Aboriginal Affairs and Northern Development Canada
Affaires autochtones et Développement du Nord Canada

PO Box 1500
Yellowknife, NT
X1A 2R3

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MVEIRB File Number: EA 0809-002

Mr. Chuck Hubert
Environmental Assessment Officer
Mackenzie Valley Environmental Impact Review Board
P.O. Box 938
YELLOWKNIFE NT, X1A 2N7
FAX: 766-7074

VIA EMAIL: chubert@reviewboard.ca

Re: AANDC Closing Arguments - Canadian Zinc Corporation Proposed Prairie Creek Mine – EA0809-002

Aboriginal Affairs and Northern Development Canada (AANDC) is pleased to submit the attached closing comments to the Mackenzie Valley Environmental Impact Review Board (Review Board) on the proposed Canadian Zinc Corporation Prairie Creek Mine (EA0809-002). AANDC would like to acknowledge the contributions of Brodie Consulting Limited and Zajdlik and Associates in the preparation of these closing arguments.

These closing arguments are based on the information received between April 6, 2009 and September 2 2011; this includes the Developer's Assessment Report (DAR), addendums to the DAR, responses to Information Requests, and information presented and provided during and following the two Technical Sessions and the Community and Public Hearings hosted by the Review Board. AANDC notes all information reviewed is contained on the Review Board's public registry.

If you have any questions about this technical report, please do not hesitate to contact Krystal Thompson by phone at (867) 669-2595 or via email krystal.thompson@aandc.gc.ca or Robert Jenkins at (867) 669-2574 or robert.jenkins@aandc.gc.ca.

Sincerely,

Teresa Joudrie
Director
Renewable Resources and Environment

Canada

ABORIGINAL AFFAIRS AND NORTHERN DEVELOPMENT CANADA

CLOSING ARGUMENTS

for

CANADIAN ZINC CORPORATION
PROPOSED PRAIRIE CREEK MINE
EA0809-002

September 13, 2011

ACRONYMS

Aboriginal Affairs and Northern Development Canada	AANDC
Aquatic Effects Monitoring Program	AEMP
Canadian Zinc Corporation	CZN
Canadian Council of Ministers of the Environment	CCME
Closure and Reclamation Plan	CRP
Deh Cho First nation	DCFN
Dense Media Separation	DMS
Developer's Assessment Report	DAR
Ecological Risk Assessment	ERA
Environmental Assessment	EA
Environmental Effects Monitoring	EEM
Effluent Quality Criteria	EQC
Government of the Northwest Territories	GNWT
Initial Dilution Zone	IDZ
Mackenzie Valley Environmental Impact Review Board	MVEIRB
Mackenzie Valley Land and Water Board	MVLWB
Mackenzie Valley Resource Management Act	MVRMA
Metal Mining Effluent Regulations	MMER
Naha Dehe Dene Band	NDDB
Nahanni National Park Reserve	NNPR
Northwest Territories	NWT
Northwest Territories Waters Act	NWTWA

Reference Condition Approach	RCA
Site Specific Water Quality Objectives	SSWQO
Surveillance Network Program	SNP
United States Environmental Protection Agency	USEPA
Waste Rock Pile	WRP
Water Storage Pond	WSP

Introduction

The Mackenzie Valley Environmental Impact Review Board (Review Board) requested written closing arguments from parties prior to the closure of the public record for EA0809-002. Aboriginal Affairs and Northern Development (AANDC) provides this submission in response to the Review Board's request.

With the exception of AANDC's recommendations on water management and storage, site specific water quality objectives and tailings disposal, to which we will provide additional clarity and rationale herein, all recommendations presented by AANDC in our June 3, 2011 Technical Report and at the public hearings held from June 22 to 24, 2011 remain as stated. AANDC has not received any concerns from the Developer or other parties to the Environmental Assessment (EA) in regards to these recommendations and as such, respectfully submits that these recommendations be placed as measures within the Review Board's report of EA. A complete list of AANDC recommendations is provided in Appendix A.

AANDC's closing arguments for EA0809-002 focus on current recommendations with respect to water management and storage, site-specific water quality objectives (SSWQOs), and tailings disposal. These issues were the focus of much debate at the June public hearings. Differences in opinion remained at the close of the public hearings, however AANDC and the Developer committed to continue dialogue in an attempt to resolve issues prior to the close of the public record.

AANDC has discussed these issues with the Developer, Parks Canada, Environment Canada, and representatives of the Naha Dehe Dene Band (NDDB) and Deh Cho First Nations (DCFN) through formal and informal meetings and communications held since the Public Hearing.

Further, work has commenced to begin addressing outstanding concerns regarding onsite water management and storage and the derivation of acceptable SSWQOs including:

- Discussions regarding information required to develop a defensible reference condition for Prairie Creek including collection of water samples for analysis using ultra-low detection limits for mercury.
- "Desk Study of Water Treatment Options Report" submitted to the Review Board by the Developer on September 2, 2011.
- Clarification of what the community of Nahanni Butte expects regarding the level of effluent treatment.
- Developer commitment to develop increased water storage capacity as described in an August 3, 2011 submission "Possible Project Modifications Related to Water Quality Objectives" (Golder Associates, 2011).

- Discussions regarding what would be required to complete an acceptable site- specific ecological risk assessment (ERA).
- Discussions regarding when site-specific ERAs are appropriate.
- Clarification regarding the current traditional use of Prairie Creek by the NDDB, and expectations regarding what changes to current use would be acceptable, and more importantly unacceptable, to the NDDB and DCFN.

Similarly, additional work towards resolving differences over tailings backfill and temporary tailings storage in the Water Storage Pond (WSP) was conducted, including:

- Discussions between AANDC and the Developer regarding the proposed backfill plan.
- "Paste Backfill Review" submitted to the Review Board by the Developer on September 2, 2011.

Significant progress was made during these discussions, and AANDC is pleased with the recent efforts made by the Developer. Although progress has been achieved, some differences in opinion continue to remain. AANDC's closing arguments clarify the departmental position on any outstanding items.

AANDC's proposed SSWQO process involves work by a number of parties following the close of the public record for EA0809-002, and AANDC looks forward to continuing to work with the Developer towards resolution of the remaining issues.

Water Management and Storage

Adequate water storage is a key component of the Developer's strategy for meeting SSWQOs in Prairie Creek. In AANDC's opinion, the available operating storage volume within the WSP, as proposed in the DAR, is not likely to provide adequate contingency to accommodate variations in mine inflows, variations in Prairie Creek flows, treatment plant upsets, or a combination of the above. Furthermore, the Developer has proposed the temporary storage of float tailings in the water storage pond during the first five years of operation, which will reduce the capacity of the water storage pond during this period.

AANDC raised concerns during the public hearings in regards to the Developer's ability to maintain the overall water balance in the event of operational upsets. The Developer's response to queries regarding contingencies, in the event of water management difficulties (e.g., pump failures, exfiltration pipe issues, treatment plant offline, etc.) is that more water will be stored in the WSP. Depending on the nature, timing and frequency of the above noted operational upsets over the year, the entire contingency volume could be exceeded during the following winter low discharge period. In addition, the volume of discharge during the winter may be restricted in order

to meet SSWQOs during winter low flow conditions in Prairie Creek, increasing the risk that the contingency volume could be exceeded.

On August 3, 2011, the Developer provided an evaluation of options for additional water storage at the Prairie Creek Mine site. The document discussed two options, specifically, enhancing the existing water storage pond and constructing a second pond.

The Developer stated that:

> *"There would be an incremental beneficial impact in that the additional storage capacity should allay concerns related to sufficient storage space to contain water during plant upsets and other unforeseen events, and the additional capacity may also lead to more stringent and achievable water quality objectives."*
>
> and;
>
> *"The beneficial impacts of the additional storage capacity that a second WSP would provide would be the same as for an expanded (first) WSP, except that these impacts would be magnified because of the considerably greater storage volume."*

On August 21, 2011, the Developer provided additional information, in response to Parks Canada's request for ruling on this subject, stating:

> *"We wish to advise that it is CZN's intention to adopt one of the two additional water storage options, and we will be making a commitment to this effect."*
>
> and:
>
> *"However, we cannot say which of the options will be adopted at this time because the decision depends on final SSWQO's and water storage requirements, and on the results of detailed geotechnical investigation and design which is required to confirm the suitability and stability of the structures involved."*

AANDC was pleased that the Developer was willing to address its concerns in regards to water storage capacity and concurs that additional water storage should provide an ability to achieve more stringent water quality objectives.

The following recommendations are provided regarding water management and storage. AANDC requests that the Review Board include these recommendations as measures within the Report of EA:

1. ***The Water Storage Pond must be operated such that the water level does not impinge on the 1 m freeboard level. The freeboard must be reserved for short-term emergency situations. (Consistent with Recommendation WM&S 2 at June 24, 2011 Public Hearing)***

2. ***Final selection of an additional water storage option must be done in conjunction with the determination of Site Specific Water Quality Objectives for Prairie Creek. If increased capacity associated with construction of an additional pond provides for the ability to meet Reference Condition Approach benchmarks as defined within the derivation process, that option must be selected and implemented. (Updated from Public Hearing)***

3. ***Enhancements to the existing pond or construction of a second pond must be conducted in accordance with Canadian Dam Safety guidelines, or equivalent standards at the time of construction. Monitoring wells must be installed to confirm the integrity of the water storage pond(s). Should a second pond be built, a double liner system must be included within the construction design. (Updated from Public Hearing)***

Site Specific Water Quality Objectives

Rationale for Proposed Derivation Methodology

AANDC feels it is critical to outline the extreme importance of establishing SSWQOs for Prairie Creek from mine related discharges. SSWQOs are the "Standard for Water" which should be maintained in order to preserve the present and future integrity of an aquatic ecosystem. Derivation of SSWQOs for receiving water need to consider both environmental and social factors that may include, but not be limited to:

- Natural background concentrations.
- Toxicity of analytes being released.
- Buffering and dilution capacity.
- Chemical characteristics that modify toxicity (such as hardness, pH, organic matter, etc.).
- Biological characteristics (such as food web diversity or protecting a species at risk).
- Existing human use of the water (such as for drinking or fishing).

These factors determine if, how, and to what extent the receiving water can accept contaminants. SSWQOs are typically set for a waterbody with the expectation that they

will be achieved at a downstream “assessment boundary” located at the edge of the mixing zone, otherwise referred to as an “initial dilution zone.” A schematic of this concept is provided as Appendix B.

SSWQOs are typically not points of regulatory control since they apply to a receiving environment that is subject to influences outside a discharger’s control. However, SSWQOs are used to set Effluent Quality Criteria (EQC), which are the regulatory control points, as effluent quality is fully under the control of the discharger (i.e. end of pipe limits).

EQCs typically allow for dilution of the effluent stream with the receiving environment in order to bring the concentrations of parameters down to SSWQOs at the edge of the initial dilution zone. AANDC notes that environmental standards and regulations legally prohibit effluent at the end of a discharge pipe from being acutely toxic to aquatic organisms (i.e. cause death within a relatively short period of time). It is typically expected that the effluent and receiving waters will mix such that SSWQOs are achieved at the end of the mixing zone. Therefore, if a company is meeting their EQCs, then in principle, the downstream SSWQOs should also always be met. AANDC acknowledges that setting EQCs is a regulatory requirement; however, the process requires that at a minimum the accepted level of water quality downstream from a discharge be determined as part of the EA phase. It is for this reason that AANDC is recommending a process be written into this assessment to determine acceptable SSWQOs for Prairie Creek. The accepted SSWQOs will be used in the regulatory phase to estimate EQCs.

Relevant NWT policy documents such as the Mackenzie Valley Land and Water Board Water and Effluent Quality Management Policy (WEQMP), March 31 2011, were developed in accordance with the concept presented above. The policy outlines the anticipated method to calculate appropriate and justified EQCs.

AANDC continues to maintain that SSWQOs derived using the Reference Condition Approach (RCA), or in other words, not exceeding an upper limit of natural variability, will afford the most appropriate level of environmental protection to Prairie Creek and will mitigate impacts to the aquatic environment from the proposed development. More detailed rationale for this position is described within AANDC’s June 3, 2011 Technical Report.

The Developer criticized AANDC throughout the process for advocating derivation of SSWQOs using the RCA as an appropriate starting point. The Developer has stated their belief that such an approach corresponds to a more stringent discharge standard than other currently operating mines, by requiring “no change” in the receiving environment. AANDC must clarify for the Review Board that its approach as presented during the public hearings and further refined in the discussion below and in Appendix

C, is to use the reference condition as an appropriate starting point upon which to base downstream water quality objectives. Such an approach aligns with the concept of non-degradation, or maintaining receiving water quality at existing background levels, which is articulated in government policies at a territorial, national and international level. AANDC's proposed approach would simply bring these existing government policies, as well as industry position statements, into practice.

The following quotations reinforce this point:

> *"Waters that flow into, within or through the NWT are substantially unaltered in quality, quantity and rates of flow." – Goal of the NWT Water Stewardship Strategy* (AANDC and GNWT, 2010)
>
> *"For waters of superior quality or that support valuable biological resources, the CCME non-degradation policy states that the degradation of the existing water quality should always be avoided."* (CCME, 1999)
>
> *"All possible steps will be taken to ensure that existing operations in World Heritage properties as well as existing and future operations adjacent to World Heritage properties are not incompatible with the outstanding universal value for which these properties are listed and do not put the integrity of these properties at risk"* (ICMM, 2003)
>
> *"MAC member companies undertake not to explore or develop mines in World Heritage sites. All possible steps will be taken to ensure that pre-existing operations in World Heritage sites as well as existing and future operations adjacent to World Heritage sites are compatible and co-exist with biodiversity goals."* (MAC, 2007)

AANDC would also like to reinforce that setting SSWQOs for the project using the RCA does not represent a "no change in the aquatic environment" approach. Within an aquatic ecosystem, natural variability will result in a range of observed parameter concentrations over time. In other words, water quality naturally fluctuates within a range. This "range" is the natural background condition.

SSWQOs set at reference conditions values would permit concentrations to be at the high end of the natural range and remain there at all times, for the entire duration of the operation. This means that at some times, downstream reference condition SSWQOs may have higher concentrations than that of water located upstream of the mine (i.e. background). This will likely cause shifts in the natural condition and the composition and abundance of native species and biological communities within Prairie Creek, but the changes should not comprise significant adverse effects. Using the reference condition as a starting point will provide a high degree of confidence that significant

adverse impacts from mine discharges to Prairie Creek have been mitigated against. Higher SSWQOs derived using other methods such as ERA will provide a lower degree of confidence that significant adverse impacts from mine discharges to Prairie creek have been mitigated against.

AANDC believes that the Developer has two primary means available for meeting RCA based SSWQOs: increasing water storage capacity and improving the level of treatment. The Developer has committed to increasing water storage capacity, and the Desk Study of Water Treatment Options Report identifies available, proven technologies that can produce higher quality effluent. Pilot testing of technologies is proposed, but the Developer has not provided a formal commitment to implement enhanced treatment, even in the event that pilot testing was successful and reference condition based SSWQOs could be technically and economically achieved.

Both the NDDB and the DCFN have stated on the public record that improving effluent quality is a priority. Treating effluent to the best available standard, also known as using Best Available Treatment Technologies (BATT) is consistent with existing guidance on water use in the NWT and mining industry publications, as identified within the excepts below:

> *"Residents of the NWT have expressed a desire to lead in the area of water stewardship. This means setting high standards to hold residents and others responsible and accountable." (AANDC and GNWT, 2010, Section 1.3, pg 9)*
>
> "*Pollution Prevention: The use of processes, practices, materials, products, or energy that avoid or minimize the creation of pollutants and waste and reduce overall risk to human health and the environment." (MVLWB, 2011, Guiding Principle of WEQMP)*
>
> *"The Boards expects Developers to identify and implement waste prevention and/or minimization measures, <u>whenever feasible</u>."* (Underlining added, MVLWB, 2011).
>
> *"Note that in accordance with the Boards' objective to minimize waste discharge, proponents are expected to minimize and, where feasible, to prevent waste from entering water in the NWT. Therefore, and consistent with the CCME nondegradation policy, the Boards may set EQC that are more stringent than what is necessary to meet water quality standards in the receiving environment." (*MVLWB, 2011)

As well, the use of BATT to achieve a high standard for water quality aligns with the Developer's vision for development of the Prairie Creek Mine:

> *"CZN has every intention of operating the Prairie Creek Mine with best available technology and environmental protection so that the temporary impact on the environment during operations are minimal, and long term effects after closure will be negligible." (Underlining added, CZN, 2011a)*

Further, the Developer has also adopted the Mining Association of Canada's "Towards Sustainable Mining Guiding Principles", which include a commitment to:

> *"Practicing continuous improvement through the application of new technology, innovation and best practices in all facets of our operations." (Underlining added, CZN, 2011b)*

In light of the information contained within the Developer's Desk Study of Water Treatment Options Report and in accordance with guidance from policies, the NDDB, the DCFN and industry intentions, AANDC recommends that should reference condition derived SSWQOs be readily achievable following pilot testing of acceptable treatment options, those values should be adopted as SSWQOs for Prairie Creek. In AANDC's view, this would be a responsible and natural next step following this analysis.

AANDC does recognize that following an analysis of practical water treatment options that all SSWQOs based upon the reference condition may still not be achievable. Only for those parameters remaining will AANDC support the use of site-specific ERAs to determine acceptable deviations from the reference condition.

The CCME provides several definitions of ERA, including:

> *The process that evaluates the likelihood that adverse ecological effects may occur or are occurring as a result of exposure to one or more stressors. (CCME, 1996)*

Assessment endpoints, otherwise known as measurement endpoints must be clearly stated within the ERA. The CCME defines an assessment endpoint as:

> *The characteristic of the ecological system that is the focus of the risk assessment. (CCME, 1996)*

The USEPA provides a similar definition, but with additional clarity:

> *An explicit expression of the environmental value that is to be protected, operationally defined by an ecological entity and its attributes. For example, salmon are valued ecological entities; reproduction and age class structure are some of their important attributes.Together "salmon reproduction and age class structure" form an assessment endpoint. (USEPA, 1998)*

Conducting an ERA will provide a level of confidence that the measurement endpoint is not being adversely affected from a potential stressor such as mine effluent. The level of confidence in the risk assessment is dependent on the data that is available to conduct the assessment and adherence to best risk assessment practices.

AANDC will only support ERAs for parameters for which reference condition SSWQOs are not achievable through the implementation of practical water treatment options. ERAs will provide a level of confidence that measurement endpoints are being protected; however, ERAs leading to SSWQOs higher than RCA based SSWQOs will not provide the same level of confidence that ecological integrity is being maintained as compared to reference condition based SSWQOs.

This is why the AANDC proposed SSWQO derivation process does not allow ecological risk assessments to be conducted until use of best available technology has been demonstrated impractical.

Recommended Process to Derive Water Quality Objectives

At the public hearings in June, AANDC presented its position with respect to the establishment of SSWQOs for Prairie Creek, as follows:

- ***AANDC recommends that the Developer be required to establish and present Site Specific Water Quality Objectives (SSWQOs) for the Prairie Creek Mine using the Reference Condition Approach consistently across all parameters. A committee consisting of the Developer and interested parties to the Environmental Assessment will evaluate the appropriateness and practicality of these generated SSWQOs. The committee will report back to the Review Board with a recommendation on appropriate SSWQOs for Prairie Creek, prior to the Review Board's closure of the public registry for EA0809-002.***

Following the June public hearings, the Review Board directed the parties to submit recommendations with respect to a path forward for the determination of SSWQOs for the Prairie Creek mine, by July 4, 2011. AANDC and the Developer worked to develop a process for establishing appropriate SSWQOs. Agreement was reached on many components of a potential process, and the proposed process was submitted to the Review Board, with any differences of opinion between AANDC and the Developer indicated. On July 15, 2011, the Review Board opted not to adopt a formal SSWQO derivation process for completion during the EA but encouraged parties to continue working together to resolve the matter.

AANDC has updated our proposed process towards the development of RCA based

SSWQOs, and provided an alternative process to derive acceptable SSWQOs for those parameters which cannot practically achieve RCA benchmarks. AANDC insists that this process be consistent with best management practices and water policy statements. An updated copy of the process, which includes recognition of what can be achieved prior to the close of the public record, is included in Appendix C. The AANDC process can be summarized as follows:

1. Can RCA based SSWQO's be met using the existing treatment scheme? *Yes or No* (Steps 1 to 6 in the AANDC process).
2. Can additional operational measures, such as additional storage or enhanced treatment, be feasibly implemented such that RCA based SSWQO's can be met? *Yes or No* (Steps 7 to 10 in the AANDC process).
3. For any parameters that answer "No" for both of the above questions, conduct a site specific ERA against an acceptable level of change. Adopt the results of these ERAs as the SSWQOs for Prairie Creek if they are equal to or fall between the reference condition and an accepted water quality guideline such as the CCME water quality guidelines (Steps 11 to 13 in the AANDC process).
4. Finalize all SSWQOs and back-calculate corresponding EQCs (Step 14).

Of fundamental importance to this process are the ERAs that need to be conducted for parameters that cannot practically achieve the RCA limit. AANDC has taken steps to identify statements of the limits of acceptable change from the development.

AANDC derived assessment endpoints to frame ERAs through discussions with NDDB, DCFN, Parks Canada and Environment Canada. Specifically, AANDC requested input regarding the existing condition and use of Prairie Creek and what would be considered unacceptable change. The discussions included consideration of both the specific condition or activity and the corresponding location within the Prairie Creek receiving environment and resulted in the identification of a number of conditions that should be preserved within Prairie Creek. These include:

- Grayling catch per unit effort (CPUE) at the mouth of Prairie Creek decrease from current CPUE as a result of mine operations.

- Edible tissue Hg concentrations in grayling collected at the mouth of Prairie Creek increase from current concentrations

- Analytes released by the mine either singly or in combination exceed the lowest of any behavioural or chronic toxicology IC/EC_{10} for bull trout.

- Hg fish tissue residues exceed the CCME mammalian tissue residue guideline for protection of wildlife consumers of aquatic biota (0.092 ug MeHg/g ww) in any fish species resident in or transiting Prairie Creek to the mouth of Prairie Creek.

Details regarding these consensus-based assessment endpoints and other assessment endpoints currently suggested by AANDC alone are presented in Appendix D.

Information on the current state of these endpoints will be required in order to provide a baseline from which to measure change. This information should be collected as soon as possible and must be collected prior to discharge in order to determine if the mine or other processes such as aerial deposition are responsible for any changes noted. This includes non-lethal fish tissue assessments and estimation of the CPUE for arctic grayling by enquiring with local Aboriginal anglers and gathering traditional community knowledge. These CPUEs can then be used as a baseline for project effects monitoring. AANDC also requires the Developer to continue its current monitoring program and include winter sampling using ultra-low detection limits.

AANDC notes other federal departments and interested parties may provide additional conditions. AANDC believes that additional conditions could be included, so long as they afford the same level of protection as provided by AANDC consensus-driven assessment endpoints.

The following recommendations are provided regarding SSWQOs. AANDC requests that the Review Board include these recommendations as measures within the Report of EA:

1. ***AANDC recommends that the Developer be required to establish and present Site Specific Water Quality Objectives for the Prairie Creek Mine, prior to the licensing phase, using the process defined within Appendix C. (Updated from Public Hearing)***

2. ***AANDC recommends that if, following pilot testing per the recommendations in the Developer's Desktop Study of Water Treatment Options, it is identified that Reference Condition Approach based Site Specific Water Quality Objectives can be readily achieved, then that treatment option(s) must be implemented during operations. (Updated from Public Hearing)***

3. ***AANDC recommends that any ecological risk assessments conducted in accordance with the Site Specific Water Quality Objectives process follow the Terms of Reference as provided in Appendix D. (Updated from Public Hearing)***

4. ***AANDC recommends that Effluent Quality Criteria (i.e. Maximum Grab Concentrations) must be back calculated from Site Specific Water Quality Objectives based on the Developer's best estimate inflow prediction. (Consistent with Recommendation SSWQO/EQC #2, at June 24, 2011 Public Hearing)***

5. ***AANDC recommends that CZN must not discharge effluent that has concentration(s) above the stipulated Maximum Grab Concentrations in the Water Licence. (Consistent with Recommendation SSWQO/EQC #3, at June 24, 2011 Public Hearing)***

6. ***AANDC recommends that any discharge from the end-of-pipe must meet the Maximum Average Concentrations as stipulated by the Surveillance Network Program in the Water Licence. Detailed instructions on the method and timing for sampling, deriving and reporting regulated average concentrations should be specifically outlined within the SNP. (Consistent with Recommendation SSWQO/EQC #4, at June 24, 2011 Public Hearing)***

7. ***AANDC recommends that any discharge must meet all other applicable federal and territorial Regulations at the end of pipe. (Updated from Public Hearing)***

Tailings Disposal

The mine development plan for the Prairie Creek mine is to have no tailings on surface after mine closure. The Developer has proposed to place all flotation tailings underground as paste backfill, thereby avoiding the requirement for an engineered tailings disposal location on the surface. In the early stages of mine development, 50,000 m^3 of float tailings would be stored in the water storage pond, but the Developer has committed to returning this material to the underground, as paste backfill, at the end of mine life.

AANDC and its retained consultant, Brodie Consulting Limited (BCL), have raised concerns since the information request phase of the EA, in regards to:

1. The quantity of tailings which is to be stored in the WSP during operations. This is of concern to AANDC as the storage of tailings reduces the capacity of the WSP to facilitate acceptable water quality and timing of the discharge of mine water to the environment.
2. The quantity of tailings which may remain on surface at the end of operations. This is an important issue as the EA of the Prairie Creek mine is based upon the premise that no tailings will remain on surface after mine closure. Surface storage options post-closure have not been assessed as a part of this EA.

The Developer's paste backfill plan was based upon the premise of 100% backfilling of development voids. Within its technical report, AANDC raised concerns that the

assumptions required to achieve 100% placement of tailings are not practically feasible for the following reasons:

1. The assumptions require 100% filling of voids, which is theoretically possible but likely difficult to achieve in practice.
2. The assumptions require that all paste be placed at the maximum achievable density. Upset conditions may require that some backfill be placed as conventional slurry tailings, which will significantly reduce backfill density.
3. Cost saving measures may lead to increased use of dense media separation (DMS) material in paste to reduce cement requirements over the life of mine.
4. Cost saving measures may lead to placement of development waste in stopes (as backfill in lieu of much more costly paste backfill).

Based upon the information provided by the Developer, BCL calculated that approximately 230,000 m^3 of tailings could require surface storage towards the end of mining operations.

Following the public hearings, additional information was provided by the Developer to the Review Board. BCL provided a subsequent review of this information for AANDC on August 8, 2011(Appendix E). In this document, BCL stated that a number of variations can be debated about the management of DMS and flotation tailings at the Prairie Creek Mine site. Two broad scenarios can be envisioned which describe the limits of tailings management:

> "*In one scenario, only flotation tailings could be directed underground; in which it could all be contained in the mined out stopes. This would leave a small void space in the mine to be filled with DMS tailings and the remaining DMS tailings would go to the rock pile on surface.*
>
> *The other scenario would be to place a blend of cemented DMS and flotation tailings in the mine in a way which gives the most efficient and least costly mining method. In the Dec 2009 GAL paste tailings report, this was identified as occurring with a mass ratio of flotation to DMS tailings of 2.8 : 1. In this case the void space for 2, 847,569 tonnes of blended tailings would accept 2,098,209 tonnes of flotation tailings and 749,360 tonnes of DMS tailings. In this case there would be 407,791 tonnes of flotation tailings on surface at the end of mining."*

The BCL report went on to conclude:

1. *The void space in the mine (during operations) has capacity for 2,847,569 tonnes of tailings.*
2. *The total mass of tailings to be produced is 3,710,000 tonnes (1,204,000 tonnes DMS and 2,506,000 tonnes flotation).*

3. *The most efficient and cost effective mine operation will leave up to 408,000 tonnes of flotation tailings on surface (in the WSP) at the end of operations.*
4. *Operational up-set conditions and/or disposal of development waste rock in the stopes will increase the amount of tailings on surface. Both of these are likely to occur.*

Subsequently, a conference call was held on August 19, 2011 between AANDC and the Developer to discuss a further the Developer's response to the August 9, 2011 BCL memo. At this meeting, the Developer identified revisions to proposed paste compositions and the paste backfill plan, as compared to the previous information contained within the DAR (December 2009 - Golder Associates paste tailings report).

One of the key changes is the overall ratio of tailings to DMS reject. Previously, efficiencies and economics were key considerations for the proposed paste backfill design, and an overall ratio of 2.8:1 tailings to DMS was proposed (Golder PasTec, 2009). As identified by BCL, such an approach would require surface storage of tailings at the end of operations. This approach has since been changed by the Developer to a current design having an overall ratio of 5:1 flotation tailings to DMS. As stated within the Developer's submission to the Review Board on September 2, 2011:

> "*The most current design of the tailings backfill management plan was principally driven to achieve 100% tailings placement underground. Economics and efficiencies played a secondary role to this primary criterion."*
>
> and
>
> *"…that all available measures will be taken to maximize the placement of flotation tailings as paste underground as a priority, over-riding any financial considerations, until it becomes clear that a significant excess of underground void space would remain. At that point, a greater proportion of DMS could be included in the paste."*

Other revisions by the Developer include:

- Reduction of the estimated achievable void fill from 100% to 98% under an expected scenario and 95% under a conservative scenario.
- There will be three separate paste blends used by the Developer: a 6" slump mix where low strength is adequate, a 10" slump where low strength is adequate but better flow properties are required and a 50:50 6" slump:DMS blend which will be used where higher strength (i.e. trafficability) is required. The blends will be placed assuming the following proportions: 35% 6" slump, 35% 10" slump and 30% 50:50 mixture (6" slump and DMS).
- A tailings only blend (10" slump) will be use to backfill the development voids.

The Developer's proposed modification falls within the limits of the two scenarios set out by BCL (above) and is technically conceivable; however, AANDC's reservations about the economic and practical constraints associated with this remain. The Department concurs that the proposed revisions to the paste backfill strategy (5:1 overall ratio of tailings to DMS) will allow for placement of all flotation tailings within the underground void space, if everything goes as predicted. It must be highlighted that unlike the previous 2.8:1 ratio of tailings to DMS, the current approach is not driven by operational efficiencies or economics. Therefore, should such issues be realized during operations there might be a need to increase the proportion of DMS within the paste, which could affect the ability to place all flotation tailings underground.

The above comments provided on tailings management address AANDC's concerns with respect to tailings storage and the operation of the WSP. An additional consequence of the revised paste ratios is an increased amount of DMS material to the waste rock pile (WRP). Depending on the amount of void space filled (95% vs 98%) up to 100,000 m^3 of additional DMS rock may be placed within the waste rock pile. This represents nearly double the amount of DMS in the rock pile compared to previous predictions provided in the DAR.

As identified within the Developer's September 2, 2011 correspondence to the Review Board, placing additional DMS in the WRP may alter the quality of leachate generated from the pile as compared to initial predictions. A sensitivity analysis completed by the Developer suggests that leachate concentrations of Sb, Hg, P and Zn will increase if additional DMS reports to the WRP.

AANDC is concerned with these new predictions, but acknowledges that the Developer has identified that DMS material will be segregated from development rock during placement in the WRP in order to facilitate additional controls on the DMS material during closure, if required. It is also acknowledged that surface runoff from the WRP will collect within the lined seepage collection pond. However, AANDC remains concerned with subsurface drainage from the WRP. The Developer has simply stated that all underground seepage will report to the underground workings and then to the mine water management circuit. AANDC is concerned that some seepage may report directly to Harrison Creek (e.g. sub-surface flow in the gravels of Harrison Creek) and then to Prairie Creek. Without additional information to clearly demonstrate that all subsurface drainage through the WRP reports and is collected through the underground workings, AANDC must take a precautionary approach and recommend that a seepage collection system for subsurface drainage from the WRP be included within the mine development plan.

Considering the new information provided since the June 2011 public hearings and the

fact that surface storage of tailings, post-closure, has not been assessed as a component of this EA, AANDC provides the following recommendations in regards to tailings management. AANDC requests that the Review Board include these recommendations as measures within the Report of EA:

1. **All flotation tailings to be placed underground as paste backfill. Paste backfill should be comprised of a 5:1 overall ratio by weight of flotation tailings to DMS. No mine waste is permitted to remain on the Prairie Creek floodplain after closure. (Updated from Public Hearing)**

2. **The volume of flotation tailings stored in the water storage pond during operations not to exceed a maximum of 50,000 m^3 and no other surface storage of flotation tailings permitted during operations. (Updated from Public Hearing)**

3. **All sediment and tailings residues remaining in the WSP after closure be recovered and included in the underground backfill. (Updated from Public Hearing)**

4. **No paste tailings to be stored on surface other than those contained within the paste plant itself. (Updated from Public Hearing)**

5. **No paste tailings to be stored within the waste rock pile. (Updated from Public Hearing)**

6. **DMS be segregated within the waste rock pile. (Updated from Public Hearing)**

7. **Seepage from the waste rock pile be routed through the mine water circuit and be discharged in accordance with effluent quality criteria back-calculated from downstream site-specific water quality objectives. Installation of a seepage collection system for the Harrison Creek aquifer should be included in the development plan. (Updated from Public Hearing)**

8. **All development waste must be brought to surface and disposed in the waste rock pile. (Updated from Public Hearing)**

Closing Statement

The preceding discussion concludes AANDC's technical input to the Review Board on EA0809-002, for the proposed Prairie Creek mine. AANDC hopes that the information provided will be useful to the Review Board during its decision-making process.

References:

Aboriginal Affairs and Northern Development Canada (AANDC), Government of the Northwest Territories (GNWT), 2010; Northern Voices, Northern Waters, NWT Water Stewardship Strategy.

Canadian Council of Minster's of the Environment (CCME), 1996; A Framework for Ecological Risk Assessment: General Guidance, PN 1195.

Canadian Council of Minster's of the Environment (CCME), 1999; Canadian Water Quality Guidelines for the Protection of Aquatic Life. Chapter 4. In: Canadian Environmental Quality Guidelines.

Canadian Zinc (CZN), 2010; Prairie Creek Mine, Developer's Assessment Report, March, 2010.

CZN, 2011a; Canadian Zinc's Vision, Development of the Prairie Creek Mine, http://www.canadianzinc.com/content/about/vision.php, September 11, 2011.

CZN, 2011b; Environment, Environmental Policy, http://www.canadianzinc.com/content/mine/environment.php, September 6, 2011.

Golder Associates Limited, 2011; Consideration of Additional Water Storage Options, Prairie Creek Mine, NWT, August 2, 2011.

Golder PasteTec, 2009; Pre-Feasibility Engineering Study for Cemented Paste Backfill Plant for the Prairie Creek Project, December 21, 2009.

International Council on Mining and Metals (ICMM), 2003; Mining and Protected Areas, Position Statement, September 2003.

Mining Association of Canada (MAC), 2007; Towards Sustainable Mining Framework, Mining and Biodiversity Conservation, June 2007.

Mackenzie Valley Land and Water Board (MVLWB), 2011; Water and Effluent Quality Management Policy, March 31, 2011.

United States Environmental Protection Agency (USEPA), 1998; Guidelines for Ecological Risk Assessment, EPA/630/R-95/002F, April 1998.

APPENDIX A – AANDC FINAL RECOMMENDATIONS

Water Management and Storage

1. ***The Water Storage Pond must be operated such that the water level does not impinge on the 1 m freeboard level. The freeboard must be reserved for short-term emergency situations. (Consistent with Recommendation WM&S 2 at June 24, 2011 Public Hearing)***

2. ***Final selection of an additional water storage option must be done in conjunction with the determination of Site Specific Water Quality Objectives for Prairie Creek. If increased capacity associated with construction of an additional pond provides for the ability to meet Reference Condition Approach benchmarks as defined within the derivation process, that option must be selected and implemented. (Updated from Public Hearing)***

3. ***Enhancements to the existing pond or construction of a second pond must be conducted in accordance with Canadian Dam Safety guidelines, or equivalent standards at the time of construction. Monitoring wells must be installed to confirm the integrity of the water storage pond(s). Should a second pond be built, a double liner system must be included within the construction design. (Updated from Public Hearing)***

Site-Specific Water Quality Objectives

1. ***AANDC recommends that the Developer be required to establish and present Site Specific Water Quality Objectives for the Prairie Creek Mine, prior to the licensing phase, using the process defined within Appendix C. (Updated from Public Hearing)***

2. ***AANDC recommends that if, following pilot testing per the recommendations in the Developer's Desktop Study of Water Treatment Options, it is identified that Reference Condition Approach based Site Specific Water Quality Objectives can be readily achieved, then that treatment option(s) must be implemented during operations. (Updated from Public Hearing)***

3. ***AANDC recommends that any ecological risk assessments conducted in accordance with the Site Specific Water Quality Objectives process follow the Terms of Reference as provided in Appendix D. (Updated from Public Hearing)***

4. ***AANDC recommends that Effluent Quality Criteria (i.e. Maximum Grab Concentrations) must be back calculated from Site Specific Water Quality Objectives based on the Developer's best estimate inflow prediction. (Consistent with Recommendation SSWQO/EQC #2, at June 24, 2011 Public Hearing)***

5. ***AANDC recommends that CZN must not discharge effluent that has concentration(s) above the stipulated Maximum Grab Concentrations in the Water Licence. (Consistent with Recommendation SSWQO/EQC #3, at June 24, 2011 Public Hearing)***

6. ***AANDC recommends that any discharge from the end-of-pipe must meet the Maximum Average Concentrations as stipulated by the Surveillance Network Program in the Water Licence. Detailed instructions on the method and timing for sampling, deriving and reporting regulated average concentrations should be specifically outlined within the SNP. (Consistent with Recommendation SSWQO/EQC #4, at June 24, 2011 Public Hearing)***

7. ***AANDC recommends that any discharge must meet all other applicable federal and territorial Regulations at the end of pipe. (Updated from Public Hearing)***

Effluent Discharge (Consistent with Recommendations from Public Hearing)

1. ***AANDC recommends that the final design of the trench and twinned pipe configuration should account for potential failure mechanisms, such as described above.***

2. ***AANDC recommends that Canadian Zinc evaluate the requirement for a screen or equivalent structure on the upstream end of the discharge pipe to minimize the potential for debris entering the exfiltration pipe and causing a blockage.***

3. ***AANDC recommends that the performance of the exfiltration trench be monitored as part of the SNP, to confirm that adequate performance is achieved.***

4. ***AANDC recommends that no effluent be discharged via the culvert into Harrison Creek unless an emergency situation has been declared for the site by the Mackenzie Valley Land and Water Board (MVLWB). Any discharges to Prairie Creek via Harrison Creek must be short term in***

duration to avoid potentially increased effects to the environment from the mine site. During this scenario a specific Emergency Plan, approved by the MVLWB, must be followed by CZN. This Emergency Plan should include a complete shut down of mining and milling operations.

Tailings Management

1. **All flotation tailings to be placed underground as paste backfill. Paste backfill should be comprised of a 5:1 overall ratio by weight of flotation tailings to DMS. No mine waste is permitted to remain on the Prairie Creek floodplain after closure. (Updated from Public Hearing)**

2. **The volume of flotation tailings stored in the water storage pond during operations not to exceed a maximum of 50,000 m^3 and no other surface storage of flotation tailings permitted during operations. (Updated from Public Hearing)**

3. **All sediment and tailings residues remaining in the WSP after closure be recovered and included in the underground backfill. (Updated from Public Hearing)**

4. **No paste tailings to be stored on surface other than those contained within the paste plant itself. (Updated from Public Hearing)**

5. **No paste tailings to be stored within the waste rock pile. (Updated from Public Hearing)**

6. **DMS be segregated within the waste rock pile. (Updated from Public Hearing)**

7. **Seepage from the waste rock pile be routed through the mine water circuit and be discharged in accordance with effluent quality criteria back-calculated from downstream site-specific water quality objectives. Installation of a seepage collection system for the Harrison Creek aquifer should be included in the development plan. (Updated from Public Hearing)**

8. **All development waste must be brought to surface and disposed in the waste rock pile. (Updated from Public Hearing)**

Post Closure Conditions (Consistent with Recommendations from Public Hearing)

1. ***AANDC recommends that post closure water quality must meet SSWQOs derived using a Reference Condition Approach. This would be determined in conjunction with the establishment and evaluation of SSWQOs for Prairie Creek.***

3. ***AANDC recommends that CZN develop a Preliminary Closure and Reclamation Plan, during the regulatory phase prior to water licence issuance. The plan must be developed in consultation with regulators, stakeholders and other interested parties. The plan should developed in accordance with AANDC's Mine Site Reclamation Guidelines (January 2007) or subsequent version.***

Aquatic Effects Monitoring Program (AEMP) and Adaptive Management (Consistent with Recommendations from Public Hearing

1. ***AANDC recommends that Canadian Zinc Corporation follow the "Guidelines for Designing and Implementing Aquatic Effects Monitoring Programs for Development Projects in the Northwest Territories, June 2009" in the development of its Aquatic Effects Monitoring Program, action levels, and related management response framework for the Prairie Creek Mine. This work should commence in conjunction with the establishment and evaluation of SSWQOs for Prairie Creek.***

Access Road – Land Disturbance, Road Construction and Operation (Consistent with Recommendations from Public Hearing)

1. ***AANDC recommends that local ground temperature measurements define the commencement of road construction activities using equipment other than low pressure ground vehicles, in areas where road construction relies on frozen ground.***

2. ***AANDC recommends that local ground temperature measurements define the duration of the road operating season, in areas where road operation relies on frozen ground.***

Access Road – Permafrost Degradation, Road Construction and Operation (Consistent with Recommendations from Public Hearing)

1. ***AANDC recommends a permafrost assessment be conducted along the access route to identify areas requiring implementation of measures to ensure the integrity of the underlying permafrost. Road construction/operation methods to maintain the organic layer in permafrost areas should be defined in advance of initial road construction.***

2. ***AANDC recommends that construction of access through side slopes containing permafrost, specifically ice rich ground, should be avoided where possible. Where unavoidable, site-specific stabilization measures should be developed and approved by regulators prior to implementation.***

3. ***AANDC recommends that ground temperature monitoring data should be collected along the access road itself and in adjacent undisturbed terrain where permafrost is present, to evaluate the success of operational measures to prevent the degradation of underlying permafrost.***

Access Road – Sediment Inputs (Consistent with Recommendations from Public Hearing)

1. ***AANDC recommends that a Sediment and Erosion Control Plan be developed in advance of mine operations. This Plan should include an assessment of the erosion sensitivity of the mine site as well as proposed watercourse crossings along the access route. Further, site-specific mitigation measures to prevent erosion should be defined.***

2. ***AANDC recommends that erosion control measures identified within the Plan be implemented in advance of operations.***

3. ***AANDC recommends that routine monitoring of erosion susceptibility at watercourse crossings along the access road should be conducted. If issues are identified, maintenance/mitigation measures should be implemented in as timely a manner as possible.***

4. ***AANDC recommends that local ground temperature measurements define the commencement of road construction activities using equipment other than low pressure ground vehicles, in areas where road construction relies on frozen ground.***

5. ***AANDC recommends that local ground temperature measurements define the duration of the road operating season, in areas where road operation relies on frozen ground.***

6. ***AANDC recommends a permafrost assessment be conducted along the access route to identify areas requiring implementation of measures to ensure the integrity of the underlying permafrost. Road construction/operation methods to maintain the organic layer in permafrost areas should be defined in advance of initial road construction.***

7. ***AANDC recommends that construction of access through side slopes containing permafrost, specifically ice rich ground, should be avoided where possible. Where unavoidable, site-specific stabilization measures should be developed and approved by regulators prior to implementation.***

8. ***AANDC recommends that ground temperature monitoring should be collected along the access road itself and in adjacent undisturbed terrain where permafrost is present, to evaluate the success of operational measures to prevent the degradation of underlying permafrost.***

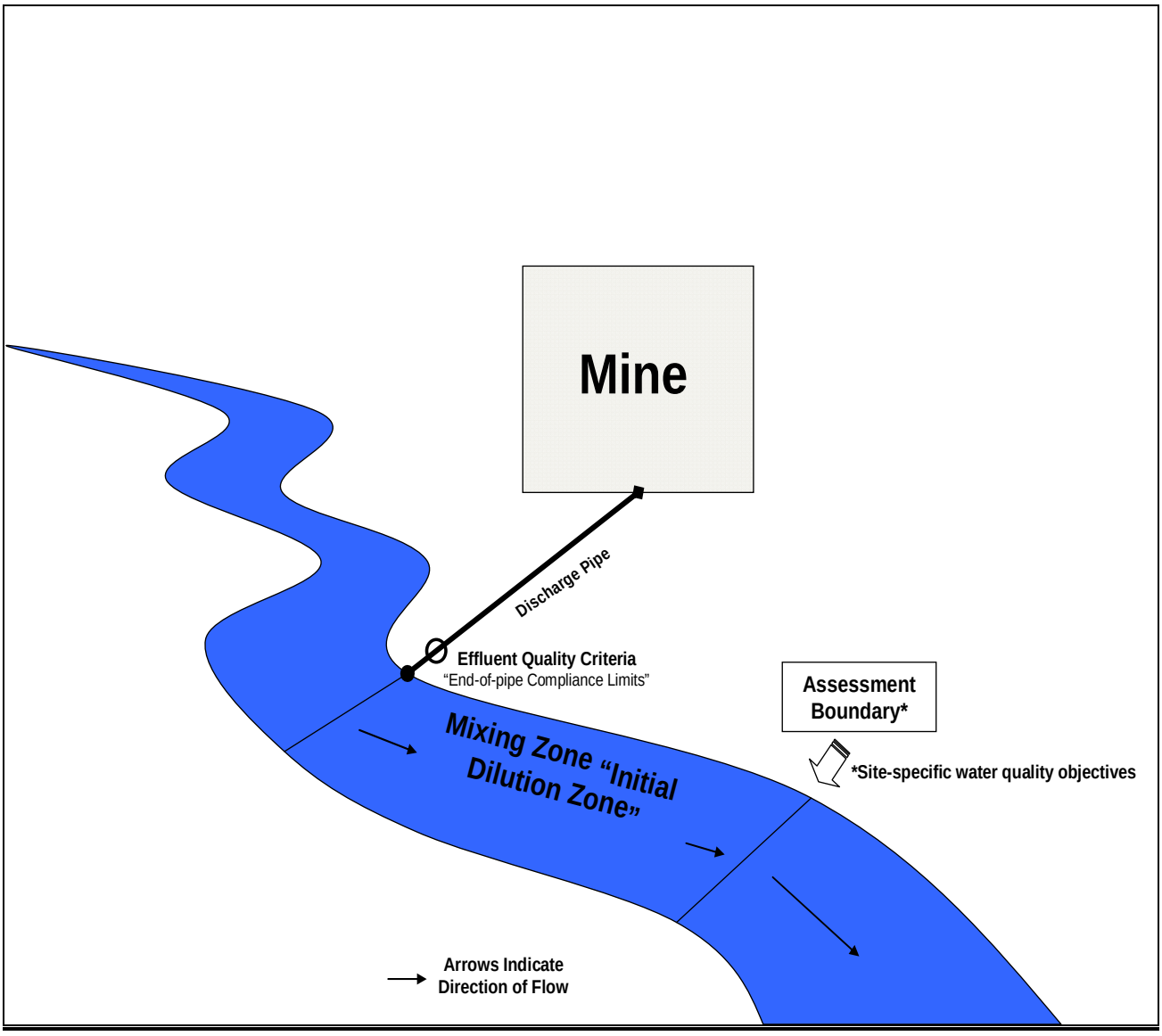
Access Road – Post Closure (Consistent with Recommendations from Public Hearing)

1. ***AANDC recommends that the Closure and Reclamation Plan include the entire length of the access road.***

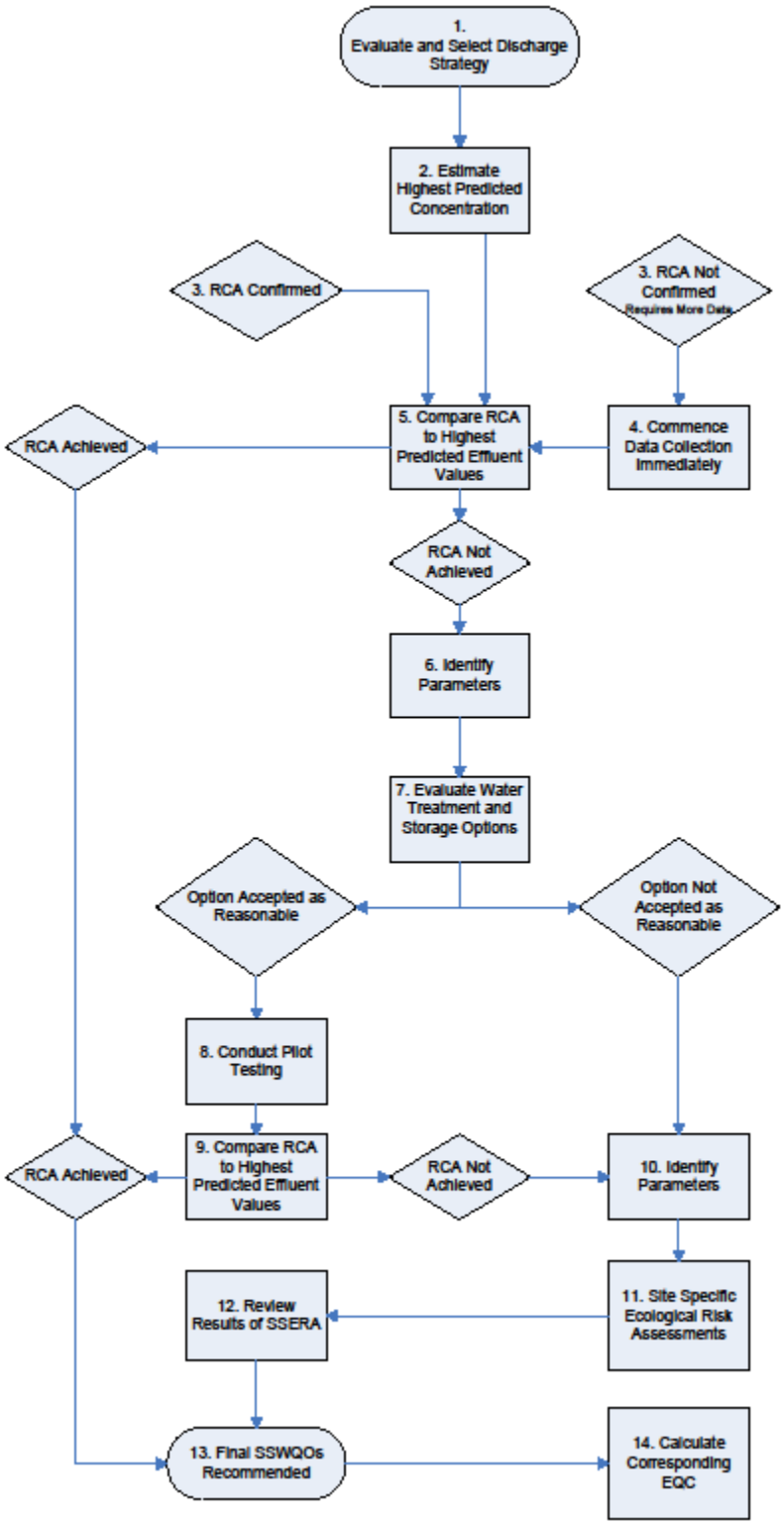
Access Road – Spills (Consistent with Recommendations from Public Hearing)

1. ***AANDC recommends that an assessment of the risk and consequence of spills along the access road be conducted by product type. This evaluation should dictate operational procedures, implementation of preventative/mitigative measures, and response measures for potential spills.***

APPENDIX B – SSWQO CONCEPT SCHEMATIC


Mine
Discharge Pipe
Effluent Quality Criteria
"End-of-pipe Compliance Limits"
Assessment Boundary*
*Site-specific water quality objectives
Mixing Zone "Initial Dilution Zone"
Arrows Indicate Direction of Flow

APPENDIX C - Proposed Process for Deriving SSWQOs for the Prairie Creek Mine


1.
Evaluate and Select Discharge Strategy
2. Estimate Highest Predicted Concentration
3. RCA Confirmed
3. RCA Not Confirmed
Requires More Data
5. Compare RCA to Highest Predicted Effluent Values
4. Commence Data Collection Immediately
RCA Achieved
RCA Not Achieved
6. Identify Parameters
7. Evaluate Water Treatment and Storage Options
Option Accepted as Reasonable
Option Not Accepted as Reasonable
8. Conduct Pilot Testing
RCA Achieved
9. Compare RCA to Highest Predicted Effluent Values
RCA Not Achieved
10. Identify Parameters
12. Review Results of SSERA
11. Site Specific Ecological Risk Assessments
13. Final SSWQOs Recommended
14. Calculate Corresponding EQC

1. Evaluate and select final discharge strategy to be used during operations.

    - Concentration-based approach (fixed EQC).
    - Load-based approach (variable EQC's based upon flow rates).

    *Ability to regulate final discharge strategy must be demonstrated.

2. Estimate highest predicted concentrations[1] under selected discharge strategy at the edge of the initial dilution zone.

    *Corresponding EQC must, at a minimum, comply with any applicable federal legislation at the end-of-pipe.

3. Confirm Reference Condition benchmarks.

    - Inclusion of any additional and relevant datasets.
    - Evaluate whether or not the concentrations of parameters change between summer and winter or among different locations upstream or downstream of the Prairie Creek mine.
    - Transparent treatment of data-points less than detection limits.
    - Consideration of bias in estimated RCA benchmarks due to unequal number of data-points by location and/or season.
    - Identify data quality and data gaps.
    - Consider use of data from both above and below Harrison Creek and from Harrison Creek itself.

4. For confirmed RCA benchmarks, proceed to step 5.

    - For parameters requiring additional data collection due to detection limit issues, poor quality data, etc., data collection should commence immediately.

5. Compare highest predicted concentrations at the edge of the initial dilution zone to confirmed RCA benchmarks.

    - Recommend RCA benchmarks as SSWQOs at the end of the initial dilution zone for parameters which can be met by the currently envisaged operations. This is based on the highest predicted receiving water concentration at the edge of the initial dilution zone (i.e. mixing zone) in Prairie Creek.

[1] "Highest predicted concentrations" are based upon the available data with a consideration of acceptable treatment process variation

6. Identify parameters that do not meet the requirements outlined within Step 5.

7. For parameters identified within Step 6, conduct an evaluation of which water treatment and/or storage options could be implemented to achieve confirmed RCA benchmarks. At a minimum, the following items would be considered:

    - Capital and operating costs
    - Desktop evaluation of water treatment options for process water
    - Best available treatment technologies
    - Options for available water storage expansion

8. If different (from currently proposed) and cost effective water treatment or storage options are recommended for consideration, conduct further analysis and laboratory testing of options.

9. Repeat Step 5 using highest predicted concentrations at the edge of the initial dilution zone, assuming additional treatment or storage options are implemented.

10. Identify parameters for which RCA benchmarks are still not achieved and note those that can be achieved.

11. Parameters identified within Step 10 to undergo site specific Ecological Risk Assessments (ERAs). The ERAs will be conducted with respect to an unacceptable level of change to the receiving environment as defined by the Review Board within their Report of EA.

    ERAs to be conducted only for parameters identified in Step 10 and Hg and Se (due to the biomagnification potential of these two parameters), in accordance with a terms of reference defined by the Review Board within their Report of EA.

12. Adopt results of ERAs that fall between RCA benchmarks and CCME WQGs, or other suitable WQGs if CCME WQGs unavailable, as SSWQOs for parameters identified within Step 10. If the ERA is above the relevant guideline or below the RCA, adopt the guideline or RCA value.

13. Recommend final SSWQOs based on the results of Steps 5, 9, and 12.

14. Back-calculate corresponding EQC.

Much of this process will now occur after the close of the public record for this EA. However, AANDC considers it important that the following elements occur during this EA:

1. Clear definition of the limits of acceptable change to be used in ERAs.
2. Clearly defined terms of reference for conducting ERAs.

The following is a brief description of the SSWQO process as proposed by AANDC:

Steps 1 to 6

The updated approach includes an initial step to demonstrate whether alternate discharge strategies (i.e. the Developer's loading base discharge strategy), can be regulated/enforced and could be reliably implemented. However, the need for alternative discharge strategies will depend upon the results of additional water storage and treatment testing and will be further developed during the licensing process. Note that the loading based method proposed by the Developer differs from the concept of an annual analyte-specific loading limit to Prairie Creek.

The Developer's loading based proposal is a process where effluent volumes and concentrations would increase during periods of higher creek flows and decrease during periods of lower creek flows. The additional dilution capacity provided by higher creek flows allows more concentrated effluent to be discharged while meeting in-stream objectives. However, annual loading limits consider the addition of contaminants to the Prairie Creek ecosystem and consider the effects of these loads (as opposed to concentrations) on the aquatic ecosystem. Annual ecosystem loading limits must be considered within any analysis of potential discharge strategies. In addition, a concentration-based approach has historically been utilized in water licences to regulate northern mining operations and this option will also have to be considered during Step 1.

Progress has been made towards collecting the data required to establish reference condition, or baseline, concentrations within Prairie Creek. However, the amount of data is still small and, for example, only includes two data points for Hg. This is an improvement over the previous state of knowledge, but does not account for factors such as seasonal differences in parameter concentrations. More data must be collected prior to and during the licensing process.

Information provided to date indicates that discharge concentrations of several parameters are such that RCA benchmarks could currently be met without any changes to the project.

Steps 7 to 10

An important component of the process is considering whether measures, such as increasing water storage volume or improving effluent treatment, are available which would improve effluent quality such that additional RCA benchmarks could be met. Since meeting RCA objectives provides a high level of confidence that significant changes to ecological integrity will not occur as a result of this project, AANDC regards increasing water storage and implementing practical treatment solutions as the natural next step in the process.

The Developer has committed to increasing water storage capacity. This modification should provide the Developer with more flexibility in managing discharge and improve effluent quality. AANDC supports the Developers efforts to increase water storage capacity.

As noted previously, the Desk Study of Water Treatment Options Report identifies readily available, proven technologies that could improve effluent quality for the project. AANDC believes that such treatment options must be implemented if testing indicates that RCA benchmarks can be reliably and consistently achieved.

Steps 11 to 13

Steps 11 to 13 recognize that there may be several specific parameters which cannot meet RCA based SSWQOs even if additional storage and enhanced treatment are provided. AANDC suggests that focused ERAs be used to determine acceptable values for these specific parameters only. Should the results of the ERA fall below the RCA or above the CCME based objectives as proposed at the public hearings by AANDC and the Developer, respectively, the RCA value or the CCME value would be adopted. Otherwise, the ERA will generate a value between these two objectives, and would be adopted as is.

Focused ERA are a defensible method to develop SSWQOs for parameters that cannot achieve RCA benchmarks and AANDC supports SSWQOs derived using focused ERA methodology under these restricted circumstances. AANDC has taken steps to develop a terms of reference (TOR) that, if followed, would provide an acceptable ERA. This proposed TOR is included in Appendix D.

Some of the information used in an ERA will, necessarily, be based upon assumptions. The expectation is that these assumptions will be made using the best available data, however a level of uncertainty will remain. Thus, AANDC re-iterates that achieving RCA based SSWQO's by enhancing treatment and providing increased storage will provide higher confidence that potential impacts to Prairie Creek are mitigated, than other higher SSWQOs.

A key element of the ERAs will be selection of appropriate assessment endpoints (i.e. the clearly stated environmental values that are to be protected). These endpoints should reflect the limit of acceptable change in Prairie Creek in order to provide ERA results that reflect the desires of interested parties.

APPENDIX D
Ecological Risk Assessments - Terms of Reference – Prairie Creek

Introduction

This ecological risk assessment (ERA) terms of reference begins with a brief discussion of the process for generating site-specific water quality objectives (SSWQOs). At the public hearing CZN presented a fundamentally different approach than that proposed by Aboriginal Affairs and Northern Development Canada (AANDC), for selecting SSWQOs, which CZN presumes will provide the necessary level of protection for the environment. Nonetheless, both parties agree that site specific ERAs for some analytes of concern will need to be conducted as part of the environmental assessment (EA) process.

AANDC and several other parties to the EA believe that all SSWQOs should be established based on CCME's background approach (i.e. the Reference Condition Approach). Adoption of RCA benchmarks follows one of the goals of the *NWT Water Strategy* released by the Government of the Northwest Territories and Aboriginal Affairs and Northern Development Canada (2010) that states:

> *"Waters that flow into, within or through the NWT are substantially unaltered in quality, quantity and rates of flow";*

The use of RCA benchmarks is also consistent with the first three guiding principles of the Mackenzie Valley Land and Water Board's "Water and Effluent Quality Management Policy" (2011) which are *sustainable development, pollution prevention and precaution,* and with the CCME (1999) non-degradation policy that states:

> *"The degradation of existing water quality should always be avoided. The natural background concentrations of parameters and their range should also be taken into account in the design of monitoring programs and the interpretation of the resulting data".*

At present, CZN does not believe the mine will be able to consistently meet the RCA-derived objectives for a number of analytes-of-concern (AOCs) given the current treatment process and proposed load based effluent discharge strategy[1]. For these AOCs, CZN has proposed toxicity-based SSWQOs that are lower than generic guidelines for the protection of aquatic life and thus, they believe, will ensure no significant impacts.

AANDC, however, advocates the use of RCA benchmarks, when reasonably possible to achieve, as their use provides high confidence that Prairie Creek and the immediate South Nahanni ecosystem will be protected for future generations. AANDC maintains

[1] CZN's proposed load based discharge strategy will be evaluated within Step 1 of AANDC's proposed SSWQO derivation process, along with a concentration based approach. Ability to implement the final discharge strategy within a regulatory authorization is a requirement.

that additional measures, such as implementing best available treatment technology (BATT) or increasing water storage capacity, should be considered when evaluating whether RCA benchmarks can be achieved.

For AOCs that do not meet the RCA benchmarks, after consideration of BATT and additional storage provisions, AANDC has proposed that an ERA will be performed.

It is AANDC's understanding that CZN proposes to conduct ERAs for those AOC predicted not to meet RCA benchmarks under current operating conditions and on the basis of their proposed effluent discharge strategy. Further, AANDC understands that CZN proposes to compare the results of the ERAs to the evaluation of BATT to determine if adoption of best achievable technology is required in order to provide the risk-based level of protection for the downstream ecosystem.

In both processes ERAs are necessary for some AOC; the scope and objectives of these ERAs will be subject to the direction given by the Review Board in their Report of EA. It is expected that the Review Board will define what would be considered as the limits of acceptable change in Prairie Creek downstream of the mine. The risk assessment would then be conducted in accordance with the Review Board's limits and descriptions.

This document provides a proposed terms-of-reference (TOR) for conducting ERAs. These ERAs would be conducted using the ERA guiding principles provided by CCME (i.e., CCME 1996, 1997).

Problem Formulation

The risk assessment will begin with a Problem Formulation (PF). The PF will explicitly define the potential environmental risks, including the three components of risk: chemical hazard, exposure pathway and receptors.

Specifically, the PF will contain sections on the regulatory setting, the physical site setting, the AOCs (including an explanation of how they were selected), ecological resources and an analysis of potential exposure pathways.

Regarding receptors and physical site setting, consideration will be given to the fact that:

1. The site is montaine and located at high latitude and that ecological resources may differ from more temperate environments;

2. Flow of water in the creek is rapid and highly variable in rate and clarity from the mine downstream to the confluence with the South Nahanni River;

3. Flows tend to be flashy and result in significant erosion of banks and stream bed material;

4. The creek is covered with ice for several months of the year;

5. There is a species-at-risk within the creek (Bull trout), and other terrestrial species such as grizzly bear and wolverine that are 'special concern' species listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) that may rely on the downstream receiving environment for food or water;

6. Aboriginal people fish for Arctic grayling in pools in Prairie Creek near the confluence with the South Nahanni River; and

7. Prairie Creek flows into and through the Nahanni National Park Reserve (a UNESCO World Heritage Site) and into the South Nahanni River (a Canadian Heritage River).

A conceptual model will be used to integrate the information gathered and will demonstrate all potential linkages between chemical hazards and receptors. Using the conceptual model, a set of assessment and measurement endpoints will be derived. The assessment endpoints will define the ecological attributes of Prairie Creek to be protected. Expressed in the form of a question, the primary assessment endpoints identified to date are as follows:

- Will the fish, specifically Arctic grayling, be safe to eat?

- Will fishing success (i.e., catch per unit effort) decrease?

- Will there be toxicity or behavioural effects to bull trout migrating through Prairie Creek?

- Will there be an accumulation of contaminants into piscivorous animals?

The selection of final assessment endpoints will account for any direction given on the subject by the Review Board. Once the assessment endpoints have been chosen, measurement endpoints will be derived. Measurement endpoints are the tools/approaches used to answer the assessment endpoint questions. Suggested measurement endpoints that demonstrate the upper limit of acceptable effects were

generated following discussion with interested parties including NDDB, DCFN, Parks Canada and Environment Canada. The suggested measurement endpoints include:

1. Grayling catch per unit effort (CPUE) at the mouth of Prairie Creek decrease from current CPUE as a result of mine operations. [2].
2. Edible tissue Hg concentrations in grayling collected at the mouth of Prairie Creek should not increase[3] from current concentrations.
3. Analytes released by the mine either on their own or in combination with other AOC should not exceed the lowest of any behavioural or chronic toxicology IC/EC10[3] specific to, or relevant to, bull trout.
4. Hg fish tissue residues should not exceed the CCME mammalian tissue residue guideline for protection of wildlife consumers of aquatic biota (0.092[4] µg MeHg/g ww in any fish species resident in or transiting Prairie Creek to the mouth of Prairie Creek)[5].

The following measurement endpoints are consistent with protecting Prairie Creek outside the initial dilution zone. The level of protection allows for change within the natural range of variability. These measurement endpoints (in addition to those presented above) represent AANDC's current recommended measurement endpoints. Measurement endpoints specific to eutrophication and other biotic assemblages (zooplankton and fish) are being considered.

1. Water concentrations for AOCs will not exceed reference condition approach benchmarks with the possible exception of those AOCs that could not meet the RCA benchmarks after consideration of best achievable technology, additional storage and the appropriate regulatory discharge strategy.
2. Sediment concentrations for AOCs downstream of the operation will not increase during the life of the mine when compared to a suitable benchmark.
3. Benthic macroinvertebrate species abundance and richness will not deviate from the upstream mean plus two standard deviations.

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[2] Studies conducted with statistical power > 90% as recommended by INAC (2009).
[3] Inhibition/effects concentration that elicits a 10% effect relative to suitable controls.
[4] CCME (2000). Note that one might reasonably argue that the most sensitive value recorded for a bird that consumes it's body weight in fish per day (0.033 µg MeHg/g ww) be adopted as the tissue residue guideline for Prairie Creek. This lower value was not selected as it is unlikely that any terrestrial animal dependent upon fish from Prairie Creek will consume fish at such a high daily proportion of its body weight/day on an annual basis especially given that Prairie Creek is ice-covered for a significant proportion of the year.
[5] Note that the tissue residue in slimy sculpin collected by Spencer (2008) in the farfield of 0.078 µg Hg/g ww is already approaching the CCME mammalian tissue residue guideline and exceeds the general CCME tissue residue guideline for protection of wildlife consumers of aquatic biota. However, the latter number is likely overly conservative for use in the Prairie Creek ecosystem due to limits on the % diet that comprises fish.

For the purpose of the environmental risk assessment, the area to be assessed will include Prairie Creek downstream of the initial dilution zone to the confluence with the South Nahanni River.

Effects assessment

It is anticipated that the potential risks associated with many of the AOCs will be addressed using a literature-based effects assessment.

Data gathered within the literature-based effects assessment will come from several sources, including USEPA's EcoTox database, recent Environment Canada data compilations (where available), and on-line literature databases. Where possible, the data collected will emphasize species resident to Prairie Creek, and/or other species that commonly inhabit cool swift moving streams. The effects assessment will largely be toxicity-based; however, population and community-level effects will be considered where data are available. An evaluation of toxicity data will focus on sub-lethal and chronic toxicity endpoints. Potential data gaps including behavioral/avoidance thresholds for migrating bull trout will be considered.

The assessment will also consider the potential for additive or synergistic-type effects among analytes. This will be done by reviewing recent scientific literature on the subject, as well as reviewing the results of sub-lethal toxicity tests using simulated treated effluent.

The criteria for inclusion of data in the literature-based effects assessment is as follows:

- Applicable data generated under relevant test/exposure conditions will be adopted if it is proposed by USEPA (i.e., EcoTox database) or by Environment Canada.
- For other remaining data, the CCME (2007) guidance on data acceptability will be followed.

Additional toxicity testing will also be considered if the review of existing data does not sufficiently address the potential issue.

Exposure assessment

The exposure assessment will assess the potential accumulation of AOCs in Prairie Creek downstream of the mine. Bioavailability of individual AOCs in Prairie Creek will also be assessed, where appropriate. The assessment will also consider seasonal variation in exposure concentration, and potential water treatment/storage scenarios (each will influence the nature of effluent release). Bioaccumulation of mercury and selenium will need to be assessed in a quantitative manner, likely requiring the use of

accumulation factors or mathematical/statistical models. Potential exposure of wildlife consumers of fish will also be considered.

Risk characterization

The risk characterization will integrate the effects and exposure assessment into an explicit quantitative description of environmental risk for Prairie Creek. The risk assessor will consider the use of a probabilistic analysis approach, but deterministic (single point) estimates may be acceptable as well, as long as a range of exposure and effects are considered. At a minimum, a worst-case and an average condition will be assessed.

Uncertainty analysis

An uncertainty analysis will discuss assumptions and uncertainties associated with the risk assessment. A consideration of uncertainty specific to biotic assemblages and keystone species within Prairie Creek will be included as part of the analysis, and consideration of whether species/populations living in northern aquatic ecosystems exhibit greater sensitivity to contaminants.

Risk Communication

The results of the risk assessments will be accompanied by a plain-language summary.

References

Canadian Council of Ministers of the Environment (CCME), 1996. A Framework for Ecological Risk Assessment: General Guidance, The National Contaminated Sites Remediation Program, CCME Subcommittee on Environmental Quality Criteria for Contaminated Sites, Winnipeg, Manitoba, PN 1195.

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Protection of Aquatic Life. 2007, Canadian Council of the Ministers of the Environment.

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MVLWB (Mackenzie Valley Land and Water Board). 2011. Water and Effluent Quality Management Policy, March 31,2011.

APPENDIX E – August 8, 2011 Memo - Brodie Consulting Limited to AANDC

BRODIE CONSULTING

MEMORANDUM

DATE: August 8, 2011

TO: Nathen Richea, Paul Green, INAC Water Resources
CC:

FROM: John Brodie, P. Eng. Cassandra Hall, P. Geo

SUBJECT: Prairie Creek Mine – Tailings Management Issues

Canadian Zinc recently forwarded a July 7, 2011 memo from SNC Lavalin concerning backfilling of tailings into the proposed Prairie Creek Mine. This memo presents commentary on that memo. In this memo, and consistent with CDZ's approach, all evaluations are presented on a "mass basis". Some minor differences between this memo and earlier memos from BCL are due to use of the tailings density of 1.84 t/m3 (as suggested by CDZ's tailings engineer) and 1.89 t/m3 as was presented in the DAR.

The following evaluation is based upon the numbers in the SNC-Lavalin memo.

	specific gravity	tonnes	in-situ volume m3
Vein Ore	3.19	3,960,000	1,241,379
Strata-bound Ore	3.38	1,035,000	306,213

Total Ore		4,995,000	1,547,592

The excavated void from mined out ore zones is 1,547,592 m3. This is the void space which can be filled with tailings during operations.

The paste tailings engineer for Canadian Zinc (Mr. F Palkovits, with reference to GAL paste tailings report of Dec 2009), confirmed in his email of May 29, 2011, that the bulk dry density of the paste tailings is 1.84 tonnes/m3. (*Note: tailings backfill determinations must be made using dry density, not wet density. The wet density is always greater than the dry density because the mass of water in the pore space*.) Filling the available void space of 1,547,592 m3 with tailings at 1.84 tonnes/m3, means that 2,847,569 tonnes of tailings can be placed underground.

Referring again to the SNC-Lavalin memo, there is 4,995,000 tonnes of ore which will yield 1,285,000 tonnes of concentrate. This leaves 1,204,000 tonnes of DMS tailings and 2,506,000 tonnes of flotation tailings, which total to 3,710,000 tonnes of tailings.

The underground capacity for tailings is 2,847,569 tonnes, which is much less than the 3,710,000 tonnes that will be produced. The surplus of tailings must be stored on surface. A small portion of this might be placed in the development drifts at the end of mining.

A number of variations can be debated about the management of the DMS and flotation tailings. Two broad scenarios can be envisioned which describe the limits of tailings management.

1

In one scenario, only flotation tailings could be directed underground; in which it could all be contained in the mined out stopes. This would leave a small void space in the mine to be filled with DMS tailings and the remaining DMS tailings would go to the rock pile on surface.

2

The other scenario would be to place a blend of cemented DMS and flotation tailings in the mine in a way which gives the most efficient and least costly mining method. In the Dec 2009 GAL paste tailings report, this was identified as occurring with a mass ratio of flotation to DMS tailings of 2.8 : 1. In this case the void space for 2, 847,569 tonnes of blended tailings would accept 2,098,209 tonnes of flotation tailings and 749,360 tonnes of DMS tailings. In this case there would be 407,791 tonnes of flotation tailings on surface at the end of mining.

<u>Conclusions</u>

5. The void space in the mine (during operations) has capacity for 2, 847,569 tonnes of tailings.
6. The total mass of tailings to be produced is 3,710,000 tonnes (1,204,000 tonnes DMS and 2,506,000 tonnes flotation).
7. The most efficient and cost effective mine operation will leave up to 408,000 tonnes of flotation tailings on surface (in the WSP) at the end of operations.

8. Operational up-set conditions and/or disposal of development waste rock in the stopes will increase the amount of tailings on surface. Both of these are likely to occur.

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