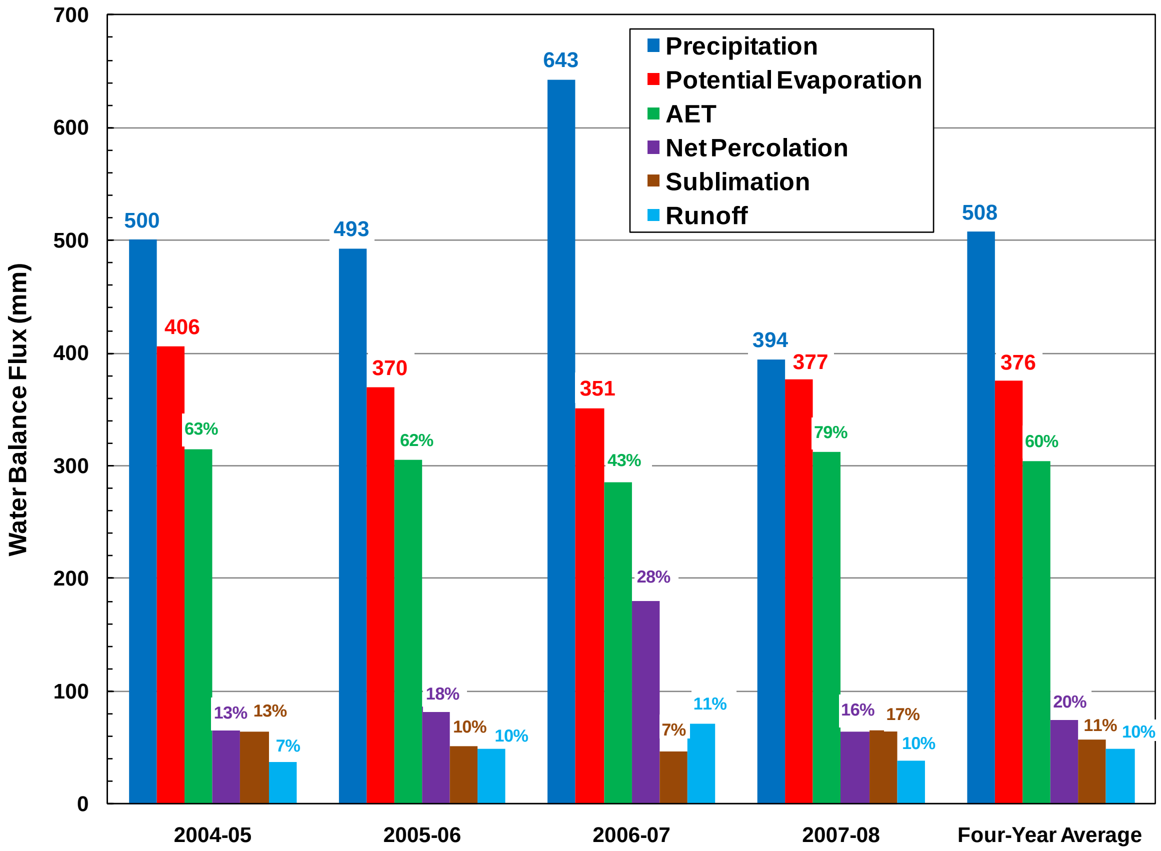


Figure 5 Summary of the water balance components for the four-year simulation of the 2.0 m non-compacted granular till cover system.

Net percolation, AET, sublimation, and runoff fluxes are shown as a percentage of annual precipitation. Annual AET was consistently between 290 mm and 310 mm during the simulation period although the percentage fluctuates due to the large changes in annual precipitation. Net percolation ranges from 13% to 28% of annual precipitation with an average of 20% over the four-year period. Both sublimation and runoff are substantial components of the overall water balance averaging 11% and 10% of annual precipitation, respectively. Snow-water equivalent (SWE) of average snowfall during the four-year period was 133 mm of which 57 mm (43%) was lost to sublimation, 36 mm (27%) produced runoff, and the remaining 40 mm (30%) reported as surface infiltration.

Table 3 provides the average monthly precipitation and net percolation values for the 2.0 m granular till cover system for the four-year site-specific climate database assuming no ponding occurs. The average annual net percolation was 100 mm or 20% of the 507 mm average annual precipitation. A substantial percentage of the spring snow melt water and early spring rainfall reported as net percolation through the granular till cover system. In May and early June, evaporation rates are relatively low compared to the summer and vegetation is not active to effectively remove water from the cover system profile. Monthly net percolation was lower during the summer months due to the increased evaporative demand. Monthly net percolation (as a percentage) increased during October when the lower reaches of the cover system profile were still non-frozen and there was little evaporative demand to remove water from the cover profile. It should be noted that these values were predicted for the base case simulation, the 2.0 m granular till cover system under the site-specific climate database. A sensitivity analysis was also completed to determine the range of percolation values that could be expected if the actual climate and material properties differ from the assumed values in the modeling program (see section below).

Table 3
Summary of monthly net percolation predicted for the granular till cover system from the site-specific climate database with no ponding.

Month	Precipitation (mm)	Net Percolation (mm)	Net Percolation (%)
January	21	0	0%
February	19	0	0%
March	17	0	0%
April	24	0	0%
May	50	31	61%
June	92	27	29%
July	111	11	10%
August	57	9	16%
September	41	7	16%
October	20	14	67%
November	30	1	3%
December	26	0	0%
Average	**508**	**100**	**20%**

A summary of the four-year model results for the two cover system scenarios with the site-specific climate database (508 mm) is shown in Table 4. The primary indicator of cover system performance examined in the soil-atmosphere modelling program was predicted rate of net percolation. A range of net percolation values are presented for each alternative. As discussed previously, the runoff simulations (low end of the net percolation range) represent the sloping areas of the WRP where excess rainfall and snow melt are assumed to runoff past the toe of the WRP without re-infiltrating back into the cover system surface. The simulations completed with ponding at the surface (high end of percolation range) would represent the plateau area with 1% back-slope if a surface with positive drainage and consistent runoff is not created.

Net percolation for the non-compacted granular till store-and-release cover system was 100 mm with runoff and 145 mm with ponding (20% and 29% of annual precipitation, respectively) for the four-year site-specific climate database. It should be noted that the AET predicted for the simulations with runoff and with ponding at the surface was similar, suggesting that even though there was additional water within the cover profile, there was not sufficient energy to remove it and increase AET rates. Instead, almost all the water that contributed to runoff in the first simulation was recorded as net percolation in the ponding simulation.

Table 4
Summary of four-year continuous modelling results with site-specific climate database (mm / % of precipitation).

Water Balance Parameter	Option 1 - Granular Till		Option 2 – Compacted Clayey Till	
	Runoff	Ponding	Runoff	Ponding
Precipitation	508	508	508	508
Net Percolation	**100 (20%)**	**145 (29%)**	**93 (18%)**	**141 (28%)**
Actual Evaporation	165 (32%)	166 (32%)	166 (32%)	166 (32%)
Actual Transpiration	140 (28%)	141 (28%)	144 (29%)	144 (29%)
Actual Evapotranspiration	305 (60%)	307 (60%)	310 (61%)	310 (61%)
Sublimation	57 (11%)	57 (11%)	57 (11%)	57 (11%)
Runoff	49 (10%)	0 (0%)	49 (10%)	0 (0%)
Change in Storage	-3 (-1%)	-2 (0%)	-1 (0%)	-1 (0%)

Net percolation predicted for the compacted clayey till cover system was slightly less but similar to the non-compacted granular till cover system. This result might appear unreasonable as the compacted clay layer has lower k_{sat} to prevent water from percolating to the underlying waste rock material. However, the low PE rates predicted for the site prevent the barrier layer from operating efficiently.

In general, a barrier cover system improves the storage capacity of the overlying non-compacted material by preventing rapid percolation of water during high infiltration periods like spring snow melt and summer storm events. The barrier layer keeps water within the upper area of the profile, within the zone of evaporation and vegetation rooting systems, so it is readily available for AET during subsequent dry periods. Due to the northern location of the Prairie Creek site, there is insufficient PE available to take advantage of the readily available water, AET rates are already at a maximum, and hence there is not a substantial increase in AET. Under the flow gradients created by the infiltration events, the k_{sat} of the clayey till barrier layer (5×10^{-7} cm/s) was still high enough to allow percolation similar to the granular till store-and-release cover system.

Table 5 presents the results of the four-year simulations with the Ft. Liard average rainfall database (451 mm). The predicted net percolation was lower than that predicted for the site-specific database with net percolation predicted to be 16% of annual precipitation with runoff and 21% with ponding for the granular till cover system. AET and sublimation predicted for each cover system was approximately the same total value, which produced an increased percentage when compared to the annual precipitation. Runoff predicted for the Ft. Liard average climate database was less than the site-specific simulations.

Table 5
Summary of four-year continuous modelling results with Ft. Liard average climate database (mm / % of precipitation).

Water Balance Parameter	Option 1 - Granular Till		Option 2 – Compacted Clayey Till	
	Runoff	Ponding	Runoff	Ponding
Precipitation	451	451	451	451
Net Percolation	**71 (16%)**	**96 (21%)**	**68 (15%)**	**94 (21%)**
Actual Evaporation	165 (37%)	166 (37%)	166 (37%)	167 (37%)
Actual Transpiration	133 (29%)	134 (29%)	134 (29%)	137 (30%)
Actual Evapotranspiration	298 (66%)	300 (66%)	300 (66%)	304 (67%)
Sublimation	53 (12%)	53 (12%)	53 (12%)	53 (12%)
Runoff	28 (6%)	0 (0%)	29 (6%)	0 (0%)
Change in Storage	1 (0%)	1 (0%)	1 (0%)	1 (0%)

Comparison to Bare Waste Rock Surface

Simulations were completed to provide a rough estimate on infiltration rates across a bare waste rock surface. This provided a measurement of the improvement in performance due to the three cover system alternatives evaluated. Table 6 compares the average net percolation predicted for each cover system alternative to a bare waste rock condition. The addition of the granular till cover system reduced net percolation by approximately 40% compared to the bare waste rock condition. A similar improvement in performance (44%) was provided by the compacted clayey till barrier cover system.

Table 6
Summary of predicted net percolation for three cover system scenarios evaluated (in mm and % of annual precipitation).

Cover System Alternative	Predicted Net Percolation in mm (% reduction as compared to bare waste rock)			
	Site Specific Database		Ft. Liard Average Database	
	Runoff	Ponding	Runoff	Ponding
Bare Waste Rock	180 mm	221 mm	143 mm	167 mm
Option 1 – Granular Till	100 mm (44%)	145 mm (34%)	71 mm (50%)	96 mm (42%)
Option 2 – Clayey Till	93 mm (48%)	141 mm (36%)	68 mm (52%)	94 mm (44%)

Sensitivity Analysis

Additional numerical simulations were completed to evaluate sensitivity in performance of the 2.0 m granular till cover system to variance of key climatic and material inputs. A sensitivity analysis is critical for this preliminary analysis because many of the inputs were unknown and therefore assumptions were required. The sensitivity simulations attempted to identify key parameters, which should be further investigated to increase the accuracy of future numerical modelling programs. The sensitivity analysis used the four-year site-specific climate database. Figure 7 presents a tornado plot summarizing the effect of varying key inputs on the predicted performance of the cover system.

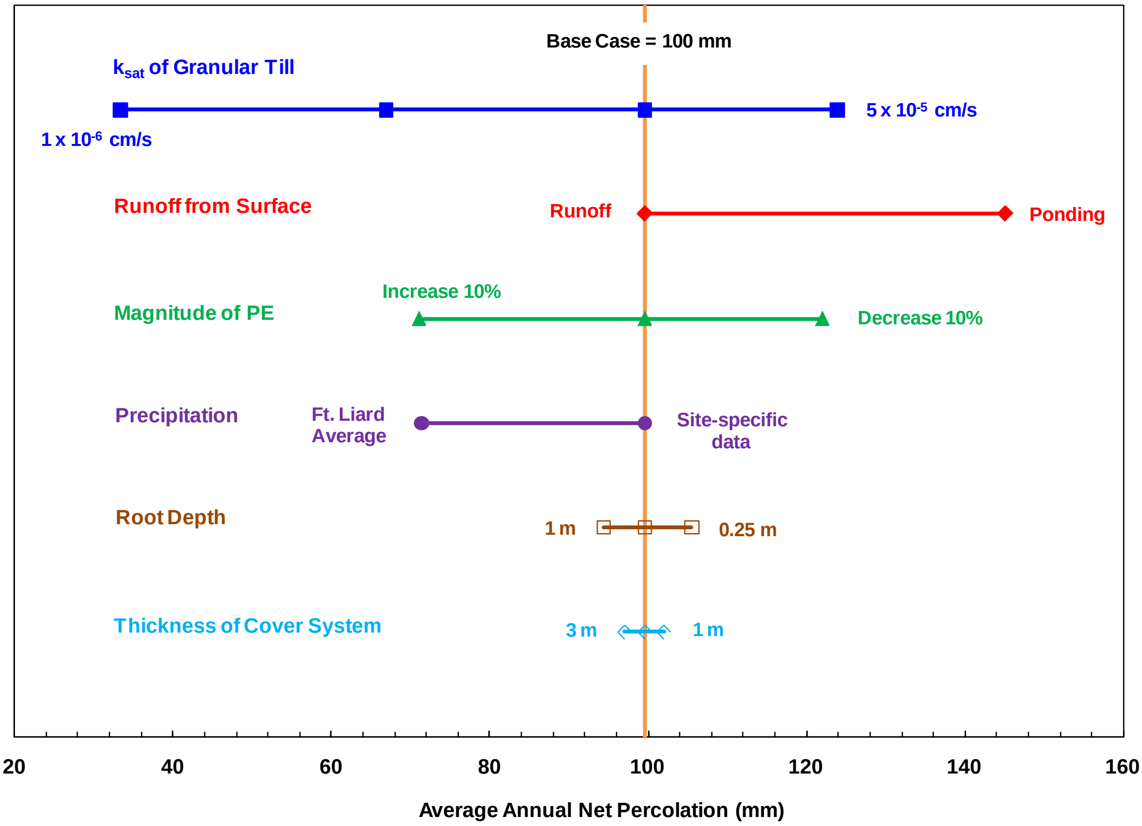


Figure 6 Tornado plot summarizing the results of the sensitivity analysis.

The k_{sat} selected for the granular till had the greatest influence on the performance of the cover system. As discussed previously, AET was similar for each of the sensitivity runs; however, decreasing k_{sat} of the till increased the amount of runoff predicted in each simulation. Decreasing k_{sat} of the granular material to 1 x 10^{-6} cm/s decreased net percolation by 66% while increasing k_{sat} to 5 x 10^{-5} cm/s increased net percolation by 24%. The base case scenario assumed a k_{sat} of 1 x 10^{-5} cm/s, it is OKC's experience that hydraulic conductivity of material similar to the granular till can vary greatly due to textural changes, placement density conditions, and *in situ* processes (e.g. freeze/thaw cycling. Hence, it is recommended that further laboratory testing of the granular till materials be undertaken to characterize the range of k_{sat} expected during cover system construction.

The influence of runoff has been discussed previously, allowing ponding on the cover system surface which could occur on the upper plateau area of the WRP if it is not properly graded, increases the predicted net percolation by 46% from the base case.

Variance of PE had a large influence on predicted performance of the base case cover system. Increasing PE by 10% (by increasing estimated net radiation values) reduced net percolation by 29%, while decreasing PE resulted in 22% greater predicted net percolation. The average PE from the four-year database was 375 mm, which is roughly equivalent to the 360 mm – 400 mm PE range estimated for the site based on OKC's experience with Alaskan and northern Canadian sites. It should be noted that the WRP will be a south-facing slope and therefore net radiation values could be slightly higher than estimated. OKC recommends installation of a net radiometer to characterize net radiation (and thus PE) for the Prairie Creek site as PE appears to be a key parameter in cover system performance.

The influence of precipitation has previously been evaluated. The site-specific climate database had a four-year average annual precipitation of 508 mm compared to the Ft. Liard average database with a 451 mm annual average precipitation. As further data is collected at the site, the magnitude of the site-specific database, whether it is representative of average or above-average conditions for the Prairie Creek site, will be defined. It is OKC's opinion that the 623 mm precipitation year (2006-07) represents a near-maximum precipitation year and therefore the numerical modelling is conservative in that it could be argued that wetter than average climate conditions have been considered.

Root depth of vegetation and the thickness of the granular till cover system had a limited effect on cover system performance. Transpiration was at a near-maximum during the base case simulation as vegetation was not limited by lack of moisture within the rooting depth. Therefore when the root depth was increased or decreased, there was little change in the total volume of water removed by transpiration.

Cover thickness had a minimal influence performance because the zone of evaporation was limited to the upper area of the cover profile. Once water percolated below the maximum depth of the evaporative zone, it lost contact with the soil / atmosphere interface and eventually migrated downward as net percolation. The numerical modelling showed the evaporative zone did not reach deeper than 1 m, which resulted in performance being similar for the 2 m and 3 m granular till cover systems. Based on the preliminary model results, it is OKC's opinion that the granular till cover thickness could be decreased to 1.5 m or 1.0 m from the 2.0 m assumed as the base case design. However, further detailed numerical modelling and investigation of rooting depths and water demand of native vegetation is recommended before finalizing the cover system thickness.

Influence of Compacted Clayey Till Barrier Layer

The modelling program showed that performance of a cover system with a compacted clayey till layer (k_{sat} = 5 x 10^{-7} cm/s) was not substantially better than a simple granular till store-and-release cover system. Additional simulations with a progressive reduction in the clayey till k_{sat} were completed to characterize the required hydraulic conductivity to substantially improve cover system performance. Reducing k_{sat} by one-half an order of magnitude to 1 x 10^{-7} cm/s decreased predicted net percolation to an average of 69 mm (14% of annual precipitation). A further k_{sat} reduction to 5 x 10^{-8} cm/s produced an average net percolation of 50 mm (10% of annual precipitation). If a compacted clayey barrier is incorporated into the cover system design of the WRP plateau area, OKC recommends completion of compaction field trials to determine the compaction energy required to construct the optimum barrier layer. OKC also recommends further thermal numerical modelling to determine the thickness of the protective granular till layer to prevent excessive freeze/thaw cycling within the compacted clayey layer.

Closure

We trust that the information provided in this memorandum meets your requirements. However, please do not hesitate to contact us should you have any questions or comments. Thank you for the opportunity to assist Canadian Zinc in the design of a closure cover system for the Prairie Creek WRP.

References

FAO (Food and Agriculture Organization of the United Nations). 2009. Online. http://www.fao.org/docrep/X0490E/x0490e00.htm#Contents

APPENDIX 23A

SNC – Lavalin, Inc
CANADIAN ZINC CORP.
Prairie Creek Project

Prepared by: Zark Bedalov

HYDRO ALTERNATIVE

Introduction:

SNC – Lavalin, have assessed the Hydro Alternative based on the (undated) figures provided by CZN. The Hydro option has been reviewed as a possible displacement of the generation by a Diesel Engine plant, 5 x 1.5 MW, for a plant continuous load of about 4MW.
Since we cannot verify the figures provided, we base our estimates on the site figures provided, thus assuming the following;

Method of generation:	Run of the river, Prairie Creek
Location	North West Territories, 61.35 Deg. North
Head:	30.5m/ km over 4km, 48" pipe intake
Total/ Net Head	122/ 100m
Flow:	2.56 m3/sec for 6 months
Water speed:	Not provided
Total capacity	2.5 MW
Projected average generation	2 MW for 6 mo/ year
Allowed water usage from river, %	Unknown

Subject to a number of unknowns, we estimate a net head at about 100 m, by assuming some losses in the pipe and the head needed for the turbine discharge. This head would produce the desired power of 2.5MW and 2MW average generated for 6 months / year.

We adjust the cost estimates for the Hydro estimate provided by CZN with the 2nd column below, as follows;

Cost Estimates:	**by: CZN**	**SNC-L**
	$$	**$$**
1. Pipe, 4km, 48"; $100/ft x 13000 ft	1,300,000	+300,000
2. Pipe transport to site, 13000/40=325 lengths	400,000	
3. Site Clearing for Pipe/ Concrete Works		+300,000
4. Power House	40,000	+110,000
5. 20 ton Crane in house		+40,000
6. Intake Civil Works		+200,000
7. Discharge Civil works		+200,000
8. Turbines	1,500,000	
9. Generators	500,000	
10. Switchgear, 4.16kV	300,000	
11. Accessories,	150,000	
12. Cables, Conduits, Trays, Grounding		+200,000
13. Plant Auxiliary Diesel Engine, 100KW		+50,000
14. Controls, Telemetering, Synchronizing		+200,000
15. Construction mobile equipment	300,000	
16. 5kV Overhead line	200,000	
17. Transport to site, Misc Equip.	250,000	
18. Labour	1000,000	
19. Engineering/ Purchasing/ Permitting		+2,000,000
20. Intangibles, Site Investigations, Spares		+1,000,000
	----------------	---------------
	5,940,000	+4,600,000
TOTAL COST:		**$10,540,000**

HYDRO ALTERNATIVE

Operating Cost:

1.	Diesel generation: .(0.25litre/ kWh)	$ 0.4/ kWh
	Spare parts and Maintenance	$ 0.05/ kWh
2.	Hydro generation: Lubricants	$ 0.01/ kWh
	Spare parts and Maintenance:	$ 0.02/ kWh
	Heating the plant for 6 months of year	$ 0.02/ kWh
3.	Operating Cost Difference: (DG-HG)	$ 0.40/ kWh

Note: Cost of fuel delivered to site is assumed to be: $1.60/litre. To be verified ?

Pay Back Analysis:

1.	Plant load:	4 MW, continuous
2.	Energy, Annual	35,000,000 kWh/ yr
3.	Hydro generation: 2 MW x 4,380 h	8,760,000 kWh/ yr
4.	Cost of Energy saved: 8,760,000 x $0.40	$ 3,500,000/ yr
5.	**Payback: 10,540,000/ 3,500,000**	**3.01 years**

Conclusions:

Based on the figures provided by CZN, without being able to verify the site capability to generate power for 6 months of the year, or how much of the river would be allowed to be used to generate it, it can be concluded that the Hydro option is worth pursuing.

The cost of building the plant ($/MW) to operate for 6 months of year is very high, but considering the cost of diesel fuel over a period of 20 years of the mine life, the cost can be recovered within 3 years. The cost saving is unaffected of the plant load, as long the load exceeds 2MW.

It is not known where the highest head is located within the 4 km of the pipe length. Assuming an average head over the whole length of the pipe, the cost of capital for the same power output could be reduced if the pipe is doubled up to run for 2 km instead of 4km, but with double the water intake. This arrangement would leave a smaller environmental imprint on the site, but would require more water to be taken. In that sense, it may not be appropriate for the river flow.
Site investigations must be conducted to define the most cost effective alternative with the smallest impact on the environment.

In view of the above, CZN must immediately undertake to arrange for the measurement of the annual river flow, if this is not available from the government agencies. Furthermore, a study must be made to define the catchment for the river ahead of the turbine discharge. These studies would define the water flow profile and the availability of water for power generation over the year.

WIND ALTERNATIVE

Introduction:

SNC – Lavalin, have assessed the Wind Alternative based on the wind profile provided by CZN. The wind intensity and direction was measured for the last three years. The Wind option has been reviewed as adisplacement of the generation by a Diesel Engine plant, 5 x 1.5 MW, for a continuous plant load of about 4MW.

Method of generation:	Wind, Prairie Creek
Location	North West Territories, 61.35 Deg. North
Wind measurements	by Anemometer, 10 m above ground
Wind Speed	3 to 10m/sec
Wind Speed average	1.02 m/sec
Period of time > 4m/sec	1.7%
Average speed above cutoff speed >4m/sec	5 m/sec
Duration of usable average wind, 2.1%	149 h/yr
Duration of cold temp. (<-25C)	Not known

The wind turbines are manufactured to generate power from 100 kW to 2500 kW, with towers as high as 100 m for the large units to spin propellers having diameters of 92 meters.
The power of the wind is directly proportional to the cube of the speed of wind. Therefore, speed of 10 m/sec will generate 8 times more power (kW) and energy (kWh) compared to the wind blowing at 5 m/sec.
Wind intensity increases with the height of the tower. This is due to higher winds at higher altitudes, and due to the vegetation obstruction at the lower levels.
For, the operation in the cold regions, the turbines are equipped with winter packages to operate down to –25C. The turbines are automatically cut off at temperatures below –25C.

Wind turbines are manufactured to take advantage of winds from 4 m/sec to 25 m/sec. At 4 m/sec the generator produces insignificant amount of energy. At speeds over 12 m/sec it produces the nominal rated power and energy. The turbines are automatically cut off when the speed falls below or above the critical workable speeds. The optimal turbine design operating speed is for wind speeds between 12 m/sec and 16 m/sec.

The wind generating farm generally consists of multiple towers, having wind turbine generators mounted on the top of towers, and the collection system to collect power from the towers and deliver it to the users. The power is generated at 600V. It is typically transformed higher to be delivered to a more remote power grid. In the case of this project, the transformation would be rated at 2.4 kV or 4.16 kV.

An appropriate wind project for this site would be in the order of 6 x 300 kW generators. A typical wind generator of this magnitude made by Mitsubishi is attached. The tower height is 100 ft and the blade diameter is 95 ft. The site area required for 6 units would be about 300 x 300 ft.

On the wind projects in the other Northern regions, on which we have participated, the suppliers expressed several major concerns; the projects were too small, (less than 10 units), the ice road was not adequate to transport the massive cranes, and the air was too cold and heavy to make the investment worthwhile. One 250kW turbine near White Horse has experienced severe rim icing.

Calculations:

A wind rose and the Wind class distribution have been prepared, as attached to define the wind distribution and intensity, based on the 25,000 hourly readings over a period of three years. The

WIND ALTERNATIVE

average wind speed over the year is 1.02 m/sec. The usable winds in excess of 4 m/s are blowing 1.7% of time, (149 hours/ year) with an average intensity of 5m/sec. The usable winds are generating power of about 7.1% of the generator nameplate.

Costs:

1.	Wind Turbines, 6 x 300kW		$ 3,000,000
2.	Collection System, O/H Line, Transf		$ 600,000
3.	Transportation		$ 700,000
4.	Installation, Site prep.		$ 1,000,000
5	Engineering		$ 500,000
	Total:		**$ 5,800,000**
	Unit Cost:	**5,800,000/ 1,800kW**	**$ 3200/kW**

Operating Cost:

1.	Diesel generation: .(0.25litre/ kWh)	$ 0.4/ kWh
	Spare parts and Maintenance	$ 0.05/ kWh
2.	Wind generation: Lubricants	$ 0.01/ kWh
	Spare parts and Maintenance:	$ 0.1/ kWh
3.	Operating Cost Difference: (DG-WG)	$ 0.34/ kWh

Note: Cost of fuel delivered to site is assumed to be: $1.60/litre. To be verified ?

Pay Back Analysis:

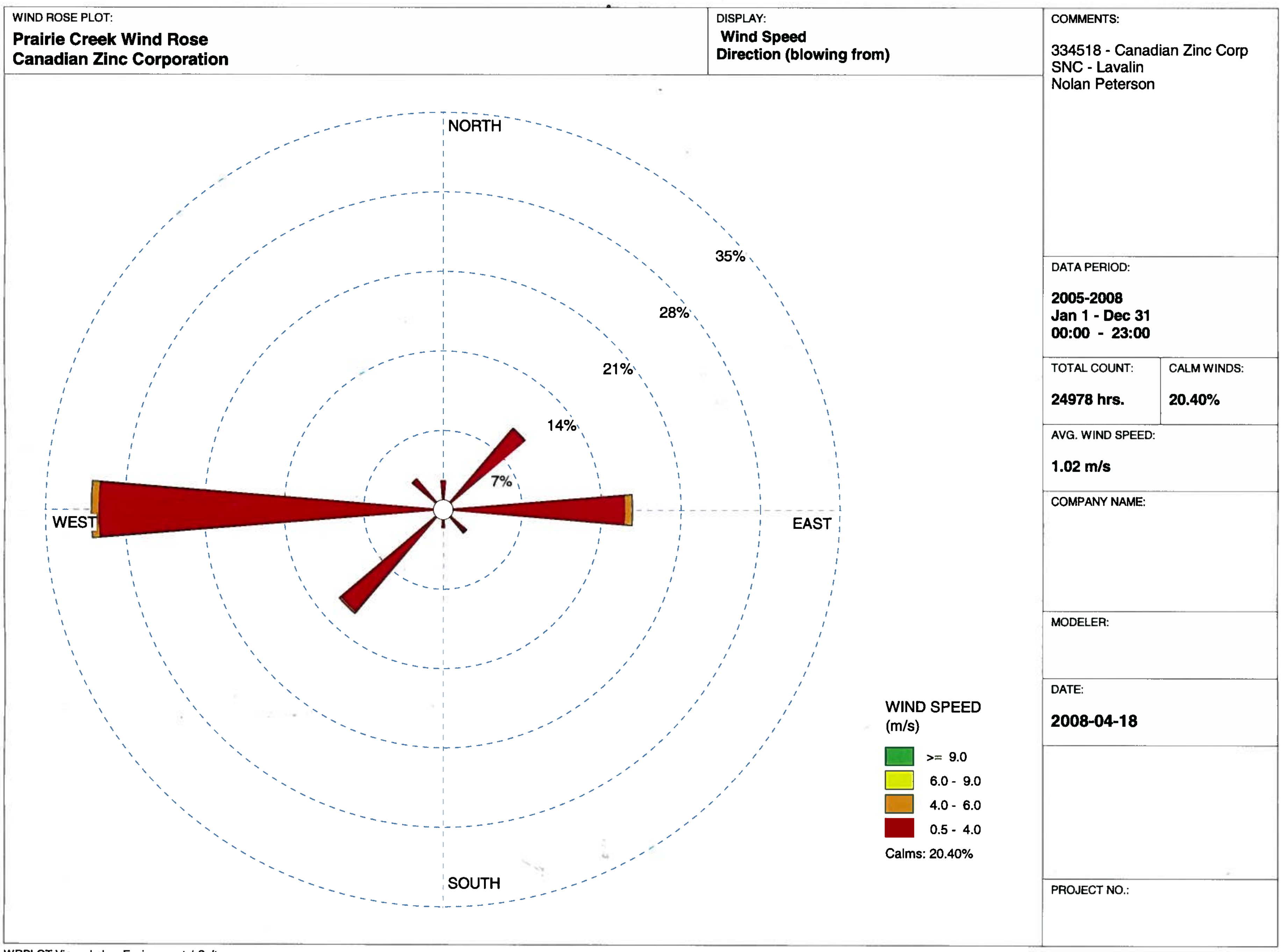
1.	Plant load:	4 MW, continuous
2.	Energy, Annual	35,000,000 kWh/ yr
3.	Wind power at average speed of 5m/sec	130 kW from 1800 kW nominal (12m/s)
4.	Wind generation: 130kW x 149h	19,370 kWh/ yr
5.	Cost of Energy saved: 19,370 x $0.34	$ 6,586 / yr
6.	**Payback: 5,800,000/ 6,586**	**880 years**

Conclusions:

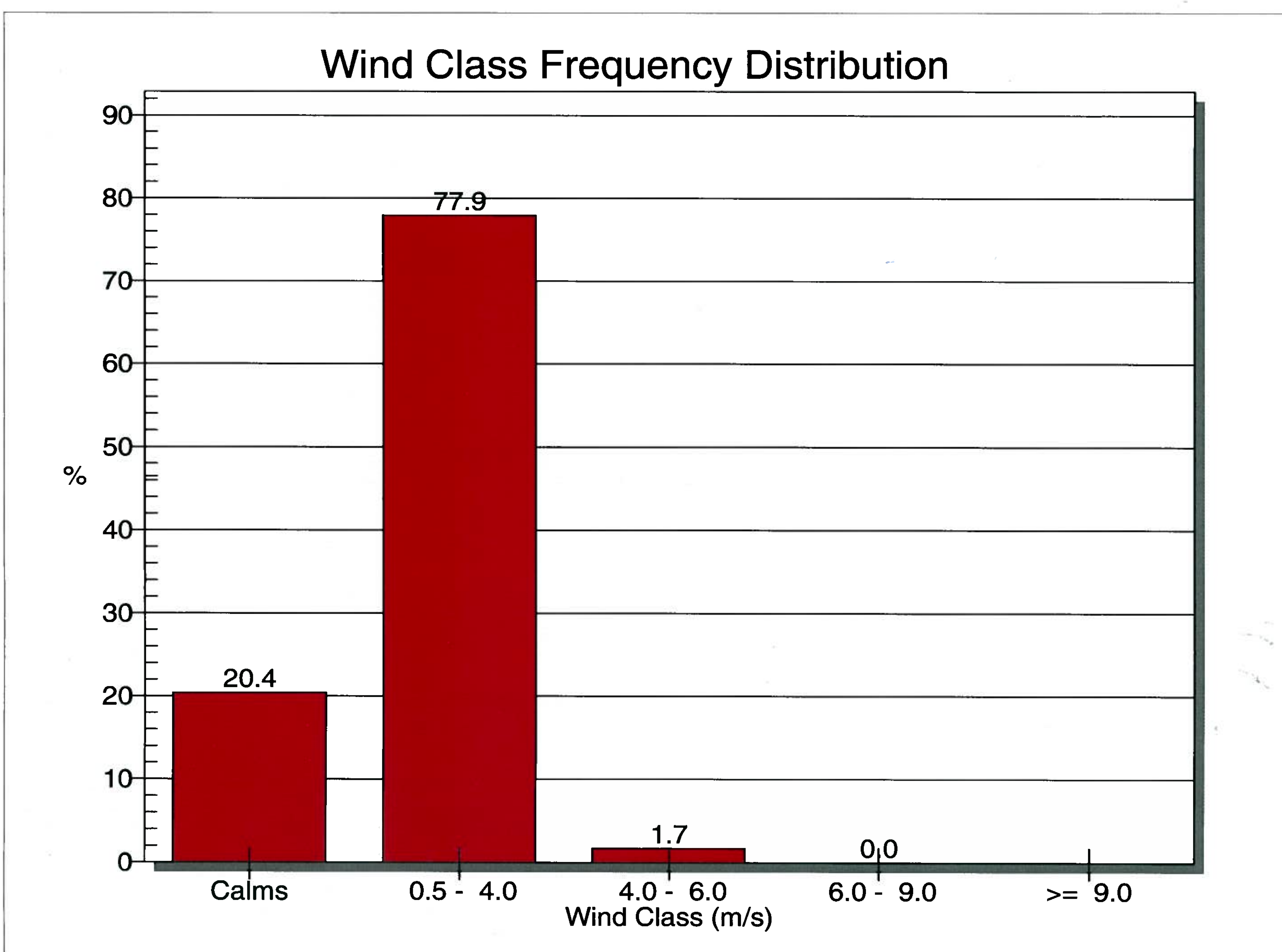
Based on the wind distribution and intensity, the Wind Option is not a viable alternative to displace the cost of generation by Diesel generation. The low wind intensity as well as short duration are providing an insignificant capacity factor for the Wind utilization. The wind was measured at the height of 10m. Somewhat higher winds could be expected at 50 meter heights, at the centre of the wind turbine hub.

Attached:

1. Mitsubishi 300kW Turbine Data sheet
2. Wind Rose
3. Wind Class Distribution



WRPLOT View - Lakes Environmental Software



WRPLOT View - Lakes Environmental Software

MODEL MWT-250/300kW TYPE

TURBINE

Type	:	Blade-pitch controlled upwind type
Rated output	:	300kW
Rotor diameter	:	95ft (29m)
Rotor speed	:	43rpm
Number of blades	:	3 (FRP material)
Rated wind speed	:	32.4mph (14.4m/s)
Cut-in wind speed	:	10.1mph (4.5m/s)
Cut-out wind speed	:	53.7mph (24m/s)
Survival wind speed	:	134mph (60m/s)

GENERATOR

Type	:	Induction generator
Rated output	:	300kW
Voltage, phase & frequency	:	480V, 3-phase, 50/60Hz

TOWER

Type	:	Monopole
Height (to center of nacelle)	:	100ft (30m)

CONTROL SYSTEMS

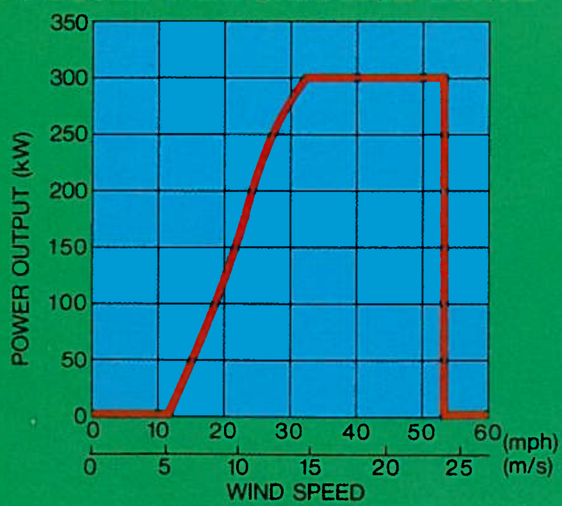
Power regulation	:	Pitch control
Yaw orientation	:	Yaw control

SAFETY INTERLOCKS

Overspeed
Low governor Oil pressure
Excessive necelle vibration
Yaw control disorder
Generator overcurrent
Controller disorder

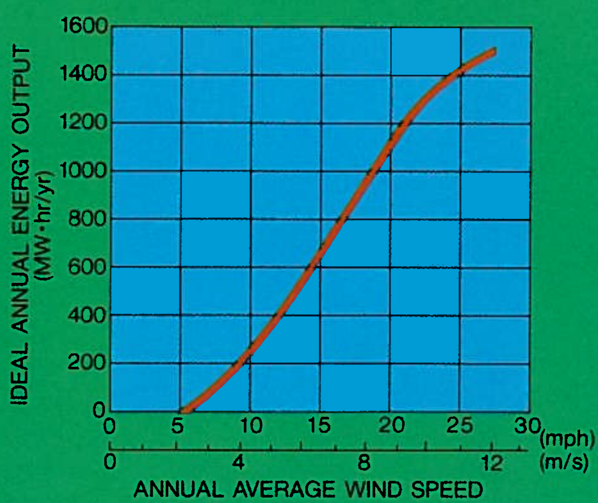
P & L Wind Farm (U. K.)

EXPECTED PERFORMANCE CURVE



ATMOSPHERIC PRESSURE : 1013hPa
ATMOSPHERIC TEMPERATURE : 20°C

IDEAL ANNUAL ENERGY OUTPUT



WIND DISTRIBUTION :
WEIBULL'S DISTRIBUTION

SOLAR ALTERNATIVE

Introduction:

SNC – Lavalin, have assessed the Solar option as a possible displacement of power generated by a Diesel Engine plant, 5 x 1.5 MW, for a continuous plant load of about 4MW.

CZN doesn't have appropriate insolation values for the area. Based on the maps provided by the equipment suppliers, the site is located in the same zone as Yellowknife and Vancouver, with an insolation index of 1. This compares to the best index of 6.5, given for Arizona. The index is established, based on the number and intensity of sunny days per year.

The solar energy can be utilized to generate heat or electricity. Since the solar resource at this site is considered available mostly in the summer when there is a surplus of (waste) heat available from the diesel engines, the solar energy for this application would best be utilized to generate electricity during the sunny periods and be shutdown during winter months.

Method of generation:	Solar
Location	North West Territories, 61.35 Deg. North
Number of sunny days/ year	Not available
Best time of day for solar generation	9 AM to 3 PM
Optimal tilt angle for Yellowknife	80 % to vertical, pointed towards South
Proposed PV power capacity	0.5 MW
Projected average output after conversion	0.425 MW for 6 mo/ year

Calculations:

The calculations were carried out on a pro-forma basis, for a 500 kW solar panel output. The calculations can be scaled up or down to arrive at conclusions for any desired solar power output.

Refer to the spreadsheet attached for the costs and output calculations of the solar power generation. The installed cost of solar power is estimated at about $ 10,000/ kW.

It was assumed that the site may have sufficient roof or other usable space to place 2500 panels, each capable of generating 200W of peak power to produce a total of 500 kW of DC power. It must be noted that 200W may not be achievable by the panels at this particular site.
The projected area of the panel coverage is 200 x 200 feet, or 40 x 100 meters. Since the panels must be placed at 80 degrees, i.e; close to vertical for the greatest sun impact, the panels must be generously spaced apart to get adequate sun exposure. Therefore, the required space to install the panels may be twice that of the area of the panels alone.

The effectiveness of the panels to generate power naturally depends on the geographical location. Everything being equal and optimal, a 1 kW solar plant placed in Arizona would generate 145 kWh a month, compared to 85 kWh a month in Yellowknife.

The proposed number of the panels has a power capacity of 500 kW, (0.5 MW), which can after conversion from DC to AC produce about 425 kW of power. This power becomes available to be fed into the system to reduce the demand on the diesel generators.

Storage batteries were not considered for this project, since the sun power can be utilized immediately and in full, as it is generated.

SOLAR ALTERNATIVE

The panels must be placed to face direct sun exposure to a maximum possible. Automatic panel angle adjustment was not considered. Subject to a number of unknowns, we estimate an average number of hours during the summer months as 3hours/ day for 6 months, for a total of 540 hours/ year, or 6.23 %,year.

Solar generation will require substantial maintenance. More so than in the Southern parts of the continent. Snow must be removed. The icing on the panels may cause damage to the panels.

The principal equipment needed for the solar generation comprises: PV panels with mounts, DC/AC inverters, cables, distribution panels, and transformation/ hook up equipment for connection to the mill power system.

Government grants have not been considered.

Volume discounts for the purchase of PV panels were not considered in the calculations. Discounts in the order of 20% could be attained for large volume purchases.

Inverters will require to be installed in a large electrical room, 20m x 10m.

Operating Cost:

1.	Diesel generation: .(0.25litre/ kWh)	$ 0.4/ kWh
	Spare parts and Maintenance	$ 0.05/ kWh
2.	Solar generation:	
	Spare parts and Maintenance:	$ 0.15/ kWh
3.	Operating Cost Difference: (DG-SG)	$ 0.30/ kWh

Note: ***Cost of fuel delivered to site is assumed to be:*** ***$1.60/litre.*** ***To be verified ?***

Pay Back Analysis:

1.	Plant load:	4 MW, continuous
2.	Energy, Annual	35,000,000 kWh/ yr
3.	Solar generation: 0.425 MW x 540 h	229,500 kWh/ yr
4.	Cost of Energy saved: 229,500 x $0.30	$ 68,850/ yr
5.	**Payback: 5,000,000/ 68,850**	**72 years**

Conclusions:

The Solar option doesn't seem to be viable alternative for the project. The main reasons are the low exposure to sun, high maintenance and high capital costs.

Attached: Solar panel data sheet

APPENDIX 23B

GE
Energy

GEPVp-200-MS

200 WATT PHOTOVOLTAIC MODULE FOR 600 VOLT APPLICATIONS

FEATURES

- 54 poly-crystalline cells connected in series
- Peak power of 200 watts at 26.3 volts
- Designed for optimum use in residential and commercial grid-tied applications
- 25-year limited warranty on power output, 5-year limited warranty on materials and workmanship*
- Junction box and two meter cable with easy-click Solarlok Connectors included

BENEFITS

- Output power tolerance of +/- 5%
- Robust, clear anodized aluminum frame with pre-drilled holes for quick installation

CERTIFICATIONS

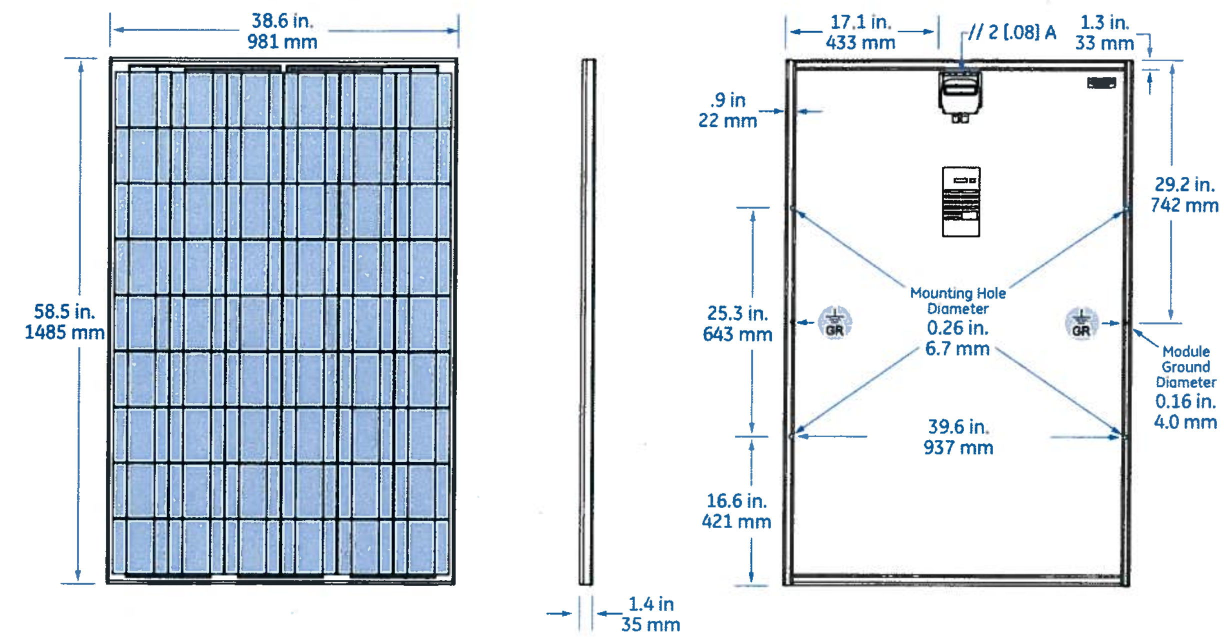
The GEPVp-200-MS Module meets the following requirements:

UL-1703 IEC-61215

*Refer to GE Energy Product Warranty for specific details

imagination at work

PHYSICAL CHARACTERISTICS

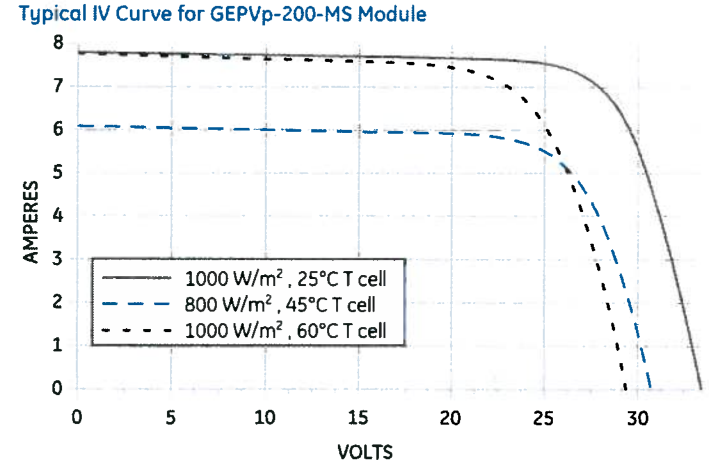


Physical Design Properties

Weight	39.0 lb [17.7 kg]
Weight (Wind) Bearing Potential	50 lbs/ft² [125 mph equivalent]
Hailstone Impact Resistance	1" @ 50 mph [25 mm @ 80 kph]

ELECTRICAL PERFORMANCE

Typical IV Curve for GEPVp-200-MS Module



Typical Performance Characteristics

Peak Power (Wp)	Watts	200
Max. Power Voltage (Vmp)	Volts	26.3
Max. Power Current (Imp)	Amps	7.6
Open Circuit Voltage (Voc)	Volts	32.9
Short Circuit Current (Isc)	Amps	8.1
Short Circuit Temp. Coefficient	mA/°C	5.6
Open Circuit Voltage Coefficient	V/°C	-0.12
Max. Power Temp. Coefficient	%/°C	-0.5
Max. Series Fuse	Amps	15
Max. System Voltage	Volts	600
Normal Operating Cell Temperature [NOCT]	deg. C	45

IV parameters are rated at Standard Test Conditions (Irradiance of 1000 W/m², AM 1.5G, cell temperature 25°C). As with all poly-crystalline PV Modules, during the stabilization process that occurs during the first few days in service, module power may decrease approximately 3% from typical maximum power due to a phenomenon known as Light Induced Degradation (LID). All measurements are guaranteed at the laminate leads. NOCT is measured at 800 W/m², 20 deg. C ambient, and 1 m/s windspeed

GE Energy
231 Lake Drive
Newark, DE 19702
866-750-3150
ge-energy.com/solar

GEA-14807 (10/06) Photo: PSP30590-03
30R/15PC

GEN SET PACKAGE PERFORMANCE DATA [516DE2A]

DECEMBER 01, 2005

Can't find what you're looking for? Click here

Performance Number: DM7040

Change Level: 00

Sales Model: 3516BDITA
Combustion: DI
Aspr: TA
Engine Power:
1450 W/F EKW 1500 W/O F EKW 1,566.0 KW
Speed: 1,200 RPM
After Cooler: SCAC
Manifold Type: DRY
Governor Type: ADEM
After Cooler Temp(C): 60
Turbo Quantity: 2
Engine App: GP
Turbo Arrangement: Parallel
Hertz: 60
Engine Rating: PGS
Strategy: Low BSFC Strategy
Rating Type: PRIME
Certification: N-C 1970 - 2100

General Performance Data

GEN W/F EKW	PERCENT LOAD	ENGINE POWER BKW	ENGINE BMEP KPA	FUEL RATE G/BKW-HR	FUEL RATE LPH	INTAKE MFLD TEMP DEG C	INTAKE MFLD P KPA	INTAKE AIR FLOW M3/MIN	EXH MFLD TEMP DEG C	EXH STACK TEMP DEG C	EXH GAS FLOW M3/MIN
1,450.0	100	1,553.3	1,989	200.100	370.5	68.3	231.9	119.8	619.3	458.4	311.2
1,305.0	90	1,401.3	1,795	198.900	332.2	67.2	202.4	109.4	600.2	447.7	279.9
1,160.0	80	1,251.1	1,602	198.400	295.9	66.0	173.2	99.1	581.3	439.3	250.5
1,087.5	75	1,176.5	1,507	198.600	278.5	65.5	158.7	94.0	571.9	436.0	236.4
1,015.0	70	1,101.7	1,411	198.800	261.1	65.3	144.3	88.9	562.4	433.1	222.2
870.0	60	953.2	1,221	199.900	227.2	64.9	116.0	78.7	542.8	427.4	194.7
725.0	50	805.3	1,031	202.300	194.2	64.5	88.2	68.5	522.4	421.6	168.5
580.0	40	661.1	847	206.800	163.0	64.0	66.0	60.3	491.7	404.3	144.7
435.0	30	512.8	657	214.600	131.2	63.5	46.6	53.2	447.4	373.8	121.7
362.5	25	437.0	560	220.900	115.1	63.2	37.8	50.0	420.1	353.7	110.5
290.0	20	360.2	461	230.100	98.8	62.9	29.7	47.0	385.9	328.0	99.4
145.0	10	203.1	260	271.100	65.6	62.2	15.4	41.9	298.1	259.3	78.1

Heat Rejection Data

GEN W/F EKW	PERCENT LOAD	REJ TO JW KW	REJ TO ATMOS KW	REJ TO EXHAUST KW	EXH RCOV TO 177C KW	FROM OIL CLR KW	FROM AFT CLR KW	WORK ENERGY KW	LHV ENERGY KW	HHV ENERGY KW
1,450.0	100	556	141	1,366	710	185	307	1,553	3,684	3,925
1,305.0	90	518	135	1,215	622	166	250	1,401	3,304	3,519
1,160.0	80	480	130	1,078	545	147	196	1,251	2,943	3,135
1,087.5	75	461	127	1,014	510	139	171	1,176	2,768	2,949
1,015.0	70	442	125	951	476	130	147	1,102	2,596	2,765
870.0	60	403	120	828	411	113	103	953	2,259	2,406
725.0	50	363	115	709	349	97	65	805	1,931	2,057
580.0	40	323	108	594	284	81	38	661	1,619	1,725
435.0	30	280	100	478	215	65	18	513	1,303	1,388
362.5	25	257	95	420	180	57	9	437	1,144	1,218
290.0	20	232	91	361	144	49	2	360	983	1,047
145.0	10	177	82	242	68	33	-9	203	653	696

EXHAUST Sound Data: 15.0 METERS

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
1,450.0	100	94	96	100	95	88	87	88	88	83
1,305.0	90	93	95	99	94	87	86	87	87	82
1,160.0	80	92	94	98	93	86	86	86	86	81
1,087.5	75	91	93	98	92	85	85	86	85	80
1,015.0	70	91	93	97	92	85	85	85	85	80
870.0	60	90	92	96	91	84	84	84	84	79
725.0	50	89	91	95	90	83	83	83	83	78
580.0	40	88	90	94	89	82	82	82	82	77
435.0	30	87	89	93	88	81	80	81	81	76
362.5	25	86	88	92	87	80	80	80	80	75
290.0	20	85	87	92	86	79	79	80	79	74
145.0	10	83	85	90	84	77	77	78	77	72

MECHANICAL Sound Data: 1.0 METERS

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
1,450.0	100	112	115	124	115	106	99	97	94	97
1,305.0	90	112	115	124	115	106	99	97	94	97
1,160.0	80	112	115	124	115	106	99	97	94	97
1,087.5	75	112	115	124	115	106	99	97	94	97
1,015.0	70	112	115	124	115	106	99	97	94	97
870.0	60	112	115	124	115	106	99	97	94	97
725.0	50	112	115	124	115	106	99	97	94	97
580.0	40	112	115	124	115	106	99	97	94	97
435.0	30	112	115	124	115	106	99	97	94	97
362.5	25	112	115	124	115	106	99	97	94	97
290.0	20	112	115	124	115	106	99	97	94	97
145.0	10	112	115	124	115	106	99	97	94	97

EXHAUST Sound Data: 2.0 METERS

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
1,450.0	100	114	113	119	114	107	105	108	107	105
1,305.0	90	113	112	118	113	106	104	107	106	104
1,160.0	80	112	111	117	112	105	103	106	105	103
1,087.5	75	111	110	116	111	104	103	106	104	102
1,015.0	70	111	110	116	111	104	102	105	104	102
870.0	60	110	109	115	110	103	101	104	103	101
725.0	50	109	108	114	109	102	100	103	102	100
580.0	40	108	107	113	108	101	99	102	101	99
435.0	30	107	106	112	107	100	98	101	100	98
362.5	25	106	105	111	106	99	97	100	99	97
290.0	20	105	104	110	105	98	96	100	98	96
145.0	10	103	102	108	103	96	95	98	96	94

EXHAUST Sound Data: 7.0 METERS

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
1,450.0	100	100	102	107	101	94	94	95	94	89
1,305.0	90	99	101	106	100	93	93	94	93	88
1,160.0	80	98	100	105	99	92	92	93	92	87
1,087.5	75	98	100	105	99	92	92	93	92	87
1,015.0	70	98	100	104	99	92	91	92	92	87
870.0	60	97	99	103	98	91	90	91	91	86
725.0	50	96	98	102	97	90	89	90	90	85
580.0	40	94	96	101	95	88	88	89	88	83
435.0	30	93	95	100	94	87	87	88	87	82
362.5	25	92	94	99	93	86	86	87	86	81
290.0	20	92	94	98	93	86	85	86	86	81
145.0	10	90	92	96	91	84	84	84	84	79

MECHANICAL Sound Data: 7.0 METERS

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCJ 8000HZ DB
1,450.0	100	98	101	111	101	92	87	86	83	86
1,305.0	90	98	101	111	101	92	87	86	83	86
1,160.0	80	98	101	111	101	92	87	86	83	86
1,087.5	75	98	101	111	101	92	87	86	83	86
1,015.0	70	98	101	111	101	92	87	86	83	86
870.0	60	98	101	111	101	92	87	86	83	86
725.0	50	98	101	111	101	92	87	86	83	86
580.0	40	98	101	111	101	92	87	86	83	86
435.0	30	98	101	111	101	92	87	86	83	86
362.5	25	98	101	111	101	92	87	86	83	86
290.0	20	98	101	111	101	92	87	86	83	86
145.0	10	98	101	111	101	92	87	86	83	86

MECHANICAL Sound Data: 15.0 METERS

GEN W/F EKW	PERCENT LOAD	OVERALL SOUND DB(A)	OBCF 63HZ DB	OBCF 125HZ DB	OBCF 250HZ DB	OBCF 500HZ DB	OBCF 1000HZ DB	OBCF 2000HZ DB	OBCF 4000HZ DB	OBCF 8000HZ DB
1,450.0	100	92	95	104	95	86	81	80	77	80
1,305.0	90	92	95	104	95	86	81	80	77	80
1,160.0	80	92	95	104	95	86	81	80	77	80
1,087.5	75	92	95	104	95	86	81	80	77	80
1,015.0	70	92	95	104	95	86	81	80	77	80
870.0	60	92	95	104	95	86	81	80	77	80
725.0	50	92	95	104	95	86	81	80	77	80
580.0	40	92	95	104	95	86	81	80	77	80
435.0	30	92	95	104	95	86	81	80	77	80
362.5	25	92	95	104	95	86	81	80	77	80
290.0	20	92	95	104	95	86	81	80	77	80
145.0	10	92	95	104	95	86	81	80	77	80

EMISSIONS DATA

N-C 1970 - 2100 ** N1

This engine rating is not emission certified by any domestic or foreign agency.

EXHAUST STACK DIAMETER	305 MM
WET EXHAUST MASS	8,842.0 KG/HR
WET EXHAUST FLOW (458.00 C STACK TEMP)	311.40 M3/MIN
WET EXHAUST FLOW RATE (0 DEG C AND 101.2 KPA)	116.20 M3/MIN
DRY EXHAUST FLOW RATE (0 DEG C AND 101.2 KPA)	103.80 M3/MIN
FUEL FLOW RATE	370 L/HR

RATED SPEED "Nominal Data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) G/HR	TOTAL CO G/HR	TOTAL HC G/HR	TOTAL CO2 KG/HR	PART MATTER G/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	12,342	2,375	241	974.7	215.9	10.10	1.2	1.28
1,087.5	75	1,176.5	9,447	2,284	189	731.9	127.6	10.50	1.2	1.28
725.0	50	805.3	7,085	796	146	512.6	76.1	11.00	1.1	1.28
362.5	25	437.0	4,333	385	128	303.7	56.7	12.90	1.2	1.28
145.0	10	203.1	2,947	353	147	171.5	30.5	15.50	0.2	1.28

RATED SPEED "Nominal Data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) mg/norm cu M @ %5 O2	TOTAL CO mg/norm cu M @ %5 O2	TOTAL HC mg/norm cu M @ %5 O2	PART MATTER mg/norm cu M @ %5 O2	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	2,896.1	557.3	56.5	50.7	10.10	1.2	1.28
1,087.5	75	1,176.5	2,950.4	713.3	59.1	39.8	10.50	1.2	1.28
725.0	50	805.3	3,173.2	356.7	65.6	34.1	11.00	1.1	1.28
362.5	25	437.0	3,282.5	291.4	97.1	43.0	12.90	1.2	1.28
145.0	10	203.1	3,909.1	468.3	194.6	40.4	15.50	0.2	1.28

RATED SPEED "Nominal Data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) PPM @ % 5 O2	TOTAL CO PPM @ %5 O2	TOTAL HC PPM @ %5 O2	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	1,410	447	91	10.10	1.2	1.28
1,087.5	75	1,176.5	1,437	570	95	10.50	1.2	1.28
725.0	50	805.3	1,547	280	106	11.00	1.1	1.28
362.5	25	437.0	1,585	235	157	12.90	1.2	1.28
145.0	10	203.1	1,893	379	315	15.50	0.2	1.28

RATED SPEED "Nominal Data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) G/HP-HR	TOTAL CO G/HP-HR	TOTAL HC G/HP-HR	PART MATTER G/HP-HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	5.93	1.14	0.12	0.10	10.10	1.2	1.28
1,087.5	75	1,176.5	5.99	1.45	0.12	0.08	10.50	1.2	1.28
725.0	50	805.3	6.56	0.74	0.14	0.07	11.00	1.1	1.28
362.5	25	437.0	7.39	0.66	0.22	0.10	12.90	1.2	1.28
145.0	10	203.1	10.82	1.30	0.54	0.11	15.50	0.2	1.28

RATED SPEED "Not to exceed data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) G/HR	TOTAL CO G/HR	TOTAL HC G/HR	PART MATTER G/HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	14,811	4,275	320	302.3	10.10	1.2	1.28
1,087.5	75	1,176.5	11,336	4,111	252	178.6	10.50	1.2	1.28
725.0	50	805.3	8,502	1,434	195	106.5	11.00	1.1	1.28
362.5	25	437.0	5,199	692	170	79.4	12.90	1.2	1.28
145.0	10	203.1	3,536	636	195	42.7	15.50	0.2	1.28

RATED SPEED "Not to exceed data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) mg/norm cu M @ %5 O2	TOTAL CO mg/norm cu M @ %5 O2	TOTAL HC mg/norm cu M @ %5 O2	PART MATTER mg/norm cu M @ %5 O2	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	3,475.3	1,003.2	75.2	70.900	10.10	1.2	1.28
1,087.5	75	1,176.5	3,540.5	1,284.0	78.6	55.800	10.50	1.2	1.28
725.0	50	805.3	3,807.9	642.1	87.3	47.700	11.00	1.1	1.28
362.5	25	437.0	3,939	524.4	129.1	60.200	12.90	1.2	1.28
145.0	10	203.1	4,690.9	843.0	258.8	56.600	15.50	0.2	1.28

RATED SPEED "Not to exceed data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) PPM @ % 5 O2	TOTAL CO PPM @ %5 O2	TOTAL HC PPM @ %5 O2	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	1,692	805	121	10.10	1.2	1.28
1,087.5	75	1,176.5	1,725	1,026	127	10.50	1.2	1.28
725.0	50	805.3	1,856	504	141	11.00	1.1	1.28
362.5	25	437.0	1,902	422	209	12.90	1.2	1.28
145.0	10	203.1	2,272	682	419	15.50	0.2	1.28

RATED SPEED "Not to exceed data"

GEN PWR EKW	PERCENT LOAD	ENGINE POWER BKW	TOTAL NOX (AS NO2) G/HP-HR	TOTAL HC G/HP-HR	TOTAL HC G/HP-HR	PART MATTER G/HP-HR	OXYGEN IN EXHAUST PERCENT	DRY SMOKE OPACITY PERCENT	BOSCH SMOKE NUMBER
1,450.0	100	1,553.3	7.11	2.05	0.15	0.145	10.10	1.2	1.28
1,087.5	75	1,176.5	7.18	2.61	0.16	0.113	10.50	1.2	1.28
725.0	50	805.3	7.87	1.33	0.18	0.099	11.00	1.1	1.28
362.5	25	437.0	8.87	1.18	0.29	0.136	12.90	1.2	1.28
145.0	10	203.1	12.98	2.33	0.72	0.157	15.50	0.2	1.28

Reference Number: DM7040 N-C 19702100N1

Parameters Reference: TM5739

GEN SET - PACKAGED - DIESEL
TOLERANCES:
AMBIENT AIR CONDITIONS AND FUEL USED WILL AFFECT THESE VALUES. EACH OF THE VALUES MAY VARY IN ACCORDANCE WITH THE FOLLOWING TOLERANCES.

ENGINE POWER	+/-	3%
EXHAUST STACK TEMPERATURE	+/-	8%
GENERATOR POWER	+/-	5%
INLET AIR FLOW	+/-	5%
INTAKE MANIFOLD PRESSURE - GAGE	+/-	10%
EXHAUST FLOW	+/-	6%
SPECIFIC FUEL CONSUMPTION	+/-	3%
FUEL RATE	+/-	5%
HEAT REJECTION	+/-	5%
HEAT REJECTION EXHAUST ONLY	+/-	10%

CONDITIONS:
ENGINE PERFORMANCE IS CORRECTED TO INLET AIR STANDARD CONDITIONS OF 99 KPA (29.31 IN HG) AND 25 DEG C (77 DEG F).

THESE VALUES CORRESPOND TO THE STANDARD ATMOSPHERIC PRESSURE AND TEMPERATURE IN ACCORDANCE WITH SAE J1995. ALSO INCLUDED IS A CORRECTION TO STANDARD FUEL GRAVITY OF 35 DEGREES API HAVING A LOWER HEATING VALUE OF 42,780 KJ/KG (18,390 BTU/LB) WHEN USED AT 29 DEG C (84.2 DEG F) WHERE THE DENSITY IS 838.9 G/L (7.002 LB/GAL).

THE CORRECTED PERFORMANCE VALUES SHOWN FOR CATERPILLAR ENGINES WILL APPROXIMATE THE VALUES OBTAINED WHEN THE OBSERVED PERFORMANCE DATA IS CORRECTED TO SAE J1995, ISO 3046-2 & 8665 & 2288 & 9249 & 1585, EEC 80/1269 AND DIN70020 STANDARD REFERENCE CONDITIONS.

ENGINES ARE EQUIPPED WITH STANDARD ACCESSORIES; LUBE OIL, FUEL PUMP AND JACKET WATER PUMP. THE POWER REQUIRED TO DRIVE AUXILIARIES MUST BE DEDUCTED FROM THE GROSS OUTPUT TO ARRIVE AT THE NET POWER AVAILABLE FOR THE EXTERNAL (FLYWHEEL) LOAD. TYPICAL AUXILIARIES INCLUDE COOLING FANS, AIR COMPRESSORS, AND CHARGING ALTERNATORS.

RATINGS MUST BE REDUCED TO COMPENSATE FOR ALTITUDE AND/OR AMBIENT TEMPERATURE CONDITIONS ACCORDING TO THE APPLICABLE DATA SHOWN ON THE PERFORMANCE DATA SET.

GEN SET - PACKAGED - DIESEL
ALTITUDE:
ALTITUDE CAPABILITY - THE RECOMMENDED REDUCED POWER VALUES FOR SUSTAINED ENGINE OPERATION AT SPECIFIC ALTITUDE LEVELS AND AMBIENT TEMPERATURES.

COLUMN "N" DATA - THE FLYWHEEL POWER OUTPUT AT NORMAL AMBIENT TEMPERATURE.

AMBIENT TEMPERATURE - TO BE MEASURED AT THE AIR CLEANER AIR INLET DURING NORMAL ENGINE OPERATION.
NORMAL TEMPERATURE - THE NORMAL TEMPERATURE AT VARIOUS SPECIFIC ALTITUDE LEVELS IS FOUND ON TM2001.

THE GENERATOR POWER CURVE TABULAR DATA REPRESENTS THE NET ELECTRICAL POWER OUTPUT OF THE GENERATOR.

DEFINITIONS:

Altitude Capability Data(Corrected Power Altitude Capability)

Ambient Operating Temp.	10 C	20 C	30 C	40 C	50 C	NORMAL
Altitude						
0 M	1,566 kw	1,566 kw	1,566 kw	1,566 kw	1,566 kw	1,566 kw
300 M	1,566 kw	1,566 kw	1,566 kw	1,566 kw	1,566 kw	1,566 kw
500 M	1,566 kw	1,566 kw	1,566 kw	1,566 kw	1,566 kw	1,566 kw
1,000 M	1,566 kw	1,566 kw	1,566 kw	1,522 kw	1,474 kw	1,566 kw
1,500 M	1,566 kw	1,529 kw	1,479 kw	1,431 kw	1,387 kw	1,526 kw
2,000 M	1,489 kw	1,438 kw	1,390 kw	1,346 kw	1,304 kw	1,451 kw
2,500 M	1,399 kw	1,351 kw	1,306 kw	1,264 kw	1,225 kw	1,378 kw
3,000 M	1,313 kw	1,268 kw	1,226 kw	1,187 kw	1,150 kw	1,309 kw
3,200 M	1,280 kw	1,236 kw	1,196 kw	1,157 kw	1,121 kw	1,282 kw

The powers listed above and all the Powers displayed are Corrected Powers

Identification Reference and Notes

Engine Arrangement:	2603686	**Lube Oil Press @ Rated Spd(KPA):**	385.0
Effective Serial No:	GZT00001	**Piston Speed @ Rated Eng SPD(M/Sec):**	8.1
Primary Engine Test Spec:	0K5867	**Max Operating Altitude(M):**	1,240.0
Performance Parm Ref:	TM5739	**PEEC Elect Control Module Ref**	
Performance Data Ref:	DM7040	**PEEC Personality Cont Mod Ref**	
Aux Coolant Pump Perf Ref:			
Cooling System Perf Ref:		**Turbocharger Model**	GT604104B-1.70
Certification Ref:	N-C	**Fuel Injector**	1950962
Certification Year:	1970	**Timing-Static (DEG):**	--
Compression Ratio:	15.5	**Timing-Static Advance (DEG):**	--
Combustion System:	DI	**Timing-Static (MM):**	--
Aftercooler Temperature (C):	60	**Unit Injector Timing (MM):**	64.3
Crankcase Blowby Rate(M3/H):	59.4	**Torque Rise (percent)**	--
Fuel Rate (Rated RPM) No Load(L/HR):	32.0	**Peak Torque Speed RPM**	--
Lube Oil Press @ Low Idle Spd(KPA):	138.0	**Peak Torque (NM):**	--

STANDBY - MAXIMUM OUTPUT AVAILABLE FOR NON PROGRAMMED POWER OUTAGES. THE EXPECTED USAGE SHOULD BE APPROXIMATELY 30 HOURS PER YEAR AND THE AVERAGE DEMAND, DURING THE OUTAGE, SHOULD NOT EXCEED THE CORRESPONDING INDUSTRIAL ENGINE CONTINUOUS RATING. STANDBY RATINGS MAY BE USED IN PEAK SHAVING AND DURING INTERRUPTIBLE UTILITY SERVICE IF THE FOLLOWING CRITERIA ARE MET.

500	HOURS/YEAR OR LESS
60%	MAXIMUM AVERAGE LOAD FACTOR
80%	LOAD PEAK DEMAND
100%	LOAD USED ONLY FOR EMERGENCIES

PRIME POWER - OUTPUT AVAILABLE FOR PEAK DEMAND OF A VARIABLE ELECTRIC LOAD INCLUDING PEAK SHAVING AND PROGRAMMED OUTAGES. THE AVERAGE DEMAND DURING ANY 24 HOUR PERIOD SHOULD NOT EXCEED THE CORRESPONDING INDUSTRIAL ENGINE CONTINUOUS RATING. ALL PRIME POWER RATINGS, EXCEPT D SERIES, HAVE 10% OVERLOAD FOR EMERGENCY USE.

CONTINUOUS - OUTPUT WHICH MAY BE UTILIZED CONTINUOUSLY WITHOUT LOAD CYCLING. ALL 3600 ENGINE CONTINUOUS RATINGS HAVE 10% OVERLOAD CAPABILITY.

APPENDIX 24

TECHNICAL MEMORANDUM

DATE 30 September 2009 **PROJECT No.** 08-1365-0081

TO Lorraine Sawdon
Fisheries and Oceans Canada

CC Jim O'Neil - Golder Associates Ltd.; David Harpley - Canadian Zinc Corporation

FROM David Hamilton **EMAIL** dhamilton@golder.com

ADDITIONAL CONSIDERATIONS FOR FISH HABITAT COMPENSATION

1.0 INTRODUCTION

The draft fish compensation plan (February 2009) for the upgrade works on the winter access road to the Prairie Creek Mine identified several options for fish habitat compensation, including:

- in-stream works in Prairie Creek; and
- rectifying fish passage issues on the Liard Highway or Mackenzie Highway.

During community meetings in early summer 2009, the Nahanni Butte First Nations expressed concerns about using culvert repairs along the highways for the fish habitat compensation. Their opinion was that this would place the compensation at too great a distance from the Prairie Creek watershed. A field visit was carried out in late July 2009 to investigate additional options for fish habitat compensation in the vicinity of the Prairie Creek Mine (i.e., re-examination of sites on Prairie, Harrison, and Funeral creeks), and on Liard Highway stream crossings.

2.0 FIELD OBSERVATIONS

Field observations were undertaken during the period 27 to 31 July 2009.

2.1 Harrison Creek

Harrison Creek was re-evaluated for possible inclusion in the fish habitat compensation plan. The rock at the culvert outfalls close to Prairie Creek (Plate 1) is likely a barrier to fish passage under most flow conditions, except perhaps under exceptionally high flow conditions. The stream was examined on 30 July 2009, the morning after an intense rain storm. Despite the heavy rain, which increased stream flows, the majority of the channel remained very shallow and provided little habitat for fish (Plates 1 and 2). Habitat suitable for juvenile fish extended for approximately 30 m upstream of the culverts (Plate 2); created primarily by flows from Prairie Creek Mine site discharge, which are a combination of site run-off and treated mine water. Upstream of this point, the stream bifurcated into several narrow channels. A significant proportion of the flows appear to be interstitial in this section based on the higher surface flows in the upper reaches and the water visibly seeping out of the gravel into the pool immediately upstream of the culverts.

Plate 1: Looking upstream from Prairie Creek at Harrison Creek culverts.

Plate 2: Looking upstream of Harrison Creek culverts.

In the upper reaches of the stream (i.e., upstream of the mill) the stream is narrow (1 m to 2 m wide) and less than 10 cm deep. As such, the available habitat would not permit fish movements or residency into the upper part of the watershed (Plate 3). The stream bed was made up of extensive unconsolidated gravel and cobble deposits, suggesting there are episodic events of high flow and bed load. Large woody debris does not appear to contribute to in-stream habitat, as the trees in the riparian areas were small (i.e., small diameter) and no trees were evident in the portions of the stream channel examined.

Plate 3: Upper Harrison Creek, near the proposed rock dump.

In summary, based on the observations made in 2008 and again in 2009, Harrison Creek does not provide useable fish habitat. The presence of very low flows, even after a heavy rain event, suggests that the stream could not support fish (with the possible exception of 30 m of channel upstream of the existing road culverts), assuming that fish are able to pass the culverts. Therefore, it is recommended that Harrison Creek not be included in the fish habitat compensation plan.

2.2 Funeral Creek

Mochnacz (2001) reported capturing bull trout in Funeral Creek, near the mouth and “approximately 3 km from the headwaters.” The data presented by Mochnacz (2001) suggests that the bull trout in Funeral Creek are a stream resident population, which resides in the stream on a year-round basis. Stewart et al. (2007) have classified the Prairie Creek bull trout population as stream resident. Immediately above the confluence with Fast Creek, the stream generally features a single narrow channel, with little off-channel habitat. There is a small side channel located at approximately Km 8.5 on the access road. The side channel is approximately 50 m in length and has a bankfull width of 6 m (Plate 4). This habitat is currently isolated from the main channel by an 18 m long culvert that has a perched outlet. The channel is fed at the upper end by seepage from the mountain side and inflow from a high gradient tributary. The channel has a series of step-pools that are approximately 25 cm high.

Replacing the existing culvert with a larger, embedded culvert could open up additional seasonal rearing habitat for bull trout. Therefore, reactivation of the side channel is an option that could be considered in the fish habitat compensation plan.

Plate 4: Looking upstream of road at Funeral Creek side channel at Km 8.5 on the access road.

2.3 Prairie Creek

Prairie Creek was examined at several locations during the July 2009 site visit. Initially the flows were low and large bars were evident in the channel (Plates 5 and 6). Heavy rains occurred during the evening and night of 29 July. Water levels were significantly higher on the morning of 30 July and many of the bars visible the day before were submerged (Plate 7).

As noted during the 2008 surveys, the in-stream habitat features were largely associated with large boulders (Plate 8) or bedrock outcroppings (Plate 5). The boulders created back eddies that were 6 m to 10 m long and 1.5 m wide (Plate 8). These microhabitats could provide potential holding and feeding areas for fish.

When the water levels increased after the rain event, another type of habitat feature became evident. There were portions of the channel where boulder clusters or rock lines were located near the margins of the channel. Visual assessments suggest that the boulders in these rock lines were generally 50 cm to 75 cm in diameter. As with the larger boulders, these boulder clusters create back eddies and slower water refuges at high flows (Plates 9 and 10), which could be used by juvenile life-stages.

The appearance of the rock lines at higher flows raised the question of the size of rock the stream was capable of moving. An investigation of a depositional bar located downstream of Harrison Creek (Plate 11) and another located near Road Section B (Plate 12) was made to assess the size of the material being deposited on the bars. The bar downstream of Harrison Creek was relatively coarse in appearance (Plate 11). A tape measure was used to lay out two transects on the bar. Stones touching the tape at approximately 2 m intervals were selected for measurement. The measurements[1] found that the mean size was 8 cm on the first transect and 12 cm on the second transect (minimum 1 cm and maximum 40 cm). The bar located on the left downstream bank near Site B was comprised of much smaller sized material, averaging approximately 2 cm (Plate 13).

[1] Measurements taken along the intermediate axis of each stone.

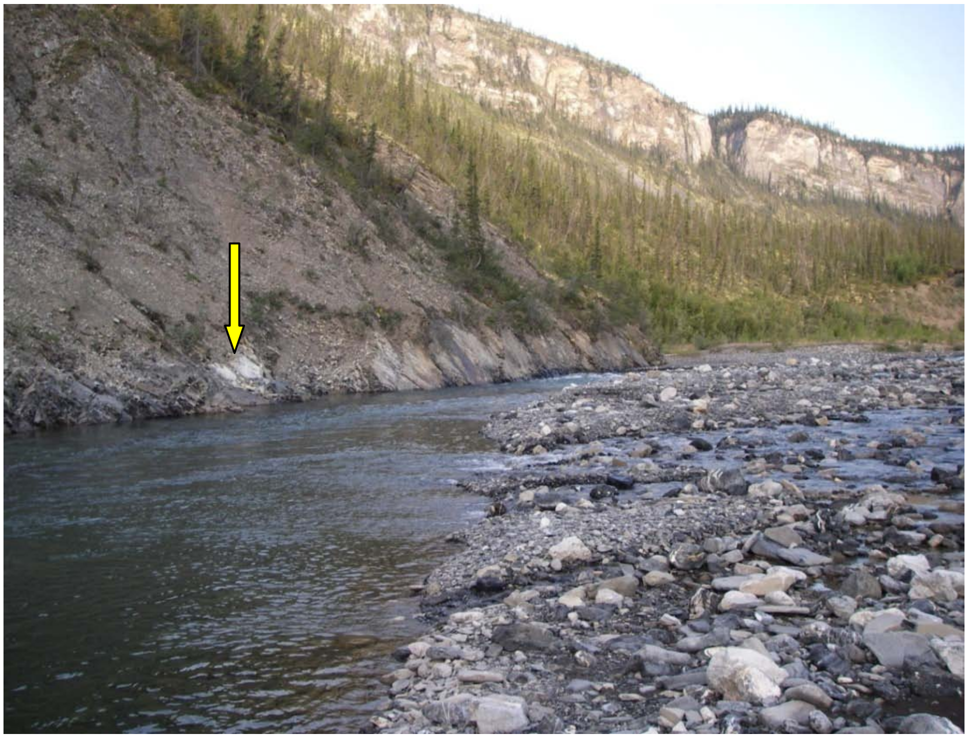


Plate 5: Looking upstream at riffle pool sequence on right downstream bank, located at the downstream end of the bar adjacent to the flood control dyke. Yellow arrow refers to same location in Plate 7.

Plate 6: Looking upstream along flood control dike. The main flow of the river is in the left of the frame (behind arrow), along the right downstream bank. The white arrows in Plate 6 and Plate 7 refer to approximately the same locations on the gravel bar.

Plate 7: Looking from left downstream bank at bar at high flows on 30 July 2009. The white arrows in Plate 5 and Plate 6 refer to approximately the same locations on the gravel bar. Yellow arrow refers to same location in Plate 5.

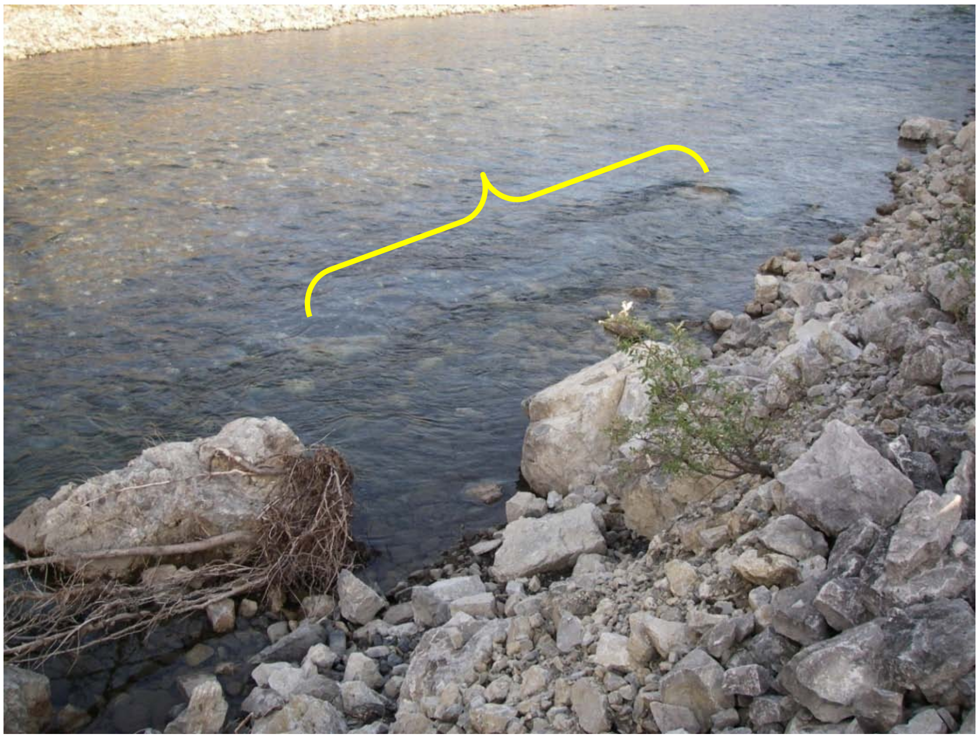


Plate 8: Back eddies created by single large boulder, positioned along the flood control dike.

Plate 9: Boulder lines and clusters along the right downstream bank, the day after heavy rain.

Plate 10: Rock line extending from left downstream bank, at a site near the quarry.

Plate 11: Bar located on the left downstream bank, below the Harrison Creek confluence.

Plate 12: Bar located on left downstream bank at Road Section B.

Plate 13: Composition of gravel bar on left downstream bank near Site B.

The information gathered from the bars suggests that while Prairie Creek has a high bed load, it is not regularly transporting large boulders. This is likely a result of the wide floodplain, which allows the stream to flood and dissipate energy at flows exceeding bankfull stage. Therefore, it is likely that large boulders (i.e., > 1.0 m diameter) form habitat features that can withstand the average peak flows.

2.4 Liard Highway

A culvert assessment was carried out at a crossing of the Liard Highway, located approximately 200 m south of the Nahanni Butte turn-off. The crossing structure was a corrugated metal pipe culvert, approximately 3 m diameter (Plate 14). The culvert appears to be appropriately sized for the dimensions of the stream (i.e., bankfull width not constricted at the culvert), and the crossing was not a fish barrier. There were no other crossings located near the Nahanni Butte access road.

Based on the conditions noted at the above-mentioned culvert, and observations made by others, it appears that the culverts at crossings on the Liard Highway are appropriately sized and installed, or bridges were installed during the original construction of the road. For this reason, fish barriers have not developed as has commonly occurred on many access roads in the north. Therefore, using culverts along the Liard Highway does not appear to be a suitable option for inclusion in the compensation plan.

3.0 CONCLUSIONS AND RECOMMENDATIONS

Based on the observations made during the July 2009 survey the following conclusions and recommendations for the fish habitat compensation plan are provided:

- The Liard Highway stream crossings do not appear to present barriers to fish passage and do not provide opportunities for fish compensation.
- Useable fish habitat in Harrison Creek is restricted to the immediate vicinity of the stream mouth and culverts, but only because of mine site discharge and the habitat may not be accessible to fish from Prairie Creek. Fish habitat available in upstream reaches is also limited.

- The replacement of the culvert on the Funeral Creek side channel may provide an opportunity to create off-channel, seasonal rearing habitat for juvenile bull trout.
- Boulders and rock lines in Prairie Creek provide in-stream habitat features that create back eddies and slower water refuge habitat that fish, particularly juvenile life-stages, could utilize. Therefore, large boulders (i.e., > 1 m) are likely resident in the channel for long periods of time, particularly in the portions of the channel where there is a large ratio between valley width and late summer channel bank full width.

Plate 14: Looking upstream at culvert crossing of the Liard Highway.

Based on these observations, it is recommended that the fish habitat compensation plan be focus on increasing habitat complexity in Prairie Creek by creating a series of rock lines or groynes in the stream channel, downstream of Road Section B (Plate 15). This would create in-channel habitat complexity in a portion of the channel that is relatively uniform, shallow run. The use of boulder structures to create habitat features is supported by observations by Mochnacz et al. (2004), who reported that boulders were the dominant form of cover in portions of Funeral Creek where they captured bull trout. The following characteristics of this reach were considered in recommending the channel near Road Section B for possible fish compensation:

- currently uniform habitat dominated by shallow run (R3) and small areas of moderately deep (R2) habitat, separated by short sections of riffle;
- large area of uniform habitat (> 300 m in length);
- wide floodplain, which would reduce erosive forces at high flows; and
- good access for equipment and materials.

The replacement of the culvert and reconnection of the Funeral Creek side channel could also be considered. This would provide approximately 300 m^2 of seasonal habitat for juvenile bull trout.

Plate 15: Looking upstream along the left downstream bank, approximately 300 m downstream of road Section B.

Mochnacz et al. (2004) report relatively low densities of fish in the study area. For example, a three-pass removal electrofishing survey in two reaches of Funeral Creek resulted in 17 and 21 bull trout being captured (Mochnacz et al. 2004). While it is anticipated that the habitat features included in the fish compensation plan will provide higher quality habitat than the habitat impacted by the road upgrade activity (refer to the draft fish compensation plan), the use of habitat compensation features will likely be sporadic. Therefore, measures of success for the habitat compensation plan should be focussed on the stability and uniqueness of the habitat features.

4.0 CLOSURE

We look forward to discussing the contents of this memo with you, via conference call. Once agreement has been reached regarding the approach to the fish habitat compensation, we can then produce a complete fish habitat compensation plan.

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Associate/Senior Aquatic Scientist

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Principal/Senior Fisheries Biologist

JDH/JPO/ldmg

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APPENDIX 25

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[Natural Resources Canada](#) > [Earth Sciences Sector](#) > Earthquakes Canada

Search the Earthquake Database

This form makes available seismic bulletin data from the National Earthquake Database (NEDB) since 1985. As some parameters like focal depth are poorly known for most earthquakes, they are often specified only as nominal or default values. Before using the data, please contact us for additional information on the limitations of the dataset. Information for recent earthquakes (within the last year) should be considered preliminary, possibly incomplete, and subject to change. Lastly, the information for *mining-related-event* and *blasts* may not be complete.

Use of this data is subject to the END-USER AGREEMENT FOR DIGITAL DATA of the GSC. In addition, all users of this data are asked to include a citation to Earthquakes Canada in their work.

Note that all queries and data use Coordinated Universal Time (UTC).
The current time is 2010-01-06 19:18:46 UTC.

Search Parameters

Your search range reaches before 1985, only events after 1985 will be shown.

Date.Time 19840101.0000 From: yyyymmdd.hhmm 20100105.0000 To: yyyymmdd.hhmm

Depth 0 km 100 km

Magnitude 0 M[n|s|l|?] 9.9 M[n|s|l|?]

Radius (selected) centre 61.554 lat -124.79 lon city /
radius 100 km

Region north 62.5533 east -122.80
south 60.5547 west -126.77

Type [x] Quakes [ ] Mining events [ ] Blasts [ ] Induced

Felt [ ] Only show earthquakes that were felt

[x] **Display List**

Sorting date (selected) lat lon depth mag

Order ascending (selected) descending

Output HTML (selected) Text XLS CSV

(Note: only html will allow map below to be visible)

[x] **Display Map**

Submit Request

	Date	Time(UT)	Lat	Long	Depth	Mag	Region and Comment
[Details]	2009/10/28	09:14:34	62.08	-124.08	5.0g	3.1ML	152 km W of Fort Simpson
[Details]	2009/10/11	17:17:57	61.83	-126.21	1.0g	3.2ML	237 km ENE of Watson Lk.
[Details]	2009/10/11	08:40:40	61.69	-126.18	1.0g	3.1ML	225 km ENE of Watson Lk.
[Details]	2009/10/10	05:21:11	61.89	-126.26	1.0g	3.3ML	240 km NE of Watson Lk.
[Details]	2009/10/09	20:03:21	61.88	-126.32	5.0g	3.5ML	237 km NE of Watson Lk.
[Details]	2009/10/09	19:29:49	61.88	-126.26	1.0g	3.4ML	239 km NE of Watson Lk.
[Details]	2009/10/07	17:56:26	61.79	-126.22	1.0g	3.5ML	232 km ENE of Watson Lk.
[Details]	2009/10/07	12:10:41	61.80	-126.20	1.0g	2.9ML	234 km ENE of Watson Lk.
[Details]	2009/10/06	05:29:13	61.83	-126.29	5.0g	2.9ML	234 km NE of Watson Lk.
[Details]	2009/10/02	03:52:02	62.27	-124.51	10.0g	3.6ML	179 km W of Fort Simpson
[Details]	2009/09/26	11:33:57	62.19	-124.15	5.0g	3.2ML	158 km W of Fort Simpson
[Details]	2009/09/20	08:44:49	61.43	-126.51	1.0g	2.9ML	192 km ENE of Watson Lk.
[Details]	2009/07/31	17:46:50	61.05	-125.50	1.0g	4.3Mw	208 km ENE of Watson Lk.
[Details]	2009/06/25	12:32:59	62.26	-124.32	1.0g	3.2ML	169 km W of Fort Simpson
[Details]	2009/06/05	14:38:01	62.20	-124.11	1.0g	2.9ML	157 km W of Fort Simpson
[Details]	2009/04/25	05:42:26	62.14	-124.20	5.0g	2.6ML	159 km W of Fort Simpson
[Details]	2009/04/25	01:33:45	62.05	-124.01	15.0g	3.0ML	147 km W of Fort Simpson
[Details]	2009/04/13	01:06:24	62.10	-124.10	5.0g	3.8ML	153 km W of Fort Simpson
[Details]	2009/03/23	10:44:02	62.03	-123.99	10.0g	2.6ML	146 km W of Fort Simpson
[Details]	2009/03/13	03:20:49	62.18	-125.05	1.0g	3.1ML	203 km W of Fort Simpson
[Details]	2009/03/08	11:31:44	62.27	-124.12	1.0g	3.1ML	159 km W of Fort Simpson
[Details]	2009/02/12	22:53:08	62.07	-124.10	15.0g	3.0ML	152 km W of Fort Simpson
[Details]	2009/02/01	15:38:54	61.98	-124.00	1.0g	3.2ML	146 km W of Fort Simpson
[Details]	2008/12/14	15:31:30	61.91	-124.39	5.0g	3.2ML	165 km W of Fort Simpson
[Details]	2008/11/30	06:30:12	61.86	-126.23	1.0g	3.4ML	239 km NE of Watson Lk.
[Details]	2008/09/17	01:48:48	61.83	-126.16	1.0g	2.8ML	238 km ENE of Watson Lk.
[Details]	2008/08/25	01:05:28	62.26	-124.00	1.0g	3.3ML	153 km W of Fort Simpson
[Details]	2008/06/06	02:46:47	62.19	-124.16	10.0g	3.1ML	159 km W of Fort Simpson
[Details]	2008/03/29	15:38:12	62.00	-124.02	1.0g	3.5ML	147 km W of Fort Simpson
[Details]	2008/03/11	00:39:46	62.37	-124.52	5.0g	3.3ML	183 km W of Fort Simpson
[Details]	2008/03/05	11:42:20	62.12	-124.05	1.0g	3.2ML	151 km W of Fort Simpson
[Details]	2007/12/02	19:05:13	60.86	-125.72	1.0g	2.6ML	188 km ENE of Watson Lk.
[Details]	2007/03/26	04:57:57	61.86	-124.15	10.0g	3.2ML	152 km W of Fort Simpson
[Details]	2007/01/06	13:10:42	62.19	-124.20	10.0g	3.2ML	161 km W of Fort Simpson
[Details]	2006/10/06	10:18:27	62.06	-124.16	1.0g	2.6MN	155 km NW of Ft. Simpson
[Details]	2006/09/27	17:40:09	62.15	-123.99	1.0g	3.5MN	149 km NW of Ft. Simpson
[Details]	2006/08/30	06:53:09	62.35	-124.42	10.0g	3.1MN	177 km NW of Ft. Simpson
[Details]	2006/08/14	16:53:51	62.02	-124.05	1.0g	2.6MN	149 km NW of Ft. Simpson
[Details]	2006/08/12	09:26:33	62.07	-124.09	1.0g	2.5MN	152 km NW of Ft. Simpson
[Details]	2006/05/15	05:35:11	62.30	-124.21	1.0g	2.7MN	165 km NW of Ft. Simpson
[Details]	2006/04/23	15:40:54	61.86	-124.13	1.0g	4.3Mw	151 km W of Fort Simpson
[Details]	2006/01/26	08:16:05	62.05	-123.98	1.0g	2.8MN	Mackenzie Mountains
[Details]	2005/12/31	10:48:58	62.29	-125.65	1.0g	4.0Mw	236 km W of Fort Simpson
[Details]	2005/12/17	06:34:28	62.15	-124.20	1.0g	2.6MN	Mackenzie Mountains
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[Details]	2004/11/30	08:02:20	62.37	-124.57	1.0g	3.2MN	Mackenzie Mountains
[Details]	2004/11/26	05:59:11	62.10	-124.22	1.0g	3.2MN	Mackenzie Mountains

[Details]	1985/10/06	07:08:33	62.19	-124.24	10.0g	3.0MN	124 km S from WRIGLEY
[Details]	1985/10/06	04:01:29	62.05	-124.27	10.0g	3.6MN	140 km S from WRIGLEY
[Details]	1985/10/06	03:52:23	62.19	-124.24	10.0g	2.9MN	124 km S from WRIGLEY
[Details]	1985/10/06	02:16:19	61.97	-124.23	10.0g	4.3MN	149 km S from WRIGLEY
[Details]	1985/10/06	01:22:50	62.03	-124.26	10.0g	4.2MN	141 km S from WRIGLEY
[Details]	1985/10/06	01:15:31	62.06	-124.29	10.0g	5.5ML	LARGEST AFTERSHOCK. Felt
[Details]	1985/10/06	00:21:54	62.19	-124.24	10.0g	3.2MN	124 km S from WRIGLEY
[Details]	1985/10/05	23:50:27	62.19	-124.24	10.0g	3.3MN	124 km S from WRIGLEY
[Details]	1985/10/05	23:48:24	62.19	-124.24	10.0g	3.1MN	124 km S from WRIGLEY
[Details]	1985/10/05	23:45:59	61.90	-124.09	10.0g	3.3MN	143 km W from FORT SIMPSON
[Details]	1985/10/05	23:17:22	62.19	-124.24	10.0g	3.3MN	124 km S from WRIGLEY
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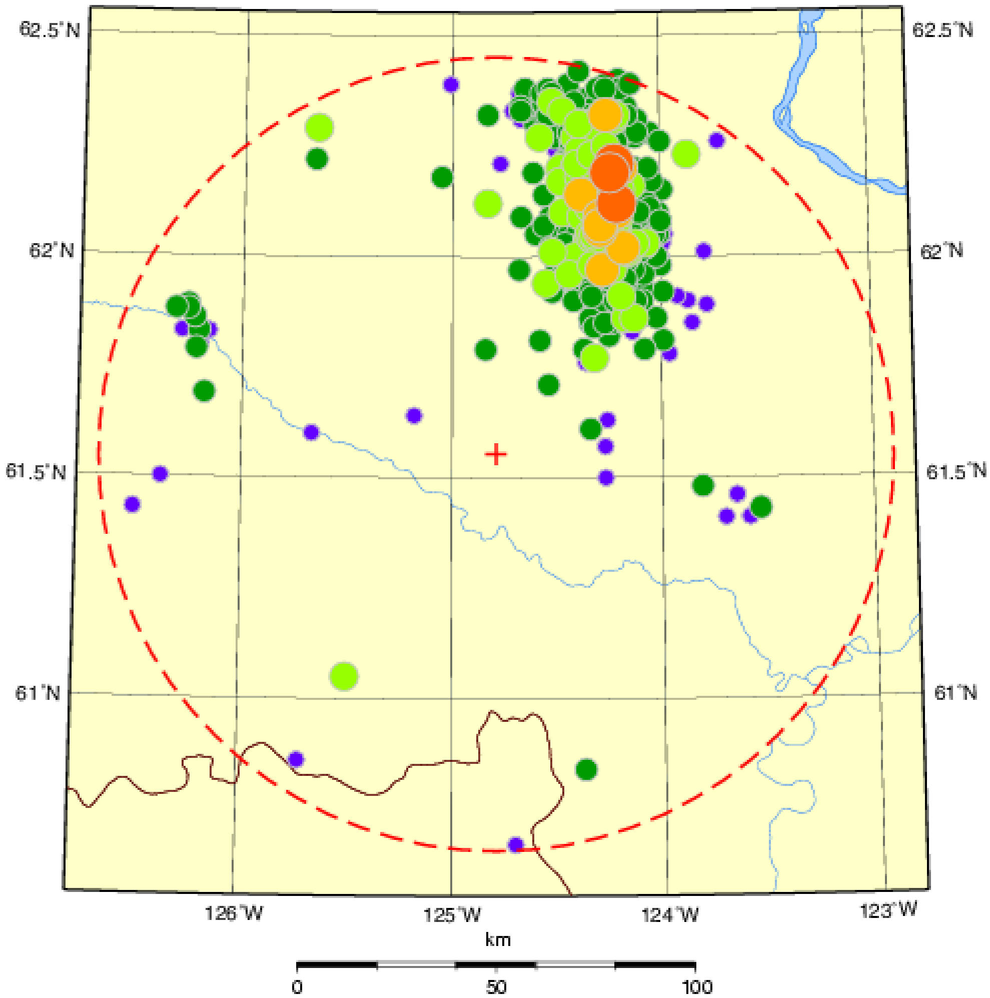
[Details]	1985/10/05	22:30:51	62.06	-124.36	10.0g	3.5MN	140 km S from WRIGLEY
[Details]	1985/10/05	22:23:52	62.19	-124.24	10.0g	3.0MN	124 km S from WRIGLEY
[Details]	1985/10/05	22:19:51	62.19	-124.24	10.0g	3.0MN	124 km S from WRIGLEY
[Details]	1985/10/05	21:48:08	62.19	-124.24	10.0g	3.1MN	124 km S from WRIGLEY
[Details]	1985/10/05	21:26:03	62.19	-124.24	10.0g	3.2MN	124 km S from WRIGLEY
[Details]	1985/10/05	20:39:55	62.19	-124.24	10.0g	3.2MN	124 km S from WRIGLEY
[Details]	1985/10/05	20:34:33	62.19	-124.24	10.0g	3.5MN	124 km S from WRIGLEY
[Details]	1985/10/05	20:07:13	62.05	-124.19	10.0g	3.3MN	139 km S from WRIGLEY
[Details]	1985/10/05	19:42:57	62.10	-124.26	10.0g	4.1MN	134 km S from WRIGLEY
[Details]	1985/10/05	19:13:57	62.06	-124.27	10.0g	4.1MN	139 km S from WRIGLEY
[Details]	1985/10/05	19:07:39	62.01	-124.26	10.0g	4.3MN	144 km S from WRIGLEY
[Details]	1985/10/05	19:00:42	62.19	-124.24	10.0g	3.6MN	124 km S from WRIGLEY
[Details]	1985/10/05	18:50:57	62.19	-124.24	10.0g	3.3MN	124 km S from WRIGLEY
[Details]	1985/10/05	18:43:12	62.26	-124.28	10.0g	3.4MN	117 km S from WRIGLEY
[Details]	1985/10/05	18:38:28	62.19	-124.24	10.0g	3.1MN	124 km S from WRIGLEY
[Details]	1985/10/05	18:35:00	62.19	-124.24	10.0g	2.9MN	124 km S from WRIGLEY
[Details]	1985/10/05	18:15:13	62.06	-124.28	10.0g	4.0MN	139 km S from WRIGLEY
[Details]	1985/10/05	17:59:20	62.26	-124.34	10.0g	3.8MN	119 km S from WRIGLEY
[Details]	1985/10/05	17:52:37	62.19	-124.24	10.0g	3.1MN	124 km S from WRIGLEY
[Details]	1985/10/05	17:44:37	62.19	-124.24	10.0g	3.0MN	124 km S from WRIGLEY
[Details]	1985/10/05	17:41:43	62.19	-124.24	10.0g	3.0MN	124 km S from WRIGLEY
[Details]	1985/10/05	17:32:41	62.21	-124.35	10.0g	4.3MN	123 km S from WRIGLEY
[Details]	1985/10/05	17:31:30	61.86	-124.17	10.0g	4.2ML	147 km W from FORT SIMPSON
[Details]	1985/10/05	17:20:43	62.19	-124.24	10.0g	3.6MN	124 km S from WRIGLEY
[Details]	1985/10/05	17:02:41	62.19	-124.24	10.0g	3.1MN	124 km S from WRIGLEY
[Details]	1985/10/05	17:01:42	62.19	-124.24	10.0g	2.9MN	124 km S from WRIGLEY
[Details]	1985/10/05	16:55:54	62.19	-124.24	10.0g	3.1MN	124 km S from WRIGLEY
[Details]	1985/10/05	16:49:47	62.08	-124.14	10.0g	3.5MN	135 km S from WRIGLEY
[Details]	1985/10/05	16:42:06	62.19	-124.24	10.0g	3.0MN	124 km S from WRIGLEY
[Details]	1985/10/05	16:07:59	62.19	-124.24	10.0g	3.1ML	124 km S from WRIGLEY
[Details]	1985/10/05	16:00:47	62.19	-124.24	10.0g	4.1ML	124 km S from WRIGLEY
[Details]	1985/10/05	15:58:23	62.19	-124.24	10.0g	4.2ML	124 km S from WRIGLEY
[Details]	1985/10/05	15:24:02	62.21	-124.22	6.0g	6.6MS	122 km S from WRIGLEY

A total of 908 events found.

Magnitude	< 1	1	2	3	4	5	6	7	8	9
Total	1	0	135	666	94	9	3	0	0	0



Date Modified: 2009-03-27

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Rock and Roll in the N.W.T.: The 1985 Nahanni Earthquakes

by R.B. Horner, M. Lamontagne and R.J. Wetmiller
Published in GEOS, Vol. 16, no. 2, Spring 1987

See also new research by A. Öncel, Earthquake-induced static stress of the 1985 Nahanni earthquakes, Northwest Territories, Canada.

The Nahanni Range of Canada's Northwest Territories, formed 60 million years ago in the Laramide Orogeny, still shows the effects of that long-past upheaval in extensive thrust faulting and folding. The North Nahanni River cuts through the mountain ranges from west to east.

A remarkable and unprecedented sequence of earthquakes is shaking the mountains west of Fort Simpson in the Northwest Territories. A magnitude 6.6 earthquake on October 5, 1985, and an even larger magnitude 6.9 event on December 23, 1985 disturbed the beautiful and mysterious Nahanni region of the Mackenzie Mountains. Between these earthquakes, and still continuing today, a long succession of aftershocks rumble and jolt the area.

The earthquake sequence amazed both the general public and the earth science community. People in the Northwest Territories, the Yukon, Alberta, Saskatchewan, British Columbia and southeastern Alaska were startled by the vibrations. Local radio stations, newspapers and police departments were swamped with callers asking for details of the tremor. Seismologists were astonished by the size of the events. All across Canada their seismographs recorded strong ground motions.

Earth scientists were surprised not only by the magnitude of these earthquakes but also by their locations. Earthquakes up to magnitude 6.5 have occurred farther north in the Richardson Mountains, but in the Mackenzie Mountains no events larger than magnitude 5 have been reported. However, little is known about the earthquake history of Canada's north; only recently have scientists been able to detect and locate small-magnitude earthquakes in the Far North (Figs. 1, 2). Prior to October 1985 the Nahanni Range was thought to be a relatively quiet earthquake zone.

Figure 1 *Earthquake activity in the northeast Canadian Cordillera has been widespread but not intense. The largest events occurred in 1944 and 1945 in the more northern Richardson Mountains. In the Mackenzie Mountains, earthquake activity had been subdued until the Nahanni events.*

Figure 2 *Earthquake activity in the Mackenzie Mountains. The largest events before the Nahanni earthquakes were only magnitude 5. Activity has been spread out and shows no linear trends that would suggest active fault systems. Map indicates the locations of temporary seismograph stations set up to study the Nahanni earthquakes' aftershocks.*

The Nahanni earthquakes gave earth scientists a unique opportunity to examine two important aspects of earthquake seismology. First, earth scientists can study the effects of intense ground motion on buildings and on natural environments - a knowledge of building dynamics could help us design structures that would better withstand major shocks. Second, the study of major earthquakes gives us more information for earthquake risk analysis: where, how, and how often such events can occur. A greater understanding of earthquake processes would tell us how to improve the National Building Code of Canada, to make Canadian buildings safer.

Before October 1985, most people in the N.W.T. had never felt an earthquake. The first tremor came as a complete surprise. Because no community is closer than 100 km to the epicentres, no major structural damage was reported. Nevertheless, the earthquakes caused widespread alarm, particularly in Wrigley, Fort Simpson, Nahanni Butte and Fort Liard, the four communities closest to the epicentre.

At Wrigley, about 115 km north of the epicentre, residents reported seeing the ground roll. Vehicles bounced on the road and trees and power lines whipped back and forth. Sections of the banks of the Mackenzie River slumped into the water. Inside homes, furniture moved, dishes fell from cupboards, unsupported shelves toppled over, liquids slopped out of containers, doors swung open and shut and walls flexed in and out. One resident was asleep until a lamp fell on his head. Several people felt dizzy. This violent activity was accompanied by rumbling and thunderous sounds that lasted for about 30 seconds.

People reported feeling the October earthquake more than 1500 km away. The isoseismal map shows that intensities did not fall off uniformly (Fig. 3). Intensity IV was reported to at least 1000 km south-east of the epicentre but only to about 500 km to the west. At Yellowknife, 500 km east, the intensity was only III. At Inuvik, about 800 km to the north, no one reported feeling the earthquake. The significant elongation of intensity in the northwest-southeast direction along the strike of the Cordillera has been observed for other earthquakes in western Canada. The larger December earthquake had a similar intensity distribution but the area in which they were felt was slightly greater and included reports of ground movement in the northwestern United States.

The lack of serious damage can be attributed to sparse population in the epicentral region as well to the type of buildings there. Most are one- or two-storey, wood-frame or log structures. These prove most resilient to earthquakes because they can bend and flex without damage.

To discover more about the causes and effects of the main shocks, earth scientists conducted field experiments immediately after the two events. GSC seismologists and technicians from the Pacific Geoscience Centre in Sydney, B.C. and from the Geophysics Division in Ottawa and Yellowknife conducted surveys following both main shocks (Fig. 4).

Figure 3 *Areas where the two main shocks were felt. Strength of ground shaking is rated according to the Modified Mercalli Intensity Scale: I for barely noticeable to XII for complete destruction.*

Figure 4 *Field crew at seismograph site in January, From left, R.J. Wetmiller, M. Lamontagne and D. Monsees of the GSC, and J. Phillips, Lakeland Helicopters pilot (Photo by R.B. Horner).*

Helicopters from Fort Simpson deployed portable seismographs in the epicentral region. Each survey lasted about a week. The long distance from Fort Simpson and severe field conditions, with temperatures of -40C and very little daylight in January, limited to five or six the number of recording sites the scientists could maintain (Fig. 5). The seismographs clarified the location of the major shocks and the field surveys allowed scientists to observe the effects of intense ground shaking.

Figure 5 *M. Lamontagne calibrating digital seismograph during Nahanni fieldwork (Photo by R.B. Horner).*

The earthquakes occurred in a north-south elongated zone about 50 km long and 15 km wide. The two main shocks were centred near the middle of the zone and are separated by only a few kilometres. The events define a wedge dipping to the west.

In the central area, scientists discovered evidence of the strong ground motion associated with large earthquakes. Although no surface break was found, large landslides and rockfalls were observed. The biggest slide, a rock avalanche, was triggered by the October earthquake. The avalanche left a 70 metre vertical scarp (Fig. 6) - mute testimony to the huge volume of rock displaced. An estimated 5 to 7 million cubic metres of rocks crashed 1.6 km down from the crest to the toe of the slide.

Figure 6 *Rock avalanche, triggered by the October 5 Nahanni earthquake, is one of the largest ever to have occurred in Canada and the first known to have been caused by an earthquake (Photo by R.B. Horner).*

Using data from Canadian and worldwide seismological networks, EMR seismologists defined the focal mechanisms of the earthquakes. The two large shocks each have two possible fault planes (Fig. 7). Both possible fault planes are striking nearly north-south; one dips shallowly to the west and the other dips more steeply to the east. By comparing this information with geological maps of the area, seismologists have deduced that the west-dipping plane represents the fault plane. The major faults of the area are of Laramide age and were created when the MacKenzie Mountains formed. The earthquakes probably occurred along a fault plane parallel to the region's major structural trend. It is puzzling that the earthquakes did not occur on faults mapped at the surface, but the existence of a hidden fault which does not reach the surface can not be ruled out.

Figure 7 F*ault-plane solutions for the two main shocks. The 'beach-balls' shows an equal-area plot of the lower focal sphere of the two possible fault planes that satisfy the event's polarity, compression or dilatation, recorded at all the seismograph stations. The two solutions are almost identical, and indicate that both main earthquakes were thrust type. The strike and dip of the west-dipping plane is almost identical to that of the area's major thrust faults (the Iverson or Nahanni faults). However, the dip of the west-dipping plane for the December event is shallower than that for October.*

An analysis of where the numerous aftershocks occurred emphasizes the similarity between the main shock mechanisms and the major faults of the region (Fig. 8). The temporary network of portable stations recorded many aftershocks. From these records, seismologists located 288 aftershocks, most smaller than magnitude 3.5, that happened in October 1985, and January 1986 (Fig. 9).

Figure 8 *Geology of the Nahanni earthquake epicentral area. The earthquakes occurred in the Mackenzie Plain, a relatively undeformed plateau between the Nahanni Range and the Mackenzie Mountains. Paleozoic and Proterozoic carbonate and clastic sedimentary rocks at least 8 to 10 km deep are underlain by the Canadian Shield. The area was extensively faulted and folded in the Laramide Orogeny and the Iverson, Battlement and Nahanni thrust faults were created at that time.*

Figure 9 *Distribution of aftershocks to the October event are shown in red, and to the December event shown in blue. Aftershock zones are similar in thrust faults and penetrate through the sedimentary column into Shield rocks. The December aftershocks appear deeper on average and are shifted a few kilometres west of the October aftershocks.*

Perhaps the most important data recovered from the Nahanni earthquakes are three strong-motion accelerograph records for the December 23 shock. The instruments that recorded these data were left deployed in the epicentral area following the October event in the hope that they would register strong aftershocks in the subsequent months. These recorders have a trigger mechanism that activates them when there is a strong event.

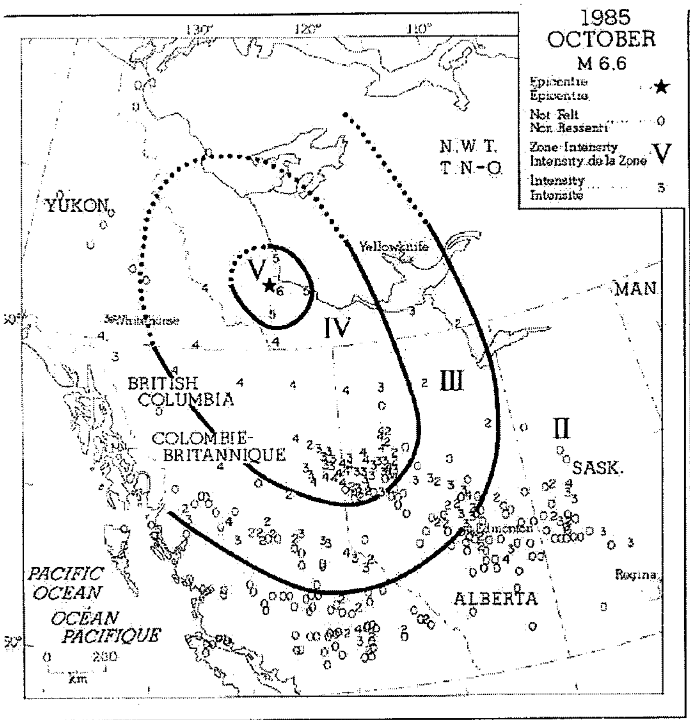
When the December shock struck, the instruments gave scientists a remarkable record of the event. Two of the three records are shown in Figure 10; the upper record (a set of three traces) shows ground accelerations more than twice the acceleration due to gravity. This is the strongest earthquake-induced acceleration ever recorded anywhere. Engineers and scientists are now pondering the implications of these records and will be using them in the future to improve the safety of important facilities throughout North America.

Figure 10 *Strong-motion accelerograms for two of three sites recorded for the December shock. The upper three traces represent a three-component ground motion display during the event at a site approximately 8 km north and west of the epicentre. The event consists of about 10 seconds of strong ground motion with an extreme peak of motion late in the trace which contains vertical acceleration in excess of 2 g. The actual peak exceeded the range of this particular instrument and has been estimated from the state of the trace before and after the peak. The lower set of three traces shows another record of the same event at a site about 8 to 10 km north of the epicentre. Here the accelerations did not exceed about 30% g.*

From our studies of how the large-magnitude Nahanni earthquakes have affected the northeastern Cordillera, we expect that future large earthquakes in the Mackenzie Mountains will be thrust-type events with shallow crustal depth and extensive aftershock zones. We will anticipate surface faulting, although none was found in this case.

Information obtained by studying the Nahanni earthquakes will have a profound effect on the future design of critical structures such as dams and pipelines in the Northwest Territories. The possible association of the Nahanni earthquakes with faults of Laramide age implies that similar earthquakes can occur anywhere along the margin of the Canadian Cordillera, where such faults lie.

A more accurate and comprehensive seismic zoning map of Canada will emerge from the study of these large shocks. In the long run, we will know better how to protect people from seismic hazard.
The Authors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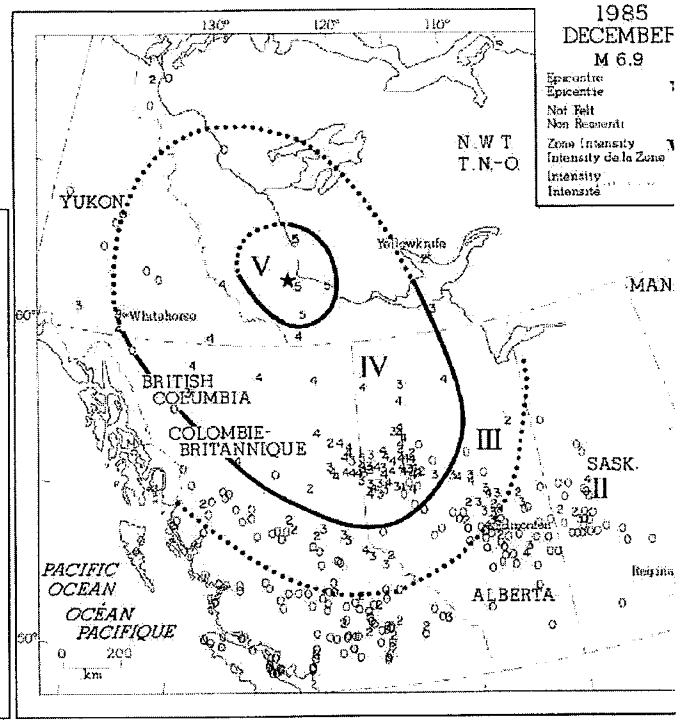
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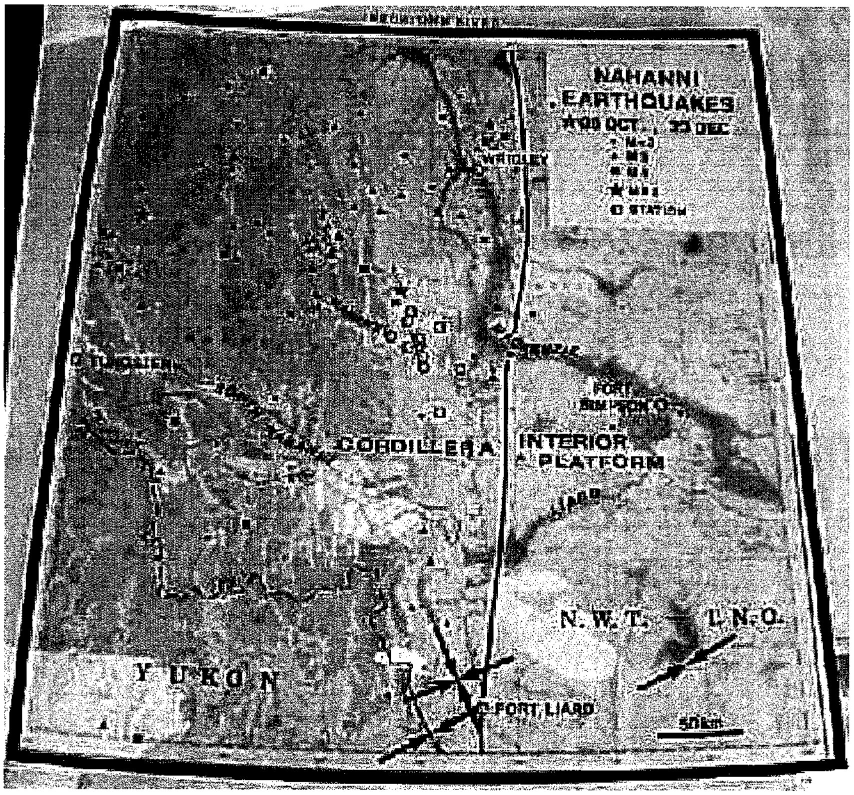
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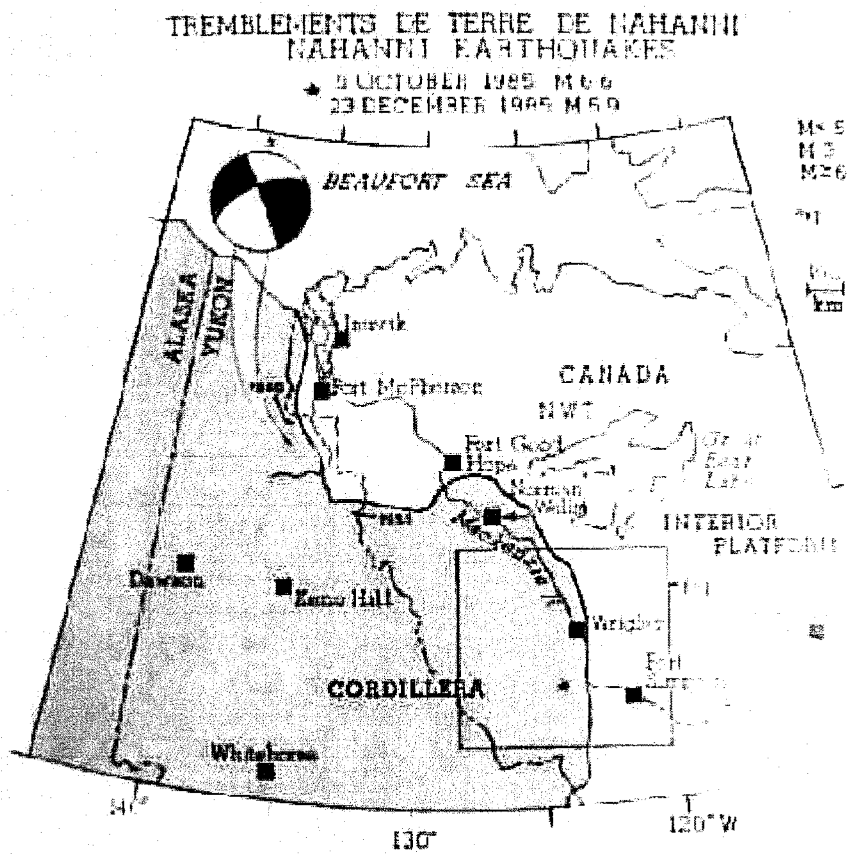
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YUKON
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Whitehorse
Wrigley
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Fig #6

APPENDIX 26

APPENDIX 26

PUBLIC ENGAGEMENT

ENGAGEMENT SUMMARY

CZN has a long history of communications with the affected parties. After acquiring the Prairie Creek Property in 1992 San Andreas Resources Corporation ("SARC) held numerous meetings with the local communities and government regulators. Most of the formal type meetings were relating to LUP's and such that were required to support exploration and development activities on site.

Since the inception of the MVRMA in 1999 the Company has had many formal and informal meetings related to its numerous Land Use Permit and Water License Applications. The majority of applications to the MVLWB were subsequently forwarded to Environmental Assessments and this triggered additional meetings both within the communities and in Yellowknife. Please consult the Review Board and Water Board registry files on their websites to view these pertinent documents.

Prior to 2008, Mr. Dan O'Rourke was CZN's Community Relations Advisor, and met with First Nation communities and government representatives on a regular basis, sometimes independently and other times in the company of other CZN representatives. At this time, frequent interaction with community representatives occurred by telephone from CZN's Vancouver office. Mr O'Rourke became ill towards the end of 2007 and was no longer able to carry out his community work. Mr Joseph Lanzon was hired on to replace Mr 0'Rourke. This was at the same time as the Company was about to submit the Operations Applications to the MVLWB. Community interaction representatives were assumed by messrs Taylor and Harpley, CZN's Chief Operating Officer and VP Environment and Permitting Affairs, respectively. Taylor and Harpley, accompanied by former chief, Leon Konisenta from Nahanni Butte, undertook Open Houses in all the main Dehcho communities in November 2007. The purpose of the open houses was to explain CZN's plans to apply for operating permits and obtain feedback.

In March 2008 at the request of the Band Chief, CZN's President visited Nahanni Butte, accompanied by Mr Harpley. Various matters were discussed, but it was agreed that a Memorandum of Understanding be drawn up between the parties to formalize the intent to cooperate on responsible mine development and accommodation of the Band's aspirations. It was also agreed that Nahanni would nominate a Band member as a Community Information Representative, and CZN would pay a salary for the part-time position. The goal of this was to ensure the flow of information to community members.
In the summer of 2008, CZN bolstered its community engagement abilities. Wilbert Antoine, originally from Fort Simpson and active in the mining industry for over 30 years, was appointed as CZN's Manager of Northern Development, to be based in Fort Simpson at CZN's regional office located in the Federal Building (Post Office). Mr Antoine has been in close contact with Dehcho communities on various matters since,

including participation in Impact Benefit Agreement negotiations with the Nahanni Butte Dene Band and Lidlii Kue First Nation.

Communications via telephone/cellular have continued from CZN’s Vancouver office, and indeed have intensified. Contact with Nahanni Butte is daily on week days. In addition, CZN has continued to support community events. The CZN golf tournament is held annually in Fort Simpson, and CZN’s management team use this opportunity to meet community members and their representatives. CZN purchased chairs for the new gymnasium in Nahanni Butte, and will be talking to the Band about an annual community event like the golf tournament.

In addition to community meetings, CZN makes frequent visits to Yellowknife and Fort Simpson (at least quarterly), and uses these opportunities to hold meetings with regulatory representatives on the Prairie Creek Mine file.

The Company has a long history of communications with the affected parties in the region and will continue to enhance its abilities with expanding administration personnel should the Prairie Creek Mine proceed to operation.

The bulk of the daily communications in the affected areas are done via telephone/cellular and meetings with CZN’s regionally based representatives. The company’s regional office is located at the Federal Building in Fort Simpson. Other means of communication support includes emails, chartered flights, couriers, public postings billboards, advertisements in the regional newspapers, and public community events sponsored by CZN.

CZN’s hands on daily interaction have been an important tool for CZN’s ability to acknowledge and address the everyday concerns of the affected local communities. In fact a senior member of the NBDB Council recently stated “when we want to know what’s going on in Nahanni, we call Vancouver.”

The primary personnel will collectively conduct more than 20 communications per day with local communities. Due to the large volume of consultation by CZN, both Indian and Northern Affairs’ and The Review Board agreed specific focus on the company’s meetings with the affected parties would be sufficient for the required TOR’s Consultation Log. The condensed version of the Consultation Log follows.

Date	Stakeholders/ Participants	Subject	Consultation Method/Location	Duration	Consultation Remarks
19-Feb-10	Nahanni Butte Dene Band - Chief Fred Tesou	DAR Update, Community Review	Meeting at Nahanni Inn, Fort Simpson	30 Minutes	CZN updated NBDB about the DAR's expected submission date. Talked about the community events and the upcoming Nahanni election for Chief and Council in April.
19-Feb-10	Liidlii Kue First Nation (LKFN) - Chief Jim Antoine, Sub Chief Wesley Hardisty	IBA Scheduling, Community Review	Meeting at LKFN Band Office, Fort Simpson	30 Minutes	CZN discussed possible upcoming IBA scheduling, and reviewed community issues for LKFN.
19-Feb-10	Sambaa K'e Dene Band (Trout Lake) - Chief Dolphus Jumbo, Former ADK Chief Dennis Deneron, Elder Joe Punch, Elder Tommy Kotchea, Business Manager Rick Phaneuf	Update on Project	Meeting at Sambaa K'e Band Office	4 Hours	CZN updated community about the Prairie Creek Mine. Trout Lake supports pipeline, oil & gas and mining. Tri-Corp with Nahanni and Jean Marie are in early stages of talks. Trying to pool together 300 people to bid on projects like Prairie Creek Mine. Band has purchased new road equipment and ready to put that investment to work with CZN. Elders support the pipeline and other developments like CZN. These make money, stability for everyone.
15-Feb-10	Mine Training Society - Hilary Jones	Beginning of MTS's Training Sessions in Dehcho	Orientation at Aurora College, Fort Simpson	1 Day	CZN assisting MTS with the beginning training sessions for Introduction to Underground Mining and Heavy Equipment Operator.
9-Feb-10	Deh Gah Gotie Dene Band (Fort Providence) - Chief Joachim Bonnetrouge, Elder Jim Elleze	Project update	Meeting at Dehcho Leadership Assembly, Fort Simpson	30 Minutes	Fort Providence Chief and Elder worked at the development (under Cadillac) and support the project. They support jobs and expanding opportunities for Dehcho.
2-Feb-10	Jean Marie River First Nation - Band Manager, Bertha Norwegian	Project update and Tri Corp progress	Meeting at Jean Marie River's Band Office	1 Hour	Discussed updates of project and the proposed Tri Corp association between NBDB, JMR, Samba Ke first nations working together for contracts with the project.
29-Jan-10	NBDB's DAR Consultant - Peter Redvers	NBDB's DAR Team	Meeting at Latitudes Restaurant, Yellowknife	1 Hour	Peter advised CZN he will be organizing the NBDB's DAR Team to ensure regulatory agency do an effective job reviewing the report.
29-Jan-10	Environment Canada - Jane Fitzgerald	Project Update	Meeting at Environment Canada's Office, Yellowknife	1 Hour	CZN provide project update and review topics of water management.
29-Jan-10	INAC - Krystal Thompson, Mark Cassas	Project Update	Meeting at INAC Offices, Yellowknife	1 Hour	CZN provide project update, DAR review and discussed water management strategy .
29-Jan-10	Mine Training Society - Doreen Apples	MTS working with NBDB	Meeting at MTS Offices, Yellowknife	30 Minutes	Discussed the progress of MTS working with NBDB. MTS will be going to Fort Simpson in the near future. CZN's Fort Simpson Office will assist the upcoming training.
27-Jan-10	Village of Fort Simpson - Mayor Shaun Wiley	Updating new mayor about the project	Meeting at Mayor's Office, Fort Simpson	1 Hour	CZN had an introductory meeting with the new Mayor of Fort Simpson Village and discussed the project. The new mayor supports the Prairie Creek Mine.
27-Jan-10	Métis (Fort Simpson) - President Marie Lafferty	Updating project	Meeting at Métis Office, Fort Simpson	1 Hour	CZN discussed the update with the project and the ongoing regulatory process.

Date	Stakeholders/ Participants	Subject	Consultation Method/Location	Duration	Consultation Remarks
27-Jan-10	Nahanni Butte Dene Band - Chief Fred Tesou, Councilor Jayne Konisenta, Councilor Tammy Matou, Councilor Jim Betsaka, Councilor Joan Ekotla, Councilor Peter Marcellais, Councilor Flora Cli, Francis Betsaka, Bobby Vital, Jean Marie Konisenta, Morgan Matou, Rick Bargery, and Greg Empson.	NBDB IBA Session	Meeting at Nahanni Butte Gymnasium	5 Hours	Furthering negotiations related to the Impact Benefits Agreement (IBA)
26-Jan-10	Nahanni Butte Community	Nahanni School Presentation and Winterfest Event	Event at Charles Yohin School and Community Gymnasium	6 Hours	CZN gave 1/2 hour presentation at the local school followed by the 1st annual Winterfest activities sponsored by CZN.
25-Jan-10	Liidlii Kue First Nation (LKFN) - Chief Jim Antoine, Nogha GM Gilbert Cazon, Councilor Jonas Antoine, Ernest Cazon and Larry Hutchinson	LKFN IBA Session	Meeting at Fort of the Forks, Fort Simpson	2 Hours	Introduction session of IBA. Discussed LKFN's vision, IBA procedures and project updates
21-Jan-10	Katlodeeche First Nation (Hay River) - Former Chief Pat Martell	Update on project	Meeting at Community Recreation Centre, Fort Simpson	15 Minutes	Hay River is far away from the project but hopes his people can find work at Prairie Creek. Supports Canadian Zinc
20-Jan-10	Akaitcho Territory Government Chiefs Edward Sangris, (Dettah) and Ted Tsetta (D'hlon)	Update on project	Meeting at Community Recreation Centre, Fort Simpson	30 Minutes	Fully support Canadian Zinc's project for the benefits of individuals and communities. Offered to assist Dehcho First Nation communities with their experience in the mining industry.
19-Jan-10	Gwich'in Territory (Aklavik) - Charlie Furlong	Update on Project	Meeting at Community Recreation Centre, Fort Simpson	15 Minutes	Supports Canadian Zinc's project for bringing jobs and opportunities to the region. Their region supports industry and what it brings to communities.
18-Jan-10	Dene Nation Assembly - National Chief Shaun Atleo, Dene National Chief Bill Erasmus, Liidlii Kue First Nation Chief Jim Antoine, Dehcho Grand Chief Sam Gargan, Tli Cho Government Grand Chief Joe Rabesca, Acho Dene Kue First Nation Chief Steve Kotchea, Akaitcho Territory Government Chief Ted Tsetta & Chief Edward Sangris, Métis Presidents - Ernie Macleod (Liard) and Marie Lafferty (Fort Simpson), Elders: Pat Martell, Gabe Hardisty, Fred Williams, Leon Moses, Sam Elleze, Sarah Hardisty, Ernest Hardisty, Mary Louise Sanguez, Sam Mantla, Archie Wetrade, Charlie Snowshoe, and Joanne Deneron	Update Dene Assembly Attendees about the Project	Meeting at Community Recreation Centre, Fort Simpson	4 Days	CZN Representative spoke separately to attending leaders about the project updates and the ongoing regulatory process. Leaders discuss the need for First Nations to work with industry. National Chief requested CZN's help facilitate his new approach to meet as many CEOs as possible to move partnerships forward for the benefit of aboriginal communities across Canada. CZN has suggested PDAC as a venue to meet many industry participants and will make arrangements for the National Chief to meet CZN's Chairman who is also the President of NWT/Nunavut Chamber of Mines.
13-Jan-10	Aurora College- President Sarah Wright-Cardinal	Attending Aurora College's Open House	Event at Aurora College, Fort Simpson	1 Hour	Discussed the employment opportunities from the Prairie Creek Mine.

Date	Stakeholders/ Participants	Subject	Consultation Method/Location	Duration	Consultation Remarks
2-Dec-09	Nahanni Butte Dene Band (NBDB) Community	NBDB Community Research Survey for DAR	Meeting several NBDB residences throughout the community	2 Days	CZN contracted northern resident Ethel Lammonte and Celine Betsaka to conduct a community research survey related to human environment and social issues concerns. Some concerns included more ongoing consultation with CZN, current crime level in the community, and youth needing opportunities. Summary comments are attached in Appendix.
1-Dec-09	Jean Marie River First Nation - Band Manager, Bertha Norwegian	Update on Prairie Creek Mine, Tri Corporation with Nahanni Butte, Sambaake Fist Nation.	Meeting at JMFN's Band Office	2 Hours	CZN updated JMFN's Band Manager about the Prairie Creek Mine. Bertha briefed CZN about the Tri-Corporation between JMFN, NBDB, and Sambaake First Nation. They are putting together a joint partnership to build capacity for bidding on future Prairie Creek Mine contracts.
2-Dec-09	Aurora College - Barb Tesou, Dean Harvey	CZN Project Presentation	Presentation at Aurora College, Fort Simpson	90 Minutes	CZN gave 1 hour presentation to students attending Aurora College. Following the presentation there was a 30 minute period for questions. Some of the questions included types of jobs at the mine, available training, and potential employment for women.
21-Nov-09	Liidlii Kue First Nation (LKFN) - Chief Jim Antoine	IBA Scoping Follow-Up	Meeting at LKFN Band Office	20 Minutes	CZN had follow up meeting regarding the Yellowknife Meeting. LKFN pursuing funding with INAC.
20-Nov-09	Mine Training Society - Hilary Jones	Nahanni Meeting Review and Prairie Creek HR Update	Meetings at MTS Offices (Yellowknife)	20 Minutes	CZN confirmed the upcoming meeting in NBDB has been postponed until the New Year as the community waits for INAC funding. MTS has Prairie Creek’s HR requirements entered into their forecasting training system. MTS discussed some short term training objectives with heavy equipment operators for road building near the NBDB community.
19-Nov-09	Standing Committee on Aboriginal Affairs and Northern Development - Link provided in comment section	Project Presentation and Q&A Period	Event at Yellowknife Inn's Copper Room.	1.5 Hours	CZN's Chairman and Chief Operating Officer were invited to provide a presentation to the Standing Committee on Aboriginal Affairs and Northern Development. . The Standing Committee is a representational panel of Federal, Territorial, and aboriginal dignitaries. Presentations were followed by a Questions and Answers Period for the remainder of the time. Minutes of the meeting can be reviewed at http://www2.parl.gc.ca/HousePublications/Publication.aspx?DocId=4281619&Language=E&Mode=1&Parl=40&Ses=2
19-Nov-09	NBDB's IBA Consultant - Rick Bargery	Organizing next IBA Session, MTS trip to Nahanni Butte	Meeting at Jim's Restaurant in Chateau Nova Hotel Yellowknife	1 Hour	NBDB's Consultant updated CZN on IBA funding issues. Next IBA meeting will be in Nahanni in the new year. CNZ explained the current events with the project and informed NBDB's consultant IBA negotiation have now begun with LKFN. NBDB has delayed the MTS visit to Nahanni until funding have been resolved.
18-Nov-09	Liidlii Kue First Nation (LKFN) - Jim Antoine, Gilbert Cazon and Larry Hutchinson	Initiating LKFN IBA Negotiations	Meeting at Latitudes Restaurant (Yellowknife)	1 Hour	Conversation focused on the continued open dialogue between the parties. IBA negotiations will likely be held early in the New Year.

Date	Stakeholders/ Participants	Subject	Consultation Method/Location	Duration	Consultation Remarks
17-Nov-09	GNWT - Deborah Archibald, Frank Pope, Jacquelyn Miller, Gerd Fricke, Kevin McLeod, Larry Purcka- Project Presentation:	GNWT Presentation	Meeting at Tree of Friendship Building	1 Hour	CZN provided a project presentation to representatives of various GNWT Departments. Questions from the attendees included employment, road realignment logistics, jurisdiction questions (park/crown lands), LKFN's involvement, target date for operations, when is the ideal time to receive the operational permit, and condition of existing/ proposed access road.
2-Nov-09	Liidlii Kue First Nation (LKFN) - Chief Jim Antoine	Confirming CZN/LKFN Meeting in Yellowknife	Meeting at LKFN's Band Office	20 Minutes	Discuss the upcoming GeoScience Trade Show in Yellowknife providing an opportunity to have a meeting with Senior Staff of CZN. CZN and Gilbert Cazon (LKFN) will be presenting at the Standing Committee of Aboriginal Northern Development held at the GNWT.
24-Oct-09	West Point First Nations - Marie and Jim Thomas, Doreen Bittman, and Audrey Berens.	Update on Prairie Creek Mine	Meeting at Jim Thomas' Home	1.5 Hours	CZN provided an update on the Prairie Creek Project.
23-Oct-09	Fort Providence First Nations - Chief Joachim Bonnet Rouge, Albert and Carol Bonnet Rouge, Leonie Lafferty, Jim Thom, and Barbara Teasdale	Update of Prairie Creek Mine	Meeting at Band Office	60 Minutes	CZN provided an update on the Prairie Creek Project.
21-Oct-09	Parks Canada Agency, Dehcho First Nations	Technical Team Meeting	Meeting at CZN's Vancouver Office	4 Hours	Discussed Prairie Creek Mine activity update, CZN regulatory process, access road, protocol for accommodating access, review of Canada National Parks Act, multi-jurisdictional issues, Dehcho update.
20-Oct-09	Pehdzeh First Nations (Wrigley) - Chief Albert Moses	Update of Prairie Creek Mine	Meeting at the Band Office	15 Minutes	CZN provided an update on the Prairie Creek Project. Discussed the band's general view of mining. Band was supportive of mining as long as it was done responsibility.
16-Oct-09	Nahanni Butte Dene Band - Chief Fred Tesou, Councilor Jim Betsaka, Councilor Peter Marcellais, Rick Bargery, Greg Empson	NBDB IBA Session	Meeting at Chateau Nova Hotel (Yellowknife)	3 Hour	Furthering negotiations related to the Impact Benefits Agreement (IBA)
15-Oct-09	Nahanni Butte Dene Band - Chief Fred Tesou, Councilor Jim Betsaka, Councilor Peter Marcellais, Greg Empson. Mine Training Society - Hilary Jones	NBDB's Introduction to Mine Training Society (MTS)	Meeting at Mine Training Society's Office (Yellowknife)	1 Hour	Mine Training Society made a presentation to NBDB's IBA Team and CZN's Representatives about the potential opportunities of training with its organization.
15-Oct-09	Nahanni Butte Dene Band - Chief Fred Tesou, Councilor Jim Betsaka, Councilor Peter Marcellais, Samantha Konisenta. Northwest Tel - Mike Ward, Joel Witten	NBDB / NorthwesTel Meeting	Meeting at Northwest Tel Head Office (Yellowknife)	2 Hours	CZN helped facilitate a meeting with NorthwesTel and NBDB for consideration of a cell service for NBDB. NorthwesTel provided a presentation and tour of their facilities to NBDB Representatives.
14-Oct-09	Dehcho Fits Nations - Ria Letcher	Training Programs for Aboriginal Tradespersons	Meeting at Latitudes Restaurant (Yellowknife)	10 Minutes	Brief discussion on upcoming ASEP meeting and potential training programs for DehCho Members.
30-Sep-09	Dehcho First Nations Leadership Assembly	Fall Assembly - Prairie Creek Mine Presentation	Presentation to Dehcho Nations Fall Leadership in Fort Providence	40 Minutes	Dehcho Grand Chief Sam Gargan invited CZN to provide a presentation on the Prairie Creek Mine's current events to the DehCho General Fall Assembly in Fort Providence.

Date	Stakeholders/ Participants	Subject	Consultation Method/Location	Duration	Consultation Remarks
23-Sep-09	Nahanni Butte Dene Band - Peter Marcellais, Raymond Vital, Leon Konisenta, Tommy Betsaka West Point Consultant - Gabrielle Prager	NBDB Archeological Program	Task - Several Locations Along Access Road	2 days	NBDB members assisted an archeological consultant with field studies following TK Consultation. Transportation services were provided by Great Slave Helicopters.
10-Sep-09	Dehcho Fits Nations - Ria Letcher	Training in Dehcho	Meeting at DCFN Office	15 Minutes	DCFN would like meet with CZN in Yellowknife for the Northern Strategy Conference. They would like to further possibilities with training for their members with MTS and ASEP programs.
3-Sep-09	Liidlii Kue First Nation (LKFN) - Chief Jim Antoine	LKFN's TK Study, Confidential Agreement, LKFN Economic Development Conference	Meeting at LKFN's Band Office	30 Minutes	CZN asked to participate in LKFN's Economic Development. CZN asked for TK Study and status of confidentiality agreement
29-Aug-09	Parks Canada Agency, Dehcho First Nations	Technical Team Meeting	Meeting at CZN's Vancouver Office	2 Hours	Discussions included updating Prairie Creek Mine activities, CZN regulatory process, CZN development proposal, status of park expansion process, update from DehCho.
24-Aug-09	Nahanni Butte Dene Band - Chief Fred Tesou, Councilor Jayne Konisenta, Councilor Lena Marcellais, Councilor Tammy Matou, Flora Cli, Jean Marie Konisenta, Morgan Matou, Anna Tsetso, George Tsetso, Violet Tesou, Bobby Vital, Lorraine Vital, Morris Vital, Raymond Vital,	NBDB - TK Consultation - Prairie Creek Mine Presentation	Meeting at Nahanni Butte Gymnasium	5 Hours	CZN participated in a follow-up TK Presentation within the Nahanni Butte Community to discuss NBDB's concerns and CZN's mitigation strategies. Robert Norwegian provided Dene interpretation services.
23-Aug-09	Dehcho Region	5th Annual Canadian Zinc Open Golf Tournament	Event held at Seven Spruce Golf Course, Fort Simpson	2 days	CZN sponsors the annual tournament. Attended by teams throughout the Dehcho and one of the largest golf events in the Northwest Territories.
23-Aug-09	Village of Fort Simpson - Mayor Duncan Carvin	Updating CZN's Community Events	Meeting at Fort Simpson Beverage	15 Minutes	CZN provided the Mayor an update of the project progressing through the EA process.
21-Aug-09	Liidlii Kue First Nation (LKFN), Village of Fort Simpson	CZN/Fort Simpson Community BBQ	Event held at the Fort Simpson Community Centre	4 Hours	CZN provided a community BBQ. Approximately 200 meals were provided. Remaining food was taken to the Stanley Isaiah Seniors Home.
20-Aug-09	Nahanni Butte Dene Band - Chief Fred Tesou, Councilor Jayne Konisenta, Councilor Lena Marcellais, Councilor Tammy Matou, Councilor Jim Betsaka, Councilor Joan Ekotla, Councilor Peter Marcellais, Councilor Flora Cli, Leon Konisenta, Jean Marie Konisenta, Raymond Vital, George Betsaka, George Tsetso, Morgan Matou.	NBDB IBA Session	Meeting at Nahanni Butte Gymnasium	5 Hours	Furthering negotiations related to the Impact Benefits Agreement (IBA)
10-Aug-09	Liidlii Kue First Nation (LKFN) - Gilbert Cazon, Mary Isaiah-Tanche, and Rosie Jane Browning	LKFN's TK Study	Meeting at LKFN's Band Office	30 Minutes	LKFN requesting more details from CZN for the upcoming council discussion regarding CZN's request for relevant TK study to the Prairie Creek Mine.

Date	Stakeholders/ Participants	Subject	Consultation Method/Location	Duration	Consultation Remarks
28-Jul-09	Nahanni Butte Dene Band - Chief Fred Tesou, Councilor Jayne Konisenta, Councilor Lena Marcellais, Councilor Tammy Matou, Flora Cli, Jean Marie Konisenta, Morgan Matou, Anna Tsetso, George Tsetso, Violet Tesou, Bobby Vital, Lorraine Vital, Morris Vital, Raymond Vital, Elsie and Jonas Marcellais (made extensive comments prior to meeting, but did attend presentation). NBDB's Consultant, Peter Redvers.	TK Presentation & Road Analysis for NBDB	Meeting at Nahanni Butte Gymnasium	4 Hours	CZN gave a presentation for the NBDB community. The presentation was related to updated project details, a request by CZN for TK information for the upcoming DAR.
26-Jun-09	Village of Fort Simpson - Mayor Duncan Carvin	Brief on CZN Developments	Meeting at Fort Simpson Beverage Business	10 Minutes	Discussion the current status of the Prairie Creek Project and regulatory progress. The Village supports the project.
26-Jun-09	NBDB IBA Committee - Rick Bargery, Greg Empson, Don Hardisty, George Betsaka (NBDB Elder)	IBA Scoping Meeting	Meeting at Nahanni Inn's Zinc Room, Fort Simpson	6 Hours	Review the IBA process, update project developments and discussed IBA process
25-Jun-09	NBDB's IBA Consultant - Rick Bargery & Greg Empson	IBA Scoping Meeting	Meeting at Fort of the Forks Motel, Fort Simpson	2 Hours	Discussed the framework for the upcoming Impact Benefits Agreement (IBA) Meetings with NBDB.
29-May-09	Parks Canada Agency, Dehcho First Nations	Technical Team Meeting	Meeting at Park's Canada Office, Ottawa	4 Hours	Discussed Prairie Creek Mine update, CZN regulatory process, CZN development proposal, status of park expansion process, and DehCho update.
29-Apr-09	Nahanni Butte Dene Band - Councilor Jim Betsaka, Councilor Peter Marcellais, Tthenaago Development Corp Manager Don Hardisty, Greg Empson,	IBA Introduction	Meeting at INAC Offices, Yellowknife	1 Hours	CZN had introductory meeting with NBDB's IBA Team.
22-Apr-09	Aurora College - Barb Tesou, Dean Harvey	Career Opportunities	Presentation at Aurora College, Fort Simpson	2 Hours	Discussions included updating Prairie Creek Mine activities, the process of mining and career opportunities for youth in Dehcho.
3-Feb-09	Parks Canada Agency, Dehcho First Nations	Technical Team Meeting	Meeting at Park's Canada Office, Ottawa	2 Hours	Discussions included updating Prairie Creek Mine activities, CZN regulatory process, CZN development proposal, status of park expansion process, update from Dehcho, access road and boundary issues, and MOU potential wording.
4-Nov-08	LKFN - Chief Keyna Norwegian, Executive Director Dennis Nelner, Nogha Enterprises Gilbert Cazon, and Finance Manager Wilbert Cook	Ceremony for Signed Memorandum of Understanding	Signing at Explorer Hotel, Yellowknife	1 Hour	Signing of MOU with LKFN
4-Nov-08	NBDB - Chief Fred Tesou, Councilor Jayne Konisenta, Development Manager Don Hardisty	Ceremony for Signed Memorandum of Understanding	Signing at Explorer Hotel, Yellowknife	1 Hour	Signing of MOU with NBDB
24-Oct-08	Parks Canada Agency, Dehcho First Nations	Technical Team Meeting	Meeting at CZN's Vancouver Office	4 Hours	Discussions included updating CZN's regulatory process, status of park expansion process, revisions to MOU, road alignment alternatives Ram Plateau, and road access control and boundary location.

Date	Stakeholders/ Participants	Subject	Consultation Method/Location	Duration	Consultation Remarks
3-Jul-08	Parks Canada	Technical Team Meeting	Meeting at CZN's Vancouver Office	N/A	Discussions included CZN's regulatory process, status of park expansion process.
22-Jun-08	Parks Canada	Signed Memorandum of Understanding	Faxed to CZN Signed MOU Agreement	N/A	Received Signed MOU from Parks Canada
25-Aug-08	NBDB -Chief Fred Tesou, Councilor Jayne Konisenta, Councilor Lena Marcellais, Councilor Lorraine Vital, Councilor Tammy Matou, Councilor Joan Ekotla, Elder George Betsaka	Discussing Memorandum of Understanding	Meeting at NBDB Band Office	2 Hours	Discussed the framework of MOU. NBDB wants to move MOU forward. Removal of cyanide helped bring more community members onside with the proposed project.
23-Aug-08	Dehcho Region	4th Annual Canadian Zinc Open Golf Tournament	Event held at Seven Spruce Golf Course, Fort Simpson	2 days	CZN sponsors the annual tournament. Attended by teams throughout the Dehcho and one of the largest golf events in the Northwest Territories.
14-Nov-07	Deh Gah Got'ie Koe First Nation, Fort Providence Community - Please refer to Appendix L of CZN's PDR	Open House Discussions about the Prairie Creek Mine	Meeting at Council Chambers	3 Hours	CZN gave detailed presentation to the community. Please refer to Appendix L of CZN's PDR
14-Nov-07	Katlogeeche First Nation Band (Hay River Reserve) - Please refer to Appendix L of CZN's PDR	Open House Discussions about the Prairie Creek Mine	Meeting at Katlogeeche Band Office	3 Hours	CZN gave detailed presentation to the community. Please refer to Appendix L of CZN's PDR
14-Nov-07	Ka'a'gee Tu First Nation (Kakisa - Hay River) - Please refer to Appendix L of CZN's PDR	Open House Discussions about the Prairie Creek Mine	Meeting at Ka'a'gee Band Office	3 Hours	CZN gave detailed presentation to the community. Please refer to Appendix L of CZN's PDR
12-Nov-07	Sambaa K'e Dene Band (Trout Lake) - Please refer to Appendix L of CZN's PDR	Open House Discussions about the Prairie Creek Mine	Meeting at Sambaa K'e Band Office	4 Hours	CZN gave detailed presentation to the community. Please refer to Appendix L of CZN's PDR
8-Nov-07	Acho Dene Koe First Nation/ Fort Liard Community - Please refer to Appendix L of CZN's PDR	Open House Discussions about the Prairie Creek Mine	Meeting at Fort Liard Community Hall	4 Hours	CZN gave detailed presentation to the community. Please refer to Appendix L of CZN's PDR
7-Nov-07	Nahanni Butte Dene Band - Please refer to Appendix L of CZN's PDR	Open House Discussions about the Prairie Creek Mine and classroom presentation	Meeting at Nahanni Butte Band Office, Presentation at Charles Yohin School	4 Hours	CZN gave detailed presentation to the community and local school. Please refer to Appendix L of CZN's PDR
6-Nov-07	Liidlii Kue First Nation (LKFN), Village of Fort Simpson - Please refer to Appendix L of CZN's PDR	Open House Discussions about the Prairie Creek Mine	Meeting at Nahanni Inn's Zinc Room	4 Hours	CZN gave detailed presentation to the community. Please refer to Appendix L of CZN's PDR

Memo

To: Alan Taylor	From: Chris Reeves
COMPANY: Canadian Zinc Corporation	Date: March 5, 2010
CC: David Harpley	Pages 4

Subject: Received NBDB Survey for DAR

☐ **Urgent** ☐ **For Review** ☐ **Please Comment** ☐ **Please Reply** ☐ **Please Recycle** ☐ **Emailed**

Alan:

During our recent IBA negotiation session with NBDB on March 3 Peter Marcellais handed the community survey requested by CZN. The survey and reference map was completed by Peter on the dates indicated on the form. Peter spoke with 11 traditional harvesters over 4 days, and included only the level of detail that the community was comfortable to provide.

Hope this is not too late to be included in the DAR.

Chris

Suite 1710, 650 West Georgia Street, PO Box 11644
Vancouver, BC V6B 4N9
Toll free: 1-866-688-2001
Tel: (604) 688-2001 Fax: (604) 688-2043
E-mail: chris.r@canadianzinc.com Website: www.canadianzinc.com

Nahanni Butte Dene Band ("NBDB") Questionnaire
Survey of Traditional Activities

Prepared By: ~~Lorraine Vital,~~ Nahanni Butte NT

What traditional activities were practiced in the Prairie Creek Mine area, including the access road corridor?

Activity : TRAPPING & SPRING HUNTING IN AREA'S 1, 2, 3, & 4

Brief description of activity: TRAPPING OCT. 7 MARCH, SPRING HUNTING APRIL 7 MAY 15th. FALL HUNNTING ALL OF SEPTEMBER

Seasonal period: ______

Activity still practiced (select one): (Yes) / No

Harvesting Involved (select one): (Yes) / No

If Yes, please provide name of animal/plant harvested, estimated annual numbers and general location

AREA 1, 2, 3 & 4, MINK, MARTEN, LYNX, AND WOLVERINE, AND BEAVER, AND WOLVES. SUMMER, B. BEARS, MOOSE. FALL, MOOSE, BEARS, AND BEAVERS.

Activity : DURING TRAPPING SEASON, WE ALSO CATCH WEASEL,

Brief description of activity: SQUIRRIL, MUSKRAT. SPRING HUNTING, MUSKRAT AND MOSTLY BEAVER.

Seasonal period: ______

Activity still practiced (select one): Yes / No

Harvesting Involved (select one): Yes / No

If Yes, please provide name of animal/plant harvested, estimated annual numbers and general location

RAT ROOT, LABRADOR TEA, BIRCH AND POPULAR.
THERE'S ONE MORE PLANT FROM VOHIN LAKE, BUT DON'T HAVE A NAME.

Activity : AREA, (ONE) 2 TRAPPERS

Brief description of activity: AREA, (TWO) 2 TRAPPERS

AREA (THREE) 3 TRAPPERS

Seasonal period: AREA (FOUR) 4 TRAPPERS

Activity still practiced (select one): Yes / No

Harvesting Involved (select one): Yes / No

If Yes, please provide name of animal/plant harvested, estimated annual numbers and general location

Activity :

Brief description of activity:

Seasonal period:

Activity still practiced (select one): Yes / No

Harvesting Involved (select one): Yes / No

If Yes, please provide name of animal/plant harvested, estimated annual numbers and general location

I WAS TOLD NOT TO USE ANY NAMES, AND TO USE ONLY THE GENERAL AREA THAT IS BEING USED, WE CAN NOT ALLOWE ANY MORE INFO THAN THIS.

[redacted]

Contractor's Name

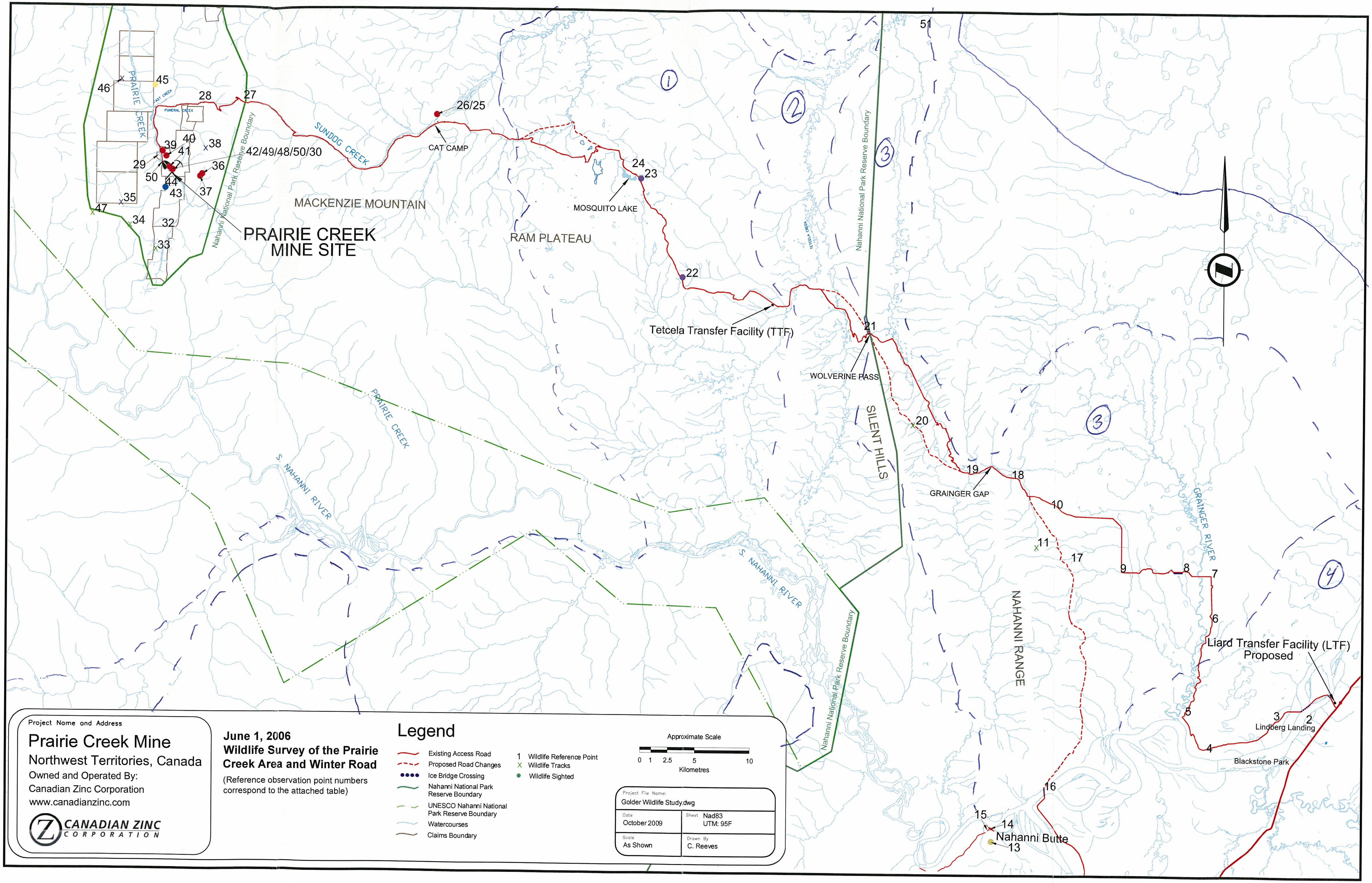
Contractor's Signature *Date*

FEB. 16th. 10 > ENTERVIED 2 TRAPPERS

FEB. 17th. 10 > " 3 TRAPPERS

FEB. 18th 10 > " 3 TRAPPERS

FEB. 19th 10 > " 3 TRAPPERS



PRAIRIE CREEK MINE SITE
PRAIRIE CREEK
SUNDOG CREEK
CAT CAMP
MACKENZIE MOUNTAIN
RAM PLATEAU
MOSQUITO LAKE
Tetcela Transfer Facility (TTF)
WOLVERINE PASS
SILENT HILLS
GRAINGER GAP
Nahanni National Park Reserve Boundary
S. NAHANNI RIVER
NAHANNI RANGE
GRAINGER RIVER
Liard Transfer Facility (LTF) Proposed
Lindberg Landing
Blackstone Park
Nahanni Butte
42/49/48/50/30
26/25
Project Name and Address
Prairie Creek Mine
Northwest Territories, Canada
Owned and Operated By:
Canadian Zinc Corporation
www.canadianzinc.com
CANADIAN ZINC CORPORATION
June 1, 2006
Wildlife Survey of the Prairie Creek Area and Winter Road
(Reference observation point numbers correspond to the attached table)
Legend
Existing Access Road
Proposed Road Changes
Ice Bridge Crossing
Nahanni National Park Reserve Boundary
UNESCO Nahanni National Park Reserve Boundary
Watercourses
Claims Boundary
1 Wildlife Reference Point
Wildlife Tracks
Wildlife Sighted
Approximate Scale
0 1 2.5 5 10
Kilometres
Project File Name: Golder Wildlife Study.dwg
Date: October 2009
Sheet: Nad83 UTM: 95F
Scale: As Shown
Drawn By: C. Reeves

REPORT: DECEMBER 5TH, 2009

COMMUNITY CONSULTATIONS WITH NAHANNI BUTTE RESIDENTS: December 1 - 4, 2009

CONSULTANT: ETHEL M. LAMOTHE

OUTCOMES: Categorized Issues and Statements in response to the question: "How do you think Canadian Zinc Mine will impact you?"

ISSUES	STATEMENTS BY NAHANNI RESIDENTS
ASSESSMENT TIMING:	• Why has Canadian Zinc waited until the end to do this? • This should have been worked on from day one. • Canadian Zinc is showing no concern about social impacts as they have delayed this work on this until now • Nahanni should do their own assessment • People want to continue this process with the consultant in the New Year, as from now until Xmas is not good for them time-wise
LEGAL	• Government is not the boss of our land; why are they being listened to? • Our old elders have said it is the elders who have the key to a successful life.
INVESTMENT OPPORTUNITY	• Can anyone be a shareholder?
DEVELOPMENT	• Occurring without our input • Some NB residents stated that they don't want the CZ mine at all • Several mentioned the impacts of the Hire North experiences, of the early 1970's, could be studied as an example of impacts from development • The pace of development is impacting us • Development is a bad name because of past experiences with oil companies the older people worked for. • CZ land base should be as that of CanTung as agreed to by the Consensus Team.
ROAD	• Elders do not want the road expansion close to Nahanni Butte • Elders spoke about the history of the road. • Some participants recommended that people should look at the experiences of road building impacts from Hire North • Others want the road close to the community as it will provide economic opportunities
ANIMALS & VEGITATION	• We are concerned about how the development will affect the animals and the natural vegetation and medicines of the land.

LAND & WATER	• All our land is for us to use, even the Park • Some of our sacred sites (burial sites) are now covered by the road • Water pollution is an issue.
ENVIRONMENT	• The land and water is a concern – • There needs to be a deposit of funds to cover mine clean-up • Planning needs to be done so we know what will happen to the old buildings • The environment is our way of life (culture), our spirit • This isn't the only issue about our environment. We are involved in the DFN process to settle with Canada. • The environment has been damaged by the work of oil & exploration companies.
MEETING FORMAT WITH CZ	• This is the first meeting with CZ in which we have been asked our opinion • Usually these meetings are "them" and "us" separated by tables
SOCIAL IMPACTS	• We are all affected by development • We are worried about the land and the water, this is causing stress; • People were born and raised there; they know lots of teaching stories from that area • The youth will be especially impacted. This causes stress and concern for the older people today. • Youth are unable to leave the community (i.e. unskilled), they live in/use the homes of Elders • Youth are unemployable; they are not using the elders; what is there for them in the future? • Youth drop out of school because of drugs • Many young people will not pass the mine's drug testing • Money from employment is not always used for the good of the family • People are not happy that they are being left out of decision making about development • Damage to medicinal plants and animals affect Dene health negatively. • We are feeling squished between Fort Liard, Canadian Zinc and Fort Simpson • Individuals and families have been negatively impacted by changes brought on by development • Alcohol and drug abuse is a big issue; it is from the influence of strangers arriving through development • When youths leave the drugs, all the others are antagonistic towards them. • The young people no longer listen to their elders or learn from them, or know how to listen to them • Youth show laziness, if we try to talk to them they threaten suicide • We expect a rise in crime, and we don't know what to do about this. e.g. break and enter, young people stealing snowmobiles,

COMMUNITY NEEDS	• Now is the time to do prevention work, not after the mine opens. • We need more training for employment (Youth meeting) • Soil and water testing, monitoring is needed. • Social Events Support e.g.: gym equipment, support to send people to golf tournaments (Simpson, Nelson) CZ sponsor a skidoo run to the mine in February • If CZ wants to help us, then they can do the community mobilization process through counseling and therapy – community healing which we need. • Community Justice process is needed • We need to begin at home to help our youth • The lack of communications between youth and older people needs to be fixed • Train some Nahanni people as environmental monitors • RCMP involvement is needed to curb drug and alcohol pushers • A documentary of the old ways would help: How old people did things – How the land used to be – respect everything – if the land is polluted, the animals are endangered. • Human resources inventory is required: i.e. What are the certifications held by Nahanni people
WILBERT ANTOINE PRESENTATION TO YOUTH MEETING.	• CZ community consultations • Trained our people in Heavy Equipment • People doing jobs • More talks • Funding for Employment • Something to be worked on • Water and land concerns • More training for mining • Getting help for students going back to school • College entrance courses • Have resources right here to be used • Will be good for the community also
INTERVIEWEES	• Thirty Nine people were interviewed (17 youth, 22 adults) 34% of population based on 2004 stats.

PARTICIPANTS - DEC. 2, 2009 MEETING

- PAULINE CAMPBELL
- WILLIAM KONISENTA
- JEAN MARIE KONISENTA
- CLAYTON KONISENTA
- CELINE BETSAKA
- JAYNE KONISENTA (BRIEFLY)
- MIKE MATOU (BRIEFLY)
- BURTON CAMPBELL

NAHANNI BUTTE DEC. 2, 2009
6:00 PM

M.A. INTRODUCED THE EVENING MEETING. " ETHEL LAMOTHE
CZN - UPDATE
ETHEL
- LONG VS SHORT REPORT
- REPORT OUTLINE
- CROSS CULTURAL PROBLEMS @ THE WORK-SITE.

Q- CLAYTON - WHY ARE WE DOING THIS, WE DON'T KNOW WHAT IS GOING TO HAPPEN IT IS NOT GOING YET.

Q.- WHY IS THIS LEFT FOR LAST

ELDERS - NOT HAPPY WITH EVERYTHING

Q. - EVERY INFORMATION IS E.S. FIRST NOT NBDB

- COMMUNICATION BREAKDOWN - JIM BETSACA - C.I.R, NBDB.
- WILBERT + ETHEL - COMFORT ZONE. NOT CITY PEOPLE.

- ROAD RELOCATION
OUT OF WATER-SHED

- LONGER TIME PERIOD. EXTEND PAST 2010?
? JANUARY?

Q.

CONCERNS

P. CAMPBELL

- ALCOHOL / DRUG PROGRAM
- COUNSELLING SERVICES

CZN - ANNUAL GOLF
- NOTHING FOR NB
- SOCIAL EVENT
- SIMPSON BENEFIT
- SKI DOO TRIP

- HIRE NORTH TYPE IMPACT (SOCIAL)

Q RISING CRIME
- DEALING W IT! HOW?

- VERY IMPORTANT BUT LAST, SHOULD BE DONE B-4

END @ 9:00pm

MEETING BEGAN TENTATIVELY, GUARDED GRADUALLY WARMED AND VERY OPEN W EVERYONE PARTICIPATING. NOT A STRUCTURED MEETING SET UP BUT W EVERYONE UP CLOSE "BEST MEETING W CZN SO FAR!"

CONCERN OF NB COMMUNITY IS YOUTH
- STEALING SKIDOOS
- STEALING GAS
- BREAKING INTO HOMES
WAREHOUSE
BAND OFFICE
GYMNASIUM
- SOLUTION MAY BE SOLVED WHEN CZN IS OPEN FOR BUSINESS I.E., FULL EMPLOYMENT → LEADS TO ATTENTION AWAY FROM THE ABOVE CONCERNS

INFRASTRUCTURE - WHAT TO DO AFTER THE MINE
THE COMMUNITY HAS NOT RAISED THIS ISSUE YET. NEED TIME TO THINK
SUGGESTIONS
- AIRSTRIP - LEAVE FOR SAFETY
- ROAD - MAYBE CAN BE USED FOR FUTURE DEVELOPMENT IN THE PRAIRIE CREEK "DOUGHNUT"
- MAYBE USE TANKS, SOME BLDGS

IF THERE IS ROOM IN THE P.C. "DOUGHNUT" NB MAYBE EXPLORATION - WHO KNOWS?

RAYMOND AND LAURA VITAL
9:15 PM
- CZN PROJECT
- OR BECAUSE IT IS ALREADY THERE!
- IF UP TO ME - NO BUT ↑ - LAURA
- ROAD RELOCATION
- LAURA - USE OLD ROAD TO LINDBERG LANDING
- RAYMOND WANTS NEW RELOCATION, OUT OF WATERSHED - SOLID GROUND

Q - WATER
EXPLAINED OUR PLAN TO CONTROL RUNOFF, TREATMENT EVENTUAL RELEASE GOOD QUALITY H_2O BACK TO WATERSHED.

Q TESTING
EXPLAINED PLAN AND ACTUAL TEST AREAS THROUGHOUT THE H_2O FLOW - ENTRY TO RELEASE POINTS AND BEYOND

Q HISTORICAL
CONCERNS TO HOW PRAIRIE CREEK WAS INITIALLY PUSHED IN - 80'S
EXPLAINED CZN POSITION OF TODAY - UPFRONT

ETHEL - 4 DAY CONTRACT TO RELEASE A SHORT REPORT - FEELING A MUCH MORE DETAILED REPORT IS REQUIRED

BOTH LAURA / RAYMOND - FEELING LEANING SAME AS ETHEL ABOUT REPORT LENGTH.
EXPLAINED THE REQUIREMENT FOR 'NOT A LONG DETAILED REPORT BUT A SHORT LOCAL ONE TO POINTS TOUCHING EACH ISSUE'.

DEC. 3, 2009 9^00 AM
LENA, CELINE BETSAKA
- ETHEL EXPLAINED PROJECT SHE IS WORKING ON
- CONCERNS → YOUTH
→ ABUSE *
→ EDUCATION
→ OPPORTUNITIES.
→ TRAINING
→ ROAD
→ MINE
→ ENVIRONMENT
→ FAMILIES
→ PAST MISTAKES

* "NO ONE WILL DO THE JOB ETHEL IS DOING HERE (NAHANNI BUTTE)"

GEORGE VITAL 10^00 AM
PRAIRIE CREEK MINE "DOES NOT MATTER" TO HIM
ROAD RELOCATION IS GOOD

FOR NAHANNI BUTTE → TO FATHER MARY HILL ROUTE ALONG BELOW THE MOUNTAIN RANGE FROM GRAINGER GAP TO SWAN POINT ICE CROSSING IS NO PROBLEM.

- ONLY PROBLEM IS FORESTRY PLUGGED MTN TOP HOLE. THIS IS NOT GOOD!
- WATER QUALITY - TAILINGS CONCERN AT TUNGSTEN MINE — CZN PRAIRIE CREEK MINE - NO TAILINGS IS OK.

ETHEL - NOTE: CZN → NO TAILINGS - TUNSTEN HAS TAILINGS.

GEORGE ... "GOOD"

- HIRE NORTH HISTORICAL PROBLEMS, FAMILIES, NO COMMUNITY CONSULTATION, DRUGS - ALCOHOL RAMPANT ABUSE, LET'S NOT REPEAT THESE MISTAKES.

JEAN MARIE KONISENTA

- PROJECT IS GOOD FOR NAHANNI BUTTE
- ROAD IS GOOD - RELOCATION

" "NEED TO START NOW - COMMUNITY BASED COUNSELLING PROGRAM"

YOUTH CONCERNS - EDUCATION, ABUSE FAMILIES.

→ FEBRUARY SKIDOO TRIP - GOOD IF CZN SPONSORED THIS.

GOOD IDEA FOR COMMUNITY BASED

CELEBRATION, CARNAVAL STYLE FESTIVITIES HANDGAMES, DRUM DANCES. DRUG / ALLOHOL FREE!

" - WINTER ROAD MAYBE A PROBLEM NEED PREVENTION NOW!" NOT AFTER IT IS OPENED --- NOW!

WILLIAM KONISENTA 11^30 AM

- LAST NIGHT MEETING WAS GOOD (SEE NOTES;).
- HIRE NORTH DAYS - A LOT OF CONCERNS
  - LOTS OF MONEY - FREE SPENDING
  - ALCOHOL
  - FAMILY DISRUPTION
  - ABUSE
  - VIOLENCE
  - BREAK UPS. ..

WE HAVE TO LEARN FROM PAST MISTAKES

THE TIME NEED TO GET PERMITS CZN NEEDS TO START WORKING TOWARD ADDRESSING SOCIAL CONCERNS, MAINLY, DRUGS/ALCOHOL AMONGST YOUTH.

Youth Students List

December 3, 2009

Wilbert Antoine
Marcel Marcellais
Hank Matou
Samantha Konisenta
Brandon Konisenta
Robert Vital
Logan Walker
Jonathan Konisenta
Celine Betsaka
Ryley Matou
Leanna Vital
Destiny Ekotla
Charla R. Isaiah Marcellais
Josh Bertrand
Qualin konisenta
Kiyana Betsaka
Lory-ann Bertrand
Jolene Betsaka
Melvin vital
Stephanie Betsaka =)

Wilbert Antoine
Ethel Lamothe
Samantha
Robert (Bobby) Vital

DECEMBER 3. 2009 1:00 PM
YOUTH AND STUDENTS MEETING
(LIST ATTACHED)

- ETHEL BEGAN THE MEETING - THE PURPOSE OF COMMUNITY INVOLVEMENT - FOCUS ON YOUTH / STUDENTS AT THIS MEETING.
LAST NIGHT ELDERS & COMMUNITY REQUESTED WE MEET YOUTH / STUDENTS
- WILBERT PROVIDED PROJECT INTRODUCTION AND UPDATE
- ETHEL DISCUSSED THE PROBLEMS AS ASSOCIATED WITH 'HIRE NORTH' EXPERIENCE OF THE 1970'S. NO CONSULTATION, NO FORMAL INTRODUCTIONS INTO COMMUNITIES / LEADERS / ELDERS

CONCERNS OF THE YOUTH / STUDENTS
- PEOPLE NEED JOBS
- JOBS WITH A FUTURE
- EMPLOYMENT TRAINING
- SPRUCING UP THE COMMUNITY (TOUCH UP)
- ENVIRONMENTAL PROTECTION (MAKE A MODEL ~~OF~~ SHOWING EVERYTHING AT THE MINE
- LOCAL INPUT IN NAHANNI HAS TO BE FROM THE HEART OF NAHANNI BUTTE
- WHY DOES EVERYTHING HAVE TO BE BY THE GOVERNMENT. NOT US. THIS IS OUR LAND.
- MORE MINE TRAINING

- CONTINUOUS TRAINING, TO ADVANCE INTO HIGHER POSITIONS
- ELDERS / YOUTH → RESPECT EVERYONE, EVERYTHING. NOW IT IS A BIG QUESTION
- POLLUTION - DOCUMENT EVERYTHING
- * SCHOOL DROP OUT RATE (ALSO A BIG CONCERN OF NB ELDERS
- STICK TO YOUR EDUCATION, NEED FOR MORE COLLEGE GRADUATES

APPENDIX 27

PRAIRIE CREEK MINE

DRAFT PRELIMINARY
CLOSURE AND RECLAMATION PLAN

February 2010

TABLE OF CONTENTS

1.0 INTRODUCTION

This Draft Preliminary Closure and Reclamation Plan (“CRP”) for the Prairie Creek Mine has been written to fulfill requirements listed in the Terms of Reference issued by the Mackenzie Valley Review Board for environmental assessment (“EA”) EA0809-002, and is intended as an appendix to the Developer’s Assessment Report (“DAR”). For a description of the Prairie Creek Mine project, environmental characteristics of the site and area, description of mine components, mine waste geochemical properties, mine waste and water management plans, and post-closure water quality predictions, the reader is referred to the main text of the DAR.

This document focuses on the activities planned to remove or reclaim the components of the project, the expected schedule, and the monitoring expected to confirm that closure objectives are met. Three phases of closure are considered in this document: permanent closure; temporary closure; and, early closure.

At this juncture of an EA, infrastructure on a proposed mine site is usually limited to a small camp. In this case, the Prairie Creek Mine is already almost completely developed. Therefore, for most of the mine components and the site in general, reclamation requirements directly relate to established infrastructure rather than proposed infrastructure

2.0 TEMPORARY MINE CLOSURE

2.1 OBJECTIVES

Underground Mine

- Minimize operating and maintenance problems associated with the restart;
- Prevent flooding of the underground workings; and,
- Maintain water management structures and continue water treatment and water monitoring.

Mill

- Minimize operating and maintenance problems associated with the restart;
- Eliminate freeze damage to equipment and piping;
- Eliminate reagent spills; and,
- Facilitate an orderly transition from Temporary Closure to Permanent Closure should such a decision be made.

Infrastructure

- Maintain infrastructure components that are not required during Temporary Closure in a condition whereby they do not pose a potential restart, safety or environmental concern, and are able to be monitored effectively.

2.2 ACTIVITIES

Waste Rock Pile

- Continue collection of seepage, maintenance of diversions ditches and monitoring.

Underground

- Fill mined areas on a priority basis, depending on the time and fill available;
- Examine open faces to decide whether temporary support is necessary;
- Ensure that all areas into which there is water flows have systems to drain these flows to the sumps at water pumping stations;
- Monitor the operation of underground pumps and key sumps to provide data on water levels;
- Ensure all explosives and detonators are removed from temporary storage areas;
- Remove all mobile and other equipment, not required during the shut down, to surface or other safe area;
- Review all electrical installations and decide whether any equipment or cables should be moved; and,

- Review ventilation requirements to assess what reductions can be implemented.

Mill

- Empty all process equipment, tanks and piping to prevent problems on restart;
- Process all material in surface stockpiles and the fine ore bin;
- Filter, bag and store all concentrates; and,
- After an extended Temporary Closure, jack up the ball mill off of its bearings.

Water Storage Pond

- Maintain the WSP at a safe water level by intermittently treating water in the Water Treatment Plant.

Water Treatment Plant

- Shut down the process water treatment circuit, empty all liquid reagent storage tanks, blow down all distribution lines with compressed air to prevent freeze damage;
- Close all isolation valves at the acid storage tank and drain all acid lines; and,
- Maintain the mine water treatment circuit at full operational status.

On-Site Infrastructure

- Take off-line all facilities of on-site infrastructure that are not required during Temporary Closure;
- Drain water lines to prevent freezing; and,
- Monitor and maintain off-line facilities.

Off-Site Infrastructure

- All off-site infrastructure is closed seasonally.

2.3 MANAGEMENT

During Temporary Closure, a skeleton staff will remain on-site to maintain systems and continue monitoring. The site management and reporting function will revert to CZN's executive offices, as at present during the existing Care and Maintenance period.

2.4 MONITORING, MAINTENANCE AND REPORTING PROGRAM

The monitoring program specified in the Water Licence will be continued. Depending on the timing and circumstances of Temporary Closure, petition may be made to the Mackenzie Valley Land and Water Board to modify the program to suit conditions.

3.0 PERMANENT CLOSURE AND RECLAMATION

An important requirement for the development of any CRP is a clear definition of the intended future land use of the site after closure. At this time, it is not clear what that land use will be. The site already has significant infrastructure that could continue to be used after closure, including accommodations, water supply, sewage plant, power generation, fuel tank farm and water management structures. These and other structures could remain largely intact after closure, or could be pared-down for a more limited site use, or could be removed completely. In the CRP below, complete removal is assumed, although this may not occur immediately after mine closure.

Comment from local communities and Parks Canada has been requested regarding the desired long-term use of the site. No comments have been received to date.

Due to the remote location of the mine and the associated costs of moving material off site, it is likely that the mine assets on closure will have limited if any salvage or resale value. Therefore, all equipment and demolition debris is expected to be disposed of in on-site landfill. Some may be left underground and encased in backfill, but the majority is expected to be placed in a landfill in the footprint of the Waste Rock Pile (“WRP”).

3.1 GENERAL CLOSURE OBJECTIVES

Physical Stability

The primary physical stability objectives are that the site is reclaimed without promoting instability in local slopes, and that major structures will remain stable in the long-term. The latter applies mainly to the WRP and the bulkheads sealing entry to the underground workings. Reclaimed surfaces should also not be prone to erosion and prone to sediment production.

Chemical Stability

Chemical stability relates primarily to the mine wastes, specifically the backfill mix placed underground and the rock in the WRP. These sources are expected to produce dissolved metals at a slow rate which will contribute to groundwater and ultimately discharge to the environment. Waste management and closure plans have been developed to limit this discharge.

Future Use and Aesthetics

As noted above, the future use of the site after mining is unclear at this stage. At a minimum, some major structures and facilities will be removed or pared-down. Reclaimed surfaces will resemble the sparsely-vegetated rocky local terrain. If the area is to be immediately absorbed into the Nahanni National Park Reserve, the area will likely become a wilderness area and the aesthetics should reflect this end use.

3.2 CLOSURE CRITERIA

The relevant criteria for physical stability are static and dynamic factors of safety for the WRP, and confirmation of surface stability and absence of erosion as defined by suspended sediment concentrations in water quality monitoring.

Confirmation of chemical stability will be based on surface water quality monitoring and comparison of results to site-specific water quality objectives.

Criteria for aesthetic success are subjective. However, reclamation will attempt to restore the landscape to a natural condition.

3.3 ACID ROCK DRAINAGE AND METAL LEACHING

Objectives

The objectives to limit acid rock drainage ("ARD") include removal of acid generating material (mineralization), and minimizing the access of air and/or water to sites of potential acid generation. As with any lead-zinc deposit, there is potential for neutral drainage metal leaching. This leaching will be minimized by placing material in locations where the flow of oxygenated water is limited.

Pre-Mine Planning

Geochemical testing confirmed that underground wall rocks could generate ARD but have a high neutralization potential. Testing showed that tailings, rock from the mill and development rock from underground will not generate ARD, but will leach metals. Pre-mine planning included placement of tailings and most of the mill rock underground in a backfill mix to minimize contact with oxygenated water, avoid tailings placement on the Prairie Creek floodplain with a consequent long-term risk of exposure and leaching, and help seal the mine and limit mine drainage. Placement of a cover material on the WRP to limit infiltration is also planned.

Studies During Operations

Mine drainage flows will be monitored closely to refine the mine area groundwater model and allow revised predictions of groundwater discharge after closure. WRP seepage monitoring will allow refinement of metal leaching predictions which will assist in the selection of the final WRP cover.

Post-Closure Monitoring

Post-closure monitoring is discussed below as part of site monitoring.

3.4 REVEGETATION

Objectives

Reclamation objectives for revegetation are to promote the revegetation of reclaimed surfaces with local species and without exotic species, with emphasis on ground cover in riparian areas to limit sediment dispersal.

Pre-Mine Planning

The high-elevation, northern location of the mine, and absence of soil cover in many areas, means revegetation will be difficult, and/or may take many years to occur. Observations indicate that natural invasion of native species is an effective process (old drilling access roads) and should be fostered. The introduction of seed mixes is not favoured because of the difficulty of eliminating exotic species. Exposed soil surfaces near watercourses may need to be stabilized by coarse material until vegetation can develop.

Studies During Operations

Draw knowledge from observations of the natural revegetation of previously disturbed areas.

Progressive and Post-Closure Reclamation

Progressive revegetation of the WRP may be possible if cover placement is started during operations.

Post-Closure Monitoring

The stability of disturbed surfaces, and progress of revegetation, will be monitored during all post-closure monitoring episodes.

3.5 WASTE ROCK PILE

Objectives

The WRP must be stable in the long-term, and must not leach metals to an extent that groundwater and surface water quality are significantly impacted. The final pile surface must not erode and must readily revegetate. Upstream runoff should naturally flow around the pile without erosion.

Pre-Mine Planning

Investigations confirmed the suitability of the WRP with preparation, and pile stability based on the proposed configuration. Preliminary cover options were evaluated.

Studies During Operations

Final cover selection will be based on further geochemical assessment during operations.

Progressive and Post-Closure Reclamation

The WRP has been designed to store 400,000 m^3 of waste rock and an additional 100,000 m^3 of inert solid waste in a landfill. The landfill will receive the following solid waste reclamation components, stripped of all contaminants that would disqualify them as acceptable solid wastes:

- Mobile equipment;
- Stationery equipment;
- Building structural materials;
- Construction materials; and,
- All other solid materials (tyres, wire, steel, parts).

At the completion of mine reclamation, the solid waste landfill will be covered with a minimum one-metre thick layer of waste rock. The final rock surface will be contoured ready for cover placement. The final cover will depend on the results of monitoring and geochemical assessment over the operating life of the mine. One possibility is a 20cm soil amendment layer with a suitable growth medium for vegetation. Sewage sludge will be stockpiled over the life of the mine, and may be used as a soil amendment in the WRP cover. The final WRP surface will be shaped to allow gentle runoff without erosion. Progressive reclamation in the form of cover placement as the pile is developed may be possible.

The WRP location is also the proposed site of a bioremediation cell for hydrocarbon-contaminated soil. This cell will be decommissioned before closure occurs so that no soil is left unremediated in the cell at closure. Any contaminated soil arising after that time will be taken off-site for disposal.

Post-Closure Monitoring

The stability of the cover and progress of revegetation will be monitored during all post-closure monitoring episodes. Water quality monitoring is discussed below.

3.6 WATER STORAGE POND

Objectives

The footprint of the Water Storage Pond (“WSP”) must not be able to impound water after closure. Site runoff should be able to drain without erosion and sediment production. Final surfaces should readily revegetate. The riparian area adjacent to Prairie Creek should not be disturbed and should remain stable and non-erodable.

Pre-Mine Planning

Site investigations focussed on the stability of the backslope for operations. This stability included a nearly full WSP which acts as a buttress. On closure, the pond will be emptied and the slope may be less stable. However, with natural conditions established, there will be no consequence if a failure occurs.

Studies During Operations

Pond backslope stability will continue to be monitored.

Progressive and Post-Closure Reclamation

At the point that the WSP is no longer required for the storage of contaminated water, the WSP will be reclaimed as follows:

- Any tailings stored temporarily in the base of the pond will be removed and sent to the backfill plant and subsequently placed underground;
- The remaining pond water will be treated in the Water Treatment Plant and discharged;
- Sediment in the base of the Water Storage Pond will be dredged and pumped to the Backfill Plant. The resulting backfill mix will either be placed underground or in the solid waste landfill at the WRP;
- After the WSP is substantially free of water and sediment, liner removal will commence. The rolled up liner will be disposed of in the WRP;
- The WSP berms will be reduced in height to the elevation of the armour adjacent to Prairie Creek. The removed material will be used elsewhere for reclamation or spread across the floor of the empty pond; and,
- The eastern berm between the WSP and the main site will be breached to allow runoff to flow out and connect with the existing site drainage ditch, or percolate into the alluvial aquifer.

Post-Closure Monitoring

The stability of the armour and progress of revegetation will be monitored during all post-closure monitoring episodes.

3.7 UNDERGROUND MINE

Objectives

All mine openings are to be sealed to prevent entry. All mine workings and access tunnels are to be completely filled to limit contact of the backfill mix with groundwater, and to restrict groundwater flow through any voids. All adits are to be completely backfilled to eliminate mine drainage via the portals.

Pre-Mine Planning

Testing was completed on the backfill mix to determine hydraulic properties. Groundwater studies were completed to predict the volume and quality of groundwater discharge after closure.

Studies During Operations

Mine drainage flows will be monitored to update groundwater closure model predictions.

Progressive and Post-Closure Reclamation

Mine Equipment:

All mine equipment will be removed from the underground before mine closure. Equipment and material that is salvageable will be taken off-site. Equipment and material that has no salvage value will be removed to the Solid Waste Landfill.

Mine Workings:

The underground mine will be progressively reclaimed during operations by backfilling mine openings. On closure, all access tunnels and ramps will be backfilled.

As mining is coming to an end, the following actions will be implemented;

- Start moving equipment not deemed necessary out of the working areas, and removing some from the mine;
- As soon as production ceases, ensure that all explosives are removed to surface;
- All supplies, other than those required for the permanent closure, are to be removed to the upper levels or from the mine; and,
- Progressively retreat pumping, ventilation, electrical installations etc prior to and during the final backfilling process.

When all mine openings have been backfilled, filling of the access development tunnels and raises on the lowest level, the 640 Level, will commence. Equipment and installations such as cables, pipes and supplies must be removed. The objective will be to tight fill the backfill mix to the backs of the openings.

As each level below the 880 Level is completed, filling of the ramp will commence. During this ramp filling, redirecting any water flows to the pumps and maintaining ventilation to the faces will be given high priority. As the filling of the ramp approaches the 720 level, filling of all openings on this level will become the priority, following the same procedure as used on 640 Level. The above procedure will continue to be used on the levels and ramp until the 880 Level is reached.

Depending on the results of groundwater modelling, hydraulic bulkheads may be constructed at key locations to limit the transmission of groundwater. This is more likely on the higher levels since this is likely to be where groundwater would discharge.

Post-Closure Monitoring

The condition of portal barricades will be inspected and observations made for evidence of seepage. Water quality monitoring is discussed below.

3.8 MILL AND ON-SITE INFRASTRUCTURE

Objectives

Remove all contaminated materials and wastes. Restore land surfaces. Return lower Harrison Creek to a natural setting.

Pre-Mine Planning

The low utilization potential of Harrison Creek by fish was confirmed.

Progressive and Post-Closure Reclamation

All surface facilities including the Mill, Paste Plant, Water Treatment Plant, administration and accommodation buildings, maintenance shops, Sewage Treatment Plant and Fuel Tank Farm will be reclaimed as follows:

- Evaluate and store for removal off-site by waste types all wastes that do not qualify for disposal in the WRP;
- Dismantle all equipment and buildings, reduce the material to manageable pieces for removal to the WRP landfill;
- Dispose of all waste that qualifies for disposal in the WRP; and,
- Grade and prepare disturbed surfaces for revegetation.

The berms lining the Harrison Creek channel will be lowered in elevation. The Fuel Tank Farm berm material will be used to fill the containment so it does not impound water. The gabions (wire baskets) in the bed of Harrison Creek will be removed and the natural gravel bed restored. The culvert outlets from the Catchment Pond will be removed and the pond dyke breached so that site drainage flows into Harrison Creek. The road crossing and large culverts in the bed of Harrison Creek near its confluence with Prairie Creek will be removed.

Post-Closure Monitoring

The stability of riparian areas and progress of revegetation will be monitored during all post-closure monitoring episodes.

3.9 OFF-SITE INFRASTRUCTURE

Objectives

Remove all contaminated materials and wastes. Restore land surfaces. Modify Funeral Creek road bed to promote stable long-term runoff.

Progressive and Post-Closure Reclamation

The off-site infrastructure at the transfer facilities will be salvaged, taken to the mine for disposal, or taken to a suitable off-site disposal location. The sites will be reclaimed by scarifying the surfaces to promote natural invasion by native species. The all season road bed along Funeral Creek will be modified to promote revegetation and clean natural runoff. The road bed and culverts will be removed at stream crossings. The remaining bed will be scarified and given a gentle slope towards the creek. This will avoid channel formation on the bed and erosion. Coarse material or organic material will be placed along the bed adjacent to the creek to prevent sediment discharge until vegetation has established.

Post-Closure Monitoring

The stability of the road bed and outer slope, and progress of revegetation, will be monitored during post-closure monitoring episodes.

3.10 MONITORING, MAINTENANCE AND REPORTING PROGRAM

Post-closure monitoring will include inspection of mine access barricades, the WRP cover and runoff controls, observation of reclaimed surfaces for erosion, and the collection of water samples. Samples will be collected from Harrison Creek and Prairie Creek, and possibly a limited number of groundwater wells. Three locations on Harrison Creek (one upstream and two downstream), three locations on Prairie Creek (one upstream and two downstream) are envisaged. The number and location of groundwater wells to be included will be determined during operations.

For the first 3 years after closure and reclamation, monitoring and inspections will occur monthly over the period March to November. In the following 5 years, monitoring and inspections will occur bi-monthly from May to September. In the final 5 years, monitoring and inspections will occur one a year in July (post-freshet). The intent of monitoring is to track the revegetation and stabilization of surfaces, and confirm that water quality is as expected.

Annual reports will generally include water quality sampling information, post closure operations statistics and other items that demonstrate the progress of the different components of the monitoring plan.

3.11 ENVIRONMENTAL CONDITIONS AFTER RECLAMATION

Waste management and closure plans have been developed to be protective of the environment after closure. Predictions have been made regarding water flow and quality, and the probability of reclamation success. Post-closure monitoring is intended to verify the predictions made.

After closure, the mine will be completely backfilled and mine water pumping will cease. Groundwater levels will ‘rebound’, following which there may groundwater discharge from the mine area to surface water. The magnitude, seasonal timing and quality of this discharge have been estimated. Similarly, the performance of the cover on the WRP has been estimated in terms of seepage discharge. The estimates indicate that surface water quality should not be significantly different from the operating period, and that downstream water quality will meet site-specific water quality objectives. The monitoring program has been designed to confirm this.

3.12 POST-RECLAMATION RISKS TO HUMANS AND THE ENVIRONMENT

After closure and reclamation, risks to human health will be negligible because the mine will be completely backfilled, and the WSP will be breached and reclaimed. Risks to environmental health should also be low, provided the predictions of post-closure water quality are as expected, as explained above. Following revegetation of disturbed areas by natural species, the health of the local environment should be similar to what it was before site development and to adjacent areas.

4.0 EARLY CLOSURE

With any mining venture, continued operations are dictated by prevailing economics. There is always a possibility that economic conditions change during the expected mine life, which may lead to an early mine closure decision. This might occur after a temporary closure, or after an operating period, the latter being more likely towards the end of the expected mine life. This section reviews if and how the approach to closure and reclamation would change in an early closure situation.

Underground

Early closure of the underground will not change the approach to closure. Mined area will have been backfilled, and the existing access tunnels will also be backfilled as part of closure.

Waste Rock Pile

WRP closure will be as before. The WRP may be smaller than originally intended. The solid waste disposal site in the WRP footprint may be exposed at the time of closure. Movement of this waste, or movement of waste rock to bury it, might be required before the final WRP cover placement can occur.

All other closure actions for all other facilities will be the same for early closure as for final closure as described above.

APPENDIX A

GLOSSARY OF TERMS

Berm: A mound or wall, usually of earth, used to retain substances or to prevent substances from entering any area.

Closure: When a mine ceases operations without the intent to resume mining activities in the future.

Closure Criteria: Detail to set precise measures of when the objective has been satisfied.

Monitoring: Observing the change in physical, hydrogeological or geochemical measurements over time.

Progressive Reclamation: Actions that can be taken during mining operations before permanent closure, to take advantage of cost and operating efficiencies by using the resources available from mine operations to reduce the overall reclamation cost incurred. It enhances environmental protection and shortens the timeframe for achieving the reclamation objectives and goals.

Reclamation: The process of returning a disturbed site to its natural state or one for other productive uses that prevents or minimizes any adverse effects on the environment or threats to human health and safety.

Tailings: Material rejected from a mill after most of the recoverable valuable minerals have been extracted.

Temporary Closure: When a mine ceases operations with the intent to resume mining activities in the future. Temporary closures can last for a period of weeks, or for several years, based on economical, environmental, political or social factors.

Waste Rock: All rock materials, except for ore and tailings that are produced as a result of mining operations.

Definitions specific to this Closure and Reclamation plan:

Off-Site Infrastructure: A temporary bagged concentrate storage facility located approximately between the mine site and Highway 77 which is used in the winter months to reduce the haul distance when the winter road is available. A bagged concentrate storage and mine operating supplies staging area located on the winter road where it meets Highway 77.

On-Site Infrastructure: All of the surface facilities at the mine site in support of the mining and processing activities. These include a camp, administration building, warehouses, fuel storage, maintenance shops, out door storage and power plant.

Process Plant: All of the surface facilities associated with the recovery of minerals from ore. These include a dump pocket, crushing plant, dense media separation plant, cemented backfill plant, flotation and dewatering plant.

Waste Rock Pile: A waste rock storage area that has been designed to also be a solid waste landfill for both Progressive Reclamation and Reclamation activities.

Water Storage Pond: A lined mine water and process water storage pond with a capacity of approximately 500,000 cubic metres.

APPENDIX 28

CANADIAN ZINC CORPORATION

Prairie Creek Project

2010

FUEL SPILL

CONTINGENCY PLAN

January 2010

TABLE OF CONTENTS

FUEL SPILL CONTINGENCY PLAN

INITIAL RESPONSE ACTIONS

In the event of a spill or potential spill incident, the following steps should be taken by personnel at the spill site:

1. Be alert, ensure your safety and the safety of others first.
2. Isolate, remove or extinguish all ignition sources
3. Assess the hazard to persons and the environment in the vicinity of the spill or leak, identify escape routes, block spill drainage paths and implement measures at the pre-identified spill control points (see Section 5.1).
4. Before undertaking a response action proximal to the spill, ensure personnel have and don the appropriate personal protective equipment (PPE) (see Section 5.3 for details)
5. If possible without further assistance, control danger to human life and the environment.
6. Assess whether the spill, leak or system failure can be readily stopped or brought under control.
7. When safe to do so, stop the leak and/or flow of the spilled material.
8. Gather information on the event and the status of the situation, including the nature, extent and approximate amount of the liquid spilled.
9. Report the spill, leak or system failure without delay to the On-Scene Coordinator. Determine if the spill is a reportable event or quantity (refer to Section 3), and if so, report the spill to the **24 hour NWT/Nunavut Spill Line at (867) 920-8130 and if the spill is within the Nahanni National Park Reserve it should be reported directly to them at 867-695-3151.**
10. Resume any safe, effective action to contain, clean up, or stop the flow of the spilled product.

PREAMBLE

This *Fuel Spill Contingency Plan* is effective from January 1, 2010 to December 31, 2010 and applies to all projects and operations of Canadian Zinc Corporation at the Prairie Creek Property and access corridor.

The following formal distribution has been made of this plan:

Mackenzie Valley Land and Water Board

Canadian Zinc Corporation - Prairie Creek Site Office

Canadian Zinc Corporation - Vancouver Office

Additional copies and updates of this Plan may be obtained by writing to:

Canadian Zinc Corporation
Suite 1710-650 West Georgia Street,
PO Box 11644,
Vancouver, British Columbia
V6B 4N9
Phone: 604-688-2001
Fax: 604-688-2043
Email: alan@canadianzinc.com

Prairie Creek Minesite Address:

Canadian Zinc Corporation
Prairie Creek Minesite
9926-101st Avenue
PO Box 500
Fort Simpson, NT X0E 0N0
Phone: 867-695-3963

Prairie Creek Minesite direct numbers:

Satellite phone: 1-600-700-2454
Satellite fax: 1-600-700-9209
VOIP: 604-357-3513

FUEL SPILL CONTINGENCY PLAN

1.0 INTRODUCTION AND PLAN PURPOSE

The purpose of Canadian Zinc Corporation's Fuel Spill Contingency Plan is to provide a plan of action for every foreseeable fuel spill event at the Prairie Creek Property and the fuel storage and transfer facilities related to the planned property access road.

It is the policy of Canadian Zinc Corporation to initiate clean up activity when, in the opinion of its management, the company is clearly associated, or likely associated with a spilled product. It is also the policy of the company to comply with existing regulations, ensure protection of the environment, and to keep employees, government officials and the public, informed.

2.0 RESPONSE TEAM

The members of the fuel spill response team, and their designations, are listed below:

On-Site:

On-scene Coordinator:	Mr. Ted Boychuk, Site Manager Canadian Zinc Corporation
On-scene Coordinator: (Alternate)	Assistant Site Manager (Individual to be determined) Canadian Zinc Corporation
On-scene Resource: (When on site)	Mr. Alan Taylor, COO Canadian Zinc Corporation

Off-Site:

Response Manager:	Mr. Alan Taylor, COO Canadian Zinc Corporation
Environmental Advisor:	Mr. David Harpley, Environmental Coordinator Canadian Zinc Corporation
Environmental/Safety Advisor:	Mr. Richard Hoos, Principal Consultant EBA Engineering Consultants Ltd.

Additional Information or Assistance

Additional resources and assistance are available from the following sources:

Shell Bulk Petroleum	Mr. Bill Streeper / Rick Baldridge
Phone (Ft. Nelson):	(250) 774-7247
Fax:	(250) 774-7250
Government of NWT	
Pollution Control Division	
Phone (Yellowknife):	(867) 873-7654
Dept. of Indian Affairs &	
Management Officers	Troy Searson
Northern Development (Ft. Simpson):	
Phone:	(867) 694-2626
Fax:	(867) 695-2615
Indian & Northern Affairs Canada	
Contaminants Phone Hot Line:	☎ 1-800-661-0827
RCMP Phone (Yellowknife):	☎ (867) 920-8311

For large or complicated spills, Shell Bulk Petroleum can be contacted who have access to additional spill response equipment available for deployment. This could be facilitated by aircraft normally operated into the site by Villers Air Service.

For advice on contaminated material management, the environmental consulting resources and INAC contacts listed can also be consulted.

3.0 REPORTING PROCEDURES

The Fuel Spill Response Team must be notified immediately about the occurrence of any spill. The following chain of command must be followed in the reporting process.

Immediately Contact:

On-Scene Coordinator

Contact Person:	Ted Boychuk, Site Manager
Phone: (Prairie Creek Camp):	1-600-700-2454
Fax:	1-600-700-9209

Or if the On-Scene Coordinator cannot be immediately contacted:

On-Scene Coordinator (Alternate)

Contact Person:	Alternate Site Manager

The on-scene coordinator is responsible for determining if the spill is reportable, based on the INAC Spill Reporting Protocol for Mining Operations dated July 27, 2004 (see Appendix A), reporting the spill if it is reportable, and for notifying CZN management. In addition, the on-scene coordinator is responsible for recording all spills on the Canadian Zinc Spill Report Form (see the end of this document), and the INAC Monthly Spill Reporting Form (attached to the INAC Protocol in Appendix A). The on-scene coordinator is also responsible for submitting the latter form to the INAC District Inspector monthly if spills have occurred.

Spills of flammable liquids, such as diesel and gasoline, are reportable if the spilled quantity exceeds 100 litres. Spills of drilling fluid, used or waste oil, vehicle fluids and wastewater are reportable if the spilled quantity exceeds 100 litres or 100 kg. Spills are also reportable if they are near or into a water body, irrespective of quantity. For more details, consult the INAC protocol.

24 Hour NWT/Nunavut Spill Reporting Line

Phone:	**(867) 920-8130**
Fax	**(867) 873-6924**
Email	**spills@gov.nt.ca**
Parks Canada	**(867)-695-3151**

Note: A spill report should be filled out on the Spill Reporting Form as completely as possible prior to calling the 24 Hour Spill Reporting Line.

4.0 FUEL SPILL RESPONSE PLANNING AND RESPONSE ACTIONS

Spills that could potentially occur during fuel handling, transfer or storage operations, and their associated impacts, will be kept to a minimum by:

- utilizing fuel transfer hoses with double locking mechanisms;
- utilizing lined and self-bermed fuel storage areas with 110% capacity of the largest tank;
- ensuring all valves on storage tanks are secured and locked when not in use;
- conducting fuel transfers over secondary containment or a surface liner (e.g. drip pans, fold-a-tanks) placed under all container or vehicle fuel tank inlet and outlet points, hose connections and hose ends;
- maintaining a supply of spill response equipment (absorbent pads, booms) at all fuel transfer and vehicle maintenance locations;
- storing all contaminated equipment and related waste in sealed drums for later disposal off-site with the appropriate authorizations;
- careful manual measurement of fuel content in the tanks when transferring fuel;
- regular inspections of fuel storage tanks and hoses for evidence of leaks;
- training in proper fuel handling procedures and transfers conducted by trained personnel;
- spill response training for personnel associated with fuel handling;
- immediate cleanup of minor spills; and,
- identifying relevant control points down-gradient of the main fuel storage and transfer locations.
- Fuel containers, should be marked with the responsible party’s name, product type and year purchased or filled.

4.1 Response Actions for Fuel Spills on Land

1. Identify the source of the leak or spill, and if safe to do so and readily possible, stop the leak or spill;

2. Contain the spill and the source if possible, and block drainage paths down-gradient, especially at the pre-determined control points;

3. Leaks from a tank can be stopped by:

   - ceasing filling operations;
   - turning off valves;
   - utilizing patching kits to seal leaks;

   In the event of a rupture to a tank, the self-bermed design is intended to capture the full capacity of the largest fuel tank within its walls. The captured fuel can be pumped into a reserve fuel storage tank.

4. Spills (on gravel, rock, soil, vegetation) can be contained by placing a soil berm down slope of the running or seeping fuel. Plastic tarps can be placed over the berm and at the foot of it, to permit the fuel to pool on the tarp for easy capture. Absorbent pads can be used for this purpose, and the pads can be squeezed into empty drums and re-used. Larger pools can be pumped back into drums, empty storage tanks, or “TIDY” tanks. It is especially important to prevent the fuel from entering a body of water where it will have greater environmental impact;

5. Stains on rock can be soaked up with absorbent sheeting. The sheeting should be placed in drums for disposal;

6. Contaminated soil and vegetation may have to be removed and disposed of in an environmentally acceptable manner. Contact the government authority identified by the 24 Hour Spill Reporting Line for approval before undertaking this.

4.2 Response Actions for Fuel Spills on Snow

- The presence of snow can assist in containing spilled fuel and functions as a natural absorbent to facilitate the collection of spilled fuel;

- Berms can be constructed from compacted snow with a plastic tarp placed over this;

- The snow-fuel mixture can be scraped up and stored in a lined area or in drums for future disposal following the appropriate authorization.

4.3 Response Actions for Fuel Spills on Water

It is important to immediately control the release of spilled fuel into water and to contain it to the immediate spill area if possible. Assuming that fuel has entered water, actions to be taken can include:

- Deploy boom (s) to contain the spill area. The effectiveness of this action can be limited by winds, currents (in the case of moving water) and other factors;

- Absorbent pads and similar materials can be used to capture small spills on water. Absorbent booms can be drawn in slowly to encircle spilled fuel and absorb it. These materials are hydrophobic (absorb hydrocarbons and repel water). Absorbent booms are often relied on to recover any hydrocarbons that escape containment booms. Contaminated material must be subsequently placed in drums for later approved disposal;

- In the event of a larger spill on water, it will be necessary to limit the extent of the spill, using booms, and immediately seek the assistance of the Shell Bulk Petroleum response team. Keep the 24 Hour Spill Reporting Line informed of the situation and developments.

- A skimmer may be deployed once a boom has been secured to capture the spilled product. The skimmer utilizes a mechanism to draw hydrocarbons (and a percentage of water). It is then pumped through hoses to empty fuel drums;

- Culverts can permit water flow while capturing and collecting fuel by using a board to control the water level. It can be staked and surrounded with absorbent material to capture the fuel on the water surface.

- Response Actions for Fuel Spills on Ice.

- Where a spill occurs on ice, snow should be compacted around the edge of the spill to serve as a berm (and lined with plastic sheeting). The ice will limit seepage of fuel into the water, but the contaminated snow/ice must be immediately scraped up. Permission may be given from the government to burn off pools of fuel (contact the 24 Hour NWT/Nunavut Spill Reporting Line). Remaining contaminated snow can be placed in drums or in a lined berm (on land) for later approved disposal.

- Fuel that escapes under the ice though breaks or cracks is extremely difficult to collect. Expertise should be sought immediately. Shell Bulk Petroleum's response team can be made available in a matter of hours.

5.0 INVENTORY OF FUEL SOURCES AND RESPONSE EQUIPMENT

5.1 Minesite Fuel Sources and Spill Control Points

The main fuel source locations at the site are as follows (see Figure 1 for locations):

- The Tank Farm consists of four 10,000 barrel capacity tanks for diesel (presently partly full), two 350 barrel capacity tanks for gasoline (presently empty), and waste oil stored in two 5,000 gallon (20,000 litre) tanks and a number of 45 gallon (200 litre) drums (a small number of these drums may contain used varsol or antifreeze). The control point for spills in the farm is the main containment berm for the tanks. Beyond this, the secondary control point would be the culverts where Harrison Creek discharges to Prairie Creek, and for spills to the south-east of the farm, the toe of the Prairie Creek containment berm;

- The Gasoline Station is located at the south end of the tank farm facility. At this time, the station contains 6 – 45 gallon drums of gasoline. The quantity of drums varies depending on site activity. Drums are located on a concrete berm with sump facilities.

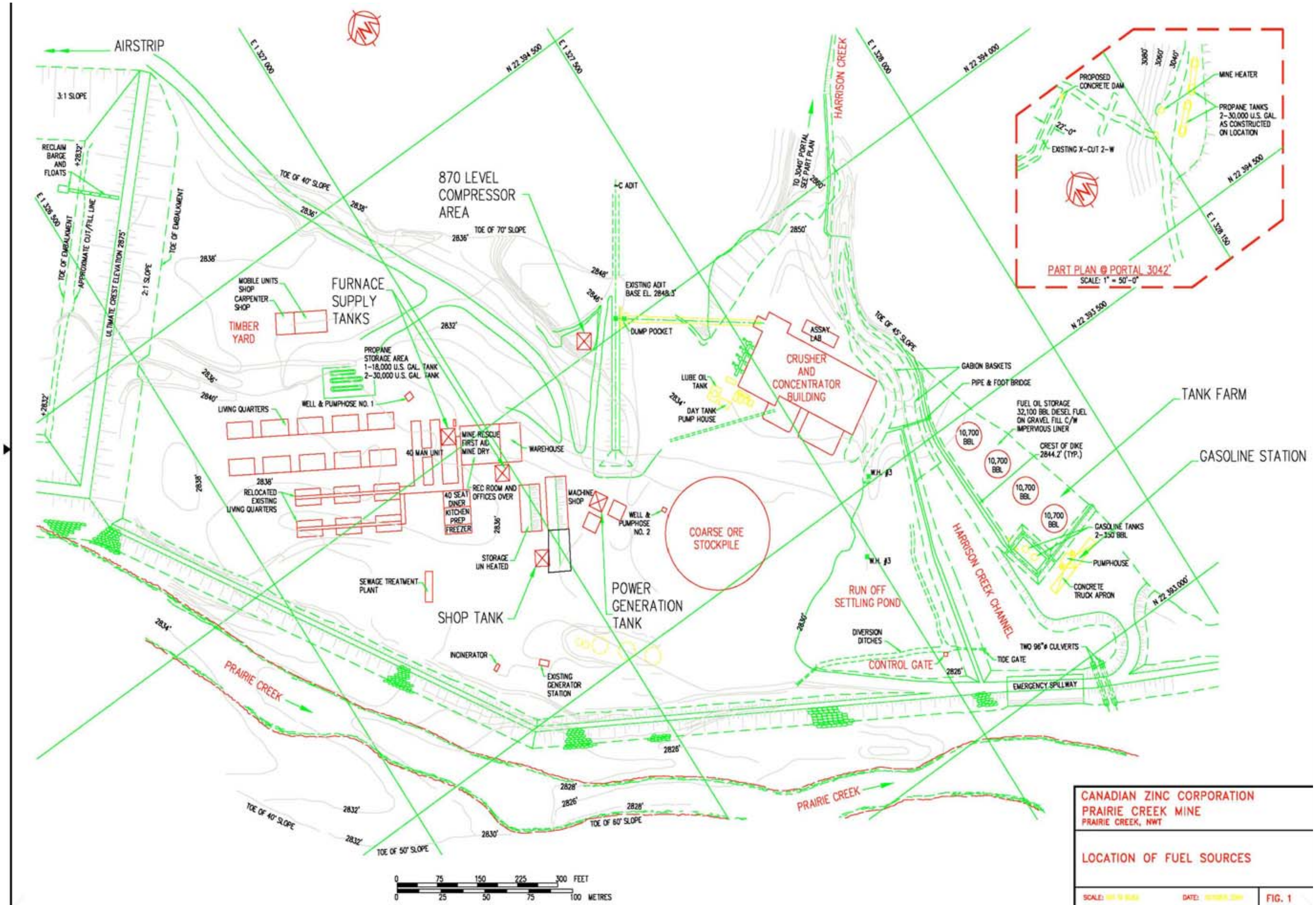
- The two camp power generators are fed by a fully bermed 1000 gallon diesel tank mounted on a steel cradle. The secondary control point for a spill is the main site drainage channel which flows into the Catchment Pond (the outlet of the Catchment Pond is also a control point with a gate weir);

- Two 5000 gallon tanks on the south-west corner of the rear Machine Shop stores 10W& 40W oil for use in vehicles, these tanks are fully contained in a cement berm. The secondary control point for a spill is the main site drainage channel;

- A 1000 gallon tank on the north-west corner, and a 200 gallon tank on the south-east corner, which are both fully bermed, of the Administration Building (which currently houses the kitchen, Mine Rescue, First Aid and Mine Dry), provide diesel for heating furnaces. The secondary control point for a spill is the main site drainage channel;

- A 500 gallon diesel tank at the 870 level underground staging area provides diesel supply to the compressor and generator for mine ventilation and electrical supply. This tank is fully bermed and the secondary control point for a spill is the main site drainage channel;

- A limited number of 45 gallon (200 litre) drums containing aviation gas or Jet B are stored at the airstrip. The drums are located on a clay liner. The control point for a spill beyond the containment is the toe of the Prairie Creek containment berm.

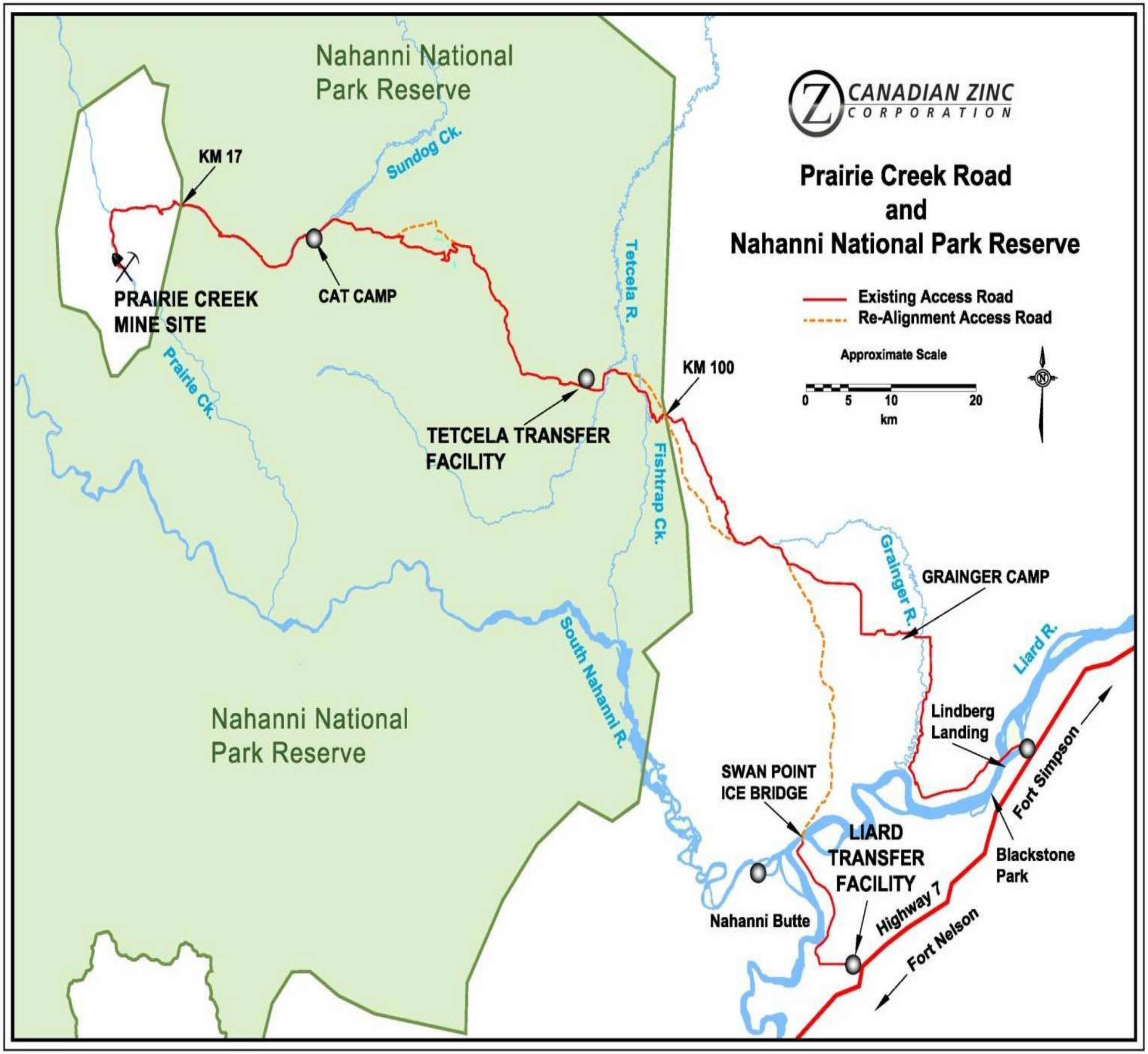

AIRSTRIP
870 LEVEL COMPRESSOR AREA
FURNACE SUPPLY TANKS
TIMBER YARD
MOBILE UNITS SHOP
CARPENTER SHOP
PROPANE STORAGE AREA 1-18,000 U.S. GAL. TANK 2-30,000 U.S. GAL. TANK
WELL & PUMPHOSE NO. 1
LIVING QUARTERS
40 MAN UNIT
MINE RESCUE FIRST AID MINE DRY
WAREHOUSE
RELOCATED EXISTING LIVING QUARTERS
40 SEAT DINER KITCHEN PREP FREEZER
REC ROOM AND OFFICES OVER
MACHINE SHOP
WELL & PUMPHOSE NO. 2
STORAGE UN HEATED
SEWAGE TREATMENT PLANT
SHOP TANK
POWER GENERATION TANK
INCINERATOR
EXISTING GENERATOR STATION
COARSE ORE STOCKPILE
EXISTING ADIT BASE EL. 2848.3'
DUMP POCKET
LUBE OIL TANK
DAY TANK PUMP HOUSE
ASSAY LAB
CRUSHER AND CONCENTRATOR BUILDING
HARRISON CREEK
HARRISON CREEK CHANNEL
GABION BASKETS
PIPE & FOOT BRIDGE
FUEL OIL STORAGE 32,100 BBL DIESEL FUEL ON GRAVEL FILL C/W IMPERVIOUS LINER
CREST OF DIKE 2844.2' (TYP.)
10,700 BBL
TANK FARM
GASOLINE STATION
GASOLINE TANKS 2-350 BBL
PUMPHOUSE
CONCRETE TRUCK APRON
RUN OFF SETTLING POND
DIVERSION DITCHES
CONTROL GATE
TWO 96"ø CULVERTS
TIDE GATE
EMERGENCY SPILLWAY
PRAIRIE CREEK
RECLAIM BARGE AND FLOATS
3:1 SLOPE
2:1 SLOPE
TOE OF EMBANKMENT
APPROXIMATE CUT/FILL LINE
ULTIMATE CREST ELEVATION 2875'
TOE OF 40' SLOPE
TOE OF 70' SLOPE
TOE OF 45' SLOPE
TOE OF 50' SLOPE
TOE OF 60' SLOPE
PART PLAN @ PORTAL 3042'
SCALE: 1" = 50'-0"
PROPOSED CONCRETE DAM
EXISTING X-CUT 2-W
MINE HEATER
PROPANE TANKS 2-30,000 U.S. GAL. AS CONSTRUCTED ON LOCATION
0 75 150 225 300 FEET
0 25 50 75 100 METRES
CANADIAN ZINC CORPORATION
PRAIRIE CREEK MINE
PRAIRIE CREEK, NWT
LOCATION OF FUEL SOURCES
FIG. 1

5.2 Access Road

The Access Road rehabilitation work has now begun and while the entire detail of the route has not been determined the initial stages of rehabilitation in the minesite area has established the need for this Fuel Spill Contingency Plan to expand to include this area. Protocols need to be established before any work can commence along the Access Road. This will be an evolving plan as the actual route is determined during the course of permitting.

5.2.1 Access Road Protocols

- The minesite manager must be aware of the location of any work that is taking place along the Access Road
- A detailed map location of where any construction activity is occurring will be kept up to date on a daily basis in the minesite office
- Any person operating equipment along the Access Road must be qualified and approved by the mine manager
- An operator will check their equipment on a regular basis for any leaks or drips and will keep a log of this to be filed at the minesite.
- Any significant fuel spill will be reported to the environmental and minesite manager
- A portable satellite phone must be carried by any work crew along the Access Road to give them the immediate ability to report any fuel spill
- Active monitoring of a dedicated Access Road radio channel frequency will be maintained by all vehicles and operators utilizing the Access Road
- Location kilometre markers will be established along the road in order to accurately locate where a spill may have happened


CANADIAN ZINC
CORPORATION
Prairie Creek Road
and
Nahanni National Park Reserve
Existing Access Road
Re-Alignment Access Road
Approximate Scale
0
5
10
20
km
Nahanni National
Park Reserve
Sundog Ck.
KM 17
CAT CAMP
PRAIRIE CREEK
MINE SITE
Prairie Ck.
Tetcela R.
TETCELA TRANSFER
FACILITY
KM 100
Fishtrap Ck.
Grainger R.
GRAINGER CAMP
Liard R.
Lindberg
Landing
Fort Simpson
Blackstone
Park
South Nahanni R.
Nahanni National
Park Reserve
SWAN POINT
ICE BRIDGE
LIARD
TRANSFER
FACILITY
Nahanni Butte
Highway 7
Fort Nelson

5.2.2 Access Road Fuel Sources and Response Equipment

- The main fuel sources along the Access Road will be within the rolling equipment
- A small amount of fuel will probably be located at the Tetcela Transfer Facility for heaters and emergency supply.
- Small fuel caches (two drums), may be located at various points along the route for emergency needs. These will all be accurately located and accounted for.
- A 400,000 litre diked fuel tank is proposed to be located at the Liard Transfer Facility
- During the winter haulage season significant amounts of diesel will need to be transported in to the site and specific safety precautions should be developed relating to these units.
- Mobile storage units (on skids or wheels) containing emergency spill kits with significant equipment will be strategically placed along the Access Road Route and all operators will be aware of their locations to access in the event of an emergency
- Small spill kits should be carried with any heavy equipment and larger spill kits will be located at any work site.

5.3 General Equipment

Canadian Zinc Corporation has rotary and fixed wing aircraft on call. Heavy earth moving equipment, hand tools and miscellaneous equipment (e.g. plastic sheeting) are available at the Prairie Creek site as part of the exploration activities, and are accessible in the event of a spill. These supplies will be much enhanced when contemplating an operating mine and Access Road

5.4 Personal Protective Equipment

Personal protective equipment (PPE) is maintained on-site for the management and handling of fuels, chemicals and reagents. PPE available includes splash protection goggles, nitrile rubber gloves, impervious (Tyvek) suits and half-face masks equipped with HEPA-filters. This equipment should be used by all personnel involved in spill response who will be proximal to the spill.

For specific first aid, toxicological and other health related data, and the relevant protection equipment, the Spill Response team should consult the Material Safety Data Sheet (MSDS) for the specific fuel that has been spilled. MSDS's are maintained in the Administration Building.

5.5 Spill Kits

Spill kits (Table 6-1) are maintained on site at the main fuel farm facility, mechanical shop, gasoline station, fuel truck and at each diamond drill when operating.

Table 6-1
Items Contained in the Spill Kit

1-48" x 48" x 1/16" Neoprene Pad (Drain Stop)
Plug N Dike Granular, 1-gal U.S. (3.8 litres)
Splash Protection Goggles
2-PVC Oil Resistant Gloves
1 Pkg. Polyethylene Disposable Bags (5 mil), 10 per Package
1 Shovel (Spark Proof)
1 Case T-12 3"x12' Mini Boom, 4 Booms/Case
1 Bale 11P 256 17" x 19" x 1/2" Pads, 100 Pads / Bail

6.0 TRAINING AND SPILL EXERCISES

6.1 Training

All members of the Fuel Spill Response Team will be trained and familiarized with the spill response resources, including their location and access, the Fuel Spill Contingency Plan and appropriate spill response methodologies and reporting.

All personnel and contractors at the Prairie Creek property will be familiarized with the location of the Fuel Spill Contingency Plan on site and encouraged to read it. All personnel and contractors will be introduced to the salient aspects of initial response actions to a spill as part of site orientation on arrival.

Fuel handling crews will be trained in the safe operation of these facilities, spill prevention techniques and initial spill response actions.

6.2 Spill Exercises

Canadian Zinc Corporation will conduct annual spill exercises to test the response of the Spill Response Team to fuel spills.

A report will be made by the On-Scene Coordinator noting the responses of personnel, and any problems or deficiencies encountered. This report will be used to evaluate the ability to respond to spills and determine areas necessary for improvement.

Canadian Zinc Corporation
Prairie Creek Minesite
9926-101st Avenue
PO Box 500
Fort Simpson, NT X0E 0N0
Phone: 867-695-3963
Satellite phone: 1-600-700-2454
Satellite fax: 1-600-700-9209
VOIP 604-357-3513

Canada

NT-NU SPILL REPORT

OIL, GASOLINE, CHEMICALS AND OTHER HAZARDOUS MATERIALS

NT-NU 24-HOUR SPILL REPORT LINE
TEL: (867) 920-8130
FAX: (867) 873-6924
EMAIL: spills@gov.nt.ca

REPORT LINE USE ONLY

A	REPORT DATE: MONTH – DAY – YEAR	REPORT TIME	☐ ORIGINAL SPILL REPORT, OR ☐ UPDATE # ________ TO THE ORIGINAL SPILL REPORT	REPORT NUMBER ____-________
B	OCCURRENCE DATE: MONTH – DAY – YEAR	OCCURRENCE TIME		
C	LAND USE PERMIT NUMBER (IF APPLICABLE)	WATER LICENCE NUMBER (IF APPLICABLE)		
D	GEOGRAPHIC PLACE NAME OR DISTANCE AND DIRECTION FROM NAMED LOCATION	REGION ☐ NWT ☐ NUNAVUT ☐ ADJACENT JURISDICTION OR OCEAN		
E	LATITUDE DEGREES MINUTES SECONDS	LONGITUDE DEGREES MINUTES SECONDS		
F	RESPONSIBLE PARTY OR VESSEL NAME	RESPONSIBLE PARTY ADDRESS OR OFFICE LOCATION		
G	ANY CONTRACTOR INVOLVED	CONTRACTOR ADDRESS OR OFFICE LOCATION		
H	PRODUCT SPILLED	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
	SECOND PRODUCT SPILLED (IF APPLICABLE)	QUANTITY IN LITRES, KILOGRAMS OR CUBIC METRES	U.N. NUMBER	
I	SPILL SOURCE	SPILL CAUSE	AREA OF CONTAMINATION IN SQUARE METRES	
J	FACTORS AFFECTING SPILL OR RECOVERY	DESCRIBE ANY ASSISTANCE REQUIRED	HAZARDS TO PERSONS, PROPERTY OR EQUIPMENT	
K	ADDITIONAL INFORMATION, COMMENTS, ACTIONS PROPOSED OR TAKEN TO CONTAIN, RECOVER OR DISPOSE OF SPILLED PRODUCT AND CONTAMINATED MATERIALS			

L	REPORTED TO SPILL LINE BY	POSITION	EMPLOYER	LOCATION CALLING FROM	TELEPHONE
M	ANY ALTERNATE CONTACT	POSITION	EMPLOYER	ALTERNATE CONTACT LOCATION	ALTERNATE TELEPHONE

REPORT LINE USE ONLY

N	RECEIVED AT SPILL LINE BY	POSITION STATION OPERATOR	EMPLOYER	LOCATION CALLED YELLOWKNIFE, NT	REPORT LINE NUMBER (867) 920-8130

LEAD AGENCY ☐ EC ☐ CCG ☐ GNWT ☐ GN ☐ ILA ☐ INAC ☐ NEB ☐ TC | SIGNIFICANCE ☐ MINOR ☐ MAJOR ☐ UNKNOWN | FILE STATUS ☐ OPEN ☐ CLOSED

AGENCY	CONTACT NAME	CONTACT TIME	REMARKS
LEAD AGENCY			
FIRST SUPPORT AGENCY			
SECOND SUPPORT AGENCY			
THIRD SUPPORT AGENCY			

PAGE 1 OF _____

CANADIAN ZINC CORPORATION

24 Hour spill report line: ph 867-920-8130
fax: 867-873-6924
email spills@gov.nt.ca
Parks Canada 867-695-3151

CANADIAN ZINC FUEL SPILL REPORT FORM

Date and Time:

Person Reporting:

Date and Time of Spill:

Exact Location of Spill:

Cause of Fuel Spill:

Nature of Fuel and Amount Estimated:

Action Taken:

Follow-up:

Appendix A: INAC Spill Reporting Protocol (April 2007)

Terms and Conditions
For Implementing the Spill Reporting Protocol
For Mining Operations

1. Applies to both exploratory and production mineral operations

2. Applies only to spills for which Indian and Northern Affairs Canada (INAC) would be designated as Lead Agency under the NWT/Nunavut Spills Working Agreement.

3. This Spill Reporting Protocol does not apply to spills for which the Government of the Northwest Territories (GNWT). Government of Nunavut (GN), Environment Canada Environmental Protection Branch (EPB), Canadian Coast Guard (CCG), National Energy Board (NEB), of Inuvialuit Land Administration (ILA) would be designated the Lead Agency under the Northwest Territories. Nunavut Spills Working Agreement.

4. Immediately reportable spills include releases as per Schedule 1, and releases of substances of lesser volumes that are likely to be imminent environmental or human health hazard or where an operator is uncertain if a release is reportable.

5. All spills requiring assistance by the Operator (i.e. not cleaned up immediately and assistance is required for cleanup) continuing spills, or situations where further spillage is possible are to be reported immediately.

6. An on-site record shall be kept of all minor spills and immediately reportable spills and be available to INAC Inspectors of officials upon request.

7. All minor spills shall be reported to the District INAC Inspector(s) either monthly in a condensed form attached, or at an interval acceptable to the Inspector.

8. Operator, i.e., the company or individual that holds an authorization for the project, must have all spill contingency plan approved by either INAC or a party acceptable to INAC.

9. Spill contingency plan must meet the appropriate regulatory requirements and/or spill contingency planning guidelines, including procedures to clean up minor spills and ensure environmental protection.

10. Appropriate field spill kits, as indicated in the spill contingency plan must accompany each crew and/or mobile equipment and/or vehicle.

11. Contractors and subcontractors for the Operator must abide by the Protocol and the spill contingency plan. All spills or releases, whether by operator, contractors or subcontractors, remain the liability of the Proponent and or Operator.

12. All spills, regardless of size (areal extent), amount and product, remain the liability of the Proponent and must be cleaned up immediately. All spills must be cleaned up to the satisfaction of the INAC Inspector.

INAC Monthly Spill Reporting Form

Company Responsible:_______________________________________
Project Name and Water License #:___________________________
Month:____

Date of Spill (d/m/y)	Product Spilled	Amount	Extent of Contaminated Area (m2)	Location (latitude and Longitude)

DIAND District Fax Numbers

North Mackenzie District (Inuvik):	**(867) 777-2090**
Norman Wells Sub-District:	**(867) 587-2928**
South Mackenzie District (Yellowknife):	**(867) 669-2720**
Hay River Sub-District:	**(867) 874-2460**
Fort Smith Sub-District:	**(867) 872-3472**
Fort Simpson Sub-District:	**(867) 695-2615**
Nunavut District:	**(867) 979-6445**

Schedule 1 – Immediately Reportable Quantities

TDG **Class**	**Substance**	**Immediately Reportable Quantities for NWT/NU 24-Hour Reports**
1 **2.3** **2.4** **6.2** **7** **None**	Explosives Compressed gas (toxic) Compressed gas corrosive) Infectious substances Radioactive Unknown substance	Any amount
2.1 **2.2**	Compressed gas (flammable) Compressed gas (non-corrosive, non-flammable)	Any amount of gas from containers with a capacity greater that 100 L
3.1 **3.2** **3.3**	Flammable liquid	≥ 100 L
4.1 **4.2** **4.3**	Flammable Solid Spontaneously combustible solids Water reactant	≥25 kg
5.1 **9.1**	Oxidizing substance Miscellaneous products or substances excluding PCB mixtures	≥50 L or 50 kg
5.2 **9.2**	Organic peroxides Environmentally hazardous	≥ 1 L or 1 kg
6.1 **8** **9.3**	Poisonous substances Corrosive substances Dangerous wastes	≥ 5L or 5 kg
9.1	PCB mixtures of 5 or more parts per million	≥ 0.5 L or 0.5 kg
None	Other contaminants (e.g. crude oil, drilling fluid, produced water, waste or spent chemicals, used or waste oil, vehicle fluids, wastewater etc.)	≥ 100 L or 100 kg

As well, all releases of harmful substances, regardless of quantity, are immediately reportable to the 24-Hour Spill Line where the release:

- **Is near or into a water body;**
- **Is near or into a designated sensitive environment or sensitive wildlife habitat;**
- **Poses an imminent threat to human health or safety; or**
- **Poses an imminent threat to listed species at risk or its critical habitat.**

Example Scenarios
(assumes spills are under control)

Activity	Spill Location	Quantity and Product Spilled	Spill Reporting
Fuel tank refilling	Bermed storage tank are on crown land	100 L gasoline	Immediately reportable To NWT 24-Hour Spill Report Line
Truck refueling	Within licensed project area on Crown Land	2 L of diesel	On-site record of spill, clean-up, and included in minor spill reporting to INAC Inspector
Camp Operations	Camp on Crown Land	75 L of grey water overflows camp sump	On-site record of spill, clean-up, and included in minor spill reporting to INAC Inspector
Exploratory drilling	Within a creek on the project area	5 L hydraulic oil	Immediately reportable to the 24-Hour Spill Report Line

APPENDIX 29

CANADIAN ZINC CORPORATION

PRAIRIE CREEK MINE SITE

OCCUPATIONAL HEALTH AND SAFETY PLAN

February 2010

EMERGENCY NUMBERS

LOCATION OF SITE: LONGITUDE- 124°, 46', 46.0" W
LATITUDE - 61°, 32', 44.1" N

AMBULANCE	**Fort Nelson**	**250-774-2344**
HOSPITAL	**Fort Nelson**	**250-774-8100**
HOSPITAL	**Fort Simpson**	**867-695-7000**
HOSPITAL	**Fort Simpson [Emergency]**	**867-695-3232**
R.C.M.P.	**Fort Simpson**	**867-695-1111**
FIXED WING	**VILLERS Ft. Nelson**	**250-774-2072**
FIXED WING	**WOLVERINE Ft. Simpson**	**867-695-2263**
HELICOPTERS	**CANADIAN, Ft. Nelson**	**250-774-6171**
HELICOPTERS	**GREAT SLAVE HELI, Ft. Simpson**	**867-695-2326**
W.C.B.	**Yellowknife**	**867-920-3888**
INDIAN & NORTHERN AFFAIRS	**Yellowknife**	**867-669-2500**
ENVIRONMENT CANADA	**NWT - 24 hour spill line**	**867-920-8130**
CANADIAN ZINC CORP.	**Vancouver**	**604-688-2001**

When calling appropriate agencies as listed above, be sure to give the following information to whom you speak with;

- YOUR NAME
- LOCATION OF SITE
- TYPE OF EMERGENCY
- INJURIES? HOW MANY AND WHAT TYPE
- SPECIAL EQUIPMENT OR PERSONNEL NEEDED
- WHAT IS BEING DONE ALREADY
- WEATHER CONDITIONS AND LANDING AREA IF FLIGHT REQUIRED

If a medivac has been called for, be sure to keep landing area clear of debris and people, as the pilot does not have a visual sight below the plane or helicopter.

INITIAL RESPONSE ACTIONS

In the event of a health or safety incident, the following steps should be taken by personnel at the incident site:

1. Ensure your safety first.
2. Attend to the health and/or safety of the persons affected by the incident. **DO NOT MOVE PATIENT** unless it is essential to prevent further injury to the victim or other personnel. Make them as comfortable as possible and provide warmth if necessary.
3. Contact the Medic, Site Safety Officer, and the Camp Manager if this is not the same person, in that order. Inform them of the incident and situation.
4. Before undertaking a response action to remove or reduce a health or safety risk, ensure personnel have on the appropriate personnel protective equipment (PPE).
5. If possible without further assistance, control the danger.
6. Gather information on the event and the status of the situation.

PREAMBLE

This ***Health and Safety Plan*** is effective from January 1, 2010 and applies for all projects and operations of Canadian Zinc Corporation at the Prairie Creek Property and access corridor.

The following formal distribution has been made of this plan:

NWT WCB

Mackenzie Valley Land and Water Board

Canadian Zinc Corporation - Prairie Creek Site Office

Canadian Zinc Corporation - Vancouver Office

Additional copies and updates of this Plan may be obtained by writing to:

Canadian Zinc Corporation
Suite 1710-650 West Georgia Street,
PO Box 11644
Vancouver, British Columbia
V6B 4N9
Phone: 604-688-2001
Fax: 604-688-2043
Email: alan@canadianzinc.com

Prairie Creek Minesite Address:
Canadian Zinc Corporation
Prairie Creek Minesite
C/O Villers Air Service,
P.O. Box 328,
Fort Nelson,
British Columbia
V0C 1R0

Satellite phone: 1-600-700-2454 or 604-357-3513 / 604-357-7386

Satellite fax: 1-600-700-9209

TABLE OF CONTENTS

PLAN OVERVIEW

The guidelines and procedures outlined in the following chapters of this Health and Safety Plan (the Plan) are designed for the health and safety of the employees, visitors or contractors of CANADIAN ZINC CORPORATION (CZN) while working or visiting on or around the Prairie Creek Minesite. It is the Company's policy that proper procedures be implemented and followed at all times, to **protect** the health and safety of everyone involved in the project.

Canadian Zinc Corporation also has adopted the Safety Guidelines of the Association for Mineral Exploration of British Columbia. The company has provided a copy of the Safety Guidelines for Mineral Exploration in Western Canada and we encourage you to read and carry out the appropriate safety guidelines and practices in your everyday activities.

This Plan lists policies and procedures intended to meet or exceed the regulations of the N.W.T. WCB applicable to the various projects taking place on the site. All required safety equipment shall be provided by CZN with the exception of steel toed boots, which are the employees' responsibility.

Please read each section thoroughly so as to understand the importance of each topic as it pertains to your work area.

This Plan covers health and safety issues and response to incidents, emergency fire response and CZN's alcohol and drug policy. This Plan does not address responses to fuel spills, except for the related health and safety issues. In the event of a fuel spill, the reader should consult CZN's *Fuel Spill Contingency Plan*.

This Plan is a working document. Any comments or suggestions for improvements or updates should be directed to one of the following:

Alan Taylor
COO & V.P. OF EXPLORATION
Vancouver, B.C.
OFFICE: 1 604 688 2001
FAX: 1 604 688 2043
alan@canadianzinc.com

Health & Safety Representative
Prairie Creek Minesite
Sat phone: 1-600-700-2454
Sat fax: 1-600-700-9209

1.0 EMERGENCY MEDICAL ATTENTION

ALL PERSONNEL MUST BE PREPARED TO ASSIST THE MEDIC SHOULD THE NEED ARISE

1. Ensure your health and safety first.

2. If there is an injury, make the person as comfortable as possible. Provide warmth if necessary. **DO NOT MOVE PATIENT** unless it is essential to prevent further injury to the victim or other personnel.

3. Contact medic immediately via radio or in person and tell them the following:
   - ✓ Location of injured persons
   - ✓ number of injured persons
   - ✓ type (s) of injury

4. Contact site safety officer and the camp manager if not the same person, by radio and give the exact details that led to the incident.

5. Administer first aid until medic arrives on scene.

6. Prepare any and all equipment needed to assist in rescue / extraction of injured worker.

7. If medivac is required, designate someone to phone the ambulance service and give all information required as outlined below.

8. The medic will examine the injured person (s) to determine the full extent of injury. The medic will continue to provide treatment as needed until passed on to a person with a higher level of certification, or a hospital has been reached.

9. In the event that the medic must accompany the injured worker during transport, the manager shall order that all work on the property cease until the medic returns, unless a person with proper training or certification remains on site.

10. Notification of major injury shall consist, but not be limited to, the following:

ALAN TAYLOR - CANADIAN ZINC CORPORATION (604-688-2001)

PETER BENGTS - N.W.T./W.C.B. (867-669-4412)

R.C.M.P./ FT. SIMPSON (IF ACCIDENT FATAL) (867-695-1111)

11. In the event of major or fatal injury, the manager will order all work on the property to halt and nothing be moved, except for the purpose of preventing injury or relieving suffering, until:

- ✓ **W.C.B. INVESTIGATION IS COMPLETE.**
- ✓ **W.C.B. INFORMS OTHERWISE.**
- ✓ **CZN ACCIDENT INVESTIGATION IS COMPLETE.**
- ✓ **RCMP OR CORONER'S INVESTIGATION IS COMPLETE IN THE EVENT OF A FATALITY.**
- ✓ **RCMP OR CORONER INFORMS OTHERWISE IN THE EVENT OF A FATALITY.**

12. All witnesses to a major or fatal accident must remain on site until all agencies have completed their investigation or interviews.

LOCATION OF SITE: LONGITUDE- 124°, 46', 46.0" W LATITUDE - 61°, 32', 44.1" N

EMERGENCY NUMBERS

AMBULANCE	**Fort Nelson**	**250-774-2344**
HOSPITAL	**Fort Nelson**	**250-774-8100**
HOSPITAL	**Fort Simpson**	**867-695-7000**
HOSPITAL	**Fort Simpson [Emergency]**	**867-695-3232**
R.C.M.P.	**Fort Simpson**	**867-695-1111**
FIXED WING	**VILLERS Ft. Nelson**	**250-774-2072**
FIXED WING	**WOLVERINE Ft. Simpson**	**867-695-2263**
HELICOPTERS	**CANADIAN, Ft. Nelson**	**250-774-6171**
HELICOPTERS	**GREAT SLAVE HELI, Ft. Simpson**	**867-695-2326**
W.C.B.	**Yellowknife**	**867-920-3888**
INDIAN & NORTHERN AFFAIRS	**Yellowknife**	**867-669-2500**
ENVIRONMENT CANADA	**NWT - 24 hour spill line**	**867-920-8130**
CANADIAN ZINC CORP.	**Vancouver**	**604-688-2001**

When calling appropriate agencies as listed above, be sure to give the following information to whom you speak with;

- **- YOUR NAME**
- **- LOCATION OF SITE**
- **- TYPE OF EMERGENCY**
- **- INJURIES? HOW MANY AND WHAT TYPE**
- **- SPECIAL EQUIPMENT OR PERSONNEL NEEDED**
- **- WHAT IS BEING DONE ALREADY**
- **- WEATHER CONDITIONS AND LANDING AREA IF FLIGHT REQUIRED**

If a medivac has been called for, be sure to keep landing area clear of debris and people, as the pilot does not have a visual sight below the plane or helicopter.

2.0 EMERGENCY RESPONSE TEAM (ERT)

All members of the response team will have the following qualifications;

- First aid certification
- Fire response training
- Evacuation training
- General rescue training

All members of the response team will have the following equipment at their disposal;

- ✓ Coveralls
- ✓ Full brim hard hats
- ✓ Level II first aid kit
- ✓ Fall arrest full body harness
- ✓ Flashlight with extra batteries
- ✓ Appropriate Personal Protective Equipment (PPE)
- ✓ Back pack to hold said equipment

The emergency response vehicle on site will be accessible to the members at all times and be equipped with the following;

- ✓ Fire fighting equipment
- ✓ Spill response equipment
- ✓ Emergency rescue equipment
- ✓ Radio communication

In the event of an emergency, the head of the response team is in complete charge of the scene until another agency responds, or the matter at hand has been remedied.

A report will be filled out and sent to the appropriate agencies after a complete investigation has been done and the safety supervisor feels satisfied that the investigation is complete.

In the event that the response team feels evacuation of the site is critical, a muster point far enough away from the site will be established, well marked and accessible 24 hours a day by helicopter.

A map of the camp and surrounding area shall be established and located on the safety board in the main building. Coordinates for precise locations will be marked on the map and a copy will be given to each designated air carrier.

In the event of an aircraft-related incident, the involved air services company will be notified immediately and they will make the appropriate calls to the authorities. The members of the ERT will be trained to respond to the scene of the accident as outlined in Appendix B: Emergency Response Guide.

Members shall be released from their regular duties to undergo training when necessary.

3.0 GENERAL SAFETY PRECAUTIONS

All personnel shall be provided with an effective means of communication while working alone or away from the main site. This is to ensure contact with safety or rescue personnel should an emergency arise.

All personnel shall wear ALL appropriate personal protective equipment (safety glasses, face mask, tyvek suit) relevant to the task at hand. The company will strictly enforce this so as to prevent injury to its workers.

All personnel involved in drilling must have a valid current standard first certificate. A copy of this certificate will be provided to the site safety officer.

All yard personnel shall have a valid first aid certificate acceptable to the site safety officer.

An OFA Level 3 or St. John’s Advanced First Aid Level 2 certified first aider shall be on site at all times and ready for immediate dispatch in the event of an emergency.

All safety and rescue equipment will be current, under the direct control of the site safety officer, inspected regularly, and replaced as required.

First aid equipment shall be supplied by CZN, and will be under the direct control of the on-site first aider.

All personnel and visitors to the site will be given a safety orientation within 12 hours of arrival, or before work or touring commences, which ever is sooner.

- ✓ Villers Air Services (based in Fort Nelson) is our designated medivac carrier and are available to us during daylight hours, at any time. In the event of a helicopter evacuation, Great Slave Helicopters will be called upon and transport will be made to Ft. Nelson (weather and visibility permitting).
- ✓ Wolverine Air Services (based in Fort Simpson) is our alternate medivac carrier and are available to us during daylight hours, at any time.
- ✓ In a medivac scenario, details including casualties’ injuries, condition and ETA are to be provided to the receiving hospital prior to departure.

No worker or person on site shall be asked or expected to perform duties that they are not comfortable with or trained for.

No person shall attempt to operate equipment of any kind unless they have shown they are competent in its safe use. Only then will they operate the equipment after a supervisor grants permission.

Power and machine tools are only to be operated if the operator is trained in its safe use and if all safety precautions are in effect.

Any person seen to be intentionally performing an unsafe act, which could harm themselves or others, shall be immediately reprimanded or dismissed from the site.

No person is permitted in restricted areas, such as underground or inside powerhouses, unless given proper consent by an immediate supervisor, and only then if both the camp manager and site safety officer are aware of where they are.

No person shall leave the immediate site area unless a supervisor is informed, and a destination is given with an estimated time of return.

During operations, the following response teams will be on site:

- ✓ **EMERGENCY RESCUE**
- ✓ **EMERGENCY FIRE RESPONSE**
- ✓ **EMERGENCY SPILL RESPONSE.**

Anyone on site who sees or feels there is a hazard or threat to personal safety should report the hazard to the site safety officer at once.

Hazard and warning signs are posted throughout the area and are to be heeded by anyone in the area. Personnel caught purposely ignoring these signs will be dealt with in a strict manner.

No work shall be performed on the site unless authorized by senior supervisory personnel.

All vehicles used for transporting personnel shall have all safety precautions in place as outlined in the regulations sec.10.29(3) through (5) (see below).

10.29. (3) All mobile equipment shall be equipped with
(a) a firmly secured seat for the operator and any authorized passenger; and
(b) clearance lights, reflectors and direction of travel indicator devices that are suitable and acceptable to the chief inspector.
(4) The seat referred to in subsection (3) shall be well maintained in a comfortable and shock absorbing condition that reduces the transfer of machine induced whole body vibrations to the operator.
(5) Mobile equipment equipped with an enclosed operator's cab shall have
(a) windshields, side and rear windows;

(b) rear vision mirrors, unless the unit is bi-directional;
(c) glazing material that (i) meets the requirements of ANSI Standard Z26.1, Safety Code for Safety Glazing Materials for Glazing Motor Vehicles Operating on Land Highways or another standard approved by the chief inspector,
(ii) is kept in such condition as to provide clear visibility, and
(iii) is replaced if it obstructs the vision of the operator;
(d) suitable defrosting and defogging devices; and
(e) where applicable, windshield washers and wipers.

All personnel will be trained in the prevention of heat stroke/exhaustion in the summer, and hypothermia in the winter.

4.0 EMERGENCY FIRE RESPONSE

The following equipment shall be readily accessible to the members of the EMERGENCY FIRE RESPONSE TEAM;

- ✓ Fire retardant coveralls.
- ✓ Emergency breathing equipment.
- ✓ Protective headgear with chinstrap.
- ✓ Fire retardant gloves.
- ✓ Fire retardant face protection.
- ✓ Emergency response vehicle.

All equipment outlined above will be kept in a dispatch location and free of any obstacles which may hinder an immediate response.

As well as the above mentioned equipment, emergency personnel shall have an effective means of communication (radios) as well as an effective means of identifying emergency response members [ERT on back of jacket] from other personnel.

All personnel on site must be prepared to assist the response team in the event of a fire.

Training exercises will be carried out on a regular basis, with each team member receiving not less than 20 hours a year designated to this training.

All personnel newly hired to the site will be shown the whereabouts and use of fire fighting equipment within 48 hours of their arrival by the site safety officer.

An effective means of alerting personnel of a fire shall be established at the site, and all workers will be aware of the following:

- ✓ Where to meet in the event of an alarm sounding.
- ✓ How to safely reach this location in an orderly manner.
- ✓ How to assist the response team as needed.

There are areas on the site that are designated as **CONTROLLED BURNING AREAS**. Burning will only be done if the supervisor advises it and the material is fit for burning.

Aerosol cans, paint cans, diesel conditioner cans or any other potentially explosive device shall be disposed of in the incinerator **ONLY.** This will prevent the risk of personal injury from exploding objects.

Each burn area shall have at least 2 extinguishers at the ready in the event of fire spread or risk of fire spread.

All controlled burns will be closely monitored at all times until they have extinguished on their own, or with assistance.

In the event of fire in the main building or a housing trailer, personnel who discover the fire will do the following:

- ✓ Ensure that all other workers are alerted for evacuation
- ✓ Call the response team for assistance
- ✓ Try to extinguish the fire (if feasible)
- ✓ Sound a warning device

Should a fire start while refuelling equipment, personnel shall immediately contact the response team and try to extinguish the fire as quickly as possible. If this is not feasible, the area should be evacuated immediately and other workers in the area alerted. Response team members should be assisted as needed.

If a fire should start at the chemical storage area, the area should be evacuated immediately and the response team contacted. The response team will in turn assist in the evacuation of all employees to the airstrip after contacting the appropriate agencies who have the equipment needed to extinguish chemical fires.

In the event of fire at the main fuel storage area, all workers should be evacuated to the airstrip immediately. When safe to do so, the response team should be alerted and transportation called for.

All agency phone numbers should be posted by the telephone in the safety area of the main administration building for quick access.

All fuel storage areas will be clearly marked with signs indicating “no smoking” and “flammable”.

Flammable material, such as refuse, oily rags and paper, shall not be allowed to accumulate, and shall be properly disposed of at least once a day.

All equipment related to fire response should be properly maintained and serviced by the qualified person on a regular basis.

5.0 DIAMOND DRILLING

Each drill will be equipped with the following:

- ✓ First aid kit
- ✓ Eye wash station
- ✓ Emergency stretcher
- ✓ Means of communication
- ✓ Fall arrest equipment
- ✓ Fire Extinguisher
- ✓ Spill kit

Each member of a drill team shall have, or be provided with, the following personal protective equipment:

- ✓ Hardhat
- ✓ Ear and eye protection
- ✓ Fire resistant coveralls
- ✓ Steel toe footwear
- ✓ Hand protection

Each member of a drill crew shall have a current standard first aid certificate and the foreman shall additionally possess a WCB supervisor's certificate. Copies of these tickets shall be kept on file for future reference.

All safety mechanisms will be installed and in place before drilling commences. These will be inspected weekly and after a drill has been transferred to a new location. Also, all guards, lifelines, etc. shall be repaired or replaced, as necessary.

Each drill site shall be equipped with appropriate means to fight a fire at the drill. Each employee of that drill will be trained in its use and care before drilling commences.

Drill shacks shall have a means of illumination inside and out. All power cords will be kept in such a manner so as not to cause a tripping, hanging or otherwise harmful hazard to workers.

Shacks are to be kept free of flammable and general debris. Garbage cans are to be used and emptied after each shift so as not to attract animals.

Drill crew members shall be trained in **EMERGENCY SURVIVAL** in the event an overnight stay in the shack is required **and each shack shall be provided with emergency rations and drinking water.** Rations should be sealed and safely stowed so as not to attract animals.

Workers employed at drill sites will be trained in the prevention and management of heat stroke and hypothermia, and in emergency evacuation of the drill site.

Driller helpers, while in the basket, will wear the fall arrest equipment provided. Proper use of this equipment will be shown to those new on the site or who have not previously been certified in fall arrest procedures.

In the event of an injury, contact the medic via radio and explain what happened, drill location and condition of the patient. Be prepared to assist the medic as necessary upon his/her arrival.

Any person who enters a drill shack while drilling is in progress shall wear appropriate protective clothing.

Drillers shall inspect all wire lines and cables before and after their shift for any wear or stress. Worn cables will be replaced immediately.

Drill personnel shall install a guard or take other precautions so that they do not get pant legs caught in drill rods while in motion. No work is to be done on or near spinning rods.

Drill rods will be inspected regularly to check for stress and cracks. Damaged rods will be taken out of service and replaced as needed.

All vehicles that are used to transport drill personnel shall have flood lights installed to assist in night vision while driving in steep mountainous terrain. These same vehicles will be equipped with the following:

- ✓ Radio communication
- ✓ First aid kit
- ✓ Spare tire and related equipment
- ✓ Extra fuel.
- ✓ Fire extinguisher.

Drill towers will be inspected regularly to check for cracks or stress wear. Damaged towers will be repaired before work commences with that drill.

Any unsafe action, accidental or otherwise, will be reported to the site safety officer immediately for investigation.

Personnel working on drill sites who do not conform to personal or general safety procedures will be reprimanded and possibly dismissed from the site.

6.0 YARD AND FIELD CREW

Yard Crew

All yard crew shall be equipped with, and wear at all appropriate times, the following personal safety apparel;

- ✓ Hardhat
- ✓ Hi-viz vest
- ✓ Safety glasses
- ✓ Hearing protection
- ✓ Gloves (as needed)

Steel toe footwear is the responsibility of the worker and shall be worn at all times while working on the site.

All yard personnel shall be under the supervision of a qualified supervisor at all times, and no work is to be performed ***until approved by the supervisor***.

Yard personnel shall work in teams of two to minimize the risk of injury and facilitate response to injury. Each team shall be supplied with at least one radio.

If the need arises for a worker to work alone, they will be supplied with a radio and the supervisor will check on that worker on a regular basis.

Yard personnel will be trained in the use of power tools before being allowed to use them.

If a worker feels that an area or work practice is unsafe, they should bring the matter up with the site safety officer as soon as possible.

No worker shall be asked to perform a job which he/she feels is unsafe or that they have not been properly trained to perform.

Field Crew

All members of field operations shall be equipped with the following items;

- ✓ First aid kit
- ✓ Emergency blanket
- ✓ Hi-viz signal flag
- ✓ Waterproof matches
- ✓ Clothing and footwear suitable for the conditions
- ✓ Bear banger, spray or equivalent protection

When field operations personnel leave the site for the day, their estimated location will be marked on the map which will be located in the geology drafting room on the second floor of the administration building.

Field personnel will also give the safety supervisor an estimated time of arrival. **The camp should be notified of any changes of plan.**

Field personnel will be trained in emergency survival in case of an overnight stay in the mountains.

If field personnel are required to stay the night in the field for any reason and they do not contact camp the following day, emergency response members will start an immediate search for the worker.

Field workers shall bring enough food to suffice in the event of overnight stay.

It is advised that field workers take a change of clothes in case they get wet to prevent sickness or hypothermia.

Each member of field operations should have some form of first aid training.

If a helicopter is used for fieldwork, the pilot will have the same radio frequency as the workers in the field to enable calls for pick-up or **notification of emergencies**.

In the event of an emergency in the field, the pilot will return to camp to retrieve the medic and at least one other member of the response team with the appropriate gear, and immediate evacuation/rescue will occur.

Vehicle Checks

The following checks are to be made, at least once every day before a vehicle is operated:

1) Check of the condition and operation of vehicle controls.
2) Proper travel of the steering wheel, in both directions.
3) Proper braking of the vehicle, within acceptable limits.
4) Proper travel of the clutch, in both directions.
5) Proper E-brake movement, within acceptable limits.
6) Check fluid levels.
7) Check conditions of belts and hoses.
8) General check of conditions of tires.
9) Check all warning systems installed.

ONLY PEOPLE AUTHORIZED BY THE SITE MANAGER ARE PERMITTED TO
OPERATE ANY MOBILE PIECE OF EQUIPMENT

7.0 WILDLIFE AND ENVIRONMENTAL ISSUES

IMPORTANT NOTE TO FIELD AND YARD PERSONNEL!!!

GRIZZLY BEARS ARE PRESENT IN OUR AREA. YOU MUST BE AWARE OF THE POSSIBILITY OF AN ENCOUNTER AT ALL TIMES. APPROPRIATE MEASURES MUST BE TAKEN TO AVOID SUCH ENCOUNTERS (WORK TOGETHER. WORK CLOSE TO VEHICLES).

IF A BEAR IS SPOTTED, BACK-UP SLOWLY, LEAVE THE AREA AND REPORT ITS PRESENCE TO THE CAMP MANAGER. IN THE EVENT AN ENCOUNTER CANNOT BE AVOIDED, TAKE ALL POSSIBLE MEASURES TO ENSURE YOUR SAFETY! LET OFF A BEAR BANGER, AND/OR USE AVAILABLE EQUIPMENT TO MAKE A LOT OF NOISE, CLIMB A TREE, USE BEAR SPRAY.

IN A WORST CASE SCENARIO, LAY FACE DOWN AND COVER YOUR NECK AND HEAD WITH YOUR ARMS. DO NOT RUN AND DO NOT REMOVE YOUR BACKPACK! THIS ITEM COULD SAVE YOUR LIFE.

These points and more will be covered in animal attack prevention training.

The manager shall ensure that all personnel are informed of the possibility of animal attack, trained in the prevention of such an attack and that all reasonable measures are taken to prevent or protect from such an attack. All yard and field personnel will particularly be made aware of the risk of animal attack and be supplied with a means of protection, as well as training in attack prevention.

At NO time during the company's presence on this site is hunting permitted. The logging of wildlife sightings is ongoing on site. Please respect this rule during your stay with us. The only exception to this rule is if you or a partner is in **LIFE THREATENING DANGER** due to actual or imminent animal attack. If an animal is killed or wounded, **the Territorial Department of Environment and Natural Resources is** to be notified immediately.

Please do not torment **ANY** animals on site. This includes ground squirrels, crows, or any other "annoying" animal. All project related wildlife fatalities must be reported immediately, accidental or otherwise.

Garbage cans are available and should be used at all times. **NO** litter should be left out where animals and birds could be exposed to it. CZN wishes to impose a minimal impact on the local wildlife. If you see garbage, pick it up and dispose of it properly. Metals and other non-biodegradable items will be placed in labelled bins for proper disposal at a later date.

Please refer to Appendix A for a more detailed review of appropriate actions related to bears based on information provided by the Government of the Northwest Territories.

IF YOU SEE ANY ENVIRONMENTAL ISSUE YOU FEEL SHOULD BE ADDRESSED, PLEASE ADVISE YOUR SUPERVISOR IMMEDIATELY.

8.0 DRUG AND ALCOHOL POLICY

THE COMPANY MAINTAINS A 'ZERO-TOLERANCE' POLICY THAT ILLICIT DRUGS AND ALCOHOL AND THEIR USE ARE NOT PERMITTED AT THE PRAIRIE CREEK PROPERTY

COMPLIANCE TO THIS POLICY IS CONSIDERED A CONDITION OF EMPLOYMENT

CZN is committed to the safety and well being of our employees, contractors and their families along with our business partners and the communities from which we operate. The Company recognizes that the use of illicit drugs and the misuse of alcohol or other drugs can limit an employee's ability to properly perform their job, and can have serious negative impacts and consequences on the health and safety of themselves and others.

The intent of this policy is one of awareness, prevention and rehabilitation, while attempting to minimize intrusion into our employee's personal lives. The policy is subject to ongoing review and amendments from time to time as the Company sees fit to ensure its effectiveness.

Scope

This policy applies to all applicants for employment, temporary, part time and full time employees, contract workers performing work or services for CZN, or any visitor while on the Prairie Creek property.

For the purposes of this policy, drugs of concern include illegal and illicit drugs, alcohol, inhalants, medications or any other substances, which inhibit or may inhibit an individual's ability to perform their job safely and productively.

Prescription drugs must be cleared with the First Aid Attendant prior to engaging in work at the site.

Substances and Applicable Rules

For all employees, contract workers, and visitors on the site, the Company prohibits:

- Anyone being unfit for work because of the use or after effects of alcohol or drug use;
- The misuse of medications, either prescribed or over the counter;
- The use, possession, distribution or offering of sale of illicit or illegal drugs or alcohol; drug paraphenalia or the presence in the body of illicit or illegal drugs;

Searches and Drug Testing

CZN reserves the right to conduct searches and drug and alcohol testing, to enhance the effectiveness of this Policy and the Company's commitment towards providing a safe and healthy working environment.

ANY PERSON FOUND TO BE IN BREACH OF THE CONDITIONS OF THIS POLICY WILL BE TERMINATED IMMEDIATELY AND WILL BE HELD RESPONSIBLE FOR THEIR TRANSPORTATION COSTS

Canadian Zinc Corporation

APPENDIX A

PRAIRIE CREEK MINE

APPROPRIATE ACTIONS RELATED TO BEARS

AVOIDING PROBLEMS

Problem Bears

Problems can occur whenever bears and people occupy the same area. You can encounter a bear by chance, or because the bear is attracted to your activity. Bears are curious, and often investigate a strange object, smell, or noise. They also have a tremendous and constant drive to find as much nutritious food as they can during their time out of the den. These two traits, coupled with a bear's remarkable sense of smell, often lead bears to areas of human activity. The outcome of a bear's visit to a camp or community will influence its future behaviour. If it does not find food, it may not return once its curiosity has been satisfied. If it successfully obtains food from a human source - such as a garbage dump, backpack, or unclean camp - it begins to associate food with anything human, and investigate areas used by humans whether or not food is actually detected. A bear will gradually lose its tendency to avoid people as it learns to associate them with food. It may become bold and aggressive.

Once started, the habits of problem bears are difficult to break. It is your responsibility in bear country to ensure that your actions do not encourage those habits. It is unfortunate, but a problem bear is often destroyed.

General Conduct

Safety is everyone's responsibility - it is not a job that can be delegated to someone else and then forgotten about. The actions of each individual affect the safety of everyone else.

Remember these simple rules:

Be alert at all times.

- Respect all bears - they can be dangerous.
- Never approach a bear for any reason. Photographs should be taken from a safe distance with a telephoto lens.
- Never feed bears or other wildlife.
- Have a plan of action for dealing with bears and be sure everyone understands it.

FIELD WORKERS

If you are approaching your work area from the air, check for bears from the aircraft before landing. Work in pairs and stay alert. Alternate responsibilities so one person is watching for bears. If both partners are busy working, a bear may approach unnoticed.

Make sure someone knows where you are going and when you plan to return. If possible carry a portable hand-held radio for communication with the aircraft or base camp.

ENCOUNTERING A BEAR

The Bear's Behaviour

A bear's reaction to you will be influenced by many factors, and is therefore never entirely predictable. Given the opportunity, bears usually avoid people. Some bears are more dangerous or aggressive than others. Old or wounded bears may be in pain or starving. They may aggressively seek food from people if they are unable to obtain enough on their own. Any bear that has become accustomed to people and shows no fear of them is dangerous.

Every bear defends a critical space. The size of the space varies with each bear and each situation: it may be a few metres or a hundred metres. Intrusion into this space is considered a threat and may provoke an attack. All female bears aggressively defend their cubs. If a female with cubs is surprised at close range, or separated from her cubs she is likely to charge.

Bears also aggressively defend their food, and are often reluctant to leave it until it is all eaten. In some cases, a bear that is threatened may engage in displays intended to scare away an opponent. These may include huffing, panting, hissing or growling; looking directly at you, sometimes with lowered head or ears laid back; slapping one or both feet on the ground; jaw-popping; or charging to within several metres, then stopping suddenly or veering to the side. Threat displays may be followed by an attack, but may end with the bear walking or running away.

A bear standing on its hind legs is probably trying to pick up your scent and figure out what you are. It may sniff the air or swing its head from side to side. Bears do not charge on their hind legs.

Most grizzlies avoid contact with humans if possible. However, there is good reason for their reputation for ferocity. If cornered, threatened, or surprised, the grizzly can be very aggressive, and will usually stand its ground or charge.

Black bears are often less aggressive and flee from danger. However, because they are more curious and adaptable than grizzlies, they quickly become accustomed to human activity, and may develop aggressive food-seeking habits which make them dangerous. Therefore, treat all black bears with caution. In very few cases, a bear has stalked a person that it apparently considered potential prey. Although such incidents are rare, you should know the difference between the behaviour of a hunting bear, and the behaviour of a threatened bear.

A hunting bear does not bother with displays and shows no signs of annoyance or fear. It may approach you directly at a fast walk or turn, follow you, or circle carefully, making cautious approaches.

YOUR BEHAVIOUR

The thought of facing a bear can be frightening. However, bears rarely attack a person on sight, and only a very small percentage of charges result in serious injury or death.

There is always a possibility you may surprise a bear at close range, or encounter a problem bear which is not afraid of people. There is no guaranteed formula for reacting to a bear encounter because every encounter is unique. There are, however, guidelines which may help. Most are based on good judgment, common sense, and familiarity with bear behaviour.

Stop, stand still, and stay calm.

- ✓ If you are carrying a means of communication, alert others to your situation and ask for assistance.
- ✓ If the bear is aware of you, help it identify you as a person. It may leave. Staying upwind will help it to smell you. Talk in low tones and slowly wave your arms.
- ✓ Do not run from a bear unless you are sure you can reach a safe place before the bear catches up. Running may cause the bear to chase you, and a bear is faster than you are.
- ✓ Always leave a bear an open avenue of escape.
- ✓ If you see a bear at a distance, alert the bear to your presence. Quietly walk back the way you came or make a wide detour around the bear. Do not come between a bear and its cubs.
- ✓ If time, distance and circumstances permit, try to scare the bear away by firing flare cartridges or noisemakers.
- ✓ In a close encounter, stand still and assess the situation. Do not shout or make sudden movements which might provoke the bear, and avoid direct eye contact. At 50 feet, even if the bear is displaying threat behaviour, there is probably still time for you to avoid an encounter.
- ✓ Back away slowly. Only leave behind an article of clothing or gear if the bear is still trying to identify you. This will not work if the bear is following you. Leave food or an article of clothing only as a last resort.
- ✓ Climb a tree if one is available. You will have to climb higher than four metres - grizzlies can reach that high. Remember that black bears can also climb trees.
- ✓ If the bear is very close (30 ft.), it is usually best to stand your ground.

IF A BEAR CHARGES

A bear charges at high speed on all four legs. Many charges are bluffs. Bears often stop or veer to the side at the last minute. However, if contact appears unavoidable, you should play dead if you are attacked by a grizzly, or fight back if attacked by a black bear.

Playing Dead

Playing dead may prevent serious injury if you are attacked by a grizzly bear. Do not play dead during a black bear attack or if a grizzly bear is treating you as prey. Playing dead will help protect your vital areas, and the bear may leave if you appear harmless. There are two recommended positions:

- lie on your side, curled into a ball, legs drawn tightly to your chest, hands clasped behind your neck;
- lie flat on the ground, face down, fingers intertwined behind your neck.

Stay in these positions even if moved. Do not resist or struggle - it may intensify the attack. Look around cautiously, and be sure the bear is gone before moving.

Fighting Back

If a black bear attacks you or a grizzly bear shows signs that it considers you prey, do not play dead. Act aggressively. Defend yourself with whatever means are available. You want to appear dominant and frighten the bear. Jump up and down, shout, and wave your arms. It may help to raise your jacket or pack to make you look bigger.

Canadian Zinc Corporation

APPENDIX B

PRAIRIE CREEK MINE

AIRSTRIP OPERATIONS PROTOCOL

and

EMERGENCY RESPONSE GUIDE

Introduction

The purpose of this document is to provide information to assist in response to an emergency situation at Prairie Creek. It is intended to serve only as a guide. Below are details on how to address the following recovery issues: aircraft crash, earthquake, explosion etc. This document will direct you to emergency resources and provide information on preventing or minimizing loss. In all emergency situations, phone the appropriate agencies as soon as possible and follow the direction of the ERT captain.

AIRCRAFT ACCIDENT RECOVERY PROCEDURES

Protocol for Arrival/Departure at Prairie Creek Mine (Airstrip ID: CBH4)

When expecting an arrival, be present at the airstrip before the ETA (Estimated Time of Arrival) with ground-to-air radio communications set to freq. 122.800 so weather and any other relevant information can be communicated to the inbound pilot. When a plane is departing, you must stay at the airport until the aircraft is safely airborne.

Notify airline of departure time after plane has left.

Log time of arrival and departure.

Airstrip Inspection and Maintenance

Prior to aircraft arrival, check airstrip for wildlife, large rocks and debris. Airstrip markers and sock should be checked for visibility. The airstrip should be closely inspected at least every month and more frequently when marginal conditions exist.

Overdue Aircraft

An aircraft is considered overdue if it has not arrived or no communications have been made within 30 minutes of the ETA. If an aircraft is overdue, confirm the flight's ETA into the minesite and contact the air service provider.

Steps After an Aircraft Accident

Report any aircraft accident by the fastest means possible to the air service provider involved.

Those members of the camp who are trained in ERT procedures and trained to provide care for the injured should be available and in attendance PROVIDED IT IS SAFE TO BE IN THE AREA. Untrained individuals should NOT enter the crash site. A well-intentioned but untrained and ill-equipped person who enters the crash site risks serious injury or death. DO NOT approach a crash site if it could place your life in peril!

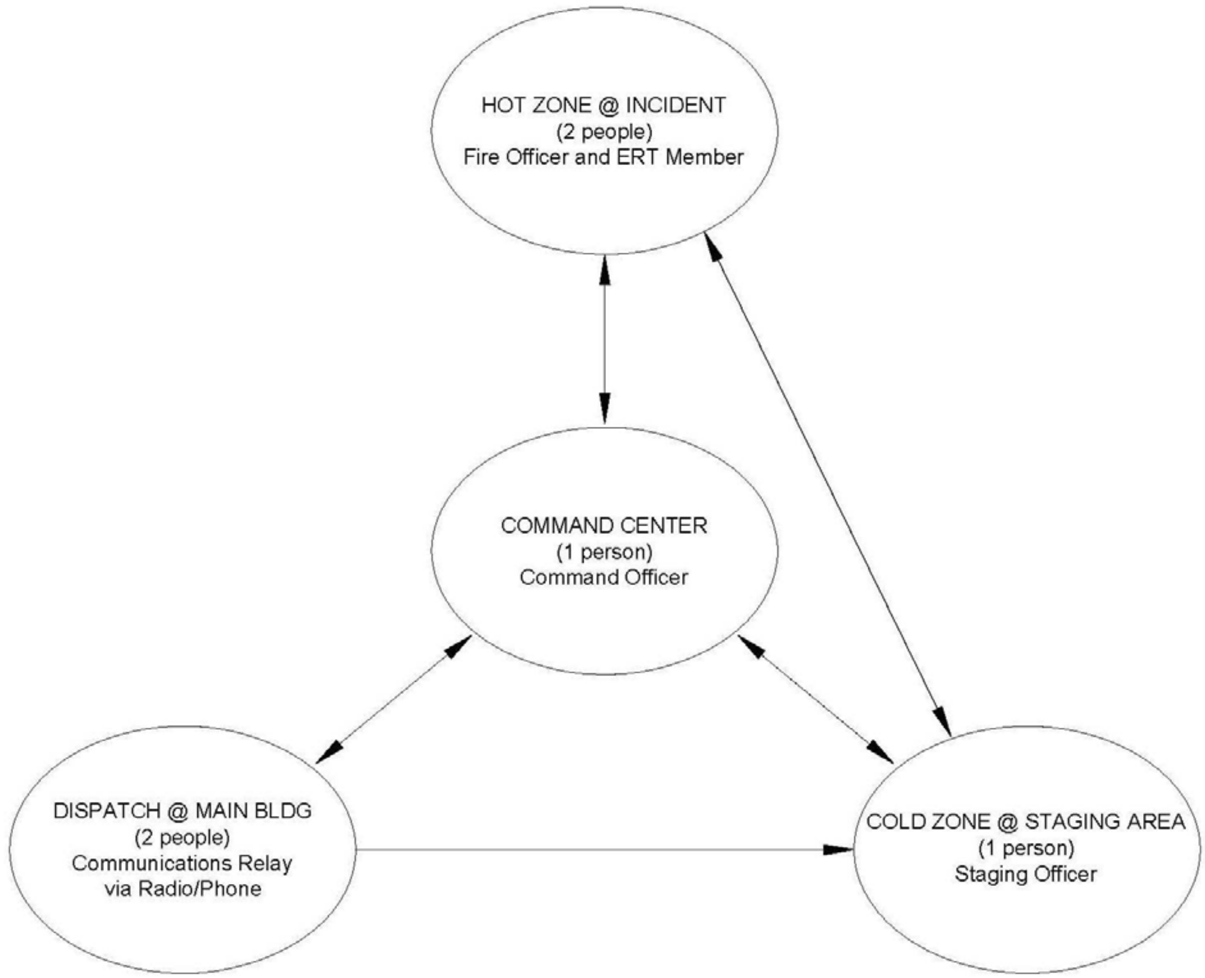
An airplane crash is often accompanied by smoke and fire. The smoke can be very toxic, and it is important to protect yourself. You must be aware of all other hazards when entering the crash area such as: explosion, falling trees/branches if in a wooded area, metal debris, etc.

If you need to move any debris material to make a safe rescue, make notes of what was moved and where, this information will be required by investigators following up on the incident.

ERT actions to be taken in the event of an aircraft accident:

- Report of crash – note time
- Initial Response – site ambulance, medic, ERT member assist (total 3)
- Arrive at scene – report immediately to base, description of injuries, type of disaster, ID number of patients
- Hazards involved – fire, smoke, fuel leak, condition of aircraft
- Establish a command safe zone – command officer (1)
- Call for backup – ie: ERT, fire truck, extinguishers, rescue equipment, extrication
- Establish a cold zone – Stage Officer (1) – coordination of the equipment, rescuers, communications with the command zone, and sending rescuers with equipment on the command zones advise into the hot zone.
- Command communications with base – 2 people responsible as dispatcher and phone communications with outside agencies (Airline, Hospital etc). Communications with other agencies such as the RCMP, WCB etc will be notified by the Airline.
- Logging the time and information is the very important.
- Do not delay, remember to keep calm and do not panic. Act responsible and in a professional manner.
- Keep communication lines clear for emergency purposes only.

Remember to **remain calm** and assist those who need help. The people involved, injured or not, will be experiencing a great deal of stress. If you panic, the patient will likely panic as well, so maintain composure and assure that the patient is as comfortable as possible.



Locations and Lines of Communication for ERT Members in Event of Emergency

PRELIMINARY AIRCRAFT ACCIDENT REPORT

Prairie Creek Airstrip ID: CBH4

Do Not Delay

Date: ____________________ Time: ____________________

Reported by: ____________________ Telephone: ____________________

LOCATION OF ACCIDENT (use most appropriate)

1) Distance and direction of crash from airfield.
2) Location, ie: Prairie Creek (Longitude 124˚, 46', 46.0"W) (Latitude 61˚, 46', 46.0"N)

Is the crash site accessible? ____________________

Type of aircraft ? ____________________

Description of aircraft: ____________________

Intact: ____________________

Destroyed: ____________________

Widely Scattered: ____________________

IS FIRE INVOLVED?

Number and severity of injuries?

____

____

____

Others called or already at site? (ie: ERT, fire truck etc.).

AIRCRAFT INFORMATION

Name of Owner: ____________________

Name of Pilot: ____________________

Date and Time of Accident? ____________________

Last Point of Departure and Point of Intended Landing: ____________________

____

____

Number of Crew: __________ Number of Injuries: __________ Number of Fatalities: __________

Number of Passengers: __________ Number of Injuries: __________ Number of Fatalities: __________

Description of Accident and Extent of Injuries: ____________________

____

____

Description of Any Dangerous Goods on Board: ____________________

____

____

Name of Person Making Report: ____________________

Signature of Person Making Report: ______________________________

Contact airline involved and they will contact Transport Canada, RCMP etc.

It is expected that Canadian Zinc employees refrain from discussing and information regarding accidents, unless information is needed by the RCMP, WCB etc.

Do not disclose any information to family members as RCMP will handle this matter.

Relatives and friends of the passengers and crews may call for information. Please respond in a polite and courteous manner – “We do not have any information to release at this time, someone will return your call when we have more information”. Record their name and phone number.

FIRE

There is little time!

In less than 30 seconds a small fire can get completely out of control and turn into a major fire. It only takes minutes for thick black smoke to fill a room. Most fires occur when people are asleep. If you wake up to a fire, you won't have time to grab valuables because fire spreads quickly and the smoke is too thick. There is only time to escape.

A fire's heat alone can kill. Room temperatures in a fire can be 100 degrees at floor level and rise to 600 degrees at eye level. Inhaling this super hot air will scorch your lungs. This heat can melt clothes to your skin. In five minutes a room can get so hot that everything ignites at once: this is called a flashover.

CARBON MONOXIDE

Carbon monoxide is an odorless, colorless and toxic gas. Because it is impossible to see, taste or smell the toxic fumes, CO can kill you before you are aware it. At lower levels of exposure, CO causes mild health effects that are often mistaken for the flu. These symptoms include:

headaches
dizziness
disorientation
nausea
fatigue

The effects of CO exposure can vary greatly from person to person depending on age, overall health and the concentration and length of exposure.

CO gas can come from several sources:

motor vehicle exhaust
charcoal grills
wood-burning furnaces or fireplaces

ELECTRICAL SAFETY

If you have sustained flood or water damage, and you can safely get to the main breaker or fuse box, turn off the power.
Assume all wires on the ground are electrically charged. This includes cable TV and computer feeds.
Look for and replace frayed or cracked extension and appliance cords, loose prongs, and plugs.
Exposed outlets and wiring could present a fire and life safety hazard.
Appliances that emit smoke or sparks should be repaired or replaced.
Have a licensed electrician check for damage.

GAS SAFETY

- Smell and listen for leaky gas connections. If you believe there is a gas leak, immediately leave and leave the door(s) open.
- Never strike a match. Any size flame can spark an explosion.
- Before turning the gas back on, have the gas system checked by a professional.

WINTER HAZARDS

Winter weather brings concerns about heat and maximizing its retention, frozen pipes, and prevention of frostbite and freezing. Also included in this list, but not as obvious, are fire and electrical emergencies, since winter weather can delay emergency vehicles or cause a sudden power loss. For more information about fire or electrical emergencies, please refer to their respective sections of this Guide.

EARTHQUAKE

The following checklist is meant to help you identify the areas that are most susceptible to the ravages of an earthquake and to suggest ways to minimize damage.

Steps to take WHEN an earthquake strikes:

If outdoors, get away from buildings and other structures like powerlines. Stay in the open.

If indoors, stay away from windows, bookcases, and other top heavy furniture. Get under heavy tables, desks or stand in doorways where you can be protected from flying debris.

If indoors, it is important not to panic and run outdoors during the shaking as bricks and other flying debris could be a greater hazard than that faced inside.

Steps to take AFTER an earthquake strikes:

Check all utility lines for breaks inside buildings. Broken gas and powerlines can be both a safety and fire hazard.

If there are any problems, the main gas valve, electrical circuit, or water line should be shut off.

Use the telephone only for emergency calls.

Stay out of any damaged buildings.

Be prepared to experience a number of aftershocks, some of which may be nearly the size of the initial earthquake.

There are four phases to effective emergency planning: (1) identify and rank your risks, (2) take steps to reduce the damage, (3) respond to the emergency, and (4) recover from the emergency. Much can be done to minimize the effect of an earthquake. Preparedness is the key.

EXPLOSION

Preparing for an explosion involves knowing what to do in an emergency and where you may be exposed to potential dangers. By examining who's at risk, you can begin to get an idea of what to look for, and what behaviors and locations that may put people at risk.

Preparing for a Building Explosion

The possibility of being caught in a building during an explosion is traumatic. Take the following precautions to increase the chances that, should the unimaginable happen, you will survive:

- Review emergency evacuation procedures.
- Know where fire exits are located.
- Carry a pocket-handkerchief or use clothing to cover your face and filter out dust and debris.

The following items should be kept in a designated place on each floor of the building.

- portable, battery-operated radio and extra batteries
- several flashlights and extra batteries
- first-aid kit and manual
- several hard hats
- fluorescent tape to rope off dangerous areas

After an Explosion

When trapped in debris:

- If possible, use a flashlight to access your surroundings.
- Signal for help by tapping on a pipe or wall to aid rescuers in locating you by following the sound. Shouting can cause a person to inhale dangerous amounts of dust and debris, so look for alternate signal methods.
- Stay in your area so that you don't kick up dust.
- Cover your mouth with your handkerchief or a piece of clothing.

*** * ***

APPENDIX 30

CANADIAN ZINC CORPORATION

PRAIRIE CREEK MINE

HUMAN RESOURCES MANAGEMENT PLAN

JANUARY 2010

Table of Contents

SECTION 1 INTRODUCTION

1.1 PURPOSE & SCOPE

This plan has been prepared by Canadian Zinc Corporation to provide a framework for human resources management during the operation of the Prairie Creek Mine in Northwest Territories. This plan is conceptual in nature and will be finalized prior to operation of the mine. Successful outcome of the on-going IBA negotiations will provide further details to supplement the Human Resources Management Plan. Since significant mine programs have already been carried out at the mine site a preliminary plan is already in place and will only need revisions to accommodate actual operations.

1.2 IMPACT BENEFIT AGREEMENTS (IBA)

To continue our heavy emphasis on community consultation CZN signed two Memorandum of Understanding Agreements (MOU) with the project's two most directly affected First Nation communities. The MOU with LKFN was signed October 2008, and the MOU with NBDB was signed November 2008. NBDB are the closest community and directly located 97 kilometres southeast from the development. LKFN are the largest community in the region and will be a major staging point for the development.

The main purpose of these MOUs was to set a framework for IBA negotiations between NBDB, LKFN and CZN. IBA negotiations are well underway and several of these negotiations are taking place within these communities.

The IBAs are the primary instrument for:

- Establishing the expected community benefits
- Mitigating social impacts of the mine
- Enhancing CZN's involvement in the communities
- Mandating the means of implementation of various training programs.
- Setting up the method of dispute resolution pertaining to employment and contracting

CZN has been actively involved with the above communities since 1994. The IBA process solidifies the ability for local community participation in the training, employment, and business partnerships associated with the development.

SECTION 2 EMPLOYMENT & TRAINING

During full operations, the Prairie Creek mine will directly employ approximately 220 people (for a breakdown of the workforce by category, see Table 6.25 in main DAR text). In order to attract, retain, and develop the calibre of employees necessary to optimize operations at the Prairie Creek project, CZN will encourage and provide opportunities for advancement and promotion to employees.

CZN will adhere at all times to the training requirements outlined in the *Mine Health and Safety Act* and regulations. Where an employee is required to have specific skills to operate equipment in the course of their duties, training will be provided. When necessary, people with operating skills will be employed. CZN reserves the right to train on an as-needed basis; it is not our intention to train employees in skills that they may never have the opportunity to use at the Prairie Creek operation.

All employees will be required to undergo appropriate training and testing before they will be allowed to operate company equipment. Comprehensive testing and training programs will be implemented to ensure the safety of all employees at the mine site.

CZN will also endeavor to carry out relevant training programs that are offered through cooperation with other agencies in the Territory to support regional education and build up a further educated Territorial workforce. CZN has already participated in such training programs with the Mine Training Society and Aurora College to carry out two Environmental Training Programs which the company hosted at the Prairie Creek Site in 2007 and 2008.

CZN will also endeavor to continue with the Scholarship Programs which have been on-going for six years.

2.1 ACCESS TO TRAINING PROGRAMS

Employees will be provided job-specific training and instruction as part of their employment. Training will be accessed as a prerequisite to employment (orientation, for example), or upon request by an employee’s supervisor. Training may occur on or off site.

2.2 CROSS-CULTURAL TRAINING

As part of their ongoing employment, all employees will take part in cross-cultural training to assist with the development of positive working relationships at the mine.

2.3 LIFE SKILLS TRAINING

Life skills training will be made available on an as need basis through the Training Department. Life skills training programs provide employee assistance in coping with new situations from camp life, long distance commuting to basic financial planning that is needed as a result of increased income.

Consideration to fill apprenticeship positions will be based on:

- qualifications
- demonstrated interest
- performance in current or prior assignment
- education and technical skill acquired.

Training and apprenticeship opportunities will also be determined during IBA negotiations and outlined in the final IBA.

SECTION 3 COMPENSATION, WORK ROTATION & PAY SCHEDULES

3.1 COMPENSATION

CZN is committed to providing fair and equitable salary programs to ensure internal equity while maintaining external competitiveness. It will reward individuals for their contribution to the company. Salary reflects the responsibilities of the position held as well as the individual's skills and performance.

3.2 WORK ROTATION

Work rotations at the Prairie Creek operation are based on three week turnarounds (i.e., three weeks working followed by three weeks off). Work shifts are 12 hours per day. The potential positive impacts of rotational employment include reduced cross-cultural contact within communities, time and resources for traditional ways of life, and workforce discipline while on-the-job contributing to long-term capacity building.

3.3 PAY SCHEDULES

Pay schedules for staff and hourly employees are expected to be bi-monthly.

SECTION 4 BENEFIT PROGRAMS

CZN will provide an option for all its employees to participate in a comprehensive benefits plan coverage, which includes dental, medical, AD&D, life insurance (both short- and long-term disability coverage), as well as an employee assistance program.

4.1 EMPLOYEE ASSISTANCE PROGRAM

The employment assistance program (EAP) is designed to assist employees and their immediate family members with problems that may affect their well-being and/or their ability to perform their jobs. The EAP will be operated by a third-party professional counseling service (accessible in the first instance by phone) and services will be available to the CZN employees and their immediate family (spouse, partner and dependents).

The primary objective of the employment assistance program is to maintain the employee's ability to be fully productive by offering this service, including early intervention and prevention.

Confidentiality will be maintained at all times.

4.2 VACATION LEAVE/PAY

All CZN employees are entitled to vacation as provided under the Northwest Territories *Employment*

Standards Act and Regulation.

Vacation pay will be 4% of the total wages of an employee during a year of employment (for those entitled to a vacation of two weeks' duration), and 6% of the total wages of an employee during a year (for those employees entitled to a vacation of three weeks' duration).

4.3 OTHER

Other benefit programs may involve some or all of the following:

- Health Care
- Retirement Plan
- Group Registered Retirement Savings Plan
- Canada Savings Bond
- Group Life Insurance
- Sickness/Injury Income Protection Plan
- Long Term Disability Insurance
- Medical Travel Assistance Program
- Remote Work Site Allowance.

SECTION 5 HEALTH & SAFETY PROGRAMS

CZN believes that a healthy workplace is a fundamental right of our employees. We are committed to protecting the health and safety of our workers and to meeting, and/or surpassing, legislated occupational health and safety standards. Health and safety considerations will be paramount in all aspects of the Prairie Creek project, from design through construction, commissioning, start-up, and operations. Management is committed to providing all resources necessary to prevent injuries and to maintain a healthy work environment. Our goal is an injury-free workplace for all of our employees.

To this end:

- All relevant laws and regulations are incorporated in CZN's Occupational Health & Safety (OHS) programs as minimum standards.

- Senior management is responsible for making funds and other resources available to ensure the successful implementation of the Occupational Health & Safety program (OHSP) and for hiring and training qualified personnel for all activities at the Prairie Creek project.

- All supervisors are responsible for ensuring that their employees are trained in approved work procedures to obtain optimal output without accidents and injuries, and that employees follow safe work methods and all related regulations.

- All employees are required to fully support the OHS programs, to make health and safety a part of their daily routine, and to ensure they are following safe work methods and relevant regulations. At the Prairie Creek project, mine safety is everybody's business.

- Employee responsibility extends to fitness for duty. There will be zero tolerance for individuals who are unfit for duty in the workplace, whatever the reason.

- A Health and Safety Committee (HSC), co-chaired by management and employee representatives and composed of salaried and hourly employees, will be established when mining commences at Prairie Creek.

- Through effective communication with all employees and recognition of good performance, we aim to foster individual commitment to safety and responsible attitudes, behavior, and practices in the workplace.

All employees at the Prairie Creek operation will receive a mandatory property safety induction as well as a work place induction. All employees are to participate in safety huddles and will be trained on the proper operation of relevant equipment. CZN will follow the rules and regulations of the NWT Mines Inspection Services.

SECTION 6 HIRING PRACTICES

CZN is an equal opportunity employer with **Dene and Northern preference**. As part of our responsibility to the Northwest Territory, we are strongly committed to employing and training people who are native to this area and/or are permanent residents. To achieve this, travel assistance will be provided for employees traveling from designated points of hire.

Medical: All employees will be subject to a medical examination prior to commencing employment, and will be required from time to time to undergo other medical tests to comply with legislation. Tests for drug and alcohol use will also be required.

Orientation: The Company will provide a complete orientation for all new employees that discusses policy issues ranging from safety and environment to camp rules. An employee handbook will be provided to each employee; this book will be reviewed during orientation.

Employee Responsibility: It is each employee's responsibility to carry out their duties in accordance with the Northwest Territories *Mine Health and Safety Act* and regulations.

To provide an effective, systematic, and effective method for the recruitment and selection of suitable employees, CZN will ensure compliance with the legislation governing human rights and employment are maintained.

All vacant positions in Prairie Creek operation that are required to be filled will be staffed by qualified candidates selected and appointed on the basis of education, experience, knowledge, abilities, suitability and, when appropriate, seniority, residency and is similar to other employment agreements.

CZN is committed to respecting all principles of employment equity and will ensure that nondiscriminatory practices are adopted in all employment-related systems.

These programs have the objective of preventing discrimination based on race, ethnic origin, ancestry or nationality; colour of skin, religion, age, sex, family, social or marital status; pregnancy, language, professional conviction, sexual orientation, political conviction; membership in a non-prohibited organization, or handicap.

SECTION 7 EMERGENCY & DISASTER CONTROL

CZN is committed to protecting the health and safety of all its workers and the environment and to adhering to all legislated safety standards. The necessary resources will be available to respond quickly and efficiently to all emergencies to prevent injury to, or degradation of, the health of individuals or the environment. In implementing this emergency response policy, CZN will set preparedness targets and report its progress on a regular basis. To this end:

- All relevant safety and emergency response laws and regulations will be incorporated into CZN's Emergency Response Plan (ERP) as minimum standards.
- Senior management is responsible for making funds and other resources available, including hiring and training qualified personnel, to ensure the successful implementation of the ERP in the event of an emergency.
- All supervisors are responsible for ensuring that their employees are aware of, and trained in, the proper emergency response procedures and that procedures and contact information are posted in all work areas. Supervisors are also responsible for ensuring that all employees follow safe work methods and all related regulations to prevent emergencies from occurring (for more information, see CZN's OHSP plan).
- An emergency response team and coordination centre will be established at the Prairie Creek site when the project becomes active.

A draft ERP has been prepared by CZN in concert with the EIS to address the requirements for a more comprehensive emergency response plan for the Prairie Creek project. The final ERP will address mining, processing, and related activities at the Prairie Creek site. CZN will ensure the mining contractor fully understands and complies with all legislated safety standards as well as the policies and procedures outlined in the final ERP before any work commences at the Prairie Creek site.

Development of the final ERP will be guided by the following principles:

- a clear chain of command for safety and health activities
- accountability for safety and health performance
- well-defined corporate expectations regarding safety and health
- comprehensive hazard prevention and control methods
- record-keeping requirements to track program progress.

The ERP will be reviewed annually, or more frequently as required, to evaluate its effectiveness and to ensure continual improvement in the procedures. All employees are encouraged to offer suggestions for ways to eliminate potential hazards and improve work procedures.

CZN has also developed an "OHSP plan;" "Spill Contingency Plan;" and "Hazardous Materials Management Plan" (HMMP) which will need to be revised to accommodate operations.

SECTION 8 DRUGS, ALCOHOL & SMOKING

8.1 DRUGS & ALCOHOL

Alcohol and illegal drugs are **not** permitted at any of CZN's properties at any time, including special occasions. Anyone caught with alcohol or illegal drugs will be subject to disciplinary action up to, and including, termination.

Employees who report to work under the influence of alcohol or illegal drugs will not be allowed to work their scheduled shift and are subject to disciplinary action up to, and including, termination.

Employees found to be using alcohol or illegal drugs during their scheduled shift will not be allowed to complete their shift and will be subject to disciplinary action up to and including termination.

Employees who arrive at the air terminal to depart to Prairie Creek under the influence of illegal drugs or alcohol will not be allowed on the aircraft. They will be sent home immediately and will be subject to disciplinary action up to, and including, termination.

The present CZN Drugs and Alcohol Policy currently in effect at Prairie Creek and outlined in the 2009 Health and Safety Plan is as follows:

COMPLIANCE TO THIS POLICY IS CONSIDERED A CONDITION OF EMPLOYMENT

CZN is committed to the safety and well being of our employees, contractors and their families along with our business partners and the communities from which we operate. The Company recognizes that the use of illicit drugs and the misuse of alcohol or other drugs can limit an employee's ability to properly perform their job, and can have serious negative impacts and consequences on the health and safety of themselves and others.

The intent of this policy is one of awareness, prevention and rehabilitation, while attempting to minimize intrusion into our employee's personal lives. The policy is subject to ongoing review and amendments from time to time as the Company sees fit to insure its effectiveness.

Scope

This policy applies to all applicants for employment, temporary, part time and full time employees, contract workers performing work or services for CZN, or any visitor while on the Prairie Creek property.

For the purposes of this policy, drugs of concern include illegal and illicit drugs, alcohol, inhalants, medications or any other substances, which inhibit or may inhibit an individual's ability to perform their job safely and productively.

Prescription drugs must be cleared with the First Aid Attendant prior to engaging in work at the site.

Substances and Applicable Rules

For all employees, contract workers, and visitors on the site, the Company prohibits:

- Anyone being unfit for work because of the use or after effects of alcohol or drug use;
- The misuse of medications, either prescribed or over the counter;
- The use, possession, distribution, offering of sale of illicit or illegal drugs, drug paraphenalia or the presence in the body of illicit or illegal drugs;
- Employees and contract workers performing safety sensitive functions having a blood alcohol concentration exceeding 0.04% (0.04 grams/100ml) while on duty.

Searches and Drug Testing

CZN reserves the right to conduct searches, and drug and alcohol testing, to enhance the effectiveness of this Policy and the Company's commitment towards providing a safe and healthy working environment.

ANY PERSON FOUND TO BE IN BREACH OF THE CONDITIONS OF THIS POLICY WILL BE TERMINATED IMMEDIATELY AND WILL BE HELD RESPONSIBLE FOR THEIR TRANSPORTATION COSTS

8.2 SMOKING

Where government regulations restrict or prohibit smoking, employees are asked to comply. Out of respect for others, smoking is prohibited within offices except in areas designated for this purpose. Smoking is also permitted in designated areas outside.

SECTION 9 SEXUAL & GENDER HARASSMENT

The objective of the human rights policy is to ensure that all employees are assured of a work environment that is free of all forms of discrimination, including personal and sexual harassment. It is the intention of CZN to ensure proper work place behavior and that the treatment of individuals is fair and equitable and in full compliance with all applicable human rights legislation.

The Canadian human rights legislation protects individuals from acts of discrimination with respect to employment, or any term or condition of employment because of a person's race, colour, ancestry, place of origin, political belief, religion, marital status, family status, physical or mental disability, sex, sexual orientation, or age.

It is the responsibility of all employees to comply fully with the human rights policy, and it is the responsibility of every department manager to monitor and ensure that the work environment is free from all forms of discrimination, including personal and sexual harassment, and to conduct appropriate investigations promptly and confidentially.

A substantiated harassment violation will be considered as a serious incident. Where appropriate, one or more of the following measures may be taken:

- written apology
- mandatory counselling

- written warning
- final written warning
- suspension
- discharge
- legal action/charges

Personal or sexual harassment involving physical assault warrants immediate suspension without pay during the investigation period, and if found to be culpable, is grounds for dismissal and possible legal action.

If a complaint is unfounded, any income or benefits lost as a result of suspension will be reinstated. Where an allegation is found to be malicious, the accuser will be subject to disciplinary action.

SECTION 10 EQUAL EMPLOYMENT OPPORTUNITY

CZN is committed to the principles of being an equal opportunity employer and this philosophy will govern all dealing with employees and applicants alike. CZN does not discriminate against qualified applicants or employees because of race, colour, religion, national origin, gender, sexual orientation, age, or disability.

CZN will take affirmative action to make sure that all applicants and employees are treated without regard to these characteristics. CZN seeks to ensure that:

- Recruiting, hiring, training, promotions, and placement decisions will be conducted without regard for these characteristics.
- Personnel actions including but not limited to pay, benefits, discipline, transfers, layoffs, training and recreational programs will be administered without regard to the above-mentioned characteristics.
- Reasonable accommodations will be made to enable qualified employees with disabilities to perform the essential functions of their jobs.

SECTION 11 LABOUR RELATIONS

CZN believes in the right of every employee to be able to express a position or lodge a complaint that he/she has been treated unfairly and can do so without fear or retribution. Accordingly, CZN will develop specific procedures for employees to air their complaints in a manner that allows the greatest opportunity for an amicable resolution and harmony within the workplace.

11.1 PROCEDURE FOR SUBMITTING GRIEVANCE OR CONCERNS

Under principles established under labour law, an employee is expected to comply with all work assignment directives unless an assignment constitutes that which is clearly detrimental to the safety and well-being of the employee or others. Following completion of a work assignment; however, the employee should be encouraged to discuss the issue on a “one-to-one” basis with his/her supervisor. Should this dialogue not produce a mutually satisfactory solution to the problem, the employee may formalize the complaint by initiating a grievance.

Generally, timely resolution of issues helps to promote a positive a harmonious work environment. It is crucial, therefore, that employees be encouraged to discuss with their supervisor, on an informal basis, any problems, concerns, or differences that arise. It is equally important that supervisors are approachable, take the time to listen, and make every effort to try and resolve an employee's complaint before it becomes a formal grievance.

CZN is committed to resolving grievances in a manner that meets the interests of the company and the concerns of its employees.

It is CZN's intent to provide its employees and their representatives with a workable mechanism for the timely resolution of grievances. If an issue cannot be resolved through this initial process, it is likely that the grievance will be documented and submitting to the supervisor and the dispute resolution committee by the employee and his/her representative.

11.2 DISCIPLINARY PROCEDURES & PROGRESSIVE DISCIPLINE

It is the policy of CZN to operate efficiently and to ensure that all employees are treated fairly and consistently. There are certain rules and certain basic standards of work, safety, and dependability that will be maintained. Employees will be disciplined for violation of company rules and regulations, inappropriate behavior, unexcused absenteeism, or deliberate performance problems.

The object of "progressive discipline" is to correct unacceptable behavior in a positive fashion. Shortcomings are to be brought to the attention of the employee and if the employee continues to fail to meet reasonable standards of behavior, disciplinary suspensions will result. In the event that an employee fails to modify his or her behavior to conform to acceptable standards, discharge for cause on the basis of a culminating incident will result. There are also some infractions that will justify immediate discharge.
Discipline may include:

- warning letter
- second warning letter
- final warning letter
- dismissal.

The level of discipline will depend on the severity of the offence and/or prior warnings. Discipline shall be the decision of the department manager in consultation with the human resources manager. If discipline results in dismissal, the termination policy will be followed.

Barring unforeseen circumstances, within one week of learning of the infraction in question, the department manager will discuss the situation with the employee to determine any mitigating factors.

All notes of any disciplinary measures will be placed on the employees human resources file.

SECTION 12 EMPLOYEE COMMUNICATIONS

CZN believes that strong employee relations, good morale, and a constructive atmosphere of teamwork depends on good communication between all supervisors and their employees. Senior management is committed to ensuring that good communication takes place within the management infrastructure, and that upward communication through all levels of management is encouraged. Therefore, every member of management is responsible for, and plays a crucial role in, facilitating communication.

Appendix A Socioeconomic Commitments

TABLE OF CONTENTS

A. Formation of a Mine Information Office and Appointment of Community Information Representative in the Community of Nahanni Butte:

INTENT

CZN will appoint a staff member as an Information Officer to locate in a Mine Information Office to assist in communications with the community of Nahanni Butte in respect of the socio-economic commitments made in this schedule.

ADMINISTRATION

Both CZN and Nahanni Butte will jointly appoint the candidate for Community Information Representative (CIR) before operations commence.

ROLES AND RESPONSIBILITIES

1. The CIR will assist CZN to ensure that the provisions of this schedule are observed.
2. The CIR's mandate will include:

   a) Assisting in identifying local persons and/or businesses interested in taking advantage of the PRAIRIE CREEK Project-related employment and business opportunities;
   b) Acting as an on-site liaison with the Dene employees of CZN
   c) Assisting with the achievement of business opportunities set out in this schedule
   d) Assisting with the implementation of work place training for Dene employees;
   e) On-going consultation with Dene employees of CZN to identify their needs, issues and concerns
   f) Developing ways and means to mitigate adverse socio economic impacts of the PRAIRIE CREEK project.

B. Employment Opportunities at the site:

INTENT

1. CZN recognizes the Dene labour supply as a valuable resource in meeting the labour demands of the PRAIRIE CREEK project.

APPLICATION

2. The provisions of this schedule shall apply to the employment practices of CZN, regarding the recruitment and employment of Dene for the PRAIRIE CREEK project.

CONSULTATION

3. CZN will develop recruitment and hiring policies and procedures that will encourage Dene employment at the PRAIRIE CREEK project.

POSITIONS AT THE PRAIRIE CREEK PROJECT

4. All positions, when vacant, at the PRAIRIE CREEK project shall be open to Dene who at the time of the vacancy have the ability, work skills, experience, necessary qualifications and any combination of factors required by the positions. Where appropriate, CZN will consider ability, skills and experience as an equivalent to formal qualifications as identified in job descriptions.

POSTING SYSTEM

5. CZN will ensure that its internal posting system for hiring personnel for the PRAIRIE CREEK project will include posting at the PRAIRIE CREEK project and in Nahanni Butte. If no qualified candidates are identified and hired within 21 days through the internal posting system, then may recruit from outside the region. If the particular job opening is of a critical nature and requires immediate filling, then the Company reserves its right to recruit from wherever a suitable candidate can be located.

WORK ROTATION

6. Work schedules and rotations for the PRAIRIE CREEK project will be established by CZN. It is recognized that a rotational work schedule will generally afford sufficient time away from the work site for Inuit employees to pursue traditional lifestyles.

POINT OF HIRE

7. Point of Hire will include the community of Nahanni Butte and other Dehcho communities as decided by CZN. CZN will provide transportation for its Dene employees to the PRAIRIE CREEK project, which transportation is scheduled on the basis of the regular work rotation for the project.

CONTRACTORS AND SUBCONTRACTORS

8. CZN will take all reasonable steps to ensure that its Contractors and any Subcontractors adopt a hiring policy consistent with CZN'S policy and hiring commitments as set out in this schedule.

MINIMUM QUALIFICATIONS

9. CZN will identify jobs for which formal entry level educational requirements will be adjusted for Dene job applicants. For greater certainly, but subject to applicable law, CZN commits to requiring Dene to have a minimum Grade 10 for all entry level positions at the PRAIRIE CREEK project, and will, from time to time, adjust formal entry level educational requirements for vacant positions in order to improve the acceptability of potential Inuit job applicants for these positions.

LANGUAGE

10. Dene who do not possess knowledge of the English language, either written or verbal, will be given reasonable opportunities to qualify for jobs where lack of knowledge of the English language does not compromise the safety of the employee, safety of others or job performance.

11. Dene employees will not be disciplined or terminated due to their inability to speak the English language, but may be transferred to a job requiring less knowledge of the English language or to a training program to suit them to another job. Such transfer will be at the discretion of CZN.

12. Where necessary, as determined by CZN, signs, safety, regulations and job advertisements shall be translated. In making these determinations, human safety and job performance shall be paramount.

C. Commitments to take on an Apprentice if skilled Tradesmen are Among the Complement at the site:

INTENT

1. It is recognized that CZN wishes to provide opportunities for participation by Dene in the development of the PRAIRIE CREEK project, and that to do so training will be required to position Dene to take advantage of business and employment opportunities associated with the PRAIRIE CREEK project.

2. CZN recognizes that the development, maintenance and retention of a skilled and qualified workforce are important for productive operations at the PRAIRIE CREEK project site.

3. The PRAIRIE CREEK project may be of short duration and is essentially exploration and consequently, provision of traditional training and education programs by CZN is not possible in this short term.

EMPLOYMENT OF APPRENTICE

4. CZN recognizes that regardless of the term of the PRAIRIE CREEK project, it may have the opportunity to ensure Dene are provided with training as a direct result of the PRAIRIE CREEK project. CZN will employ Dene apprentices, if available and if there are qualified tradesmen on site to supervise an apprentice

D. Local Contracting Opportunities:

INTENT

1. CZN recognizes that the development of the PRAIRIE CREEK project can assist in providing opportunities for expanding and/or enhancing the business community and employment of Inuit, and can add value to the Dehcho Regional economy.

2. CZN recognizes that businesses which maximize Dene content should, consistent with the terms of this schedule, be given preference in the provision of commercial services for the PRAIRIE CREEK project.

3. CZN should only be obligated to contract with businesses which have the ability to deliver products and/or services in a timely, efficient and competitive manner and whose quality and service to CZN will be assured during all phases of the PRAIRIE CREEK project.

APPLICATION

4. CZN will make best efforts to notify and contract with Dene based businesses during the exploratory phase of the PRAIRIE CREEK project.

E. Regular Communication with home Communities via Satellite or other Phone Systems:

INTENT

1. CZN acknowledges the importance of communication between employees at the PRAIRIE CREEK site and their families to morale, health and well-being.

APPLICATION

2. CZN will provide at its cost regular but limited opportunities for Dene employees to communicate with immediate family in their home communities using PRAIRIE CREEK satellite or other phone systems.

APPENDIX 31

CANADIAN ZINC CORPORATION

CODE OF BUSINESS CONDUCT AND ETHICS

1. Purpose of the Code

This Code of Business Conduct and Ethics ("**Code**") is intended to define the ethical and regulatory standards applicable to all directors, officer and employees (including contractors) and their family members (the "**Representatives**") of Canadian Zinc Corporation and its subsidiaries and affiliates (together, the "**Company**"), to promote:

- honest and ethical conduct;
- avoidance of conflicts of interest, whether actual or potential;
- full, fair, accurate, timely and understandable disclosure in financial statements, reports and documents that the Company files with, or submits to, shareholders and securities regulators, as well as in other public communications made by the Company;
- compliance with various legislation and regulations applicable to the Company;
- prompt internal disclosure of any violation of the Code; and
- accountability for any failure to respect the Code.

The Code is not a comprehensive guide to all of the Company's policies or to all of the Representatives responsibilities under applicable laws and regulations governing the Company and its operations.

The Code is intended to provide general parameters and expectations of the Company with respect to the conduct of the Company's Representatives. Violations of law or of the Company's policies, including this Code may lead to disciplinary action, including, but not limited to, dismissal and possible legal prosecution.

2. Honest and Ethical Conduct

Representatives are vested with both the responsibility and authority to protect, balance, and preserve the interests of all of the Company’s stakeholders, including shareholders, clients, employees and suppliers. Representatives fulfill this responsibility by prescribing and enforcing (in the case of senior officers) and abiding by the policies and procedures of the Company and by exhibiting and promoting the highest standards of honest and ethical conduct.

In this regard, Representatives shall:

- ensure they are familiar with and abide by the Company's corporate policies, including but not limited to the Company's Corporate Disclosure Policy, Whistleblower Policy and Insider Trading Policy;

- comply with all applicable laws, rules and regulations;
- deal fairly with the Company's security holders, customers, suppliers, competitors and employees;
- not use corporate assets or their position to obtain advantage for themselves, family members or associates, or otherwise abuse their authority;
- refrain from engaging in conduct that would discredit and/or compromise the integrity and reputation of the Company, including: neglect of duty, deceit, breach of confidence, corrupt or other unlawful practices, abuse of authority;
- keep confidential all previously undisclosed information regarding the Company and its subsidiaries' business, assets and operations;
- serve loyally, without self-interest, and free from conflicts with other commitments; and
- avoid any conflict of interest with respect to their fiduciary responsibilities and disclose actual and potential conflicts of interest in accordance with this Code.

3. Precautions, Rules and Obligations in Case of Conflicts of Interest

Generally, a Representative must not place himself in a situation of conflict of interest, whether actual or potential, and must not take into consideration, in the performance of his functions, interests that are not exclusively the best interests of the Company. In circumstances where a Representative has a conflict of interest or becomes aware of a potential conflict of interest, the Representative shall report the conflict or potential conflict to the executive officer to whom that person reports in the course of his employment responsibilities, or, in the case of a senior executive officer, to the Chairman of the Board of Directors and Chair of the Audit Committee (the “Ethics Representatives”) and fully inform such person or the Ethics Representatives, as applicable, of the facts and circumstances related to the conflict or potential conflict. The Representative shall not take any further action in respect of the matter or transaction giving rise to such conflict or potential conflict unless and until he is authorized to do so by his reporting officer, or the Ethics Representatives, as applicable.

The following are examples of relationships, interests, or circumstances that may rise to a conflict or perceived conflict of interest. These are provided for guidance only and are not exhaustive, nor are they determinative that a conflict exists. Every matter or transaction should be considered in the context of the general rule and the specific transaction or matter:

- employment by or service to (e.g. as a consultant or director) a competitor, customer, supplier or person with whom the Company conducts business;
- having, directly or indirectly, a significant financial interest in any entity that does business, seeks to do business or competes with the Company;
- a relationship with persons working for any external auditor of the Company, or any of its subsidiaries, other than relationships directly and exclusively related to the performance of the external audit mandates;
- accepting gifts, favours, loans (other than borrowing on commercial terms from entities that are in the business of lending) or preferential treatment from any person that does business, seeks to

do business or competes with the Company unless consistent with the policy described under *Dealing with Suppliers and Gifts* below;

- an interest pursuant to which the Representative or an associate of the Representative is likely to derive a profit from a transaction concluded or planned by the Company with a third party, other than in his capacity as a shareholder of the Company;

- conducting business on behalf of the Company with immediate family members or an entity in which an employee or his/her immediate family members or friends have a significant financial interest; and

- taking personal advantage of opportunities that are presented to or discovered by an employee, director or officer as a result of his/her position with the Company or through the use of the property or information of the Company.

For the purpose of this code, conflict of interest means every situation in which a Representative could be inclined to favour his own interests or those of a third party in a manner that is contrary or in preference to the interests of the Company. It is understood that apparent conflicts of interest can also cause harm to the Company and Representatives should be conscious of how their conduct is likely to be perceived by others both within and outside the Company and avoid conduct, circumstances or events which could reasonably be expected to be perceived as placing such Representative or the Company in a conflict of interest position.

4. Financial Records and Compliance

As a public company it is important that the Company's filings with the appropriate regulatory authorities be accurate and timely. All financial data must be gathered, compiled, and reviewed by the Representatives with rigour and integrity, in order to give a fair, true and accurate picture of the financial situation of the Company.

All reports and financial statements must be set out in a complete, fair, accurate, comprehensive and timely manner.

Depending upon their position with the Company, Representatives may be called upon to provide necessary information to Regulators and Securities Commissions to ensure that the Company's public reports are complete, fair and understandable. The Company expects Representatives to take this responsibility very seriously and to provide prompt, accurate answers to inquiries related to the Company's public disclosure requirements with regard to regulatory inquiries.

In the performance of their functions, the Representatives must comply with the laws and regulations applicable to the Company, ensure compliance with Generally Accepted Accounting Principles (GAAP) in Canada and, where applicable, the U.S. and the rules prescribed by the regulatory authorities having jurisdiction over the activities of the Company, and must comply with the policies of the Company.

The integrity of the Company's record keeping systems will be respected at all times. Representatives are forbidden to use, authorize, or condone the use of *off-the-books* bookkeeping, secret accounts, unrecorded bank accounts, *slush* funds, falsified books, or any other devices that could be utilized to distort records or reports of the Company's true results of operations and financial condition or could otherwise result in the improper recording of funds or transactions.

If a Representative has any concerns regarding the Company's accounting practices or procedures, the employee should immediately report the matter in accordance with the procedures outlined in the Company's *Whistleblower Policy*.

5. Protection and Proper Use of Company Assets

All Representatives should protect the Company's assets and ensure their efficient use. Theft, carelessness and waste have a direct impact on the Company's available resources. All of the Company's assets should be used only for legitimate business purposes and not for personal use. Reasonable, incidental personal use of Company provided computers and phones are permitted provided that such activities do not interfere with the performance of duties (as described in other Company policies).

6. Competitive Practices

The Company does not seek competitive advantages through illegal or unethical business practices or behaviour. The Company seeks to comply with and supports laws of all countries which prohibit restraints of trade, unfair practices, or abuse of economic power.

The Company will not enter into arrangements which unlawfully restrict its ability to compete with other businesses, or the ability of any other business organization to compete freely with the Company. Company policy also prohibits Representatives from entering into, or even discussing, any unlawful arrangement or understanding.

7. Dealing with Suppliers and Gifts

The Company is a customer for many suppliers of goods, services and facilities. People who want to do business or to continue to do business, with the Company must understand that all purchases by the Company will be made exclusively on the basis of price, quality, service and suitability to the Company's needs.

(a) *Kickbacks* and Rebates

Purchases of goods and services by the Company must not lead to Representatives receiving any type of personal kickbacks or rebates. Representatives must not accept any form of *under-the-table* payment.

(b) Receipt of Gifts and Benefits

Representatives must exercise care and good judgment in accepting or offering business-related gifts.

Accepting or offering business-related gifts of moderate value is acceptable in situations where business-related gift giving is legal and in accordance with local business practice and the gifts involved are appropriate for the occasion. Representatives must not, however, accept or offer business-related gifts of any kind in circumstances that could be perceived as inducing or influencing the recipient to give business opportunities to, or make business decisions in favour of, the Company. If there is any doubt with respect to a particular situation, Representatives should seek assistance from the executive officer to whom that person reports..

Employees who accept gifts (of more than moderate value, estimated at about $100) must report the gift to the executive officer to whom they report or an Ethics Representative. The monetary value of the gift, local customs and legal requirements will be considered when determining whether the gift should be retained by the Representative, given to the Company or returned. A gift that is given to the Company will normally be donated to a charity or made available to all employees in the applicable work unit.

The following items must not be accepted or offered as gifts under any circumstances, regardless of value:

- cash or personal cheques;
- drugs or other controlled substances;
- product or service discounts that are not available to all employees;
- personal use of accommodation or transportation; and
- payments or loans to be used toward the purchase of personal property (other than borrowing on commercial terms from entities that are in the business of lending).

No Representative may request a gift of any kind from a supplier, customer or other person with whom the Company conducts business or from a competitor of the Company.

8. Financial Inducements

Representatives must not make payments or give gifts or other favours to third parties to induce or influence them to give business opportunities to, or make business decisions in favour of, the Company. Bribes, *kickbacks,* secret commissions and similar irregular payments are prohibited.

9. Political/Charitable Activities and Contributions

Representatives are encouraged and entitled to participate in personal political or charitable activities as long as they do not do so on company time and do not use the financial or other resources of the Company. Representatives that do participate in personal political or charitable activities must make every effort to ensure that they do not leave the impression that they speak or act for the Company.

10. Equal Opportunity

The Company supports the principle that every individual must be accorded an equal opportunity to participate in the free enterprise system and to develop their ability to achieve their full potential within that system.

There will be no discrimination against any employee or applicant because of race, religion, color, sex, sexual orientation, age (as defined in the Human Rights Code (British Columbia)), national or ethnic origin, or physical handicap (unless demands of the position are prohibitive). All Representatives will be treated with equality during their employment without regard to their race, religion, color, sex, sexual orientation, age (as defined in the Human Rights Code (British Columbia)), national or ethnic origin, or physical handicap, in all matters. The Company will maintain a work environment free of discriminatory practice of any kind.

No employee will have any authority to engage in any action or course of conduct or to condone any action or course of conduct by any other person which will in any manner, directly or indirectly, discriminate or result in discrimination in the course of one's employment, termination of employment, or any related matter where such discrimination is, directly or indirectly, based upon race, religion, color, sex, sexual orientation, age (as defined in the Human Rights Code (British Columbia)), national or ethnic origin, or physical handicap.

11. Health, Safety and Environmental Protection

It is the Company's policy to pay due regard to the health and safety of its Representatives and others and to the state of the environment. There are federal, provincial and local workplace safety and environmental laws which through various governmental agencies regulate both physical safety of Representatives and their exposure to conditions in the workplace. Should you be faced with an environmental health issue or have a concern about workplace safety, you should contact the executive officer to whom you most directly report immediately.

12. Confidential Information

All information that has been developed or acquired by the Company, including technical, financial and business information, and not generally disclosed ("confidential information") is the property of and confidential to the Company and must be protected against theft, loss or misuse.

Representatives must not disclose confidential information to other Representatives without authorization from their manager unless it is reasonably required by them to perform their jobs. Representatives must not reveal confidential information to third parties (other than approved auditors, lawyers and other professional advisors, financial advisors and banks or other financial institutions) without authorization by the Chief Executive Officer. Such disclosure should be limited only to those who need-to-know and be made pursuant to a confidentiality agreement restricting the recipient from disclosing or using the information in an unauthorized manner.

Representatives must use confidential information only for authorized purposes on behalf of the Company and not for their own personal gain or benefit.

13. Use of Agents and Non-Employees, Officers and Directors

Agents or other non-employees cannot be used to circumvent the law and will not be retained by any Representatives to engage in practices that run contrary to this Code.

14. Standards of Compliance

Representatives have the responsibility to maintain their understanding of this Code and must seek assistance from the executive officer to whom they report or, in the case of the Board or officers of the Company, the Ethics Representatives if they do not understand any part of the Code or what to do in any particular situation. This includes any case where a more specific procedure has not been established in the present code or in another official communication of the Company.

Executive officers have the responsibility to maintain awareness on the part of Representatives of the importance of their adhering to this Code and for reporting deviations from it.

15. Procedure and Sanctions

A Representative or any other officer that has a well founded suspicion and/or knowledge of any violation of this code must immediately report and bring this alleged violation to the attention of the executive officer to whom they report and/or the Ethics Representatives.

Every violation of this code shall be disclosed to the Ethics Representatives in a timely manner.

Any Representative who does not comply with this code is subject to disciplinary sanctions that could include the termination of his employment. Representatives should be aware that in addition to any disciplinary action taken by the Company, violations of some of this Code may require restitution and may lead to civil or criminal action.

In no circumstance, and without restricting the protections granted by law, will the action of raising questions regarding the applicable procedure for the treatment of accounting data be considered as a motive for disciplinary sanctions or the termination of employment of the Representative who raised the questions.

Retaliation in any form against an individual who reports a violation of this Code or of law in good faith, or who assists in the investigation of a reported violation, is itself a serious violation of this Code. Acts of retaliation should be reported immediately to an executive officer or the Ethics Representatives, and will be disciplined appropriately.

Executive officers have the responsibility of taking remedial steps to correct any operating procedures that may contribute to violations of this Code.

16. Review and Disclosure

The Company will periodically review and reassess the adequacy of this Code. The Code may be amended, modified or waived by the Board of Directors and waivers may also be granted by the Audit Committee. Representatives will be fully informed of any material revisions to the Code.

All amendments to and waivers of this code shall, if material, be publicly disclosed by the Company where required pursuant to applicable legal and regulatory requirements.

17. Scope

The rules set out in this Code are not exhaustive and must not be interpreted as a limitation to the other policies and rules applicable to the employees of the Company, in general, and to the Representatives, in particular. Furthermore, these rules are not intended to and do not restrict the discretion and authority to manage and direct the Company.

This Code of Business Conduct and Ethics was adopted on November 1, 2007 by the Board of Directors of Canadian Zinc Corporation

By order of the Board of Directors

CANADIAN ZINC CORPORATION

APPENDIX 32

CANADIAN ZINC CORPORATION

PRAIRIE CREEK MINE

WILDLIFE MANAGEMENT PLAN

MINE AND ACCESS ROAD OPERATIONS

March 2010

Table of Contents

INTRODUCTION

Canadian Zinc Corporation (CZN) has prepared this wildlife management plan (WMP) to support the planned operation of the Prairie Creek Mine, access road and associated transfer facilities.

Major wildlife species in the area are caribou, moose, Dall's sheep and grizzly bear. Bison may also be present near Nahanni Butte.

This WMP is for the protection of wildlife near the Mine site year round, and in proximity to the access road during the operating period in winter.

CONSULTATION FOR PLAN DEVELOPMENT

This WMP draws from material developed during previous environmental assessments (EA). That material was the subject of consultation with representatives from the GNWT Department of Environment and Natural Resources (ENR). No consultation has been undertaken with respect to this WMP to date since it is a preliminary draft written for inclusion in a Developer's Assessment Report (DAR). It is anticipated that consultation will occur during the EA, and if the project proceeds, during the permitting stage.

PRE-EXISTING WILDLIFE MITIGATION AND MANAGEMENT PLANS

A WMP was written in support of a land use permit (LUP) for development of an underground Decline within the Mine. That WMP also supported a LUP for drilling in areas outlying from the Mine site (Phase 3). The WMP focused on wildlife sightings at the Mine site and documentation of these in a Wildlife Sighting Log, and preparedness and advice regarding bear encounters. The material has been incorporated into this WMP.

A Flight Impact Management Plan (FIMP) was developed previously for the Phase 3 drilling project. This plan will be reviewed and updated, as appropriate, for mine operations.

PROPOSED WILDLIFE MITIGATION AND MANAGEMENT

The following actions have been proposed to mitigate and manage potential effects on wildlife from Mine and access road operations:

- A 'no hunting' requirement will be enforced for all CZN employees and contractors. Instructions will also be given to avoid contact with, and disturbance of, wildlife;

- Wildlife sightings in proximity to the Mine site and access road will be recorded in a log. Recordings will indicate the approximate location of the sighting, the species, the number and approximate age of animals, and their activity (direction of movement etc.);

- All mine site staff, on arrival at site, will receive a copy of CZN's health and safety plan and will be required to read it and receive briefings on the possibility of bear encounters. The type of information that will be provided is shown in Appendix A;

- All mine site staff, on arrival at site, will be briefed on policies, including the no hunting and no harassment of wildlife requirements;

- Wildlife sightings along the access road will be reported immediately to road controllers if the wildlife is within 100 m of the road and hauling along the access road is in progress. The report will contain the species, number, and approximate road Km marker. Controllers will issue travel alerts to drivers;

- Speed limits will be set and posted for all sections of the access road for vehicle and wildlife safety;

- If wildlife sightings are common along a particular section of the access road, and the wildlife are in close proximity to the road, consideration will be given to a lower speed limit to minimize the risk of vehicle-animal collisions; and,

- Use of the access road will be controlled due to concerns regarding safety and un-authorized use for hunting. Some form of check-point and screening is proposed near the south-eastern terminus of the road.

WIDLIFE MONITORING

The recording of wildlife sightings and operations of logs for the Mine site and access road are noted above. CZN will also closely monitor incidents of bear encounters, and the un-authorized use of the access road for hunting.

ADAPTIVE MANAGEMENT

As noted above, if wildlife sightings are common along a particular section of the access road, and the wildlife are in close proximity to the road, consideration will be given to a lower speed limit to minimize the risk of vehicle-animal collisions.

If monitoring of un-authorized use of the access road for hunting determines that the use is excessive, and could lead to unacceptable wildlife pressures, First Nations, ENR, Indian and Northern Affairs Canada (INAC) and Parks Canada representatives will be consulted, as appropriate, to consider solutions.

REPORTING

Copies of wildlife sighting logs, as well as monitoring information collected during access road operations will be compiled in an annual report. The report will be circulated to First Nations and appropriate regulatory authorities. It is expected that the contents of the report will also be discussed at CZN-Parks Canada-First Nation committee meetings, and that forum will be used to determine whether any adjustments or adaptive management is required.

APPENDIX A
BEAR ENCOUNTERS

The following advice is drawn from the Government of the Northwest Territories (GNWT), Department of Environment and Natural Resources (ENR) website.

Bear Contacts - What to Do

Situation	Black Bear	Grizzly Bear
At a distance	Alert bear to your presence, back away or detour, scare away with noise	Alert bear to your presence, back away or detour, scare away with noise
Close encounter (50 ft.)	Back away slowly and quietly	Back away slowly and quietly, climb a tree
Very close encounter (30 ft.)	Stand your ground	Stand your ground
Bear Charges	Shoot, Fight back	Shoot, Play dead
Bear treats you as prey	Shoot, Fight back	Shoot, Fight back

Problem Bears

Problems can occur whenever bears and people occupy the same area. You can encounter a bear by chance, or because the bear is attracted to your activity. Bears are curious, and often investigate a strange object, smell, or noise. They also have a tremendous and constant drive to find as much nutritious food as they can during their time out of the den. These two traits, coupled with a bear's remarkable sense of smell, often lead bears to areas of human activity. The outcome of a bear's visit to a camp or community will influence its future behaviour. If it does not find food, it may not return once its curiosity has been satisfied. If it successfully obtains food from a human source - such as a garbage dump, backpack, or unclean camp - it begins to associate food with anything human, and investigate areas used by humans whether or not food is actually detected. A bear will gradually lose its tendency to avoid people as it learns to associate them with food. It may become bold and aggressive.

Once started, the habits of problem bears are difficult to break. It is your responsibility in bear country to ensure that your actions do not encourage those habits. It is unfortunate, but a problem bear is often destroyed.

General Conduct

Safety is everyone's responsibility - it is not a job that can be delegated to someone else and then forgotten about. The actions of each individual affect the safety of everyone else.
Remember these simple rules:
Be alert at all times.

- Respect all bears - they can be dangerous.
- Never approach a bear for any reason. Photographs should be taken from a safe distance with a telephoto lens.
- Never feed bears or other wildlife.
- Have a plan of action for dealing with bears and be sure everyone understands it.

Field Workers

If you are approaching your work area from the air, check for bears from the aircraft before landing. Work in pairs and stay alert. Alternate responsibilities so one person is watching for bears. If both partners are busy working, a bear may approach unnoticed.
Make sure someone knows where you are going and when you plan to return. If possible carry a portable hand-held radio for communication with the aircraft or base camp.

The Bear's Behaviour

A bear's reaction to you will be influenced by many factors, and is therefore never entirely predictable. Given the opportunity, bears usually avoid people. Some bears are more dangerous or aggressive than others. Old or wounded bears may be in pain or starving. They may aggressively seek food from people if they are unable to obtain enough on their own. Any bear that has become accustomed to people and shows no fear of them is dangerous.

Every bear defends a critical space. The size of the space varies with each bear and each situation: it may be a few metres or a hundred metres. Intrusion into this space is considered a threat and may provoke an attack. All female bears aggressively defend their cubs. If a female with cubs is surprised at close range, or separated from her cubs she is likely to charge.

Bears also aggressively defend their food, and are often reluctant to leave it until it is all eaten. In some cases, a bear that is threatened may engage in displays intended to scare away an opponent. These may include huffing, panting, hissing or growling; looking directly at you, sometimes with lowered head or ears laid back; slapping one or both feet on the ground; jaw-popping; or charging to within several metres, then stopping suddenly or veering to the side. Threat displays may be followed by an attack, but may end with the bear walking or running away.

A bear standing on its hind legs is probably trying to pick up your scent and figure out what you are. It may sniff the air or swing its head from side to side. Bears do not charge on their hind legs.

Most grizzlies avoid contact with humans if possible. However, there is good reason for their reputation for ferocity. If cornered, threatened, or surprised, the grizzly can be very aggressive, and will usually stand its ground or charge.

Black bears are often less aggressive and flee from danger. However, because they are more curious and adaptable than grizzlies, they quickly become accustomed to human activity, and may develop aggressive food-seeking habits which make them dangerous. Therefore, treat all black bears with caution. In very few cases, a bear has stalked a person that it apparently considered potential prey. Although such incidents are rare, you should know the difference between the behaviour of a hunting bear, and the behaviour of a threatened bear.

A hunting bear does not bother with displays and shows no signs of annoyance or fear. It may approach you directly at a fast walk or turn, follow you, or circle carefully, making cautious approaches.

Your Behaviour

The thought of facing a bear can be frightening. However, bears rarely attack a person on sight, and only a very small percentage of charges result in serious injury or death.
There is always a possibility you may surprise a bear at close range, or encounter a problem bear which is not afraid of people. There is no guaranteed formula for reacting to a bear encounter because every encounter is unique. There are, however, guidelines which may help. Most are based on good judgment, common sense, and familiarity with bear behaviour.

Stop, stand still, and stay calm.

- If you are carrying a means of communication, alert others to your situation and ask for assistance.
- If the bear is aware of you, help it identify you as a person. It may leave. Staying upwind will help it to smell you. Talk in low tones and slowly wave your arms.
- Do not run from a bear unless you are sure you can reach a safe place before the bear catches up. Running may cause the bear to chase you, and a bear is faster than you are.
- Always leave a bear an open avenue of escape.
- If you see a bear at a distance, alert the bear to your presence. Quietly walk back the way you came or make a wide detour around the bear. Do not come between a bear and its cubs.
- If time, distance and circumstances permit, try to scare the bear away by firing flare cartridges or noisemakers.
- In a close encounter, stand still and assess the situation. Do not shout or make sudden movements which might provoke the bear, and avoid direct eye contact. At 50 feet, even if the bear is displaying threat behaviour, there is probably still time for you to avoid an encounter.

- Back away slowly. Only leave behind an article of clothing or gear if the bear is still trying to identify you. This will not work if the bear is following you. Leave food or an article of clothing only as a last resort.

- Climb a tree if one is available. You will have to climb higher than four metres - grizzlies can reach that high. Remember that black bears can also climb trees.

- If the bear is very close (30 ft.), it is usually best to stand your ground.

If a Bear Charges

A bear charges at high speed on all four legs. Many charges are bluffs. Bears often stop or veer to the side at the last minute. However, if contact appears unavoidable, you should play dead if you are attacked by a grizzly, or fight back if attacked by a black bear.

Playing Dead

Playing dead may prevent serious injury if you are attacked by a grizzly bear. Do not play dead during a black bear attack or if a grizzly bear is treating you as prey. Playing dead will help protect your vital areas, and the bear may leave if you appear harmless. There are two recommended positions:

- lie on your side, curled into a ball, legs drawn tightly to your chest, hands clasped behind your neck;

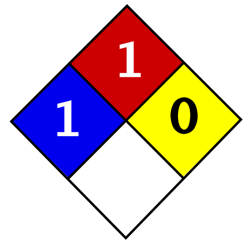
- lie flat on the ground, face down, fingers intertwined behind your neck.

Stay in these positions even if moved. Do not resist or struggle - it may intensify the attack. Look around cautiously, and be sure the bear is gone before moving.

Fighting Back

If a black bear attacks you or a grizzly bear shows signs that it considers you prey, do not play dead. Act aggressively. Defend yourself with whatever means are available. You want to appear dominant and frighten the bear. Jump up and down, shout, and wave your arms. It may help to raise your jacket or pack to make you look bigger.

APPENDIX 33



Health	1
Fire	1
Reactivity	0
Personal Protection	C

Material Safety Data Sheet
Ethylene glycol MSDS

Section 1: Chemical Product and Company Identification

Product Name: Ethylene glycol

Catalog Codes: SLE1072

CAS#: 107-21-1

RTECS: KW2975000

TSCA: TSCA 8(b) inventory: Ethylene glycol

CI#: Not available.

Synonym: 1,2-Dihydroxyethane; 1,2-Ethanediol; 1,2-Ethandiol; Ethylene dihydrate; Glycol alcohol; Monoethylene glycol; Tescol

Chemical Name: Ethylene Glycol

Chemical Formula: HOCH2CH2OH

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Ethylene glycol	107-21-1	100

Toxicological Data on Ingredients: Ethylene glycol: ORAL (LD50): Acute: 4700 mg/kg [Rat]. 5500 mg/kg [Mouse]. 6610 mg/kg [Guinea pig]. VAPOR (LC50): Acute: >200 mg/m 4 hours [Rat].

Section 3: Hazards Identification

Potential Acute Health Effects:
Hazardous in case of ingestion. Slightly hazardous in case of skin contact (irritant, permeator), of eye contact (irritant), of inhalation. Severe over-exposure can result in death.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Non-mutagenic for bacteria and/or yeast.
TERATOGENIC EFFECTS: Not available.
DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to kidneys, liver, central nervous system (CNS).
Repeated or prolonged exposure to the substance can produce target organs damage. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human

organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention if irritation occurs.

Skin Contact:
Wash with soap and water. Cover the irritated skin with an emollient. Get medical attention if irritation develops. Cold water may be used.

Serious Skin Contact: Not available.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation: Not available.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. If large quantities of this material are swallowed, call a physician immediately. Loosen tight clothing such as a collar, tie, belt or waistband.

Serious Ingestion:
Medical Conditions Aggravated by Exposure:
Persons with pre-existiing kidney, respiratory, eye, or neurological problems might be more sensitive to Ethylene Glycol.
Notes to Physician:
1. Support vital functions, correct for dehydration and shock, and manage fluid balance.
2. The currently recommended medical management of Ethylene Glycol poisoning includes elimination of Ethylene Glycol and metabolites. Elimination of Ethylene Glycol may be achieved by the following methods:
a. Emptying the stomach by gastric lavage. It is useful if initiated within < 1 of ingestion.
b. Correct metabolic acidosis with intravenous administration of sodium bicarbonate, adjusting the administration rate accoridng to repeated and frequent measurement of acid/base status.
c. Administer ethanol (orally or by IV (intravenously)) or fomepizole (4-methylpyrazole or Antizol)) therapy by IV as an antidote to inhibit the ormation of toxic metabolites.
d. If patients are diagnosed and treated early in the course with the above methods, hemodialysis may be avoided if fomepizole or ethanol therapy is effective and has corrected the metabolic acidosis, and no renal failure is present. However, once severe acidosis and renal failure occured, however, hemodialysis is necessary. It is effective in removing Ethylene Glycol and toxic metabolites, and correcting metabolic acidosis.

Section 5: Fire and Explosion Data

Flammability of the Product: May be combustible at high temperature.

Auto-Ignition Temperature: 398°C (748.4°F)

Flash Points: CLOSED CUP: 111°C (231.8°F). (Tagliabue.)

Flammable Limits: LOWER: 3.2%

Products of Combustion: These products are carbon oxides (CO, CO_2).

Fire Hazards in Presence of Various Substances:
Slightly flammable to flammable in presence of open flames and sparks, of heat.
Non-flammable in presence of shocks.

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.

Fire Fighting Media and Instructions:
SMALL FIRE: Use DRY chemical powder.
LARGE FIRE: Use water spray, fog or foam. Do not use water jet.

Special Remarks on Fire Hazards: Not available.

Special Remarks on Explosion Hazards:
Explosive decomposition may occur if combined with strong acids or strong bases and subjected to elevated temperatures.

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to local and regional authority requirements.

Large Spill:
Stop leak if without risk. Do not get water inside container. Do not touch spilled material. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Eliminate all ignition sources. Call for assistance on disposal. Finish cleaning by spreading water on the contaminated surface and allow to evacuate through the sanitary system. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep away from heat. Keep away from sources of ignition. Empty containers pose a fire risk, evaporate the residue under a fume hood. Ground all equipment containing material. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Wear suitable protective clothing. If ingested, seek medical advice immediately and show the container or the label. Keep away from incompatibles such as oxidizing agents, acids, alkalis.

Storage: Keep container tightly closed. Keep container in a cool, well-ventilated area. Hygroscopic

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Safety glasses. Synthetic apron. Gloves (impervious). For most conditions, no respiratory protection should be needed. However, if material is heated or sprayed and if atmospheric levels exceed exposure guidelines, use an approved vapor (air purifying) respirator.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Boots. Gloves. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
STEL: 120 (mg/m3) [Australia]
TWA: 100 (mg/m3) from ACGIH (TLV) [United States]
CEIL: 125 (mg/m3) from OSHA (PEL) [United States]
CEIL: 50 (ppm) from OSHA (PEL) [United States]

TWA: 52 STEL: 104 (mg/m3) [United Kingdom (UK)] Inhalation
TWA: 10 (mg/m3) [United Kingdom (UK)] SKIN3
Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (syrupy)

Odor: Odorless.

Taste: Mild sweet

Molecular Weight: 62.07 g/mole

Color: Clear Colorless.

pH (1% soln/water): Not available.

Boiling Point: 197.6°C (387.7°F)

Melting Point: -13°C (8.6°F)

Critical Temperature: Not available.

Specific Gravity: 1.1088 (Water = 1)

Vapor Pressure: .06 mmHg @ 20 C; .092 mmHg at 25 C

Vapor Density: 2.14 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: The product is more soluble in water; log(oil/water) = -1.4

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water, acetone.

Solubility:
Soluble in cold water, hot water, acetone.
Slightly soluble in diethyl ether.
Miscible with lower aliphatic alcohols, glycerol, acetic acid, acetone and similar ketones, aldehydes, pyridine, similar coal tar bases.
Practically insoluble in benzene and its homologs, chlorinated hydrocarbons, petroleum ether.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability: Excess heat, incompatible materials.

Incompatibility with various substances: Reactive with oxidizing agents, acids, alkalis.

Corrosivity: Non-corrosive in presence of glass.

Special Remarks on Reactivity:

Hygroscopic. Absorbs moisture from the air.
Avoid contamination with materials with hydroxyl compounds.
Also incompatible with aliphatic amines, isocyanates, chlorosulfonic acid, and oleum

Special Remarks on Corrosivity: Not available.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Ingestion.

Toxicity to Animals:
Acute oral toxicity (LD50): 4700 mg/kg [Rat].
Acute toxicity of the vapor (LC50): >200 mg/m3 4 hours [Rat].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: A4 (Not classifiable for human or animal.) by ACGIH.
MUTAGENIC EFFECTS: Mutagenic for mammalian somatic cells. Non-mutagenic for bacteria and/or yeast.
May cause damage to the following organs: kidneys, liver, central nervous system (CNS).

Other Toxic Effects on Humans:
Hazardous in case of ingestion.
Slightly hazardous in case of skin contact (irritant, permeator), of inhalation.

Special Remarks on Toxicity to Animals:
Lowest Published Toxic Dose/Conc:
TDL [Man] - Route: oral; Dose: 15gm/kg
Lethal Dose/Conc 50% Kill
LD50 [Rabbit] - Route: dermal; Dose: 9530 ul/kg

Special Remarks on Chronic Effects on Humans:
May cause adverse reproductive effects and birth defects (teratogenic) based on animal test data. No human data has been reported at this time.
May affect genetic material (mutagenic)

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: May cause skin irritation. May cause more severe response if skin is abraded. A single prolonged exposure is not likely to result in material being absorbed through skin in harmful amounts. Massive contact with damaged skin may result in absorption of potentially harmful amounts
Eyes: Vapors or mist may cause temporary eye irritation (mild temporary conjunctival inflammation) and lacrimation. Corneal injury is unlikely or insignificant..
Ingestion: It is rapidly absorbed from the gastrointestinal tract. Oral toxicity is expected to be moderate in humans due to Ethylene Glycol even though tests with animals show a lower degree of toxicity. Excessive exposure (swallowing large amounts) may cause gastrointestinal tract irritation with nausea, vomiting, abdominal discomfort, diarrhea.
It can affect behavior/central nervous system within 0.5 to 12 hours after ingestion. A transient inebriation with excitement, stupor, headache, slurred speech, ataxia, somnolence, and euphoria, similar to ethanol intoxication, can occur within the first several hours. As sthe Ethylene Glycol is metabolized, metabolic acidosis and further central nervous system depression (convulsions, muscle weakness) develop. Serious intoxication may develop to coma associated with hypotonia, hyporeflexia, and less commonly seizures, and meningismus. 12 to 24 hours

Section 12: Ecological Information

Ecotoxicity:
Ecotoxicity in water (LC50): 41000 mg/l 96 hours [Fish (Trout)]. 46300 mg/l 48 hours [water flea]. 34250 mg/l 96 hours [Fish (bluegill fish)]. 34250 mg/l 72 hours [Fish (Goldfish)].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Not a DOT controlled material (United States).

Identification: Not applicable.

Special Provisions for Transport: Not applicable.

Section 15: Other Regulatory Information

Federal and State Regulations:
Illinois toxic substances disclosure to employee act: Ethylene glycol
Illinois chemical safety act: Ethylene glycol
New York release reporting list: Ethylene glycol
Rhode Island RTK hazardous substances: Ethylene glycol
Pennsylvania RTK: Ethylene glycol
Minnesota: Ethylene glycol
Massachusetts RTK: Ethylene glycol
Massachusetts spill list: Ethylene glycol
New Jersey: Ethylene glycol
Louisiana spill reporting: Ethylene glycol
TSCA 8(b) inventory: Ethylene glycol
TSCA 4(a) proposed test rules: Ethylene glycol
SARA 313 toxic chemical notification and release reporting: Ethylene glycol
CERCLA: Hazardous substances.: Ethylene glycol: 5000 lbs. (2268 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada): CLASS D-2A: Material causing other toxic effects (VERY TOXIC).

DSCL (EEC):
R22- Harmful if swallowed.
S46- If swallowed, seek medical advice immediately and show this container or label.

HMIS (U.S.A.):

Health Hazard: 1

Fire Hazard: 1

Reactivity: 0

Personal Protection: C

National Fire Protection Association (U.S.A.):

Health: 1

Flammability: 1

Reactivity: 0

Specific hazard:

Protective Equipment:
Gloves.
Lab coat.
Not applicable.
Safety glasses.

Section 16: Other Information

References: Not available.

Other Special Considerations: Not available.

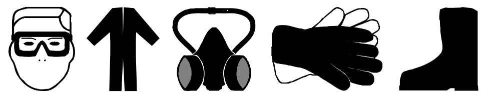
Created: 10/10/2005 08:18 PM

Last Updated: 11/06/2008 12:00 PM

Quadra

Material Safety Data Sheet

Validated and verified by: Regulatory Affairs / Affaires réglementaires **Validation date** **5/19/2006.**

WHMIS	**Protective Clothing**	**TDG Road / Rail**
		

Section 1. Chemical product and company identification

Sodium sulfide flakes (C)

Code : Q04575/ M01663

Synonym : Not available.

Manufacturer : Chem One

Supplier : QUADRA CHEMICALS LTD.
370, boul. Joseph-Carrier
Vaudreuil-Dorion QC J7V 5V5
Tel: (450) 424-0161

Burlington ON Tel: (905) 336-9133
Delta BC Tel: (604) 940-2313
Edmonton AB Tel: (780) 451-9222
Calgary AB Tel: (403) 232-8130

Material uses : Industrial applications.

TRANSPORTATION EMERGENCY - 24HRS/DAY - 7 DAYS/WEEK
IN CANADA - CALL 1-800-567-7455

Section 2. Composition, Information on Ingredients

Name	CAS #	% by weight	Exposure limits
sodium sulphide hydrate	27610-45-3	60-100	Not available.

Consult local authorities for acceptable exposure limits.

Section 3. Hazards identification

Emergency overview CORROSIVE OR SEVERELY IRRITATING TO THE EYES, SKIN, RESPIRATORY OR GASTROINTESTINAL TRACT. HARMFUL IF INHALED OR SWALLOWED.

Routes of entry : Dermal contact. Eye contact. Inhalation. Ingestion.

Potential acute health effects

Eyes : Corrosive to the eyes. Symptoms of exposure may include redness, tearing, pain, burning and blurred vision. Prolonged exposure may cause severe and permanent eye injury (blindness).

Skin : Severely irritating and corrosive to the skin. Prolonged and repeated contact may cause an allergic skin reaction, resulting in rash, swelling, itching and possibly blistering.

Inhalation : Irritating to the respiratory system. Symptoms of exposure may include coughing, sore throat and shortness of breath. Exposure can cause pulmonary oedema, headache and dizziness. Effects may be delayed.

Ingestion : Harmful if swallowed. May cause burns to the mouth and throat. Symptoms of exposure may include nausea, vomiting, diarrhea and abdominal pain.

Potential chronic health effects : **CARCINOGENIC EFFECTS** Not listed as carcinogen by OSHA, NTP, IARC or ACGIH.
MUTAGENIC EFFECTS Not available.
TERATOGENIC EFFECTS Not available.
DEVELOPMENTAL TOXICITY Not available.

Continued on next page

Medical conditions aggravated by overexposure : No additional information.

Over-exposure signs/symptoms : Overexposure to the hydrogen sulfide may cause memory loss, paralysis of facial muscle, nerve damage, pulmonary edema, unconsciousness or death.

See toxicological Information (section 11)

Section 4. First aid measures

Eye Contact : IMMEDIATELY flush eyes with running water for at least 15 minutes, keeping eyelids open. COLD water may be used. Seek immediate medical attention.

Skin Contact : Flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Seek immediate medical attention.

Inhalation : Allow the victim to rest in a well ventilated area. If breathing is difficult, administer oxygen. If the victim is not breathing, perform artificial respiration. Seek immediate medical attention.

Ingestion : DO NOT induce vomiting. If the victim is conscious, give a little water or milk. NEVER give an unconscious person anything to ingest. Seek immediate medical attention.

Notes to Physician : Treat symptomatically and supportively. Amyl nitrite or sodium nitrite, although controversial, have been recommended as antidotes for hydrogen sulfide exposure by preventing severe anoxia.

Section 5. Fire fighting measures

Flammability of the product : Non-flammable.

Auto-ignition Temperature : Not applicable.

Flash Points : Not applicable.

Flammable limits : Not applicable.

Products of combustion : May emit toxic gases under fire conditions: sulphur oxides and disodium oxide. Contact with water and under fire conditions releases hydrogen sulfide.

Fire hazards in presence of various substances : Not applicable.

Explosion hazards in presence of various substances : Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.
Dust can combine with air to form an explosive mixture.

Fire fighting media and instructions : Use flooding quantities of water. Use water spray to cool fire exposed containers. Wear NIOSH approved self-contained breathing apparatus (SCBA) when either in confined areas or exposed to combustion products.

Section 6. Accidental release measures

Spill or leak : Use appropriate tools to put the spilled material in a convenient waste disposal container. Finish cleaning by spreading water on the contaminated surface and dispose of according to federal, provincial and municipal environmental control regulations.

Section 7. Handling and storage

Handling : Follow routine safe handling procedures. Avoid breathing dust.

Storage : Keep container tightly closed. Keep in a cool, dry and well ventilated place. Avoid dust generation. Store away from incompatible materials. Keep away from heat. Use corrosion resistant structural materials and lighting and ventilation systems in the storage area. Empty containers retain product residue and can be hazardous. Do not cut, weld, drill near containers.

Section 8. Exposure Controls, Personal Protection

Engineering controls : Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapours below their respective threshold limit value. Ensure that eye stations and safety showers are proximal to the work-station location.

Personal protection

Eyes : Splash goggles.

Body : Full suit.

Respiratory : If user operations generate dust, fume, mist or if workplace contaminant level is above threshold limit, ensure to use a MSHA/NIOSH approved respirator or equivalent.

Hands : Chemical resistant gloves.

Continued on next page

Feet	Chemical resistant boots.

Section 9. Physical and chemical properties

Physical State and Appearance	: Solid. (Flakes.) (Turns gray upon exposure to light and air.)
Color	: Yellow.
Odor	: Hydrogen sulfide.
Molecular formula	: $Na_2S.nH_2O$
Melting/freezing point	: 50°C (122°F)
Specific Gravity	: 1.427 (Water = 1) (@ 16°C)
Solubility	: Soluble in water: 18 g/100 ml water @ 25°C.

Section 10. Stability and reactivity

Stability and Reactivity	: The product is moderately stable.
Conditions of instability	: Aqueous solutions may slowly give off hydrogen sulfide gas.
Incompatibility with various substances	: Avoid water, heat and ignition sources. Reacts with acids, liberating extremely flammable and toxic hydrogen sulfide. Can react violently with oxidizing agents and form sulphur dioxide. Reacts explosively with diazonium salts and N,N-dichloromethyl amine. Reaction with carbon releases heat
Hazardous Decomposition Products	: Sulphur oxides and disodium oxide. Contact with water and under fire conditions releases hydrogen sulfide.
Hazardous polymerization	: Will not occur.

Section 11. Toxicological information

Toxicity data	: LD50: Not available. LC50: Not available.
Chronic effects on humans	: No additional information.
Other toxic effects on humans	: No additional information.
Remarks on toxicity to animals	: No additional information.

Section 12. Ecological information

Ecotoxicity data	: Harmful to aquatic organisms.
Remarks on the products of biodegradation	: No additional remark.

Section 13. Disposal considerations

Waste information	: Waste must be disposed of in accordance with federal, provincial and municipal environmental control regulations.
Waste stream	: Avoid entry of product into the sewage system or water streams.

Consult your local or regional authorities.

Section 14. Transport information

Regulatory Information	Shipping name and Class	UN number	Packing group
TDG Classification	SODIUM SULFIDE, HYDRATED Class 8	1849	II

Continued on next page

Section 15. Regulatory information

WHMIS (Canada) : CORROSIVE OR SEVERELY IRRITATING TO THE EYES, SKIN, RESPIRATORY OR GASTROINTESTINAL TRACT. HARMFUL IF INHALED OR SWALLOWED.
Class E: Corrosive solid.

DSL (CEPA) : CEPA DSL: All ingredients are listed or exempted.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations.

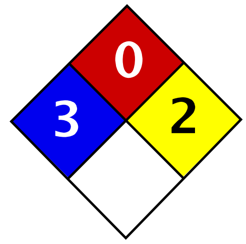
Section 16. Other information

References : Canadian Guide of the Law and Regulations of the Transportation of the Dangerous Goods.
Manufacturer's Material Safety Data Sheet.
This product has been classified in accordance with the hazard criteria of the Controlled Products Regulations and the MSDS contains all the information required by the Controlled Products Regulations.

Other special considerations : No additional remark.

Regulatory Affairs Department : (450) 424-0161

Science Lab.com
Chemicals & Laboratory Equipment



Health	3
Fire	0
Reactivity	2
Personal Protection	

Material Safety Data Sheet
Sulfuric acid MSDS

Section 1: Chemical Product and Company Identification

Product Name: Sulfuric acid

Catalog Codes: SLS2539, SLS1741, SLS3166, SLS2371, SLS3793

CAS#: 7664-93-9

RTECS: WS5600000

TSCA: TSCA 8(b) inventory: Sulfuric acid

CI#: Not applicable.

Synonym: Oil of Vitriol; Sulfuric Acid

Chemical Name: Hydrogen sulfate

Chemical Formula: H2-SO4

Contact Information:

Sciencelab.com, Inc.
14025 Smith Rd.
Houston, Texas 77396

US Sales: **1-800-901-7247**
International Sales: **1-281-441-4400**

Order Online: ScienceLab.com

CHEMTREC (24HR Emergency Telephone), call:
1-800-424-9300

International CHEMTREC, call: 1-703-527-3887

For non-emergency assistance, call: 1-281-441-4400

Section 2: Composition and Information on Ingredients

Composition:

Name	CAS #	% by Weight
Sulfuric acid	7664-93-9	95 - 98

Toxicological Data on Ingredients: Sulfuric acid: ORAL (LD50): Acute: 2140 mg/kg [Rat.]. VAPOR (LC50): Acute: 510 mg/m 2 hours [Rat]. 320 mg/m 2 hours [Mouse].

Section 3: Hazards Identification

Potential Acute Health Effects:
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (irritant, corrosive), of ingestion, of inhalation. Liquid or spray mist may produce tissue damage particularly on mucous membranes of eyes, mouth and respiratory tract. Skin contact may produce burns. Inhalation of the spray mist may produce severe irritation of respiratory tract, characterized by coughing, choking, or shortness of breath. Severe over-exposure can result in death. Inflammation of the eye is characterized by redness, watering, and itching. Skin inflammation is characterized by itching, scaling, reddening, or, occasionally, blistering.

Potential Chronic Health Effects:
CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH.
MUTAGENIC EFFECTS: Not available.
TERATOGENIC EFFECTS: Not available.

DEVELOPMENTAL TOXICITY: Not available.
The substance may be toxic to kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth. Repeated or prolonged exposure to the substance can produce target organs damage. Repeated or prolonged contact with spray mist may produce chronic eye irritation and severe skin irritation. Repeated or prolonged exposure to spray mist may produce respiratory tract irritation leading to frequent attacks of bronchial infection. Repeated exposure to a highly toxic material may produce general deterioration of health by an accumulation in one or many human organs.

Section 4: First Aid Measures

Eye Contact:
Check for and remove any contact lenses. In case of contact, immediately flush eyes with plenty of water for at least 15 minutes. Cold water may be used. Get medical attention immediately.

Skin Contact:
In case of contact, immediately flush skin with plenty of water for at least 15 minutes while removing contaminated clothing and shoes. Cover the irritated skin with an emollient. Cold water may be used.Wash clothing before reuse. Thoroughly clean shoes before reuse. Get medical attention immediately.

Serious Skin Contact:
Wash with a disinfectant soap and cover the contaminated skin with an anti-bacterial cream. Seek immediate medical attention.

Inhalation:
If inhaled, remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, give oxygen. Get medical attention immediately.

Serious Inhalation:
Evacuate the victim to a safe area as soon as possible. Loosen tight clothing such as a collar, tie, belt or waistband. If breathing is difficult, administer oxygen. If the victim is not breathing, perform mouth-to-mouth resuscitation. WARNING: It may be hazardous to the person providing aid to give mouth-to-mouth resuscitation when the inhaled material is toxic, infectious or corrosive. Seek immediate medical attention.

Ingestion:
Do NOT induce vomiting unless directed to do so by medical personnel. Never give anything by mouth to an unconscious person. Loosen tight clothing such as a collar, tie, belt or waistband. Get medical attention if symptoms appear.

Serious Ingestion: Not available.

Section 5: Fire and Explosion Data

Flammability of the Product: Non-flammable.

Auto-Ignition Temperature: Not applicable.

Flash Points: Not applicable.

Flammable Limits: Not applicable.

Products of Combustion:
Products of combustion are not available since material is non-flammable. However, products of decompostion include fumes of oxides of sulfur. Will react with water or steam to produce toxic and corrosive fumes. Reacts with carbonates to generate carbon dioxide gas. Reacts with cyanides and sulfides to form poisonous hydrogen cyanide and hydrogen sulfide respectively.

Fire Hazards in Presence of Various Substances: Combustible materials

Explosion Hazards in Presence of Various Substances:

Risks of explosion of the product in presence of mechanical impact: Not available.
Risks of explosion of the product in presence of static discharge: Not available.
Slightly explosive in presence of oxidizing materials.

Fire Fighting Media and Instructions: Not applicable.

Special Remarks on Fire Hazards:
Metal acetylides (Monocesium and Monorubidium), and carbides ignite with concentrated sulfuric acid.
White Phosphorous + boiling Sulfuric acid or its vapor ignites on contact.
May ignite other combustible materials.
May cause fire when sulfuric acid is mixed with Cyclopentadiene, cyclopentanone oxime, nitroaryl amines, hexalithium disilicide, phorphorous (III) oxide, and oxidizing agents such as chlorates, halogens, permanganates.

Special Remarks on Explosion Hazards:
M i x t u r e s o f s u l f u r i c a c i d a n d a n y o f t h e f o l l o w i n g c a n e x p l o d e : p - n i t r o t o l u e n e , p e n t a s i l v e r
trihydroxydiaminophosphate, perchlorates, alcohols with strong hydrogen peroxide, ammonium tetraperoxychromate, mercuric nitrite, potassium chlorate, potassium permanganate with potassium chloride, carbides, nitro compounds, nitrates, carbides, phosphorous, iodides, picratres, fulminats, dienes, alcohols (when heated)
Nitramide decomposes explosively on contact with concentrated sulfuric acid.
1,3,5-Trinitrosohexahydro-1,3,5-triazine + sulfuric acid causes explosive decompositon.

Section 6: Accidental Release Measures

Small Spill:
Dilute with water and mop up, or absorb with an inert dry material and place in an appropriate waste disposal container. If necessary: Neutralize the residue with a dilute solution of sodium carbonate.

Large Spill:
Corrosive liquid. Poisonous liquid.
Stop leak if without risk. Absorb with DRY earth, sand or other non-combustible material. Do not get water inside container. Do not touch spilled material. Use water spray curtain to divert vapor drift. Use water spray to reduce vapors. Prevent entry into sewers, basements or confined areas; dike if needed. Call for assistance on disposal. Neutralize the residue with a dilute solution of sodium carbonate. Be careful that the product is not present at a concentration level above TLV. Check TLV on the MSDS and with local authorities.

Section 7: Handling and Storage

Precautions:
Keep locked up.. Keep container dry. Do not ingest. Do not breathe gas/fumes/ vapor/spray. Never add water to this product. In case of insufficient ventilation, wear suitable respiratory equipment. If ingested, seek medical advice immediately and show the container or the label. Avoid contact with skin and eyes. Keep away from incompatibles such as oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.
May corrode metallic surfaces. Store in a metallic or coated fiberboard drum using a strong polyethylene inner package.

Storage:
Hygroscopic. Reacts. violently with water. Keep container tightly closed. Keep container in a cool, well-ventilated area. Do not store above 23°C (73.4°F).

Section 8: Exposure Controls/Personal Protection

Engineering Controls:
Provide exhaust ventilation or other engineering controls to keep the airborne concentrations of vapors below their respective threshold limit value. Ensure that eyewash stations and safety showers are proximal to the work-station location.

Personal Protection:
Face shield. Full suit. Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Gloves. Boots.

Personal Protection in Case of a Large Spill:
Splash goggles. Full suit. Vapor respirator. Boots. Gloves. A self contained breathing apparatus should be used to avoid inhalation of the product. Suggested protective clothing might not be sufficient; consult a specialist BEFORE handling this product.

Exposure Limits:
TWA: 1 STEL: 3 (mg/m3) [Australia] Inhalation
TWA: 1 (mg/m3) from OSHA (PEL) [United States] Inhalation
TWA: 1 STEL: 3 (mg/m3) from ACGIH (TLV) [United States] [1999] Inhalation
TWA: 1 (mg/m3) from NIOSH [United States] Inhalation
TWA: 1 (mg/m3) [United Kingdom (UK)]Consult local authorities for acceptable exposure limits.

Section 9: Physical and Chemical Properties

Physical state and appearance: Liquid. (Thick oily liquid.)

Odor: Odorless, but has a choking odor when hot.

Taste: Marked acid taste. (Strong.)

Molecular Weight: 98.08 g/mole

Color: Colorless.

pH (1% soln/water): Acidic.

Boiling Point:
270°C (518°F) - 340 deg. C
Decomposes at 340 deg. C

Melting Point: -35°C (-31°F) to 10.36 deg. C (93% to 100% purity)

Critical Temperature: Not available.

Specific Gravity: 1.84 (Water = 1)

Vapor Pressure: Not available.

Vapor Density: 3.4 (Air = 1)

Volatility: Not available.

Odor Threshold: Not available.

Water/Oil Dist. Coeff.: Not available.

Ionicity (in Water): Not available.

Dispersion Properties: See solubility in water.

Solubility:
Easily soluble in cold water.
Sulfuric is soluble in water with liberation of much heat.
Soluble in ethyl alcohol.

Section 10: Stability and Reactivity Data

Stability: The product is stable.

Instability Temperature: Not available.

Conditions of Instability:
Conditions to Avoid: Incompatible materials, excess heat, combustible material materials, organic materials, exposure to moist air or water, oxidizers, amines, bases.
Always add the acid to water, never the reverse.

Incompatibility with various substances:
Reactive with oxidizing agents, reducing agents, combustible materials, organic materials, metals, acids, alkalis, moisture.

Corrosivity:
Extremely corrosive in presence of aluminum, of copper, of stainless steel(316).
Highly corrosive in presence of stainless steel(304).
Non-corrosive in presence of glass.

Special Remarks on Reactivity:
Hygroscopic. Strong oxidizer. Reacts violently with water and alcohol especially when water is added to the product.
Incompatible (can react explosively or dangerously) with the following: ACETIC ACID, ACRYLIC ACID, AMMONIUM HYDROXIDE, CRESOL, CUMENE, DICHLOROETHYL ETHER, ETHYLENE CYANOHYDRIN, ETHYLENEIMINE, NITRIC ACID, 2-NITROPROPANE, PROPYLENE OXIDE, SULFOLANE, VINYLIDENE CHLORIDE, DIETHYLENE GLYCOL MONOMETHYL ETHER, ETHYL ACETATE, ETHYLENE CYANOHYDRIN, ETHYLENE GLYCOL MONOETHYL ETHER ACETATE, GLYOXAL, METHYL ETHYL KETONE, dehydrating agents, organic materials, moisture (water), Acetic anhydride, Acetone, cyanohydrin, Acetone+nitric acid, Acetone + potassium dichromate, Acetonitrile, Acrolein, Acrylonitrile, Acrylonitrile+water, Alcohols + hydrogen peroxide, ally compounds such as Allyl alcohol, and Allyl Chloride, 2-Aminoethanol, Ammonium hydroxide, Ammonium triperchromate, Aniline, Bromate + metals, Bromine pentafluoride, n-Butyraldehyde, Carbides, Cesium acetylene carbide, Chlorates, Cyclopentanone oxime, chlorinates, Chlorates + metals, Chlorine trifluoride, Chlorosulfonic acid, 2-cyano-4-nitrobenzenediazonium hydrogen sulfate, Cuprous nitride, p-chloronitrobenzene, 1,5-Dinitronaphthlene + sulfur, Diisobutylene, p-dimethylaminobenzaldehyde, 1,3-Diazidobenzene, Dimethylbenzylcarbinol + hydrogen peroxide, Epichlorohydrin, Ethyl alcohol + hydrogen peroxide, Ethylene diamine, Ethylene glycol and other glycols, , Ethylenimine, Fulminates, hydrogen peroxide, Hydrochloric acid, Hydrofluoric acid, Iodine heptafluoride, Indane + nitric acid, Iron, Isoprene, Lithium silicide, Mercuric nitride, Mesityl oxide, Mercury nitride, Metals (powdered), Nitromethane, Nitric acid + glycerides, p-Nitrotoluene, Pentasilver trihydroxydiaminophosphate, Perchlorates, Perchloric acid, Permanganates + benzene, 1-Phenyl-2-methylpropyl alcohol + hydrogen peroxide, Phosphorus, Phosphorus isocyanate, Picrates, Potassium tert-butoxide, Potassium chlorate, Potassium Permanganate and other permanganates, halogens, amines, Potassium Permanganate + Potassium chloride, Potassium Permanganate + water, Propiolactone (beta)-, Pyridine, Rubidium aceteylene carbide, Silver permanganate, Sodium, Sodium carbonate, sodium hydroxide, Steel, styrene monomer, toluene + nitric acid, Vinyl acetate, Thalium (I) azidodithiocarbonate, Zinc chlorate, Zinc Iodide, azides, carbonates, cyanides, sulfides, sulfites, alkali hydrides, carboxylic acid anhydrides, nitriles, olefinic organics, aqueous acids, cyclopentadiene, cyano-alcohols, metal acetylides,
Hydrogen gas is generated by the action of the acid on most metals (i.e. lead, copper, tin, zinc, aluminum, etc.).
Concentrated sulfuric acid oxidizes, dehydrates, or sulfonates most organic compounds.

Special Remarks on Corrosivity:
Non-corrosive to lead and mild steel, but dillute acid attacks most metals.
Attacks many metals releasing hydrogen.
Minor corrosive effect on bronze.
No corrosion data on brass or zinc.

Polymerization: Will not occur.

Section 11: Toxicological Information

Routes of Entry: Absorbed through skin. Dermal contact. Eye contact. Inhalation. Ingestion.

Toxicity to Animals:
WARNING: THE LC50 VALUES HEREUNDER ARE ESTIMATED ON THE BASIS OF A 4-HOUR EXPOSURE.
Acute oral toxicity (LD50): 2140 mg/kg [Rat.].
Acute toxicity of the vapor (LC50): 320 mg/m3 2 hours [Mouse].

Chronic Effects on Humans:
CARCINOGENIC EFFECTS: Classified 1 (Proven for human.) by IARC, + (Proven.) by OSHA. Classified A2 (Suspected for human.) by ACGIH.
May cause damage to the following organs: kidneys, lungs, heart, cardiovascular system, upper respiratory tract, eyes, teeth.

Other Toxic Effects on Humans:
Extremely hazardous in case of inhalation (lung corrosive).
Very hazardous in case of skin contact (corrosive, irritant, permeator), of eye contact (corrosive), of ingestion, .

Special Remarks on Toxicity to Animals: Not available.

Special Remarks on Chronic Effects on Humans:
Mutagenicity: Cytogenetic Analysis: Hamster, ovary = 4mmol/L
Reproductive effects: May cause adverse reproductive effects based on animal data. Developmental abnormalities (musculoskeletal) in rabbits at a dose of 20 mg/m3 for 7 hrs.(RTECS)
Teratogenecity: neither embryotoxic, fetoxic, nor teratogenetic in mice or rabbits at inhaled doses producing some maternal toxicity

Special Remarks on other Toxic Effects on Humans:
Acute Potential Health Effects:
Skin: Causes severe skin irritation and burns. Continued contact can cause tissue necrosis.
Eye: Causes severe eye irritation and burns. May cause irreversible eye injury.
Ingestion: Harmful if swallowed. May cause permanent damage to the digestive tract. Causes gastrointestial tract burns. May cause perforation of the stomach, GI bleeding, edema of the glottis, necrosis and scarring, and sudden circulatory collapse(similar to acute inhalation). It may also cause systemic toxicity with acidosis.
Inhalation: May cause severe irritation of the respiratory tract and mucous membranes with sore throat, coughing, shortness of breath, and delayed lung edema. Causes chemical burns to the repiratory tract. Inhalation may be fatal as a result of spasm, inflammation, edema of the larynx and bronchi, chemical pneumonitis, and pulmonary edema. Cause corrosive action on mucous membranes. May affect cardiovascular system (hypotension, depressed cardiac output, bradycardia). Circulatory collapse with clammy skin, weak and rapid pulse, shallow respiration, and scanty urine may follow. Circulatory shock is often the immediate cause of death. May also affect teeth(changes in teeth and supporting structures - erosion, discoloration).
Chronic Potential Health Effects:
Inhalation: Prolonged or repeated inhalation may affect behavior (muscle contraction or spasticity), urinary system (kidney damage), and cardiovascular system, heart (ischemic heart leisons), and respiratory system/lungs(pulmonary edema, lung damage), teeth (dental discoloration, erosion).
Skin: Prolonged or repeated skin contact may cause dermatitis, an allergic skin reaction.

Section 12: Ecological Information

Ecotoxicity: Ecotoxicity in water (LC50): 49 mg/l 48 hours [bluegill/sunfish].

BOD5 and COD: Not available.

Products of Biodegradation:
Possibly hazardous short term degradation products are not likely. However, long term degradation products may arise.

Toxicity of the Products of Biodegradation: The products of degradation are less toxic than the product itself.

Special Remarks on the Products of Biodegradation: Not available.

Section 13: Disposal Considerations

Waste Disposal:
Sulfuric acid may be placed in sealed container or absorbed in vermiculite, dry sand, earth, or a similar material. It may also be diluted and neutralized. Be sure to consult with local or regional authorities (waste regulators) prior to any disposal. Waste must be disposed of in accordance with federal, state and local environmental control regulations.

Section 14: Transport Information

DOT Classification: Class 8: Corrosive material

Identification: : Sulfuric acid UNNA: 1830 PG: II

Special Provisions for Transport: Not available.

Section 15: Other Regulatory Information

Federal and State Regulations:
Illinois toxic substances disclosure to employee act: Sulfuric acid
New York release reporting list: Sulfuric acid
Rhode Island RTK hazardous substances: Sulfuric acid
Pennsylvania RTK: Sulfuric acid
Minnesota: Sulfuric acid
Massachusetts RTK: Sulfuric acid
New Jersey: Sulfuric acid
California Director's List of Hazardous Substances (8 CCR 339): Sulfuric acid
Tennessee RTK: Sulfuric acid
TSCA 8(b) inventory: Sulfuric acid
SARA 302/304/311/312 extremely hazardous substances: Sulfuric acid
SARA 313 toxic chemical notification and release reporting: Sulfuric acid
CERCLA: Hazardous substances.: Sulfuric acid: 1000 lbs. (453.6 kg)

Other Regulations:
OSHA: Hazardous by definition of Hazard Communication Standard (29 CFR 1910.1200).
EINECS: This product is on the European Inventory of Existing Commercial Chemical Substances.

Other Classifications:

WHMIS (Canada):
CLASS D-1A: Material causing immediate and serious toxic effects (VERY TOXIC).
CLASS E: Corrosive liquid.

DSCL (EEC):
R35- Causes severe burns.
S2- Keep out of the reach of children.
S26- In case of contact with eyes, rinse immediately with plenty of water and seek medical advice.
S30- Never add water to this product.
S45- In case of accident or if you feel unwell, seek medical advice immediately (show the label where possible).

HMIS (U.S.A.):

Health Hazard: 3

Fire Hazard: 0

Reactivity: 2

Personal Protection:

National Fire Protection Association (U.S.A.):

Health: 3

Flammability: 0

Reactivity: 2

Specific hazard:

Protective Equipment:
Gloves.
Full suit.
Vapor respirator. Be sure to use an approved/certified respirator or equivalent. Wear appropriate respirator when ventilation is inadequate.
Face shield.

Section 16: Other Information

References:

-Material safety data sheet emitted by: la Commission de la Santé et de la Sécurité du Travail du Québec.
-The Sigma-Aldrich Library of Chemical Safety Data, Edition II.
-Hawley, G.G.. The Condensed Chemical Dictionary, 11e ed., New York N.Y., Van Nostrand Reinold, 1987.

Other Special Considerations: Not available.

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